



# Rehabilitation in Sudden Onset Disasters

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**HANDICAP**  
INTERNATIONAL



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# About the icons

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Indicates a resource is available on the UKIETR / Handicap International USB stick



Indicates a patient leaflet or printable resource is available on the topic. These can be found at the end of each chapter and also on the USB sticks.



Indicates a 'Cheat Sheet' is available on the topic. These are designed for when you are under pressure and need a quick review of the subject with points to consider for that patient group.



Indicates that further information and skills are available on a practical workshop offered to UKIETR members



Indicates that ELearning is being developed to support this



# Foreword

The role of rehabilitation professionals in responding to Sudden Onset Disasters (SODs) is evolving rapidly, and our professions increasingly find themselves at the forefront of emergency response teams. At the same time, there is a movement towards the professionalisation of the humanitarian response sector, in particular Emergency Medical Teams, and a recognition that specialist training is required to prepare professionals for work in an austere humanitarian environment.

The intended audience of the manual are physiotherapists and occupational therapists who may deploy to provide rehabilitation in the immediate aftermath of a sudden onset disaster. It was developed to support volunteers on the UK International Emergency Trauma Register (UKIETR), but with the aim of being relevant to all rehabilitation professionals interested in rapid deployment to austere environments. The content is restricted to the context of sudden onset disasters such as an earthquake or tsunami, and has been developed to support work in an austere environment, where the type of equipment and support that is normally available has been disrupted.

UKIETR professionals are UK based volunteers who receive specialist training to prepare them for international deployment as part of team in response to emergencies. They may be deployed within a multi-disciplinary foreign medical team in a field hospital scenario, or as part of a more specialist 'cell' offering niche medical, surgical or rehabilitation services.

The manual is designed to complement the three day core rehabilitation training run by Handicap International which all UKIETR members must attend. It is a clinical manual, and the contents are directly linked to modules taught on the core training course. In addition there are a number of 'cheat sheets' and patient education resources at the back of the manual which are designed to be used in the field.

Each chapter has been developed by a team of highly specialised professionals, using current evidence or based on best practice consensus, whilst highlighting specific clinical issues which professionals may encounter in an emergency setting. The content has been reviewed by a group of humanitarian medical and rehabilitation professionals, and endorsed by the organisations that led on the writing of each chapter. This is to ensure the standard of practice during deployment is of the highest quality possible within the constraints of available resources. As with all such resources, content is not intended to replace clinical judgement or experience in the field.

**Peter Skelton and Alice Harvey**

March 2015

# HANDICAP INTERNATIONAL

## Rehabilitation and the UKIETR

**This chapter covers the integration of rehabilitation into the UK International Emergency Trauma Register (UKIETR). If you are not a part of the UKIETR, you can jump to chapter 2.**

There is a long tradition of volunteers from the UK responding to emergencies overseas, many of whom are working in the NHS. In particular the UK has established an international reputation for the provision of specialist surgical teams in the immediate aftermath of sudden onset disasters. This was recognized in the 2011 Humanitarian Emergency Response Review of the UK Government with a recommendation that the UK deploys niche specialist surgical teams to sudden onset disasters overseas. The UK International Emergency Trauma Register (UKIETR) was established to facilitate this. It is run by the NGO UK-Med ([www.uk-med.org](http://www.uk-med.org)) who are funded by the UK Department for International Development (DFID) to support the recruitment, training and maintenance of a register to provide an emergency trauma response from the UK to sudden onset disasters overseas. UK registered professionals with trauma experience working in the NHS (or elsewhere) who feel they may wish to volunteer to work in response to disasters should join the register. All registrants receive pre-deployment, deployment and overseas training.

### Background

In 2013, Handicap International (HI) was awarded funding from DFID to integrate rehabilitation professionals into the UKIETR, and to develop clinical training for those professionals to ensure that they have skills that are adapted for work in a humanitarian setting across all identified areas of need in an emergency setting. All rehabilitation members of the register must be UK based, HCPC registered physiotherapists and occupational therapists. In addition to attending pre-departure training which has been developed by UK-Med, therapists undergo a mandatory 3 day "core" course to prepare them for rehabilitation work in an emergency setting. This is supplemented by 1 day "top up" practical trainings in key clinical areas for staff who do not rate themselves confident in particular areas. These clinical training modules have been developed in collaboration between British Professional Networks and a number of International Non-Governmental Organisations, with the support of a humanitarian steering committee, and leadership from Handicap International.

## Rationale

During an emergency response, foreign medical teams (FMTs) may be required to respond to a range of injuries and conditions. There is a need that any rehabilitation professional working as part

of an FMT has the required clinical skills to effectively manage all commonly seen conditions in an environment that may be unpredictable and with access to limited resources and supervision.



## What is involved in being part of the register?

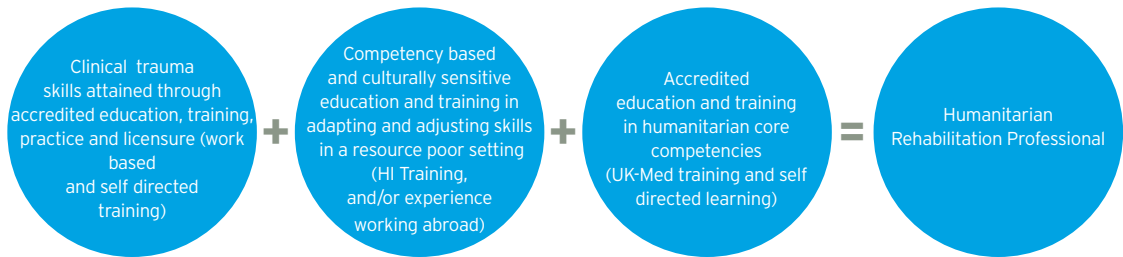
As an evolving platform, the UKIETR currently allows any HCPC registered UK based Physiotherapist or Occupational Therapist to join a community of practice. This means that there is huge variety in both professional and international experience within the rehabilitation professionals in this community. Following the mandatory training components for rehabilitation

staff, some members may be ready for deployment as part of an initial team, some may be ready to deploy later in a response in a clinical specialist role, whereas others may require additional training or experience to increase particular skills sets before they will be ready to deploy to a situation of sudden onset disaster.

## Rehabilitation and the UKIETR

### What makes me ready to deploy?

(Adapted with the kind permission of Dr F Burkle)



### Training opportunities

**3 Day Core Training** - this manual is designed to support the mandatory 3 day training, which covers core theoretical clinical components, as well as training in disability in emergencies, Psychological First Aid (manual available from [http://www.who.int/mental\\_health/publications/guide\\_field\\_workers/en/](http://www.who.int/mental_health/publications/guide_field_workers/en/)) and the Motivation Emergency Wheelchair.

**Practical workshops** - Currently these are available as one day workshops in Spinal Cord Injury, Splinting with Plaster of Paris and Early Amputee Rehabilitation in emergencies.

**E-learning** - Modules to supplement this training are being developed for rehabilitation professionals.

**UK Med courses** - these are open to all professionals on the register. They currently include "Pre Deployment" and "Deployment" courses where different professionals work together in deployment scenarios. Rehabilitation members of the register can access training in these areas, as it is expected that all team members will offer assistance in non-clinical areas. A mandatory safety and security training, offered by the IFRC is available online at <https://ifrc.csod.com/client/ifrc/default.aspx>

### Deploying with the UKIETR

If you are deployed with the UKIETR you will be appropriately briefed within the time available by the leadership team and by the rehabilitation programme manager at Handicap International. In the early stages following a sudden onset disaster, information dissemination is often difficult and patchy, you may therefore be deploying in a situation with only basic information.

Prior to leaving the country you will be provided with an essential medical kit and other essential equipment (such as a tent, if needed) and you will be expected to be up to date with your vaccinations. You will have as much information as possible about the country and region you are deploying to. You should also use this time to review your UKIETR rehabilitation resources (contained in this manual), prepare for likely injury patterns and familiarise yourself with the paperwork again.

No two deployments will be the same, but you can be prepared as much as possible by familiarising yourself with your own kit, the customs and culture and a few basic words of the language(s) of the country you will be deployed to.





The field hospital has a full Health Information System (HIS) to support its day to running, which you must be familiar with. The most up to date versions of the HIS paperwork are included on your USB. Make sure you are familiar with these prior to any deployment. They include admission and discharge forms, an outcome measure, and a rehabilitation daily sheet.

Populations after SODs often move around to find shelter or work opportunities, or to stay with family. Remember that although there may be no follow up for your patient now, another organisation may arrive in a week and you will need to be able to direct them to your discharged patients. Recording mobile phone numbers of patients or family members is critical. Patients may not have addresses, but try to make a clear note of their discharge destination.

### Equipment

What equipment is deployed with UKIETR teams depends very much on the context and scale of the deployment. Where the full field hospital is deployed, rehabilitation equipment will include items such as crutches, walking frames, stump compression socks and

bandages and the Motivation Emergency Wheelchair. However, in other circumstances teams may be deployed to support existing facilities with little more than hand held kit, and will have to work with whatever equipment they find on the ground.



The most up to date equipment list for the UKIETR deployment module is available on the USB resource.

## An Introduction to Rehabilitation Following Sudden Onset Disasters

**Peter Skelton**

This chapter introduces some of the key issues that rehabilitation professionals working clinically in response to sudden onset disasters (SOD) need to be aware of. Content has been developed simultaneously with a WCPT briefing paper on the role of physiotherapists in responding to sudden onset disasters. The WCPT paper covers the entire spectrum of the disaster continuum and has a focus on those most vulnerable in emergencies, while this chapter maintains a strong focus on clinical practice in the immediate aftermath of a disaster.

### Sudden Onset Disasters

Sudden Onset Disasters are usually the result of sudden-onset hazards, such as:

- earthquakes
- tsunamis
- hurricanes, typhoons, wind storms and associated storm surges
- floods
- volcanic activity
- landslides

Some definitions also include biological disasters, such as epidemics, and others expand the list to include fires. In some cases hazards may be coupled, as in the flood caused by a hurricane or the tsunami that is created by an earthquake. The term "sudden onset" in the context of hazards can be misleading: often there are lead times of

up to a week ahead of major storms, while the areas most at risk of earthquakes can be predicted. For the purposes of this chapter, biological disasters are not included.

The type and distribution of injury vary widely according to the type of hazard and a range of other factors, such as time of day, building quality, local preparedness and level of health infrastructure, but in general, documented common injuries that can lead to impairments include:

- Fractures
- Limb amputations
- Spinal Cord Injury
- Traumatic Brain Injuries\*
- Soft tissue injuries (including burns)
- Peripheral nerve injuries

\*While brain injury is a major cause of death during sudden onset disasters, there is little data on impairment caused by traumatic brain injury as a result of sudden onset disasters. It is likely though that a combination of factors may lead to an increase in stroke and other neurological conditions during the response and recovery phases following a disaster (Mateen, 2010).

Floods and Tsunami are also associated with high rates of respiratory complications, in particular pneumonia, both as a result of aspiration of contaminated water and as a secondary effect of displacement and living in a damp unhygienic environment. (Robinson, Alatas, Robertson, & Steer, 2011)

While disasters cause injuries, they also disrupt existing systems which can lead to exacerbations of pre-existing health conditions and cause or exacerbate impairments. A second wave of admissions to hospitals is a commonly seen several weeks after a disaster, caused by complications of initial injuries, as well as exacerbations of chronic conditions and outbreaks of communicable diseases resulting from insanitary conditions.

Significantly, traumatic injuries rarely occur in isolation, and patients frequently present with complex poly-trauma. In many scenarios, soft tissue injuries requiring extensive grafting may also be present, while for months after a disaster, a need for reconstructive surgery (and subsequent rehabilitation) is likely to persist.

The incidence of mortality and morbidity varies widely depending on a range of factors, although ratios of injury to mortality are generally increasing (Reinhardt et al., 2011). While no disaster is the same, by understanding the scale and types of injury associated with certain types of disaster, we can plan and respond more effectively. It should be noted that across all hazards, there is an inverted correlation between the gross domestic product of a country and the number of deaths per thousand of the population. Quite simply, you are more likely to die as a result of a sudden onset

disaster if you live in a poor country. In fact, low income countries account for only 9% of the world's disasters, but over 48% of mortality (Government of Japan & World Bank, 2012). This emphasises the fact that disasters are a development issue as well as a humanitarian one.

Listed below are the key natural hazards from a rehabilitation perspective and the commonly associated types of primary injury. During the immediate response to sudden onset disasters accurate data on injuries sustained is difficult to collect and of inconsistent quality. In such cases observed injury patterns and anecdotal evidence replace statistics.

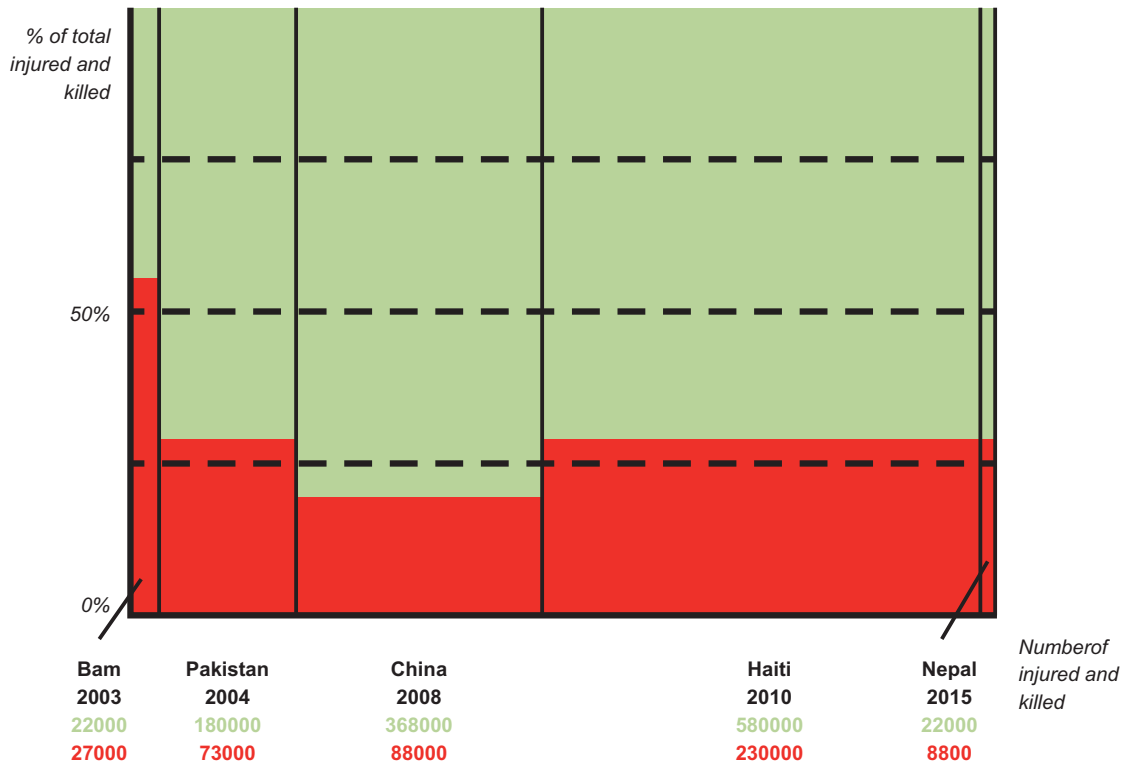
#### **Earthquakes:**

Earthquakes typically result in a higher ratio of morbidity to mortality when compared to other hazards. The number of people killed and injured, as well as the types of injury, depends on the:

- Epicentre - urban centres can result in higher casualties whereas more rural areas may be harder for rescuers to reach.
- Seismic factors (depth, magnitude etc.)
- Built environment (construction standards, materials, quality, height etc.)
- Number of people indoors when the earthquake occurred (time of day, culture)
- Early warning, rapid response and capability of rescue services
- Local climatic conditions

As a general rule, Limb injuries are most commonly seen, with fractures predominating. Morbidity to mortality ratios are typically around 3:1, although this also varies:

## Relationship between killed and injured in five recent earthquakes



Data Source: CRED, EM-DAT. Used with kind permission of Ian Norton (WHO).

Commonly seen complications resulting from earthquake injuries include crush syndrome, post-operative sepsis and infected wounds. Peripheral Nerve Injuries are frequently missed during initial life-saving procedures and may be identified later by rehabilitation professionals. Of those injured, approximately 10% will be left with permanent impairment (Demey, Nielsen, Weerts, & Sheng, 2008).

Survival rates of patients with high spinal cord injuries (SCI) are likely to be incredibly low, although as responses improve, more patients with SCI are likely to survive. Rathore et al., (2008) report not seeing a single complete tetraplegic case following the 2005 earthquake in Pakistan, while only 1 of a sample of 18 SCI patients involved in a pilot study in Haiti had tetraplegia (Rauch, Baumberger, Moise, von Elm, & Reinhardt, 2011). Lumbar injuries are generally the most common, followed by thoracic injuries (Mallick, Aurakzai, Bile, & Ahmed, 2010).

A higher rate of complete injuries may also be seen, relating to difficulties with pre-hospital care (Priebe, 2007) although as demonstrated by Zhang et al, in a sample of 26 patients following the Sichuan earthquake, only six were ASIA A (complete) so this is not always the case (X. Zhang et al., 2012).

### Hurricanes and Windstorms:

High numbers of deaths and injury do not typically result as consequence of the wind or from building damage, but from the associated impact of the storm, including:

- flooding
- landslides
- sea-surge (such as in Tacloban, the Philippines in 2013).

Hurricanes and windstorms generally have a lower morbidity/mortality ratio, due to drowning or being trapped in landslides. Common injuries include penetrating trauma

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and lacerations and blunt trauma from debris. Wounds are commonly contaminated, leading to need for debridement and increased risk of infection and secondary damage to tissues. There is a risk of electrocution.

There is a lack of epidemiological evidence relating to injuries and disability following hurricanes and windstorms in low and middle income countries. Research following Hurricane Katrina found a significant decline in health in the adult population of New Orleans in the year after the hurricane, with the disability rate rising from 20.6% to 24.6% largely due to a rise in mental impairments and, to a lesser extent, in physical impairments (Sastry & Gregory, 2013). Bloodworth et al (2007) provide a frank account of life in the Astrodome shelter following Hurricane Katrina, and report as physiatrists treating a range of patients including *“cardiovascular, metabolic, cutaneous, orthopedic, chronic pain and musculoskeletal conditions, sub-acute stroke, and chronic spinal cord injuries.”* (page 771). What is clear from their account is that it was those with chronic health conditions and existing disability that were the worst affected.

#### **Tsunami:**

Also known as seismic sea waves or (incorrectly) tidal waves, tsunami are caused by the displacement of large volumes of water, most frequently as a result of earthquakes. Evidence from recent tsunami in Japan (2011) and the Indian Ocean (2004) indicates that typically more people die than are injured. Where tsunami occur in the absence of a nearby triggering hazard (normally a seismic event), services beyond the reach of the wave are left intact and are normally able to respond, whereas the combination of earthquake and associated tsunami close to an urban centre can decimate any local response.

The 2004 Indian Ocean Tsunami resulted in a high ratio of mortality to morbidity with over 200,000 people killed as it struck populated coastal areas, with the

majority of deaths occurring from drowning. Aspiration pneumonia was a significant cause of morbidity with pneumonia being a particular problem following the aspiration of contaminated water (Robinson et al., 2011). A number of factors also combine following tsunami that mean that respiratory infections may continue to predominate for several weeks (Robinson et al., 2011). Doocy, et al (2009) examined injuries following the 2004 Indian Ocean Tsunami in Aceh, Indonesia; again they found a high mortality (23%) to morbidity (7-10%) ratio. Mortality was highest among the elderly and young, while women were more likely to die than men. Conversely, men were less likely to die but proportionately more likely to be injured. The most common injury type seen was laceration (74.8%) of which just under half were infected. 14% of those injured were hospitalised. Large variations were seen depending on geographical location.

#### **Floods:**

While floods generally do not directly kill or injure large numbers of people, immediate deaths and injuries from sudden onset floods follow a similar pattern to tsunami. The leading immediate cause of death from sudden onset floods is drowning, while aspiration (Robinson et al., 2011) and trauma from floating debris can contribute to morbidity. It is the secondary effects of flooding which can be the most devastating. The 2010 Pakistan floods, for example, affected over 20 million people (www.emdat.be) killing under 2000. The destruction of homes, loss of food and livestock and breakdown of water and sanitation systems leaves populations at increased risk of hypothermia and disease, with those with existing health conditions and disability being particularly vulnerable. As with other disasters, an exacerbation of mental health problems following flooding is also a recognised problem. In their review of literature (2004-2010) Stanke, Murray, Amlôt, Nurse, & Williams, (2012) found that flooding has an effect across the age spectrum and that many secondary stressors can prolong the psychosocial effects on people. Particular

factors that impact on the long term effects include a lack of close relationships with family, friends and community; belonging to vulnerable groups including children and the elderly and repeated flooding events. A collaborative approach to management is advocated including a focus on physical well-being.

### The Role of Rehabilitation Responders

The role of rehabilitation professionals in responding to sudden onset disasters depends on many factors, including the nature of the hazard, whether they were in country at the time of the disaster or not, the time that has passed after the disaster, the skills of the therapist, the position of rehabilitation within the health system and local culture, and the types of difficulties the local population are experiencing. Experiences in wealthy nations are likely to differ significantly from those in low or middle income countries. This guidance has been written for those who may find themselves working in low resource settings.

Rehabilitation Professionals may find themselves working in a local health facility, as part of a foreign medical team (FMT), working for a local or international rehabilitation or disability organisation, or, if in the country at the time of the disaster, as part of the wider emergency response (WCPT, 2011a). What is certain is that the improved international medical response to disasters is likely to result in decreased mortality but increased impairment and rehabilitation needs (Landry, O'Connell, Tardif, & Burns, 2010)

The role of rehabilitation professionals in the immediate response to disasters in austere environments can include (where appropriately trained and as part of a coordinated response):

- The assessment of need for rehabilitation
- The mapping of available rehabilitation and other specialist services for those with injuries and/or disabilities.

- The provision of acute rehabilitation, including orthopaedic, neurological, respiratory and burns rehabilitation, either in local hospitals, the community, or as part of foreign medical teams.
- The provision of holistic education of patients, carers and other health personnel
- Triage and referral
- The coordination of discharge and follow up
- The provision of psycho-social support (Mulligan, Smith, & Ferdinand, 2014) or referral to appropriate services.
- The provision or replacement of assistive devices
- Assessment of environments (such as camps) and environmental adaptation to ensure accessibility for those with injuries and disabilities.
- Preventative care for the elderly, people with chronic health conditions and those with disability, affected by the disaster.
- The identification or assessment of people at increased risk, such as the elderly or those with disability.
- The provision of musculoskeletal rehabilitation or manual handling training and support to other professionals involved in the response.

Subjective accounts also exist of physiotherapists being diverted from their usual roles to take on paramedical or auxiliary roles in health facilities during the immediate aftermath of disasters.

A holistic approach is important in areas where resources are stretched or access to care is limited. Therapists may find themselves needing broad rehabilitation skills, but also need to be aware of wider clinical and social issues patients may face, including psychosocial concerns. For example, Raissi, (2007), visiting patients with spinal cord injury 1 month after an earthquake in Iran, found only 3 had received education regarding bladder care and only 1 had received education regarding bowel care. Many patients had pain syndromes, but there was little attention to pain management.

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The benefits of integrated rehabilitation provided following sudden onset disasters have been suggested to include:

- Decreased mortality (The Sphere Project, 2011)
- Decreased morbidity (Gosney, 2010)
- Reduced length of stay in hospital (Landry et al., 2010; Norton, von Schreeb, Aitken, Herard, & Lajolo, 2013)
- Improved quality of life (The Sphere Project, 2011)
- Improved functional outcome (F. A. Rathore, Gosney, Reinhardt, Haig, & Li, 2012)

The increased need for mobility devices, including wheelchairs, walking frames and crutches, has been documented, both for those with new impairments, as well as for those with existing needs who have either lost their device or are experiencing

increased difficulty as a result of the disaster (Bloodworth, Kevorkian, Rumbaut, & Chiou-Tan, 2007). It is important that devices provided, including prosthetics and orthotics, are appropriate for the individual and the environment, and that they can be maintained or replaced in country.

While emergency response teams may adopt an “in-out” approach, parachuting in expertise, the longer term needs for rehabilitation render this approach in isolation as ineffective (Demey, Nielsen, Weerts, & Sheng, 2008) and highlight the need either for strong links with local providers, or longer term collaborative interventions. Coordination, whether via existing local systems or the UN cluster system, is key to any effective response, whether working as an individual, part of a smaller medical team or as a member of an international organisation.



It is recommended that anyone interested in working in emergencies should take the e-learning course [www.buildingabetterresponse.org/](http://www.buildingabetterresponse.org/) which explains how coordination following a disaster works.

Following major disasters well intentioned international volunteers, including rehabilitation professionals, often travel to areas affected to offer assistance. Spontaneous health volunteerism can overwhelm a response system and, unless coordinated, can make things worse instead of better (Merchant et al., 2010). International volunteers should not travel independently to disaster zones without the support of a local or international organisation. Instead, they should register in advance with international non-governmental organisations, with their home nation’s foreign medical team, or with their national coordinating body. Those interested in responding internationally should also access specific training in humanitarian response prior to departure, and should critically examine their own

clinical skills and capacity to respond. International organisations that send rehabilitation professionals to work in emergencies include:

- CBM [www.cbmuk.org.uk/](http://www.cbmuk.org.uk/)
- Handicap International (HI) [www.handicap-international.org.uk/](http://www.handicap-international.org.uk/)
- International Committee of the Red Cross and Red Crescent (ICRC) [www.icrc.org/](http://www.icrc.org/)
- International Federation of the Red Cross and Red Crescent (IFRC) [www.ifrc.org/](http://www.ifrc.org/)
- International Medical Corps (IMC) [www.internationalmedicalcorps.org.uk/](http://www.internationalmedicalcorps.org.uk/)
- Médecins Sans Frontières (doctors without borders) (MSF) [www.msf.org.uk/](http://www.msf.org.uk/)
- Médecins Du Monde (doctors of the world) (MDM) [doctorsoftheworld.org.uk/](http://doctorsoftheworld.org.uk/)
- Motivation <http://www.motivation.org.uk/>

Any international response should facilitate not neglect or disempower local responders, as they have borne the brunt of the initial response and will continue to provide ongoing input long after FMTs have left.

*"The first people to respond to disasters and conflict are the ones affected by them. Friends and neighbours search through the rubble for loved ones after earthquakes; local hospitals work through the night to care for the injured."* (Ashdown, 2011).

Collaboration with and capacity building of local responders should be considered and taken into account from the very beginning of any post-disaster response that aims at provision of rehabilitation services (Demey et al., 2008).

### **Management of injuries following sudden onset disasters in austere environments**

As stated, the consequences of disasters in low and middle income countries are generally worse than in wealthier nations. At the same time, acute care and rehabilitation resources in such settings may be limited even prior to disasters. As a consequence, international support is more often required. Medical teams working in response to large scale sudden onset disasters may find themselves working with limited access to energy sources and equipment, as well as in potentially un-sterile surroundings. As a result, the management of injuries in austere environments needs to be adapted. There are several high quality guides to the medical and surgical management of trauma in emergencies, including those developed by WHO, (2007) and ICRC, (2009) but to date no rehabilitation guidance exists. Key differences for common injuries are highlighted below, accompanied by the implications for rehabilitation professionals. This list is intended as an illustrative introduction:

1. Fractures: Some fractures, for example simple pelvic, lumbar, rib and ankle fractures, may be missed in cases of major trauma where the focus has been on life saving surgery, and may be identified by the physiotherapist when

first mobilising or treating a patient. Generally, fractures are more likely to be managed conservatively or fixed with external fixators. Rehabilitation professionals should be aware of potential complications caused by inappropriate pin siting, increased risk of infection and risk of contracture. Weight bearing and functional status should be determined in collaboration with the surgeon where possible. Follow-up of these patients needs to be carefully co-ordinated as the foreign medical teams may no longer be in country when a review is needed. Rehabilitation following emergency treatment of fracture has been shown to improve activities of daily living and life satisfaction (X. Zhang et al., 2012).

2. Amputations: Selection of level may be influenced by locally available prosthetic provision. Stump closure is often delayed to rule out infection. Some techniques such as myoplasty may be preferable in order to lessen time in theatre and free up operating rooms. Rehabilitation is frequently complicated by poly-trauma. Guillotine amputation is almost always contraindicated (unless for extraction) however it is still seen at times. Overall guidance is available from Knowlton et al (2011).
3. Spinal Cord Injury: Spinal Fractures may be more likely to be managed conservatively unless specialist spinal surgeons and hardware available. Survival is generally low amongst those with high cervical injuries, while poor pre-hospital and hospital care can result in a higher incidence of complete injuries, and poor hospital and ongoing care can result in an increased incidence of complications such as pressure sores and urinary tract infections. There is growing consensus that SCI patients should be grouped to receive specialist care following disasters (Burns, O'Connell, & Rathore, 2012, Rathore et al., 2008, Li et al., 2012). Recommendations are available from Burns et al., (2012).
4. Brain Injury: Incidence varies significantly, perhaps related to the efficacy of search and rescue and availability of specialised



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medical care including access to ventilators or intensive care units. Access to CT scanners is likely to be very limited. Increases in stroke may be seen later as a secondary consequence of events which disrupt chronic health condition care (Mateen, 2010).

5. Burns and soft tissue injuries: Carry a particularly high risk of infection, often exacerbated by growing levels of diabetes in low and middle income countries. Burns can be seen as a direct result of a disaster, or as a result of the post disaster environment, for example people living in temporary shelters and relying on open flame for cooking. Appropriate pain management is vital.
6. Peripheral Nerve Injuries: Often missed during initial life-saving procedures, nerve injuries are a neglected aspect of major trauma care in disasters. It is important to ascertain local options for early repair if appropriate. Compressive neuropraxic injury can be seen following earthquakes in the absence of major trauma as a result of being trapped for long periods under rubble or in sustained postures. (Yoshida, Tada, Uemura, & Yonenobu, (1999) and Uzun, Savrun, & Kiziltan, (2005)).

Rehabilitation professionals should also be aware of specific early complications of crush injuries, including rhabdomyolysis and compartment syndrome. In the experience of

the author, pain management is frequently neglected in disaster response situations. Particular attention should be paid to the management of neuropathic pain, especially in patients with amputation, SCI or nerve injury.

While injuries can be categorised for simplicity and to allow for data collection, it is important not to focus attention on any one particular injury or impairment following a disaster. For example, while amputations frequently receive a huge amount of attention following sudden onset disasters, they make up a relatively small proportion of those requiring rehabilitation. Following the 2010 earthquake in Haiti, amputee rehabilitation accounted for between 3.5% and 6% of the total demand for services in terms of number of beneficiaries (Redmond et al., 2011) but received a large amount of publicity and was a significant focus of service provision and research. Other less visible injuries such as nerve injuries can cause significant impairment and require significant ongoing rehabilitation, yet they receive far less focus in the media and academic literature.

Whereas trauma in non-disaster settings tends to occur more frequently in certain groups, disasters affect all ages and therefore the therapist should be confident working with all ages.

### What are the guidelines in relation to Rehabilitation?



All guidelines are included on the accompanying USB resource, or are freely available online.

The Sphere Guidance (The Sphere Project, 2011) sets out minimum standards across the entire humanitarian response. They make the following key recommendations regarding physical rehabilitation:

- Surgery provided without any immediate rehabilitation can result in a complete failure in restoring functional capacities of the patient.

- Early rehabilitation can greatly increase survival and enhance the quality of life for injured survivors.
- Patients requiring assistive devices (such as prostheses and mobility devices) will also need physical rehabilitation.
- Post-trauma and post-surgical rehabilitation should be established only by agencies with appropriate expertise and resources.
- Where available, partnership with community-based rehabilitation programmes can optimise the post-operative care and rehabilitation for injured survivors.

The Minimum Standards for Foreign Medical Teams (Norton et al., 2013) established minimum standards that Foreign Medical Teams (FMTs) responding to disasters should adhere to. The guidance states that:

- Rehabilitation is one of the core functions of trauma care systems in regular healthcare and as such, FMTs should have specific plans for the provision of rehabilitation services to their patients post SOD.
- Rehabilitation is included as a core component (either integral or via referral) of any inpatient surgical team, while it is noted that specialist rehabilitation teams may be deployed to provide support to FMTs and hospitals unable to provide rehabilitation services.
- In the case of amputations, rehabilitation services and psychological support ideally should be involved prior to or at the same time as the surgery.
- In SOD beds become rapidly filled up and it is difficult to discharge people due to loss of home and long distance referrals. Rehabilitation specialist support embedded within the team can offer triage and peri-operative advice as well as rehabilitation post-surgery, and have been shown to reduce length of stay.
- FMTs should be aware that cross cutting issues of disability and vulnerable population care is an important part of ethical SOD response, and teams should plan to

- specifically assist or refer those with disability that present for treatment. Studies quote increased odds ratios for death in those with pre-existing disability of up to 2.0.
- Of note, LMC generally have poorly resourced rehabilitation services, which are quickly overwhelmed by victims of an SOD. Early rehabilitation can reduce the complication rate; inpatient stay and long-term health burden as well as improve the overall outcome of trauma victims post SOD.
- FMT rehabilitation experts are encouraged to provide rapid training to local staff and their teams to maximise the impact of consistent and continuous rehabilitation care
- An accompanying "Minimum Standards for Rehabilitation" paper will be published by the WHO in late 2015.

The Humanitarian Action Summit resulted in a document making key recommendations (Ikeda et al., 2011) for best practice surgical response in humanitarian emergencies. With reference to rehabilitation, these included:

Statement 1: Surgery and anaesthesia are essential services in the crisis response, and along with rehabilitation, are part of the spectrum of care of the injured patient.

Statement 7: Follow-up of the surgical patient should occur within an appropriate time frame, with the view towards long-term rehabilitation, prevention of disability, quality of life and community reintegration.

Also that:

- An assessment of the team infrastructure and capacity must also include the resources for anaesthesia and pain management, surgical capabilities, and the ability to provide peri-operative care, rehabilitation and psychosocial services.
- Teams that provide postoperative physical rehabilitation should coordinate with physical rehabilitation service providers for provision of required assistive devices (e.g., prostheses) and mobility aids (e.g., wheelchairs and crutches) as necessary.



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There are also a number of guides that focus on trauma care in emergencies, not exclusively in sudden onset disasters. For example, ICRC (2009) have published a guidance on war surgery in austere environments. ICRC advocate for early physiotherapy as a core step of the management of war wounds. They also specify that:

- The outcome of surgery is determined by the quality of hospital treatment (resuscitation, surgery, post-operative care, physiotherapy and rehabilitation).
- Following primary specialised care should include: definitive surgical treatment including reconstructive procedures; physiotherapy and rehabilitation, both physical and psychological.
- High-quality physiotherapy is required to ensure early mobilization after surgery and a good functional result. Treatment is not complete, however, until the patient is rehabilitated; prosthetic workshops are needed to fit amputees and provide other suitable devices, such as orthoses, crutches or wheelchairs.
- The functional result of ultimate wound healing depends to a great extent on proper physiotherapy to retain muscle mass and joint mobility, and should be instituted early as part of the healing process.
- Good post-traumatic or post-operative pain relief not only helps to alleviate suffering, but also allows for rapid mobilization of the patient and early physiotherapy which help attain as good a functional result as possible.
- In patients with established tetanus, Chest physiotherapy is required to prevent respiratory complications.
- In the treatment of burns, Physiotherapy and mobilization should begin as soon as the grafts are solid. A hand should never be immobilized longer than ten days... The same general principles apply to the feet and over joint surfaces.

### **Clinical Practice**

Working in a Humanitarian Context is NOT an excuse for disregarding national and international standards, including the WCPT Guideline for Standards of Physical Therapy Practice (2011). These standards are in place to ensure clinical practice is safe and effective. Particular attention should be paid to the following areas:

### **Documentation**

Effective documentation is essential where patients may encounter multiple professionals or medical teams during the course of their treatment and may lack a good understanding of their medical care to date. It is also frequently neglected during disasters, resulting in treatment duplication or error. Physiotherapists should continue to adhere to guidance set out by WCPT (2011). All interventions should be documented. Notes should be legible. Avoid the use of acronyms and abbreviations.

Record management in sudden onset disasters can be challenging. It may be appropriate where patients are highly mobile for them to take their notes with them, while also maintaining a central or duplicate record. It is important to maintain a central database of activities, including basic demographic information, diagnosis, disability, and follow up and equipment needs to enable appropriate follow up and management of resources. As patients may be lost to follow up, the recording of a mobile phone number (with consent) of the patient or family member can help ensure patients receive on going care. Any data should be stored safely and securely, ensuring confidentiality. Where possible, a common data set should be agreed between key providers.

### Referral

Rehabilitation Professionals should play a role in ensuring patient referral mechanisms and protocols are established, linking acute service providers with appropriate hospital and community-based rehabilitation services. Appropriate follow up is key to a positive outcome for patients. Ideally, coordination should be done through existing mechanisms to avoid duplication. In large disasters this will be via the Health Cluster or FMT coordination Group.

### Informed Consent and confidentiality

Principles of informed consent are of vital importance during emergencies. Please see the WCPT policy statement (WCPT, 2011b) for more information on informed consent.

### Data Collection

There is very limited data focusing on injury or impairment following disasters, while even

fewer studies examine functional outcomes of those injured. Additionally, a lack of data on the increased risks faced by people with disability during emergencies is also a significant issue. The lack of research into rehabilitation and disability in emergencies is a major cross cutting issue. At the same time, the lack of established research or best practice hinders efforts, as does a lack of accepted measures.

Work is currently underway to agree on standards for disability data disaggregation, injury classification, and appropriate generic functional outcome measures that can be used. Both injury specific and generic outcome measures are included in the USB resource that accompanies the manual. At the time of writing, there is not one single generic outcome measure that is appropriate for use with trauma patients in the acute stages of an emergency. Generic tools have been used in other emergency contexts to measure function or disability including:



- WHODAS 2.0
- Barthel Index
- EQ5D
- FIM
- Washington Group Short Set of (6) Questions

### Scope of Practice

The Humanitarian environment is not an opportunity to experiment or expand scope of practice beyond what you are qualified or competent to do.

### Regulation

If coming from outside of their normal country of work, health workers should seek information on professional regulation and standards in the affected country and should always register with the relevant body. Establishing contact with their host professional association (where it exists) in the country is advised, and this is normally best managed by your sending or host organisation. Health

workers on short term visits are generally liable for regulation by both their own regulatory body and that of the host country, and should abide by whichever has the tighter regulation. In the UK for example, regulation for those on short trips continues to be applied by the Health Care and Professions Council.

### Hand Hygiene and Infection Control

In accordance with the 2011 WCPT Policy on infection prevention and control, *“physical therapists [must] implement best practice in infection prevention and control when working in any practice setting.”* (WCPT 2011). The need for infection control in disasters is a key issue, particularly as you are likely to encounter a high number of patients with open and/or

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infected wounds, and find yourself working in unsanitary conditions. This is underlined by the fact that diarrhoea was found to be the leading cause of illness in ICRC humanitarian workers, affecting over 44% of staff (Dahlgren, Deroo, Avril, Bise, & Loutan, 2009).

### Communication

Clear communication is critical, particularly where you may not be able to follow up with a patient. Many recruiting organisations require local language skills as essential or desirable criteria for deployment in an emergency. However this is not always possible where the population affected may

speaking a variety of languages, have varying degrees of literacy and may have additional communication needs, such as those used by people with hearing or visual impairment. Working through interpreters then becomes critical and experience important. In some contexts patients may not have heard of physiotherapy or occupational therapy, or their cultural understanding of health and health care may be very different. Double check understanding by asking the person to demonstrate or summarise what you have explained to them, and where people are literate, be sure to write clear instructions for them to follow.

### Equipment



When deploying with a Foreign Medical Team, you are likely to have access to at least basic rehabilitation equipment. It is important to manage stock carefully, and ensure patients provided with equipment are followed up appropriately. There is normally a need to improvise or adapt equipment using local resources, but care should be taken to make sure there are no risks to the patient, and that appropriate follow up is possible. Equipment provided needs to be appropriate to the local environment - for example AFOs may not be worn if patients lack footwear, or generic wheelchairs may not be suitable for patients at risk of pressure ulcers, or for use in an environment following a disaster. More information on equipment, including the Motivation Emergency Wheelchair, is available on the accompanying USB resource.

### Training Others

Responses to sudden onset disasters can involve direct clinical work, but you may often find yourself needing to train others. Experience in training, particularly across cultures and to staff with different levels of clinical knowledge, is a real advantage.

### Goal Setting

Remember in SODs, when setting goals, that your goal may not be the same as the goal of the patient. You must consider the patient's priority and respect that. With some patients, being discharged and able to search or care for remaining family members may be prioritised above their own rehabilitation and long term outcomes.

### Discharge Planning

#### 1. Know patients' discharge destination

Think through where your patients will be discharged to e.g. home/refuge tent/shared house. If it is possible and safe then take any opportunity you have to go into the community to see what the likely discharge environments are like. This will improve your ability to problem solve and set up functional treatment plans with your patients before they are discharged to ensure their safety and maximise their independence and function. Examples of challenges on discharge in emergency situations include patients sleeping on hard floors, a lack of carers, inaccessible toilet facilities, and patients not being able to return for follow up due to factors such as distance or cost or availability of transport.

### **2. Early discharges vs longer term stay patients**

A need for bed space may lead to early discharges. For example, discharges for amputees may be as early as 3-4 days therefore you must ensure you are aware of discharge plan for each patient and plan accordingly i.e. making referrals early for prosthetics and ensure a way of following up with patients. In a hospital setting, involvement in ward rounds will ensure that the multi-disciplinary team (MDT) is aware of prospective discharges. Even for long stay patients, those who are there due to ongoing wound management and/or poly trauma, you should still ensure discharge plans are made early, as disaster situations are unpredictable.

### **3. Think through levels of family/ community support**

Be aware that there are unlikely to be benefits or carer systems in place, and that those affected by disasters may also have lost their caregiver, family, home, and livelihood. Cultural awareness is key: In some cultures, patients may take on a passive role, with all their needs provided by carers. This may not help their long term recovery. Communities often have a much greater role in an individual's life than in the West, and will play a big role in how they integrate back into society. This can work positively and negatively, for example in some cultures people with disabilities are stigmatised therefore may not have very much support at all; others will ensure that it is the responsibility of the whole community to care for the person.

### **4. Adaptation**

Limited access to equipment means you have to be resourceful. Think through meaningful function for the patient, always considering what will promote maximum independence. Wheelchairs may or may not come with leg extenders, in which case stump boards may need to be found for trans tibial amputee wheelchair users, and modifications may be required for patients requiring knee extension in sitting. Logisticians will normally be deployed within the surgical field hospital and it may be possible to liaise with them to modify equipment or to manufacture or procure locally available alternatives.

### **5. Educating Family Members**

Educating family and carers about providing care or supporting independence is critical. Aim to promote functional independence where possible, remembering discharge conditions are not likely to be optimal and follow up sometimes challenging.

### **6. Follow up**

Check with the hospital set up regarding whether or not follow up of patients is a possibility. Often when with an international team it is not possible to do home visits due to security restrictions and the team may not stay long enough to complete rehabilitation. Referral to another health centre, a local provider, or an INGO such as Handicap International or CBM is paramount if your organisation is not able to provide follow up directly.



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## Key Resources

[www.buildingabetterresponse.org](http://www.buildingabetterresponse.org)

PFA: [http://www.who.int/mental\\_health/publications/guide\\_field\\_workers/en/](http://www.who.int/mental_health/publications/guide_field_workers/en/)

WCPT: The Role of Physical Therapist in Disaster Management (awaiting publication)

Scaffa, Gerardi, Herzberg, & McColl, (2006) *The Role of Occupational Therapy in Disaster Preparedness, Response and Recovery*. American Journal of Occupational Therapy Vol. 60, 642-649 <http://ajot.aota.org/Article.aspx?articleid=1870008>

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## Amputee Rehabilitation

This chapter was developed by the British Association of Chartered Physiotherapists in Amputee Rehabilitation (BACPAR) working in collaboration with Handicap International.

It aims to provide an overview of phases you are likely to experience when deployed, from pre-amputation limb salvage stage & preparation for amputation to post amputation phase, including pre-prosthetic and upper limbs considerations.

### Amputation in sudden onset disasters

The numbers of patients sustaining an amputation will vary depending on the nature of the emergency. Earthquake scenarios can typically lead to high numbers of, particularly lower limb, amputees due to crush injuries, extraction and unsalvageable limbs. It is also very likely that amputee patients you see will have sustained other injuries which may complicate their rehabilitation and means that experience of clinical reasoning with

poly trauma patients and adaptation of treatment techniques are desirable skills for working in these situations.

The content in this chapter is pitched at a core level of knowledge in acknowledgement that some therapists may have minimal amputee rehabilitation experience, particularly beyond the field of amputation for vascular patients.

### Pre-amputation Phase

#### Learning outcomes

- To recognise important aspects of the assessment process
- To understand the importance of education for the patient

Most patients will either have a pre-operative decision making phase or an immediate post operative phase where there will be limited mobility. In sudden onset disasters 'delayed primary closure' may be chosen if oedema prevents tension free coverage of the stump or to give added time to ensure infection is not

present. It will be necessary to confer with the surgeons as to what the patient is able to do before closure has been achieved. Engaging with the patient and their caregivers before being able to actively commence the amputation rehabilitation phase is however highly valuable.

### Decision to Amputate

- ▀ Limb salvage vs amputation
  - Amputation
    - In order to save the life of the patient
    - Clear evidence of nonviable (“dead”) extremity, no pulse, no bleeding, no sensation.
    - Injury severity scores (MESS or TRISS)
- ▀ Liaison with surgeon regarding level of amputation

The decision to amputate or attempt limb salvage will be made by the surgical team, who may request input from rehabilitation professionals in reference to functional outcome. Having an awareness of existing and available prosthetic services and psychosocial support services in country will help better inform decision making as

to level of amputation selection here. Injury severity scores may be used by the surgical team. UKIETR surgeons may use one of two validated injury severity scores to predict probability of limb salvage (MESS) and overall survival for multiple injuries (TRISS) (see below).



Interactive injury severity scores can be explored here:  
Mangled extremity severity score (MESS) (Johnson et al 1990)  
Trauma Score and the Injury Severity Score (TRISS) - (Boyd et al 1987)

There are rare occasions when you may see a guillotine amputation - this an amputation commonly used in the case of an emergency often due to the lack of a skilled surgeon to do otherwise or on rare occasions to enable extraction. In such situations dead muscle may be missed because of compartmental structure and there will be an uneven distribution of tissue necrosis. Stump closure and soft tissue coverage are compromised. FMT guidelines aim to ensure these are no longer performed by emergency medical teams. This is therefore only likely in patients who are transferred to a surgical facility for a definitive amputation.

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## Pre-operative Assessment

### Assessment

- Personal information
- Medical history
- Pre-morbid function
  - Objective Ax
  - Mobility - cardio-vascular fitness
  - Home to go to
  - Livelihood
  - Family role - ?dependents / survivors
  - Social activities
  - Cultural sensitivities / attitude to disability
  - Psychological status

### Assessment

- Other injuries
- Monitor for compartment syndrome
- Monitor pressure areas
- Monitor for signs of infection
- Consider high protein diet, vitamins and iron where available

Ideally your initial assessment of the patient will take place pre-operatively, however this may not always be possible in a sudden onset disaster (SOD) situation. Documentation should be within the main body of patient's notes. Above are points to note. A social history that is as accurate as possible is essential with a life changing injury such as an amputation. Meeting with family and care givers as early as possible will help treatment and discharge planning, as well as managing expectations.

You should also expect that these patients will have other injuries which will impact on your rehabilitation plan. Try to maintain range of motion and muscle power in unaffected limbs if the patient is waiting several days for definitive surgery.

Whilst awaiting surgery it is also the responsibility of all staff to monitor for compartment syndrome - signs of which include the five 'P's: pulselessness, pallor, paresthesia, pain (particularly on toe/ankle extension for calf), and paralysis.

Due to increased immobility you must also monitor pressure areas - ideally removing all pressure from any areas of concern, or at best providing extra padding.

Continue to monitor patients for signs of infection - fever, increasing pain, proximal swelling, and erythema.

### Introduction to Post-Op Therapy

- Local resources post UKIETR involvement
  - Available prosthetics
  - Available follow up therapy
- Discuss commitment to exercise / PT in preparation for prosthetics and maximising function

#### Introduction to post-operative therapy

For definitive amputations it is essential, whether meeting the patient pre-operatively or immediately post-operatively, that they are given a clear explanation of the rehabilitation phases and commitment involved. It may be that rehabilitation is not well known or accessible in that region, so don't make assumptions about a patient's knowledge of what your profession does. Be sure you are aware of what

prosthetic services are currently available in the country/region before risking providing false hope. It may be that other local or international organisations are providing prosthetic services and follow-up rehabilitation services, but ensure that you have a clear picture of their services/capacity/referral process/costs before providing this information to the patient and their family.

### Introduction to Post-Op Therapy

- Peer support - age / level / gender matched amputees
- Discuss functional outcome
  - Impact of age, co-morbidities, available prosthetics / wheelchairs
- Demonstration of available prosthetics if appropriate

Peer support can be an excellent way of engaging with new amputees. Finding a peer matched in age/gender and level and who has shared a similar situation and is further on in their rehabilitation can be ten

times more useful than being reassured by a visiting rehabilitation professional. Engaging with local rehabilitation providers or disabled people's organisations can be useful here in finding peer supporters.



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## Finally

Remember that each patient will be different, and additional injuries will complicate matters further. However establishing what motivates that patient,

what they have to get back to and what the priorities are for that individual are all ways in which to engage the patient in rehabilitation.

## Amputation Level Selection

### Learning outcomes

To know what makes a "good stump"

To know the different levels of amputation

To understand the advantages and disadvantages of various levels of amputation

To know rehab implications of amputation levels

The goal of amputation is always successful healing, preserving as much function as possible, and creating a residual limb that will work best with a prosthesis.

(D. Smith, 2003)

## What makes a good stump (residual limb/ residuum)?

- Length: There needs to be enough room for prosthetic componentry
- Soft tissue: Ideally no "dog ears", adequate cushioning and coverage of bone end
- Bone ends: Bevelled bone edge, no bony spurs, fibula cut 2cm shorter than tibia, drill holes for myodesis. Palpation or x-ray determined
- No neuromas: Nerves should be retracted deep inside the soft tissue so they can't get aggravated near the surface causing a neuroma
- Shape of stump: Ideal transfemoral shape is conical, ideal transtibial shape is cylindrical. You do not want a bulbous shape as it is very hard to fit a prosthesis
- Scar line: This should not be over the end of the bone, check whether you have an adhered scar or mobile one, and whether scar tissue is palpable or tender
- Wound: Be aware for any signs of infection (slough, smell, discharge, red, hot, necrotic skin margins), check whether stitches are in/out and be aware that some wounds will be open
- Vascular supply: There should be adequate supply for wound healing. Stump should be warm, have sensation, good colour, and pulse etc
- Proximal joint: Ideally there will be no proximal joint contractures at hip or knee, or they will be less than 20degrees and have 5/5 muscle power
- Pain/tenderness: Along scar line, neuroma, soft tissue injury

## Amputee Rehabilitation

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- Muscle cover: Evidence of myodesis and myoplasty with optimal shape. Sufficient muscle cover over the cut end of bone
- Skin condition: Be aware of scars, skin grafts, blisters, unhealed skin, dermatological problems such as eczema
- Sensation: You will need to test and check sensation is intact especially over the prosthetic weight bearing areas (patella tendon bar, paratibial and posterior of stump) as well at the end of stump

### What about the stumps below?



Short

Bulbous shape

Dog ears

Scar line across the cut end of bone therefore more at risk of tethering

Excessive soft tissue that is not holding its shape so possibly the muscles are not properly attached to the bone



Cylindrical shape - no dog ears

Good muscle cover over the end of the bone

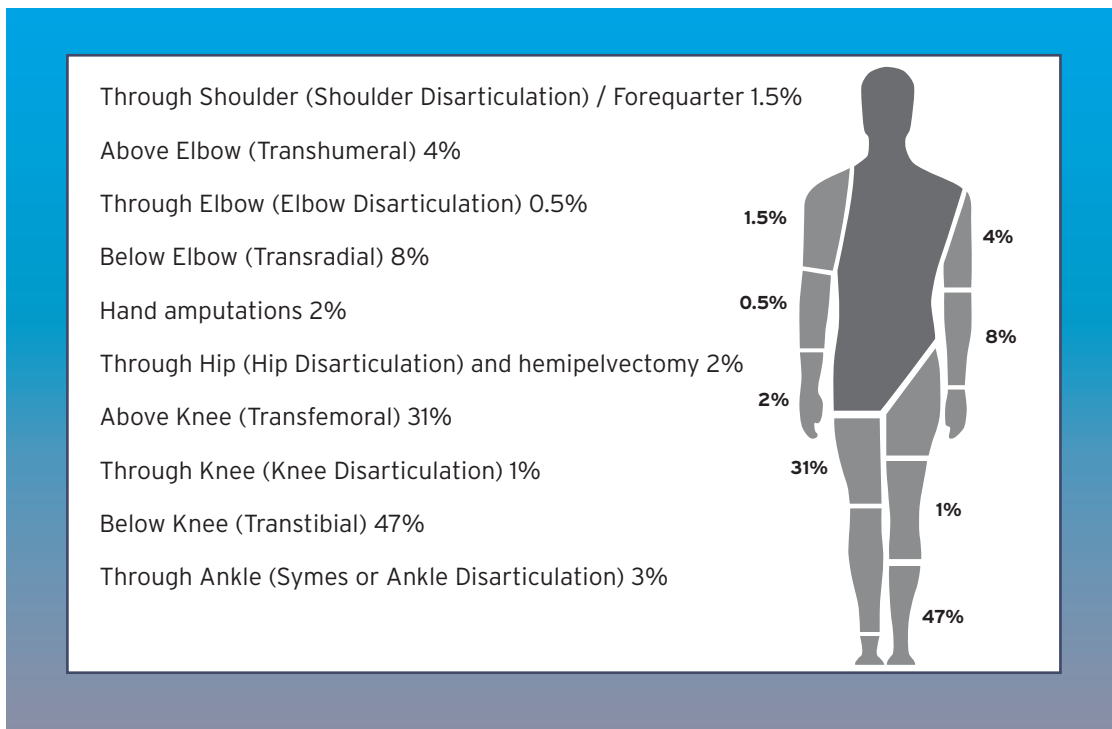
Skew flap which avoids the scar going over the end of the bone - wound healed well

Minimal swelling

Appears to have good blood supply and the skin is in good condition

Knee has good range and able to get full extension

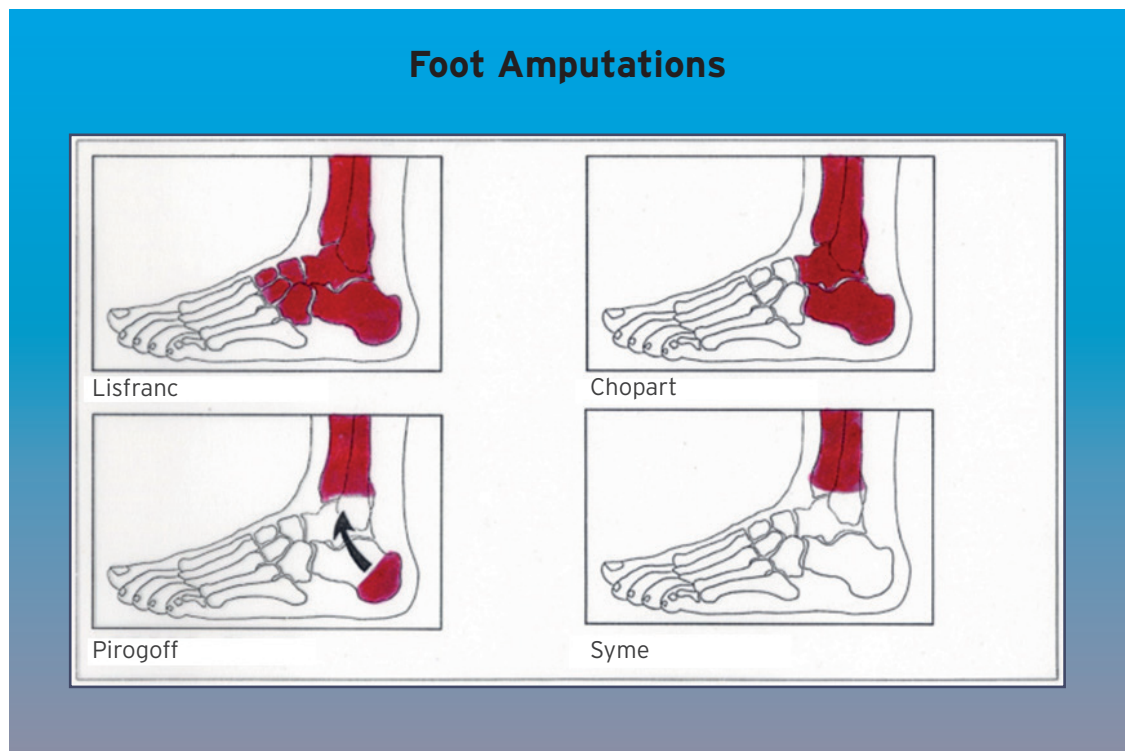
## Levels of amputation - statistics



The statistics on the slide reflect general percentages in the UK, of which most patients are vascular. Further data can be found at <http://www.limbless-statistics.org/>. Transtibial amputation is the most common at 47% followed by transfemoral amputation at 31%.

These statistics will not be reflective of what you will see if deployed to a sudden onset disaster. Numbers will reflect the type of disaster, although lower limb amputations are likely to predominate. Be aware that you are likely to encounter patients with multiple amputations.

### Foot amputation



- Lisfranc: At the tarso-metatarsal joint, the plantar soft tissues being preserved to make the flap
- Chopart: Through the midtarsal joint; that is, between the tarsal navicular and the calcaneocuboid joints. There is a risk of tight TA with implications for fit of shoe and gait. Also a high risk of wound break down especially if the patient is diabetic
- Pirogoff: Disarticulation at the ankle joint, retention of the calcaneus.
- Symes: Disarticulation at the ankle joint saving the heel pad for cushioning. Only a good option if you can save the heel pad - otherwise end weight bearing is not always possible. Decreased space for prosthetic componentry, and a less cosmetic socket



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## Trans Tibial Amputation

### Trans Tibial Amputation (Below Knee)

- 12-15cm from the patella tendon
- Needs a good vascular supply for wound healing
- The fibula should be cut 1" shorter than the tibia
- Flexion contracture needs to be less than 25"



In the amputation folder on the USB, the file **'Photos BKA surgery'** shows photographic stages of transtibial amputation

At this level the tibia and fibula should be cut at the optimum length possible so there is enough length for stability in a socket but short enough to accommodate the componentry.

The optimum length is 12-15 cm from the patella tendon.

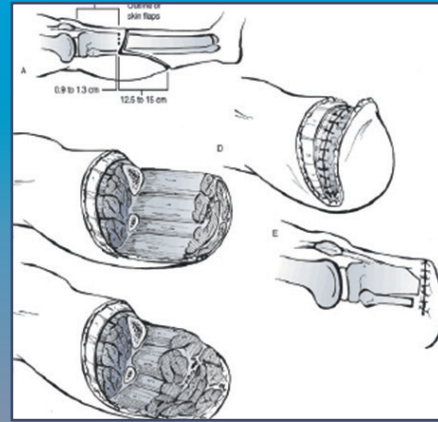
The fibula should be cut one inch shorter than the tibia so that it does not protrude as the stump shrinks over time.

It is challenging to fit a prosthesis when a flexion contracture of greater than 25° - 35° is present due to the alignment of the socket.

There are differing surgical techniques at this level, and it is important that the rehab professional is aware of which technique has been used. The main techniques are described in the following slides.

### Trans Tibial Amputation Long Posterior flap

- A long flap is fashioned using the gastrocnemius and then attached on the anterior aspect of the stump
- Scar across cut end of tibia
- Need to avoid "dog ears"



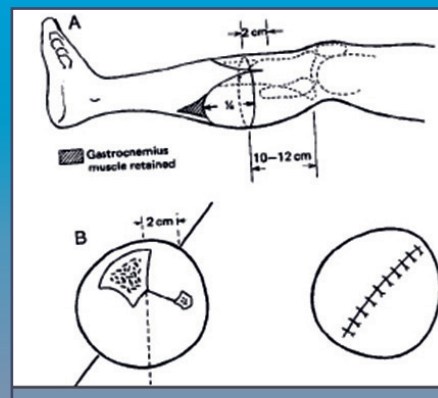
The surgical technique for a long posterior flap is described above. In SOD situations this may be the favoured technique due to improved healing and shorter length of time

in surgery. Here it is important that the muscle is filleted to minimise the redundant tissue and prevent "dog ears".



### Trans Tibial Amputation Skew flap

- Equal anterior-lateral and posterior flaps provides the best stump shape and good cover for the bone end
- Tapered residuum
- No scar across cut end of tibia



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The skew flap technique retains the advantages of the long posterior flap technique and eliminates the difficulties of prosthetic fitting due to the scar line being on the distal end of the tibia. The equal skin flaps are skewed so that the flaps become anteromedial and posterolateral,

whereas the calf muscle flap remains long underneath the skewed skin flaps. The posterior muscles are brought anteriorly covering the cut ends of the bones and are buried in between the tibia and its anterior periosteum, by suturing their margins with the periosteum.

### **Knee Disarticulation Amputation**

#### **Knee Disarticulation** (Through knee amputation)

- Non-traumatic technique with little severing of tissues and little blood loss
- Maintains both distal and proximal growth plates therefore good technique for children
- Good option for a non limb user
- Limited space for prosthetic componentry
- Debate as to whether or not to keep the patella
- There are variations of knee disarticulation techniques which are not advised e.g. gritti stokes

Knee disarticulation is a very quick operation so is likely to be a good option in the field, with decreased likelihood of infection and bony spurs as it does not require the cutting of bone or muscle.

Skin, ligaments, vessels, and nerves are cut. A high tourniquet should be used. Bleeding is also reduced as muscles are not cut, therefore maintain good strength.

Disarticulation level is recommended in children to preserve the growth plate (see separate slides on paediatric considerations). The distal femoral growth plate provides 70% of growth of the femur and an amputation at transfemoral level in a young child can result in a disproportionately short residual limb and can lead to prosthetic problems. Disarticulation also avoids terminal bony overgrowth, the most common complication in skeletally immature children.

## Amputee Rehabilitation

This amputation level can be a good option for the non limb user as it produces an end weight bearing residuum so a patient can use the stump functionally to kneel, crawl and assist with transfers. It also leaves a long lever for improved sitting balance.

The long stump length means that there is little room for prosthetic knee componentry without lowering the knee centre and causing poor cosmetic appearance. There

are a few knees that have a low build height which are polycentric knees such as a 4 bar or 6 bar knees. These knees are alignment stable a generally for a higher activity level patient but they fold underneath themselves and do not protrude as much in sitting.

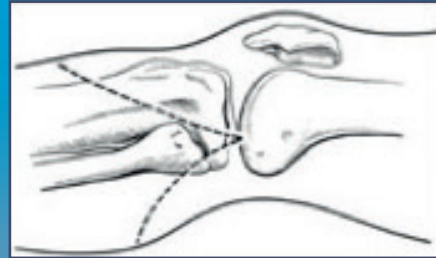
These knees may not be as available in some areas which may be a consideration for this level of amputation.

### Knee Disarticulation Skin flaps

Sagittal Flaps



Anterior Flap



#### Sagittal flaps

This technique is well suited to the dysvascular patient since the skin flaps, being equal, each have minimal length. On closure, the surgical scar lies posteriorly, between the femoral condyles. The gastrocnemius is retained to provide a cushioned soft-tissue envelope that will allow comfortable direct load transfer.

#### Anterior flap

Symmetrical anterior convex incision from joint line to distal tibial tuberosity. Develop posterior flap, approximately 1/3 length of anterior, gastrocs is separated from soleus & divided several centimetres from origin to preserve superior geniculate artery. Suture patellar ligament and hamstrings to cruciates (Fitzsimons, 2008).

---

Debate exists as to whether the patella should be kept:

Reasons for keeping the patella:

- ▀ Patients may like the feel of moving the patella as they activate quads
- ▀ Keeps the quads tendon at full strength and protects as it goes over the bone
- ▀ May help prevent socket rotation

Reasons against keeping the patella:

- ▀ Arthritic changes
- ▀ Patella fractures or cartilage damage
- ▀ Easier to fit prosthesis

There are also variations of knee disarticulation surgery used historically but not generally advocated now:

- ▀ Gritti-Stokes: remove condyles and the patella is anchored inside the end of femur
- ▀ Burgess (1977): removes patella & portions of the condyles
- ▀ Youkey: removes patella and completely removes the condyles
- ▀ Mazet (1966) removes the patella and shaves the sides and distal end of the condyles to form a truncated / conical stump

### Trans Femoral Amputation

## Trans Femoral Amputation

(Above knee)

- ▀ The stump should be 12cm above the opposite knee centre
- ▀ There should be no more than 10° hip flexion deformity
- ▀ The myodesis technique is very important
- ▀ The overall length of the residuum should be considered
- ▀ The stump should be as long as possible to assist with sitting balance for non prosthetic users.

At this level the stump must be as long as the pathology permits but should be 12cm above the opposite knee centre to allow space for a prosthetic knee.

There should be no more than 10° hip flexion deformity but a maximum of 15° - 20° can be accommodated in the socket angle.

The myodesis technique is very important to provide a good stump, anchoring the muscles to bone and providing added

stability during prosthetic stance (see below for more on myodesis).

The overall length of the residuum should be considered, not just the femoral length and redundant tissue kept to a reasonable amount.

Also do note that patients who are deemed to be NOT suitable for prosthetic rehabilitation, the stump should be as long as possible to assist with sitting balance.

## Trans Femoral Amputation Surgical Flaps

- Equal Anterior / Posterior
- Long Anterior Flaps



Here are two common surgical techniques for transfemoral amputation. In SOD situations it is more common to see equal anterior and posterior flaps used. The flaps must be

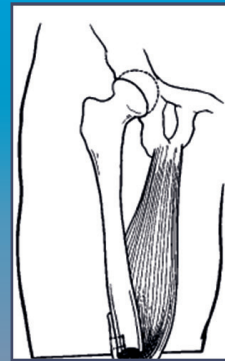
long enough to cover the end of the stump, but not be so long that their blood supply is inadequate and they necrose. The scar should be placed where pressure is minimised.



FIG 28A-7.  
Residual femur held in normal anatomic alignment following adductor myodesis.

Adductor Magnus Loss results in 70% loss of adductor strength

Adductor magnus myodesis results in good anatomical position of femur



In patients with adductor magnus myodesis the femur is stabilised in adduction by adductor magnus, this leads to improved hip flexion and hip extension. Ultimately

without this good hip flexion and extension, side trunk flexion compensation will occur and prosthetic gait re-education will be compromised.

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## **The hip disarticulation and transpelvic (hemipelvectomy or hindquarter) amputee**

Hip disarticulation is the surgical removal of the lower limb through the hip joint. Transpelvic (hemipelvectomy or hindquarter) is the removal of the entire lower limb in addition to half the pelvis.

The incidence of these amputations is very low. The commonest indication for this high level is sarcoma and this diagnosis can influence management and outcomes. On occasion this may be the level of choice in vascular disease and chronic infection. Occasionally congenital limb deficiencies are managed with a hip disarticulation.

Severe trauma to the pelvis, lower limbs and surrounding tissues is another indication for this level of amputation and may be performed urgently for life threatening haemorrhage, soft tissue loss, or infection, for example in the case of massive pelvic trauma.

Recovery can be slow with respect to wound healing.

The likelihood of amputees at this level achieving functional mobility with a

prosthesis is small. A prosthesis for this level is heavy and bulky requiring 3 joints. Furthermore satisfactory prosthetic suspension can be challenging, particularly in the transpelvic amputee. The amputee has no residual limb to act as a lever to aid prosthetic propulsion and momentum and therefore energy expenditure is high and cadence slow, often associated with gait deviations e.g. vaulting on the contralateral leg.

In some countries the provision of a prosthesis for this level is unlikely. Consequently mobility at this level is with crutches or wheelchair. Special attention must be made to ensure the transpelvic amputee is stable in a wheelchair with the supply of a suitable wheelchair cushion or simple adaptations to provide a level and stable base.

Physical rehabilitation includes strengthening of back extensors and remaining leg, core and pelvic mobility, balance and posture in sitting and standing and safe functional mobility in wheelchair and/ or crutches.

## **Myoplasty and Myodesis**

It is important that the rehab professional is aware of which surgical technique has been used in reference to the muscles, as this will also affect early rehabilitation priorities.

**Myoplasty:** The agonist and antagonist muscles are sutured together to maintain some of the muscle function

**Myodesis:** Muscle fascia are sutured to bone through drill holes which provides a very stable stump. From a rehabilitation perspective - myodesis is far better for improved control and less redundant soft tissue in the adductor region. It is the preferred surgical technique, but a lengthier procedure

### Nerves, vessels and bones in amputation surgery

#### Nerves, Vessels and Bone

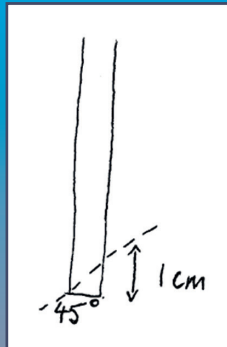
- Nerves
  - Divided under gentle tension
  - Large nerves are ligated
- Blood vessels
  - Doubly Ligated
  - Haemostasis prior to closure
- Bone
  - Avoid excessive periosteal stripping
  - Fibula is cut 2cm higher than tibia
  - Bevel and smooth
  - Ensure adequate soft tissue coverage

During surgery nerves should be cut on a stretch, they are then ligated and buried well into soft tissue. This is important so they retract back away from areas of scar, pressure and vessels.



#### Bevelled Bones

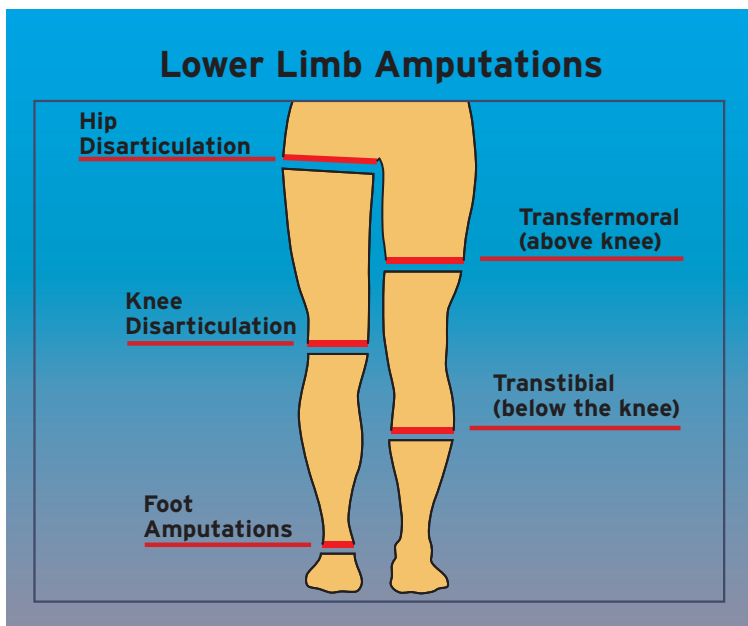
- Bone cut at a  $45^\circ$ , 1cm up from cut end of bone
- Smooth and round end with file



The tibia is triangular in shape, and the anterior corner can be quite sharp and lead to a painful bone prominence at the distal and anterior aspect of the amputation site, hence why it is bevelled and smoothed during surgery.



Advantages and Disadvantages of Lower Limb Level Selection



HD = Hip Disarticulation

TF = Trans Femoral

TT = Trans Tibial

KD = Knee Disarticulation

S = Symes

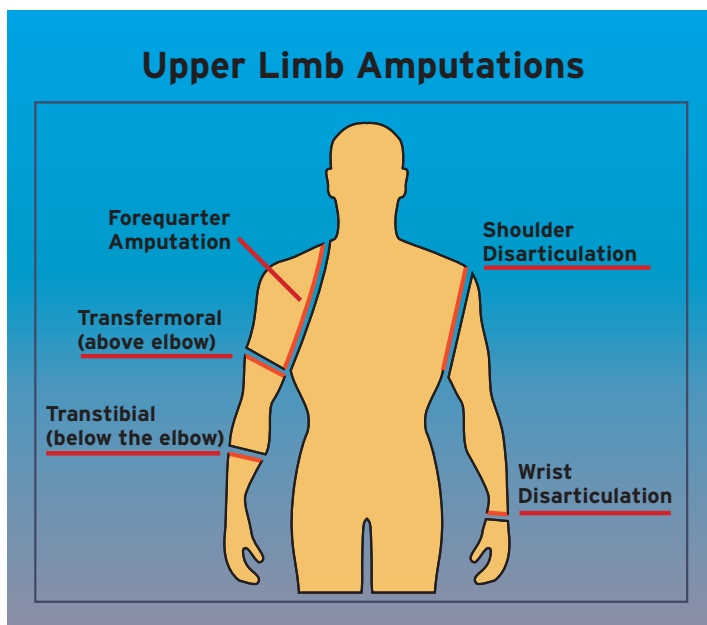
PF = Partial Foot

Disadvantages	PF	S	TT	KD	TF	HD
Poor cosmetically		○		○		
Non weight bearing surface			○		○	
End weight bearing not always possible		○		○		
Poor space for componentry		○		○		
Apparent leg length discrepancy				○		
Short lever					○	
Possibility of bony spurs			○		○	
High energy consumption				○	○	○
Seating adaptations						○
Poor posture						○
Slow prosthetic gait						○

Advantages	PF	S	TT	KD	TF	HD
Weight bearing surface		○		○		
Long lever		○	○	○		
No bony spurs and decreased risk of infection		○		○		
Self suspending socket		○		○		
Space for components			○		○	
Cosmetically acceptable			○		○	
Min excess energy consumption	○	○	○			
Muscle attachments		○		○		
Proprioception	○	○		○		
Good for kids		○	○	○		
Maintains joint function	○		○			
Lifesaving						○



## Advantages and Disadvantages of Upper Limb Level Selection



PH = Partial Hand

WD = Wrist Disarticulation

TR = Trans Radial

F = Finger

ED = Elbow Disarticulation

TH = Trans Humeral

SD = Shoulder Disarticulation

<b>Advantages</b>	<b>PH</b>	<b>WD</b>	<b>TR</b>	<b>ED</b>	<b>TH</b>	<b>SD</b>	<b>F</b>
Long lever	○	○	○				
Good Sensation and proprioception	○	○	○				
Bilateral activities	○	○	○	○			
Good for stabilising	○	○	○	○			
Good for carrying	○	○	○				
Decreased risk of infection as no cut bone		○		○		○	
Space for componentry			○		○		
Good to keep humeral head for cosmetics					○		
Life saving						○	○

<b>Disadvantages</b>	<b>PH</b>	<b>WD</b>	<b>TR</b>	<b>ED</b>	<b>TH</b>	<b>SD</b>	<b>F</b>
Limited room for componentry	○	○	○	○			
Loss of sensation and proprioception					○	○	○
Short lever				○	○	n/a	n/a
Possibility of bony spurs			○		○		
Poor posture					○	○	○
Back pain					○	○	○
Difficulty fitting componentry with short stump			○		○		
Difficult tolerating weight of componentry						○	○
Body image concerns	○	○	○	○	○	○	○
Gait and Balance						○	○

### Post-operative Phase

#### Learning outcomes

To recognise important features of early post-op assessment and treatment, including

- Wound
- Compression
- Exercise
- Practical considerations
- Positioning
- Function

To be aware of prosthetic considerations

To be aware of the challenges of the multiple amputee

To be familiar with use of outcome measures and discharge Planning in the field

### Assessment

#### Assessment

As per standard post-op assessment

#### Amputee specific assessment:

- Residual limb (stump)
- Pain, including phantom limb pain
- Presence of multiple limb loss
- Psychological state (loss)
- Mobility
- Prosthetics?



In depth post-operative assessment will be covered in the practical day **'Early Amputee Rehabilitation in Emergencies'**.

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When working as part of a multi-disciplinary team the rehabilitation professional should participate in daily ward rounds as well as morning and evening meetings. These will inform your prioritization of patients, and give opportunities to enquire about surgical details not already included on the operation notes.

Early assessment and engagement with an amputee patient, even if rehabilitation is not possible at that stage is essential in maximizing both the patients' engagement with therapy, but also long term outcomes.

**What to include in your initial assessment:**

**Injuries, surgery, and management plan**  
(including delayed closure as you need to be aware if surgery is going to be completed in stages. There may be an open wound with post-op restrictions)

**Wound restrictions:** speak to the surgeons

**Attachments:** practical implications with these, you may need to use family members or other volunteers to assist

**Respiratory Status:** don't forget standard post-op chest considerations

**Suitability for Assessment:** liaise with medical and nursing staff

**Pain:** phantom and residual (more detail in later section)

**Medication:** pain medication for nociceptive and neuropathic pain, anti-nausea, antibiotics, pre-existing medications for example insulin

**Cognition:** what's their baseline? This can be harder than you think, especially when using translators

**Stump length and shape:** read surgical notes to determine surgical technique (refer to above section on levels)

**Range of Movement and muscle power assessment** above level of amputation and in residual limbs. Consider other injuries

**Bed Mobility:** Likely to be camp beds inside field hospital, so extra care needed.

**Sitting balance / tolerance** - relevant with transfemoral amputees, especially bilateral amputees. They have short levers and therefore a shift of centre of gravity backwards

**Method of transfer and ambulation if possible:** this should be assessed as early as possible, and patients prioritised for limited equipment

**Seating / Pressure / chair requirements:** especially for bilateral amputees

**Home environment:** this is included on the front section of the UK IETR assessment form

**Stump compression:** this should be decided on by the team and will depend on, amongst other things, the state of the wound

**Psychological state and cultural considerations:** the loss of limb process is similar to the stages of grief

**Be prepared to discuss/consider prosthetics** and as mentioned earlier, ensure you are aware of prosthetic provision locally

### The residual limb (or stump)

#### The Residual Limb (Stump)

Delayed Primary Closure (DPC)

Dressings and wound care

Elevation (BKA)

Compression

Handling / Massage

Reassurance



Before inspecting the residual limb, it is particularly important to gain informed consent from the patient. This may be the first time the patient has acknowledged the visual reality of their lost limb and sensitivity is required.

#### Delayed primary closure (DPC)

In situations of SOD it is likely you will come across DPC. This is an initial amputation performed with delayed attachment of long posterior flap to allow debridement of contaminated tissue. You may also encounter patients who have undergone guillotine amputation without closure in other facilities. The post op direction following DPC will be dependent upon many factors and therefore it is vital to liaise directly with your surgeons. Patients are more likely to be on bed rest with a DPC than a direct closure.

#### Wound

It may not be your role to change dressings but it is important to know time frames and recognise need for intervention when there are: signs of infection, excessive bleeding or following a fall.

Consideration should also be given to drains and infections. Skin grafts on residual limbs or remaining limbs (harvest site) may also complicate the presentation - liaise with surgeon regarding timescales, for example if considering adding compression to a residuum which has been grafted.

#### Elevation

Education on elevation is essential for transtibial amputees but ensure they rest with their knee in extension. Simple pillows can be used. Try to avoid elevating transfemoral amputee stumps on pillows as this can shorten hip flexors.

#### Compression

There are several benefits of stump compression, including:

- Reducing oedema
- Influencing the shape of the stump
- Reducing pain
- Reducing hypersensitivity



Compression socks are included in the rehabilitation equipment -the measurement and application of these will be covered in the practical day **'Early Amputee Rehabilitation in Emergencies'**.

When fitting of a compression sock is not possible then stump bandaging may be considered and this is also covered in the practical day.



USB resources on compression within the Amputation folder include **'Guidance on compression socks'**.



Patient leaflets exist on **'Applying an elasticated bandage'** and **'Controlling your swelling and pain'**.



More information on **compression techniques** can be found through the **e-learning videos**.

### Handling/Massage

Massage can be helpful in reducing hypersensitivity; from day one gentle touch is advised and gradually increase as healing takes place (refer to later section on pain for further details).

This is also useful to improve awareness and acceptance of body image.

### Bed Mobility

#### Bed Mobility

##### Amputee specific considerations:

- Wounds
- DPC
- Bilateral or multi-limb loss
- AKA and sitting balance

#### Rolling

This is useful in both directions, this is an excellent early core exercise and often underused.

especially in bilateral amputees due to their lack of counterbalance. The lie to sit transfer will need to be re-educated. Blocks or locally made equivalents can be useful in practicing this.

#### Prone lying

Once medically stable, it is useful to increase tolerance for remaining in prone to stretch hip flexors. You will need to consider how to accommodate concurrent injuries.

#### Up and down the bed

Bear in mind sliding and shearing forces. Slide sheets may or may not be available, therefore you will need to consider how to reduced shearing forces and friction. Make bed ladders/ropes to aid independence in bed mobility. Also be aware in DPC phase - greater protection of the wound may be necessary, may require log rolling.

#### Lie to sit

As mentioned, transfemoral amputees experience a change of centre of gravity,



Bed mobility and transfers for a variety of amputee patients are covered in the practical workshop '**Early amputee rehabilitation in emergencies**'.



## Exercise

### Priorities from Day 1

- Hip and knee range (if applicable)
- Hip and knee muscle activation / strength

### Other priorities to start ASAP

- Core Strength
- CV fitness
- Upper limb work
- Exercises to aid mobility

### Priorities from day 1

#### Range of movement

Hip flexor length is essential. An amputee will commonly sit in flexion as there is less or no standing immediately post-operatively. Ensuring maintenance of length prior to prosthesis fitting is very important for gait.

- Prone lie can be very useful here.
- If not possible then knee hugs / Thomas test position with opposite leg extended
- If there are concurrent injuries such as pelvic external fixator, the patient can still prone lie between two beds if physically capable

It is also common for people to sit in hip abduction (especially trans femoral amputees), so don't forget the adductors either.

Knee full extension is also a priority as per all orthopaedic principles, maintain knee extension and quadriceps activation when at all possible. Use stump boards to aid positioning in trans tibial amputees in sitting.

### Strength training / Quality of movement

This aspect of rehabilitation will focus on:

- Balancing agonists and antagonists
- Early activation of hip extensor muscles
- Static quadriceps exercises
- Inner range quads (transtibial only)
- Straight leg raises
- Hip extension in side lie and progression to prone lie - ensuring quality of movement as it is a very common mistake to perform this exercise with hip abduction.
- Bridging with piled pillows at back of thighs
- Static adduction -with pillows between legs to start (just be aware of wounds)
- Combined movements- flexion/extension in side lying

### Programme design

- A tailored strengthening program for the residual limb and for the whole body should be
- The programme should be designed having taken into account personal factors of the amputee e.g. age, physical condition before and after the amputation, etc. Each set of exercises should:
  - ✓ Be balanced, including agonists and antagonists muscles exercises.
  - ✓ Increase gradually in number of repetitions and sets, to promote motivation and endurance but not at the detriment of quality.
  - ✓ Include stretching exercises after every session, to avoid retractions. Take into account that different muscle balances will facilitate retractions: e.g. poor positioning + excessive strengthening of hip flexors will provoke hip flexion retraction + absence of hip flexors stretching = retraction in hip flexion.

### Core conditioning

- Core stability exercises are especially important with multiple limb injuries/ patients with higher level amputations
- These exercises can start early, on even on bed rest
- Postural awareness is key, and continues its importance through to prosthetic gait education
- Kneeling is especially good for bilateral trans tibials, 4 point kneeling in later stages is useful
- Hip extension and trunk stability exercises can also be helpful in earlier stages

### Cardiovascular exercises

- Self-propelling in wheelchair
- Throwing and catching
- Balloon tennis
- As a baseline, it is useful to note that lower limb patients will need to stand for 10mins if they are being cast for a socket
- Also do note that unlike NHS settings, no early walking aids are available for pre-prosthetic rehab in the UK IETR settings

### Upper Limb

Function, range and power of the upper limb are often neglected but are key to good outcomes and quality of life

- Shoulder elevation / scapula mobility
- Scapular range is very important if using upper limb for greater function e.g. bilateral lower limb amputee or triple amputee needing to achieve on and off the floor independently.
- Also note that pectoral major / minor tightness is very likely due to greater sitting time and needs to be counteracted

### Mobility exercises

- Start with sitting balance
- Progress to sit to Stand (with and without support)
- Standing balance - be aware if the patient is a vascular amputee in terms of time spent in standin and risks of venous stasis

### Think creatively

- Equipment: Theraband will be available in limited quantities; other ideas are filling cans/bottles with sand/ water to act as weights, or making exercise band from local sources.
- Consider your environment and where it is possible to do exercises - mats on the floor may be more likely in a sub-acute rehabilitation phase in less resourced countries
- Think about what you want to do/achieve and then ask local staff or logisticians if they can think of a way to make/achieve this
- Consider individual vs group therapy if involved in later stages of rehabilitation - consider culture (i.e. in more community based cultures sometimes rehabilitation is more effective in group setting; but in others there will be gender conventions to respect); time constraints and staffing constraints are also considerable factors



Exercise programme design for a variety of amputee patients is covered in the practical workshop '**Early amputee rehabilitation in emergencies**'.

## Transfers, mobility and function

### Transfers, Mobility and Function

#### Transfers

Consider forwards / back transfer in multiple amputees  
Education (falls risk high with phantom limb sensation)

#### Mobility / Seating

Crutches or wheelchair ?  
Other injuries  
Sound foot  
Cognition

#### Function - think outside the box

Toilets, Vehicles, Floor, Kneeling



**If through hip amp think about BOS**

#### Transfers

- Consider buttock wounds and avoidance of shearing forces in all transfers
- Sideways transfers: whilst common, are not always appropriate depending on other injuries
- In bilateral or triple amputees consider forwards/backwards transfer for initial assessment. They are much safer to apply, easier to assist the patient and easier to stop and return to bed if any issues
- Warn the patient about phantom limb sensation and mobility. When the patient maybe disorientated, especially at night time, they may forget about the residual limb and try to stand and walk

#### Seating / Wheelchairs

- Wheelchairs will be available for bilateral amputees
- Bed heights are not adjustable in the field. Consider what other equipment could you use to bridge the height gaps from camp bed to the wheelchair
- Stump boards should be used by all trans tibial amputees in sitting - educate use from day 1
- Through hip amputees: important to look at their sitting position - try to use ways to bulk up one side to ensure trunk alignment.

## Heterotopic Ossification Management



Initially standard treatment is to wait it out, and be aware there is also no agreed prophylactic treatment. Non steroidal anti-inflammatories are sometimes used as a prophylactic, but there is of course an associated gastrointestinal risk with this.

As the rehabilitation professional, you may be the person who identifies its presence. It may not be in the joint or soft tissue near the site of amputation. Consider its impact in patients eg. if it affects the elbow and they require their arms to ambulate.

On discovery of HO you will need to assess the severity of functional disability to

decide on management. Ideally the team will aim for conservative management. Surgeons will try to delay the removal of HO for at least 6 months due to the likelihood of its return. However, this balance will have to be discussed with the surgeon and patient regarding limitations in function. It may also depend on the type of deployment - regarding follow up the team are able to offer. If surgery for removal is required, then six weeks of post op NSAIDs i.e. indomethacin or naproxen is usual. This will require close liaison with your surgeons, and again follow up if the deployed team leave is essential.



Research of note found in the USB resources: **Heterotopic Ossification in High Energy Wartime Extremity Injuries: Prevalence and Risk Factors. Forsberg et al (2009)**

This was a retrospective cohort study of all combat wounded patients over 3 year period (2003-06). n= 1213. It studied those patients who underwent at least 1 orthopaedic procedure on an extremity - either amputation / wound debridement or fracture management. Amongst findings were: 64.6% of patients included developed HO, the location of injuries is a significant predictor of HO and that the Injury Severity Scores were higher in HO group.

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### Crutches

- Crutch walking is advised where appropriate i.e. unilateral amputee
- Educate the patient on phantom limb sensation and the risk of trying to walk and instinctively putting limb to floor with loss of balance
- Consider risks to the sound limb too - especially if there are wounds, other injuries, or if the patient is diabetic

### Don't forget other transfers

- Toilet - here you must be aware of local toileting customs
- On/off floor - especially in communities where using chairs is unusual
- In/out of vehicles
- The patient may need to use a different method for each

### Heterotopic Ossification

#### Heterotopic Ossification

- Formation of mature lamellar bone in non-osseous tissue
- More common with blast amputation
- If the final amputation is in the zone of injury increases the likelihood

Heterotopic ossification (HO) is the formation of mature lamellar bone in non-osseous tissue. There are two forms - but 'acquired HO' is most common. It is a condition commonly observed following spinal cord injury, traumatic brain injury, total hip arthroplasty, substantial burn injuries, acetabular or elbow fractures. Unfortunately little is known regarding its molecular pathogenesis, but we do know that it can be a cause of residual limb pain in amputees.

HO can have a severe impact on rehabilitation, it can develop within weeks

post injury or surgery. Its development can lead to tissue breakdown / infection / pain / alterations in stump shape / and difficulty to wear prostheses in the future. In blast injury scenarios the surgeons have a difficult balance in deciding how high to take the amputation versus the risk of the development of HO which can be high in these high velocity injuries.

HO can also occur in joints that are not directly affected by the trauma e.g. the elbow. So ensure you monitor the ROM in all joints.

### Pain in amputees

Pain is an inevitable consequence of amputation and for many, pain will not just result from the trauma of the surgery, but will also include a neuropathic presentation known as phantom limb pain (PLP). When amputation has resulted from a traumatic incident, such as in a disaster setting, this can also be complicated by additional injury to the same limb or other parts of the body. For the physiotherapists involved in the early and post acute stages of rehabilitation, the challenge is determining the nociceptive and neuropathic causes of pain which require attention in order to manage the patient and so enable effective rehabilitation to occur. Effective pain management requires a collaborative, multi-disciplinary approach.

Assessment should seek to establish the principle drivers of the PLP. These may be centrally driven adaptation, peripheral sensitisation, psychological or social concerns, and musculoskeletal factors. Treatment should target these drivers. See table 2.2 by Le Feuvre and Aldington (2014) in the manual for more detail and suggested treatments.

Objective Measurement: In addition to identifying the area of pain, knowledge of pain intensity is helpful. The 0-3 Visual Analogue Scale (table 2.1) is an easy to administer scale which highlights where intervention is required. It is also easy to fit it with the WHO pain ladder as demonstrated below. In short, scores of 0 and 1 (nil to mild pain) require no intervention, 2 and 3 (moderate to severe) requires immediate action.

**Table 2.1: The 0-3 Visual Analogue Scale**

Pain Score	Level of Pain	Analgesic Action
3	Continuous pain at rest, severe on movement	Morphine (or other strong agent) and consider those below
1	Mild pain at rest, moderate on movement	Weak opiate/NSAID and consider those below
2	No pain at rest, mild on movement	Paracetamol
3	No pain at rest or on movement	None

**Note: The action suggested is only a suggestion and does not subsume non-pharmacological interventions**

Adapted from: Looker J, Aldington D 'Pain Scores - As Easy as Counting to Three'. J R Army Med Corps 2009; **155**: 1 42-43

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## Phantom Limb Pain

- Understand the interplay and difference between:
  - Phantom Limb Pain vs Phantom Limb Sensation
  - Post Amputation Pain
  - Residual Limb Pain
- Identify the principle drivers of pain:
  - Look for signs and symptoms of central adaptation
  - Assess factors which might be contributing to peripheral sensitisation
  - Understand the role of psychological and social factors
  - Conduct a MSK assessment to adjacent joints and movement mechanics
- A treatment plan must involve the MDT, it should be individual and it should target the dominant drivers of pain.

When treating a patient with phantom limb pain (PLP), the assessment must establish the principle driver(s) of the pain. In other words, what is the principle cause? However first you must accurately identify PLP.

It is important to note that the language used to describe pain may differ considerably dependent upon the nationality and culture of the patient.

**Post-Amputation Pain:** Post-amputation pain at the wound site should also be distinguished from pain in the residual limb and the phantom limb. After amputation, all three may occur together

**Residual Limb Pain:** PLP is often confused with pain or sensation in the areas adjacent to the amputated body part. This is known as residual limb (RLP) or stump pain and its intensity is often positively correlated with PLP.

**Phantom Limb Sensation:** This is a normal experience for the majority of amputees, but it is not a noxious sensation, and is not described by the patient as unpleasant. In such cases re-assurance is the key.

**Phantom Limb Pain:** Classified as neuropathic pain, whereas RLP and post-amputation pain are classified as nociceptive pain. PLP is often more intense in the distal portion of the phantom limb and can be exacerbated or elicited by physical factors (pressure on the residual limb, time of day, weather) and psychological factors, such as emotional stress. Commonly used descriptors include sharp, cramping, burning, electric, jumping, crushing and cramping.

The assessment should then seek to establish the principle drivers of PLP, these may be centrally driven adaptations, peripheral sensitisation, psychological / social factors, and musculoskeletal factors. Treatment can then target these drivers.

### Phantom Limb Pain: Take Home Tips

- Eliminate or manage irritants such as poor dressings, stump oedema, prosthetic causes etc.
- Differential diagnosis: HO / neuroma / infection / DVT / MSK
- Combine techniques which tap into both the central and peripheral nervous system (e.g. massage whilst using mental imagery)
- Early and effective analgesia so the patient can *WORK, REST AND PLAY...*
- Aggressive use of anti-neuropathic medication from day one.
- Psychological: Assess role of memory, anxiety, social stresses, sleep hygiene as a provoker of symptoms.
- An MDT driven pain management plan is gold standard.
- EDUCATION, EDUCATION, EDUCATION

Simply discriminating between RLP and PLP is more complex than it appears. Both often coexist and RLP may provoke PLP.

Eliminating the causes of RLP is therefore the priority as this will resolve or lessen PLP which is responsive to peripheral aggravators. It also shows the degree to which central factors may have an ongoing influence.

#### **Eliminating causes of RLP - Intraoperatively**

Guidelines, including the UKIETR anaesthetic guideline, recommend ketamine intraoperatively, as well as local anaesthetic infiltration of sciatic and femoral nerves.

#### **Eliminating causes of RLP - Immediate post-amputation**

Early effective conventional analgesia is essential, including neuropathic pain control. UKIETR guidance recommends perioperative administration of gabapentin (although it is worth noting that gabapentin can take up to four weeks to take effect).

Adjunctive measures include managing oedema using elastic stump socks, semi-rigid dressings or rigid plaster casts.



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## Eliminating causes of RLP - Post-acute management

This requires attention to both intrinsic and extrinsic causes of RLP:

### Extrinsic Causes of Residual Limb Pain

RLP will result from complications of wound healing and so infection must be excluded.

Tissue load and sheering forces placed on the limb due to a poor prosthetic fit will also evoke pain.

Scar formation can also cause pain, particularly where there is nerve entrapment, or adhesions reducing the mobility of soft tissues. In either case, scar management using soft tissue massage and moisturiser is recommended; silicone treatment can also be added if required although unlikely to be available in SOD situations.

Besides improving tissue mobility, massage can be used to desensitise the residual limb.

### Intrinsic causes of Residual Limb Pain

Can include ischaemia, joint dysfunction proximal to the residual limb, stress fracture, osteomyelitis and wound dehiscence.

Occasionally where the bone has been improperly trimmed or HO has occurred, then pain may result in high-pressure areas. Investigations will be required and revision surgery may be considered; alternatively, prosthetic adjustment can be used to unload pressure areas.

Neuroma is the most common cause of intrinsic RLP. Ectopic discharge may evoke a neuropathic response causing Phantom Limb Pain. Neuroma formation after amputation is normal, but when it becomes sensitised to mechanical or chemical stimuli, often exacerbated by entrapment, then problems ensue. Pain is intermittent and variable, but diagnosis is confirmed by a specific site of tenderness on palpation,

which can be confirmed with an injection of local anaesthetic into the site. Surgical referral can be considered, but massage, vibration, acupuncture and transcutaneous electrical nerve stimulation (TENS) may also effectively desensitise the area. It is also worth excluding muscle tension / spasm as a cause by assessing local and trigger points within the soft tissue.

Combining physical and occupational therapy with a cognitive understanding of the condition will amplify the effects of treatment. Our management should aim to equip and empower the patient, informing them about their condition and how they can take control while seeking to alter destructive or erroneous beliefs and actions.

## Techniques to reduce PLP

Common self-treatment strategies can include wearing an elastic stump sock to minimize volume changes in the residual limb, stump massage, mental imagery of the phantom limb and taking physical exercise.

### Visualisation of limb movement and prosthetic:

especially important in the case of upper limb amputees. Joint dysfunction proximal to the residual limb and prosthetic fit will however undermine this effect. Good prosthetic use is vital here if applicable.

**Normalising the gait pattern:** in part, is due to prosthetic fit and alignment. It is also dependent on good proprioception, correct motor patterning and symmetrical movement control enabling dissociation of movement between trunk and limb. In turn, the residual limb(s), trunk and spinal segments must have sufficient range and control of movement to achieve a symmetrical gait pattern.

Where limb wearing is not possible, the therapist should engage their creativity to seek ways of simulating visual and even motor stimuli in order to mimic the use of the limb.

### Mirror therapy

This is a therapeutic intervention which has been shown to affect motor and sensory processes through the relative dominance of the visual input it provides.

The effect is created by viewing a reflection of the intact limb through a mirror placed where the amputated limb would have existed. Most of the evidence for this intervention comes from case studies and anecdotal data with only a couple of well controlled studies.



### Graded motor imagery

Moseley argued that while mirrored movements may expose the cortex to sensory and motor input, the therapeutic

effect is magnified if cortical networks are gradually activated using limb recognition, motor imagery and finally, mirrored movement. This sequence of cortical exposure has become known as graded motor imagery. Clinicians wishing to add this programme to their treatment repertoire can find resources at <http://www.noigroup.com>.

### Medication

We have touched on some pain medication recommended for amputee patients, but while pharmacological agents can be of use, the way they are used is even more important. Pharmacological agents are not going to remove all pain. What really matters is that the agents enable the patient to 'do more'. In this way they can be likened to the old confectionary advertisement that suggested it allows you to 'work, rest and play'; the point being if the pharmacological agents do not have this action there is no point taking them. Often a good starting point is to enable good sleep. You can always have a good night after a bad day, but never a good day after a bad night.



Further information and techniques for treating PLP and graded motor imagery will be explored in the practical day 'Early Amputee Rehabilitation in Emergencies'.



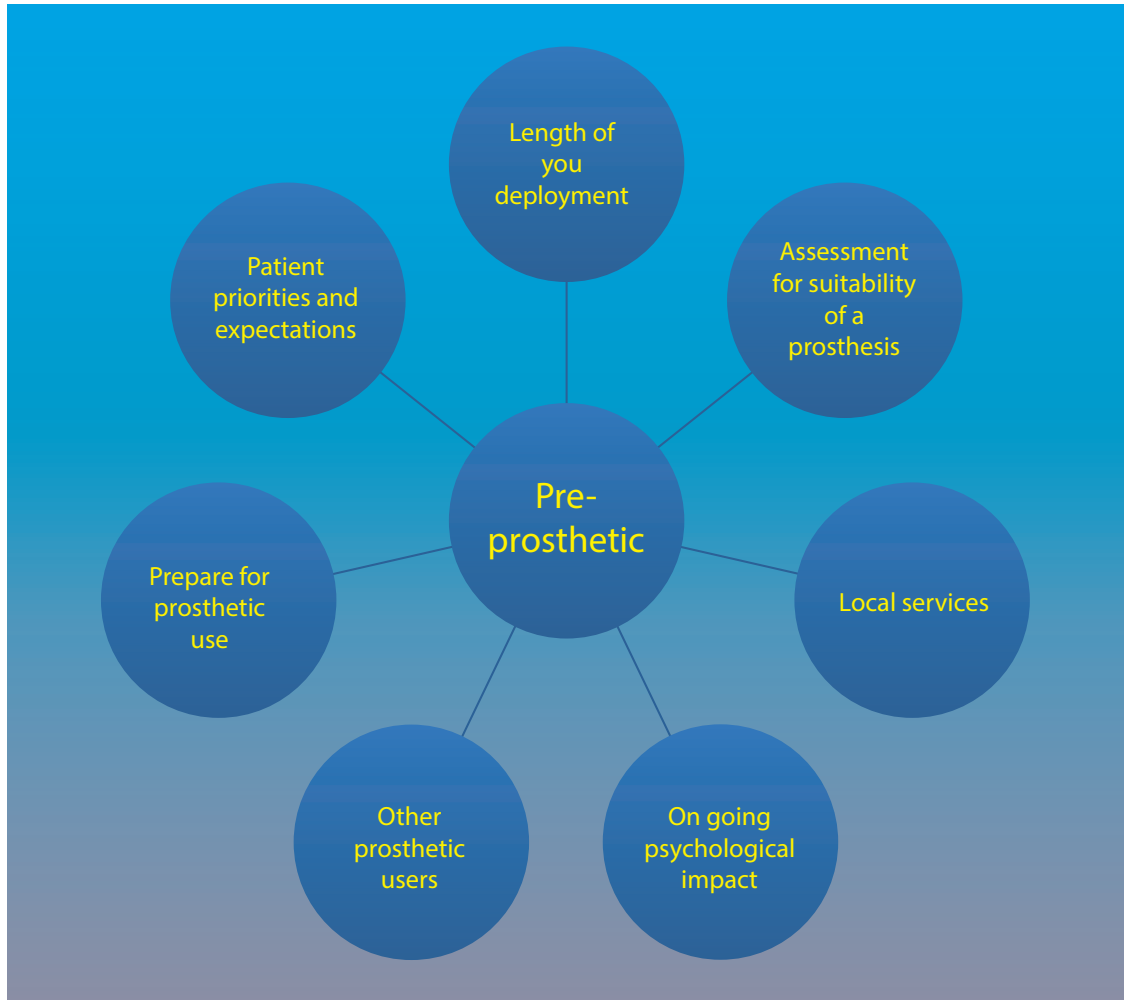
Further information on phantom limb pain, including a table of potential drivers of PLP and treatment options can be found in the document 'Phantom limb pain: key messages' on the USB

**Table 2.2: Summary of assessment process and treatments for phantom limb pain**

<p><b>HISTORY</b></p> <ul style="list-style-type: none"> <li>■ Is it pain or sensation?</li> <li>■ Description of symptoms (electric shock / burning / twisting / crushing / cramping)</li> <li>■ Location (stump end / residual limb / phantom limb)</li> <li>■ Intensity of pain recorded on the Brief Pain Inventory (BPI)</li> <li>■ History of onset</li> <li>■ 24 hour pattern</li> <li>■ Provocation / Irritant Factors (dressings / prosthetic fit / temperature / diet / infection)</li> <li>■ Drug History (including any side effects)</li> <li>■ Anxiety / Patient Beliefs / Sleep</li> </ul>	<p><b>EXAMINATION</b></p> <ul style="list-style-type: none"> <li>■ Examine skin for warmth, swelling, signs of infection</li> <li>■ Examine stump end - consider HO / Neuroma (specific point of pain) / wound breakdown</li> <li>■ Range of movement of residual limb(s)</li> <li>■ Power of residual limb(s)</li> <li>■ Examine sources of musculoskeletal referral (lower back / hip / cervical spine / shoulder)</li> </ul>	
<p><b>INVESTIGATIONS</b></p> <p>X-Ray CT / MRI Scan Nerve conduction testing Bloods Arterial Swab or wound Ultra-sound</p>	<p><b>PHANTOM LIMB PAIN PATHWAY</b></p>	<p><b>DIFFERENTIAL DIAGNOSIS</b></p> <p>Residual Limb Pain Heterogenic ossification (HO) Infection Neuroma / Neural tethering Hysteria or malingering Deep vein thrombosis Musculoskeletal injury</p>
<p><b>FIRST LINE PHARMACOLOGICAL TREATMENT</b></p> <p>Amitriptyline: 25mgs up to 100mgs at night*</p> <p>Pregabalin 75mgs bd up to 300mgs bd</p> <p>*Higher doses and alternatives are possible following specialist advice</p>	<p><b>PSYCHOSOCIAL SUPPORT</b></p> <p>Pre-existing or concurrent psychological or psychosocial issues may present, and PLT may itself precipitate psychological problems.</p> <p>Management options:</p> <ul style="list-style-type: none"> <li>■ cognitive behavioural therapy</li> <li>■ family / social support</li> <li>■ EDMR</li> </ul>	
<p><b>PHYSICAL AND OCCUPATIONAL THERAPY (in no particular order)</b></p> <ol style="list-style-type: none"> <li>1. Irritant Management: Attend to or highlight causes: (dressings, infection, swelling, drug side effects, prosthetic fitting, HO, neuroma, adhesions)</li> <li>2. Application of compression to residual limb (Juzo, tubifast, prosthesis)</li> <li>3. Education and re-assurance (10)</li> <li>4. Limb massage / De-sensitisation</li> <li>5. TNS Machine</li> <li>6. Physical Exercise</li> <li>7. Scar Management</li> <li>8. Graded motor imagery (Laterality - Motor imagery - Mirror Therapy)</li> <li>9. Acupuncture</li> <li>10. Cognitive Behavioural Therapy (CBT)</li> <li>11. Heat / Ice</li> <li>12. Relax Sock</li> <li>13. Trigger Point release in the residual limb</li> </ol>		

From: Le Feuvre P, Aldington D. Know Pain Know Gain: proposing a treatment approach for phantom limb pain. J R Army Med Corps 2014; 160(1):16-21

### Considerations for pre-prosthetic phase of rehabilitation



If you are considering a patient for a prosthetic limb, the following are some key points to consider in situations of sudden onset disaster:

#### **Length of your deployment**

How much can you realistically do within the time that you are deployed for? Is your time better spent creating links and making referrals to ensure long term follow up for this patient

Think about good handovers for patients if you are leaving and other staff are replacing you - especially in terms of treatment and management plans which will include whether or not referral for a prosthesis is necessary.

#### **Assessment for suitability for a prosthetic limb**

It is important to always bear in mind whether the amputee you are treating would benefit from assessment for a prosthetic limb.

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### **Find out the prosthetic centres available**

Be aware that there may not be any prosthetic facilities locally (or sometimes nationally), but if there are local centres then remember you will not be the therapist to make the final decision about whether or not a patient receives a prosthetic limb - this decision will be made by the prosthetic centre staff. Therefore do not promise any patient that they will definitely receive a limb.

Find out if the prosthetic centre has an outreach team that visits the hospital. Find out referral times and how you refer patients to these services. Find out about their services - i.e. how much input they can give, their time frames for casting for a limb and providing one - so you can explain this to your patients and give clear expectations. Remember you may need to build their trust in rehabilitation as a profession.

### **Consider ongoing psychological impact and need**

Always consider and be aware that this may be an issue at any stage post amputation and be aware of psychological needs and your own professional limitations in managing these needs. Refer on as indicated where services are available. Often information of psychosocial services is available from Handicap International response teams or from the Health Cluster.

### **Patient priorities and Expectations**

We have used the term patient priorities rather than patient goals intentionally. Although we always should consider what a patient would like to achieve in rehabilitation i.e. the patient goals, we wanted to reflect that when deployed you will likely have a short time frame with you patients and so the emphasis of rehabilitation will most likely be with regards to safe discharge and optimal function.

### **Is your patient suitable for a prosthesis?**

You will not be expected to make an ultimate decision as to whether a patient does or doesn't get a prosthesis - but you need to know the aspects of a patient that would indicate whether a referral should be made for full assessment by specialist therapists and prosthetists for prosthetic limb(s).

- 'Never say never' - there are many examples of patients who seem unlikely candidates for prosthetic limbs who do make good progress.
- It is easier for TTA (transtibial amputees) than TFA (transfemoral amputees) to be a prosthetic user and easier if only one limb is affected as opposed to multiple limb loss.
- Similar criteria are used to assess both TTA and TFA for both.

## Amputee Rehabilitation

The diagram below indicates the wide range of factors impacting upon a patients' potential suitability for a prosthetic limb. Take each case

individually looking not only at each individual factor but also the interplay between each factor ensuring a holistic assessment.



### Factors to consider when thinking through suitability for a prosthetic limb:

The following factors would be indicators for successful prosthetic use:

#### 👍 Independent mobility with appropriate aid

The patient is completely independent using their wheelchair indoors and understands the importance of safe wheelchair drills, e.g. breaks on, positioning of chair, removal of stump boards and footplates etc. (if you have access to a wheelchair this is). This would also include if a patient is hopping with 2 crutches

#### 👍 Independent transfers

The patient can transfer independently from wheelchair/chair to bed/chair/toilet and back using a standing pivot transfer.

#### 👍 Ability to stand

The patient is able to push up from sitting in wheelchair to standing independently in parallel bars. The patient has independent standing balance within the parallel bars (patients may need to stand for up to 5-10mins for prosthetic casting)

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**👍 Adequate range hips and knees**  
The patient has hip (and remaining knee) flexion contractures less than 25°

**👍 Good muscle power**  
Muscle strength is over 4/5 in all limbs on the MRC scale

**👍 Cognition and insight**  
The patient is cognitively intact. i.e. able to follow instructions, process new information and remember it over a period of time. Further assessment by the MDT may be required for this

The following factors may indicate difficulties with prosthetic use (however each factor alone would not necessarily mean that a patient should not be referred for prosthetic limb assessment):

**👎 Poor hand dexterity/UL loss**  
The patient has difficulty/inability to manage Velcro fastenings, straps or knee locking mechanisms on prosthetic limb(s)

**👎 Current function**  
The patient is unable to wash and dress themselves independently

**👎 Stump oedema/shape**  
There is excessive oedema will impact upon prosthetic fit

**👎 Stump length**  
A too short stump will give difficulties in controlling the prosthesis and technical problems to fit it (belts and other devices will be necessary). A too long stump can give technical problems in alignment and prosthetic components

**👎 Multiple amputee and other traumatic injuries**

Prosthetic use is more difficult for the multi amputee (especially the more proximal the amputation). Note that injuries where soft tissue loss and skeletal injury nerve repair may delay prosthetic fit

**👎 Past Medical History**

Diabetics may have reduced sensation in stump due to peripheral neuropathy and therefore may need close monitoring and education of wound and checking stump condition with prosthetic use. Other pathologies such as stroke, Rheumatoid Arthritis, Osteoarthritis, respiratory problems and poor cardiovascular (CV) state will impact upon prosthetic use making it more difficult. E.g. increased CV requirements to enable prosthetic use due to increased energy expenditure using a prosthetic limb.

**👎 Discharge destination**

May impact upon the functional gains a prosthetic limb may have, especially if terrain is poor and inclines steep

**👎 Heterotopic ossification**

Can lead to pain and skin breakdown with prosthetic use

**👎 Open Wound**

These are not for prosthetic use until the wound is fully healed. Please liaise with surgeons for guidance regarding appropriate time to commence prosthetic use regarding wound



**Helpful web links for further information:**

Temporary adjustable socket

South Thames Region transfemoral inclusion/exclusion criteria

### Preparation for prosthetic use

#### Preparation for prosthetic use

##### Stump Conditioning

- Ongoing desensitization of stump
- Scar massage

##### Weight bearing exercises

- Tolerance to pressure

Having assessed that our patients are likely to be suitable for a prosthetic limb there are a few additional treatment methods which will supplement those already discussed. (Do however note that these may also be helpful in those patients that are not suitable for a prosthetic limb).

##### Stump conditioning - desensitization and scar massage

- The lower part of the stump and sometimes the bone close to it (especially in TTA) should be prepared for weight bearing and to be in contact with prosthesis. If the stump is not prepared for prosthetic use this can cause discomfort and pain due to hypersensitivity
- Different surfaces and textures can be used to increase the tolerance of the stump to close contact with the future prosthesis: cotton balls, paper balls, straw balls, wooden balls or rice could be gradually rolled around the stump for this purpose
- Similar problems can occur with prosthetic use if the scar from the amputation is adherent. This can cause pain and wound break down with prosthetic use

- Educating patients on deep scar massage to manage this is therefore recommended. Massage the scar in all directions beginning gently and working deeper as tolerated

##### Weight bearing exercises - tolerance to pressure

- In order to prepare for prosthetic use - in patients with through knee, symes and transtibial amputations - it is important to incorporate weight bearing exercises into programs
- Through knee and symes amputees can weight bear on the end of their stump. Transtibial patients should not weight bear through the distal end of their stump but can weight bear through a flexed knee to provide proprioceptive feedback through the hip and to assist with stretching hip flexors
- Weight bearing can be practiced on any surface. Begin on a softer surface such as a cushion and gradually increase the firmness of the surface as tolerated
- Only complete these exercises when the scar is fully healed



Desensitisation, scar massage and weight bearing exercises are covered practically in the one day workshop 'Early amputee rehabilitation in emergencies'.



## Managing expectations and education for prosthetic rehabilitation

- Provide information gradually
- Local services may have a big influence
- Commitment
- Patient priorities

Good communication, use of translators and finding time to speak with patients and their carers is vital in ensuring their expectations are realistic and they are equipped to follow your advice. Remember when they leave your care, there may be some time before they encounter another rehabilitation professional.

### Provide information gradually

The expectations around a prosthetic leg are usually very high, and are many times not fulfilled. We need to provide realistic information about prosthetics gradually, in order to prepare the amputee for the fitting. This means including this information as we are talking to patients pre operatively, post operatively and pre-prosthetically.

### Local services may have a big influence

There may not be any prosthetic facilities in the area that you are deployed to - therefore make appropriate enquiries and ensure you know what services are available, at what cost, and in what time frame to whom.

### Commitment

It is important that the amputee understands the commitment required for prosthetic rehab - most of the rejections occur after finding the difficulties of using a

prosthesis as something unmanageable. This will be especially important for our more complex amputee's as prosthetic rehab for these patients will likely be slow stream, possibly intense and therefore require lots of available time to commit to rehab and motivation to continue with rehab.

It's important patients recognise that a prosthetic limb is not a "new leg", it is a walking device, a tool used to walk which requires their effort and own muscle strength to control. As any other tool, it will need time to learn how to use it. This will be done through training and rehab.

An amputee who walks the same distance as a non-amputee will have a higher level of oxygen consumption and thus energy consumption. For example, quoted figures for amputees with vascular deficiencies compared with non-amputees indicate an increase in oxygen consumption for:

- below-knee amputees from 9% to 20%
- above-knee amputees from 45% to 70%
- bilateral above-knee amputees up to 300%

As you can see - it takes more energy to mobilise the higher the amputation and higher still for bilateral lower limb patients.

## Amputee Rehabilitation

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### Patient priorities

We need to establish early on what our patients' goals are and help them to think through whether using a prosthetic limb would aid achieving these goals.

We also need to establish whether or not our patients' want a prosthetic limb and if they do - what their expectations are of using one.

### Measuring outcomes

Whilst there are no specific patient group outcome measures recommended by the UK IETR, it is useful to highlight a couple of amputee specific ones for reference.

When considering using a specific outcome measure, do consider whether it is valid for the purpose and the population, and how relevant it is to the context, and importantly whether those continuing the patient care will be able to use it.



BACPAR has created a '**Toolbox of Outcome Measures for Amputees**', which is available **online here** <http://bacpar.csp.org.uk/publications/bacpar-outcome-measure-toolbox-version-2> and on the USB.

### One such outcome measure is the Amputee mobility predictor questionnaire

This is an easy to administer outcome measure assessing function.

It is however, limited in that most of the assessments require the use of prosthetics, and within a sudden onset disaster situation

your time commitments and surrounding will not be suitable for such a detailed assessment. It is worth however looking at this document for reference.

### Discharge planning for amputees in sudden onset disasters

#### Discharge planning

- Potentially early discharges vs long term stay patients
- Know patients discharge destination
- Family and community support?
- Education
- Adaptations
- ADL's
- Follow up?

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In the introductory chapter we have already covered some of the main challenges of discharging a patient in a sudden onset disaster scenario. Amputee patients can be among some of the more complicated patients to arrange discharges for, especially if they have associated polytrauma.

**Education** is vital to an amputee patient, their family and possibly even the wider

community they are a part of. This is essential to helping the patient self-manage their condition and to regain as much functional independence as possible. Important areas to address would be wound, oedema and pain management; exercise and maintaining functional independence; management of other injuries and co-morbidities; and safe use of mobility aids.



Do not forget to issue and talk through patient leaflets on 'Oedema and pain control', 'Bandaging your stump' and 'Keeping active' which are all available on the USB resource stick.

### **Equipment and Adaptation**

You will have established whether your patient is a priority for mobility equipment, and may have to consider what adaptations need to be made - if this is possible with the equipment and facilities at the hospital deployed to. Think through meaningful function to the patient, always thinking through what will promote maximum independence. Wheelchairs may or may not come with leg extenders, in which case stump boards may need to be found for transtibial amputee wheelchair users. Logisticians will be deployed with surgical field hospitals and it is possible to liaise with them to procure items which can be adapted if not available in the equipment module.

### **Follow-up**

Finally it is essential that you ensure appropriate referrals are made, or at least that contact details are taken for patients to receive meaningful follow-up from whatever rehabilitation services are available in the region. Whilst other rehabilitation services may not have become fully operational by the time your deployment ends, you, or another member of the team may make a retrospective referral if you have all the patient information to hand. Ensure you gain consent for this referral, give patients the contact details themselves and if referring for prosthetic assessment, ensure the patient and their family are aware it is just this - and does not automatically entitle them to a prosthesis.

### Considerations for Upper Limb Loss

#### Learning outcomes

To be aware of specific rehabilitation considerations for patients with upper limb loss

### Pre-amputation and decision to amputate

- UL vs LL figures
- Anatomy, movement, purpose and function
- Single/double UL/multiple limb loss and other injuries?
- Assessment - as per pre-amp phase
  - Neck and back
- Livelihood, family, survivors
  - Hand dominance and functional ability of potential remaining arm
  - Bilateral UL loss - Ax of LLs

UK upper limb amputation figures are small (i.e. 1 in 20 amputees (NASDAB, 2007)) and consequently many therapists have minimal exposure and experience. Trauma is the commonest cause; the low incidence in the UK is influenced by health and safety regulation. In disaster situations however, acquired upper limb amputations are likely.

In considering the *effect* of an upper limb (UL) amputation on function, it is worth remembering the anatomy, mobility, purpose and function of the UL. In particular the hand e.g. *prehensile* (i.e. gripping, grasping) and *non prehensile* (i.e. manipulation, pushing with hand or digits).

The principles of upper limb salvage approach are as outlined earlier e.g. MESS, TRISS. As the rehabilitation professional, you may well be required to liaise with surgeons on level of amputation, prosthetic realities and function. It is worth referring to the earlier tables on advantages and disadvantages of each level within this manual.

Other consideration would be if the upper limb injury is isolated or associated with multiple injuries and/ or multiple limb loss? Check if there is an associated peripheral nerve injury.

Trauma with a brachial plexus avulsion injury will leave mixed muscle and sensory activity, and potentially a flail and desensate arm. With this type of injury it is recommended to wait until 2 years, if there is no improvement, amputation at mid humeral level with shoulder arthrodesis is suggested (Carnegie, 1999).

#### Assessment

For assessment principles for UL amputees see the pre-amp and post-amp phase sections of this chapter.

Specific focus in UL amputees should be to proximal joint ROM including neck and back, muscle strength, soft tissue intactness, sensation e.g. scarring, burns.

It is also worth considering the pre-morbid work situation (was it manual work?), the patients' family role and other survivors - this may determine goals and priorities for immediate treatment.

Cultural sensitivity should be used, consider the patients psychological state and that the impact of UL loss is considerable, in some cultures more than others.

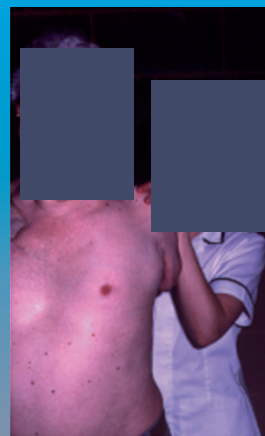
In addition note hand dominance - the physical ability of the 'sound' limb is critical as it will become dominant eventually.

If you have a patient with bilateral limb loss, ROM in the lower limbs, trunk, and particularly dexterity of feet is vital - as lower limbs may be needed to support PADLs.

### Pre-amputation phase

#### Pre-amputation and decision to amputate

- Treatment (where practical)
  - ROM and muscle strength
  - Functional activities 'dominant' arm
  - Explanation of post-amputation management
  - Expectations
- Prosthetic services?
  - Early input
- Meet another?



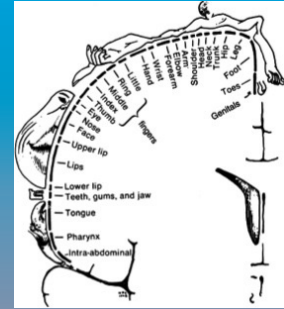
It may be that treatment is possible once the decision to amputate has been made. These principles overlap with principles of post-amputation treatment.

- Pain and situation permitting, maintain and/or increase proximal joint ROM and muscle strength both arms, to improve practical function (prosthetic or without prosthesis) and prevent overuse injuries in what will be remaining arm
- In anticipation of transhumeral prosthetic use - pre and post amputation - incorporate scapular movement e.g. protraction and retraction
- Incorporate functional activities in the 'dominant' arm and lower limbs if necessary

- Give a thorough explanation of post-amputation management including reassurance around RLP and PLP
- Start to address patients' expectations - if you can access realistic and context appropriate videos of UL amputees, and look at likely challenges and priorities. Avoid over expectations, a lot can be achieved with modest devices
- Look at the prosthetic services available locally, and do check that they offer UL prosthetics, establish links as early as possible. We would aim for, where possible, early prosthetic mobility; anecdotal evidence suggests that the earlier prosthetic rehab, the better the outcome.

#### Post-amputation management

- Wound care and oedema control - as with LL
- Pain management - as with LL
  - Stump handling (desensitisation)
- Psychological support
  - Impact of digit loss only can be significant



Wound care and oedema control can be addressed with the same principles as the lower limb, but there is less 'risk' associated with bandaging upper limb amputees.

**Pain management** should also be an area of priority.

Encourage residual limb handling and desensitising - this can help towards adjustment to changed body image. Note that PLP can be more common in the UL. Remember the relative representation of the hand on the homunculus and proximity to the face as shown in the diagram above. Thus PLP experienced by the UL amputee can be associated with facial sensations.



There are some useful references to pain management in upper limb amputees in the document '**Phantom limb pain, key messages**' on the USB.

## Psychological support

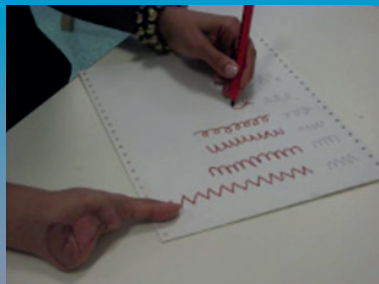
Don't under estimate the impact of UL loss; irrespective of level, this can be devastating to the patient to their status and raise certain challenges within their particular

cultural context e.g. eating, toileting. Remember in most cultures, the hand is an expression of personality and character as well as being critical for independent living.

## Post upper limb amputation management

### Post-amputation management

- Mobility and strength
- Functional, bilateral patterns of movement
- Avoid one handedness
- Fixing and stabilising



Alongside basic post amputation principles mentioned earlier in the chapter, you must try and maintain and/or increase joint ROM and muscle strength in both arms to improve practical function (prosthetic or without prosthesis). For example, Proprioceptive Neuromuscular Facilitation (PNF) facilitates functional movement patterns e.g. hand to mouth.

It is important to prevent overuse injuries in what will be the remaining UL. Include the whole shoulder girdle, thoracic and cervical spine (neck movements can be vital to hold items and assist in function).

Encourage bilateral symmetrical movement especially through function e.g. lifting. Patients may avoid using the residual limb and the amputee becomes one handed and increases risk of overuse.

As the wound heals, use the residual limb to fix and stabilise objects to aid ADLs (activities of daily living) e.g. transradial/ partial hand residuum to fix paper to allow remaining hand to write.



The document on the USB '**One handed dexterity exercises**' is a useful resource for unilateral upper limb amputees

### Post-amputation management

- Posture, gait and mobility for high UL loss
- Activities of personal daily living
  - Problem solving skills
  - Adaptive aids
- Impact of level on non prosthetic functional independence



#### Posture, gait & mobility

It is important to minimise postural deviations with high level upper limb amputees. You should be aware of postural compensations that are common e.g. shoulder elevation and retraction in trans-humeral amputees.

Work on balance & core with high level upper limb amputees - running, hopping and turning are good examples.

#### Activities of daily living

Activities of personal daily living (PADL) e.g. dressing, eating, toileting will need addressing. Try and facilitate problem solving skills at all levels of UL loss.

You may need to consider straps, or gauntlets to fit cutlery, writing implements, pointers for phones and remote controls if appropriate. Use your own problem solving skills to create aids, particularly in low resourced settings. Keep these aids simple but purposeful.

The use of non-slip materials (such as Dycem) can be useful in assisting tasks in better resourced settings.



The practical workshop '**Early amputee rehabilitation in emergencies**' will cover basic rehabilitation principles and problem solving for upper limb amputees, as well as making simple gauntlets and PADL aids.



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Finally, consider the impact of different levels in terms of functional independence prior to any prosthesis: a transradial amputee can achieve good level of

independence, whereas a trans humeral amputee will probably not be fully independent as higher levels are more challenging.

## Post-amputation and pre-prosthetic management

- Aim for early prosthetic use
- Motivation
- Hand dominance
- Overuse injury (Jones et al 1999)
- Multiple amputee - PADL and priorities
- Relate therapy to personal goals and priorities



Early prosthetic use is advised where possible, patients are more likely to adapt, and otherwise they become one handed with less motivation to use a prosthesis. Motivation is essential if patients are planning to use a prosthesis. Amputees with lower limb loss often choose to wear prostheses but those with UL loss often don't use prosthetic arms, especially children.

Hand dominance is key, as the remaining limb is responsible for all fine motor and dexterity tasks now, and there is a greater challenge if the remaining limb is not already dominant. Therefore dexterity, practice writing and functional tasks are essential.

Continue to be wary of the associated risk of overuse injury. This can occur in any proximal joint, in the remaining arm and in the back, neck and lower limbs; it is more prevalent in higher level UL amputees. There is minimal research evidence of overuse injuries in UL amputees (Jones et al 1999), but this demonstrates altered biomechanics in the UL amputee and found examples of capsulitis, bursitis, epicondylitis, carpal tunnel syndrome and tenosynovitis. Treating overuse injuries should be with rest, 'pacing' and goal setting, postural advice and addressing body mechanics, immobilisation, splinting, thermal modalities, ultrasound, NSAIDs, steroid injections, friction massage, stretching, mobility and strengthening. Really, treat as one would in the non amputee with an overuse injury (according to Gambrell 2008).

### Top Tips

- PADL and function
- Impact of level on function - with or without prosthesis
- Aim for early prosthetic activity
- Minimise risk of overuse
- Focus on individual's priorities
- Sensitivity towards body image and culture
- See additional resources eg notes of upper limb amputation

If you have had limited exposure to upper limb amputees, use the **cheat sheet** provided as a prompt for your assessment and treatment planning and follow the top

tips in the slide above. There are many resources available on the USB stick, in addition to those signposted in this manual.

### Considerations for Children

#### Learning outcomes

To be aware of specific rehabilitation considerations for children with traumatic amputation

Rehabilitation of the child with acquired amputation i.e. trauma, will depend on their age (including developmental maturity), the cause of amputation (including other injuries or pre-existing disability), their personality and family support.

The principles of assessment, treatment and management are the same as with the adult but with approaches appropriate to the age of the child e.g. through play, ADL, sports, and with parental involvement. Most children will learn to walk with a prosthesis with little difficulty.

Dormans et al (2004) highlights particular challenges associated with managing the child vs the adult with an acquired amputation:

1. The child's bones continue to grow
  - Discrepancies in limb length become greater with time. Therefore it is important to preserve as much length as possible
2. Children heal better than adults
  - Potential for greater success with surgical techniques aiming to preserve limb length e.g. use split skin grafts, rotational flaps

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### 3. Risk of bone overgrowth

- Disarticulation level is recommended where possible to preserve the growth plate. The distal femoral growth plate provides 70% of growth of the femur and an amputation at transfemoral level in a young child can result in a disproportionately short residual limb and can lead to prosthetic problems. Disarticulation also avoids terminal bony overgrowth - the most common complication in skeletally immature children
- Bony overgrowth occurs when the soft tissue surrounding the residual limb contracts as the bone grows (where the growth plate is absent), resulting in pain and potential protrusion of the bone end through the skin. Surgically this is managed by revision (with resultant shortening of the residual limb but with the risk of bony overgrowth re-occurring) or via biological 'capping'. Careful prosthetic management can accommodate a degree of bony overgrowth

### 4. Children face different emotional and psychological problems to adults, and require particular attention, particularly in the acute stage.

- Early peer support and the use of play are important. Young children in particular may not understand what has happened to them, and rehabilitation may initially need to come second to building their trust and supporting them.

- As they become older children may be increasingly aware of their disability and are susceptible to psychological difficulties e.g. body image, participation physically and socially. Parents and families will also require support. Establishing links with family support services and prosthetic services in the region - with the opportunity to meet peers with limb loss - is highly recommended

### 5. Culture

- Be aware of potential stigma associated with amputation. A child with disability may be excluded from school and community

### 6. The prognosis for function after a upper limb amputation is likely to be poor

- As with the adult UL amputee, early use of a prosthesis is encouraged
- Encourage bilateral arm use with ADLs, minimise one handedness
- Prevention of potential musculoskeletal issues e.g. overuse injuries, back pain through advice on posture, symmetry of movement and function is important

Finally, those deploying with the UKIETR will have technical support from Handicap International, as well as from the BACPAR development committee for particular clinical questions related to situations you may encounter in the field that are beyond the scope of this manual.

### Core Recommended Texts

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## Spinal Cord Injury - Acute Management

This module was developed by Association of Chartered Physiotherapists in Neurology (ACPIN) members and members of the Spinal Cord Injury Therapy Leads, working in collaboration with Handicap International.

The chapter aims to give a basic outline of the key aspects of acute spinal cord injury management, complications and early rehabilitation, with frequent referral to the restraints that may be present in a humanitarian setting.

The content is pitched at a core level of knowledge in acknowledgement that some therapists may have minimal spinal cord injury rehabilitation experience.

### Learning outcomes

- To offer guidance on specific key areas to identify on assessment of an acute spinal cord injured individual
- To understand the terminology and prognostic implications of incomplete and complete spinal cord injury
- To identify key treatment objectives and plan for management of the spinal cord injured person
- To understand stability in relation to moving and handling
- To highlight the importance of ongoing reassessment and implications for treatment planning

### Glossary

ABG	Arterial blood gas	ISNCSCI	International Standards for Neurological Classification of SCI
AD	Autonomic dysreflexia	JPS	Joint position sense
AIS	ASIA impairment scale	LT	Light touch
ARDS	Adult respiratory distress syndrome	MAC	Manual assisted cough
ASIA	American spinal injuries association	MH	Mental health
ATLS	Advanced trauma life support	PCF	Peak cough flow
DAP	Deep anal pressure	PNF	Proprioceptive neuromuscular facilitation
DRF	Digital removal of faeces	PP	Pin prick
DRS	Digital rectal stimulation	PR	Per rectal
FES	Functional electrical stimulation	PTFE	Polytetrafluoroethylene
FVC	Forced vital capacity	SCI	Spinal cord injury
ICF	International classification for function, disability and impairment	SPC	Suprapubic catheter
IDUC	In-dwelling urethral catheter	TBI	Traumatic brain injury
IPPB	Inspiratory positive pressure breathing	TV	Tidal volume
		VAC	Voluntary anal contraction
		WB	Weight bearing
		WOB	Work of breathing

### Statistics

There are approximately 40,000 people with Spinal Cord Injury (SCI) living in the UK with 800 people newly injured each year. The mean age of these patients in the UK is 37 year, with 13% over 60 years old (De Vivo, 2007). Pre-hospital and inter hospital care is clearly defined. Management is closely coordinated between Major Trauma Centres and Spinal Cord Injury Centres (SCIC) to optimise initial management and rehabilitation, with early transfer to SCIC being shown to reduce complications. This is a very different picture than that described in literature from past sudden onset disasters concerning SCI:

#### SCI in sudden onset disasters

Earthquakes in particular lead to many individuals sustaining spinal cord injury (SCI) - more than 200 SCIs following the December 26, 2003 earthquake in Bam, Iran ; an estimated 650-750 SCIs after the October 8, 2005 earthquake in Kashmir, Pakistan ; and approximately 150 survivors

of SCIs resulting from the 2012 Haiti earthquake (Burns et al, 2012). Historically, lumbar and low thoracic injuries are the most commonly seen in survivors (Mallick et al 2010) with a very low incidence of high thoracic or cervical injuries. For example, only 1 of a sample of 18 SCI patients involved in a pilot study in Haiti had tetraplegia (Rauch et al 2011). However, recent experiences following the Nepal earthquake, and improving rescue, pre-hospital and acute care may mean that increasing numbers of patients with tetraplegia survive their initial injury.

With SCI patients we know that mortality risk increases with injury level and severity and is strongly influenced by availability of timely, quality medical care. Transfer methods to hospital after injury and time to hospital admission are important factors. This is likely to be the reason why patients with high level thoracic and cervical SCIs in low-income country disaster situations do not survive extraction and transfer to appropriate medical facilities (Burns





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et al 2010). This is also the reason why you should expect a higher percentage of 'complete' injuries following a sudden onset disaster: poor extraction and transport techniques, early management, knowledge of precautions, access to resources will render incomplete injuries swiftly to complete. In the UK, approximately 62% have an incomplete SCI (NSCISC 2012), whereas one survey in Haiti found only 6 out of 19 (32%) patients was incomplete (Burns et al 2010). Following the May 12, 2008 8.0 magnitude earthquake in the Sichuan region of China, the mean extrication time for spinal injuries trapped under rubble was 12.2 hours; however, the mean time to hospital was then 3.6 days (Chen et al 2008). In the same report, researcher found that for the majority of these individuals - rehabilitation did not start until over two months post injury.

There is emerging evidence to suggest that SCI patients should be cohorted in sudden onset disasters, but as yet no mechanisms have formally been put in place which would manage to do this effectively (Burns et al, 2012). There is therefore every likelihood that you will come across some of these patients whilst responding to disasters as part of a foreign medical team.

In many low income countries, the level of pre-existing services for SCI (a low incidence injury) is minimal as it competes for resources with far more prevalent health issues. Add to this a poor cultural understanding of SCI, widespread poor standards of pressure care, lack of experience in bladder and bowel care - it is apparent that the preventable secondary conditions are just as threatening to these patients as their initial injury. Such secondary conditions (e.g. infections from untreated pressure ulcers) are no longer among the leading causes of death of people with spinal cord injury in high-income countries, but remain the main causes of death of people with spinal cord injury in low-income countries. (WHO/ISCOS 2013)

Rehabilitation professionals preparing to respond to sudden onset disasters are at least able to learn from previous experiences and aim to be prepared to address the complex needs of SCI patients - to increase the likelihood of survival and decrease long term impairment.



Reading further around the experiences of managing patients with SCI in sudden onset disasters will better prepare you for the challenges faced in such environments. There are several articles covering a number of past disasters in the folder '**SCI in Sudden onset disasters**' on the USB which you will find useful.

### Initial management of suspected or confirmed SCI

#### Initial Management

- Unstable spinal injuries
- Respiratory assessment
- Neurological assessment
- CVS
- Skin
- Bladder and Bowel
- Joint care
- Functional expectations
- Psychological wellbeing
- Pain



This manual and accompanying presentation will cover the above topics regarding initial management in the first four weeks post injury and an introduction to preparations for ongoing rehabilitation. You are advised

to read further around the subject if any of these topics are unfamiliar to you and further references and core texts can be found at the back of this chapter.



### Spinal stability

#### Spinal Stability

- Date injury
- Bone level of injury
- Neurological level of injury
- Stable/Unstable
- Surgical/Conservative management
- Precautions for Therapy
- Turning - 5 person/4 person



On receiving the patient it is important to know the date of injury and ideally mechanism of injury. This is particularly important when responding to situations of sudden onset disaster where your facility may receive patients several days after the incident. Key questions to ask in this situation would be about method of extraction, where has the patient been in the interim, what care and manual handling precautions have or have not been used.

### Bony Injury

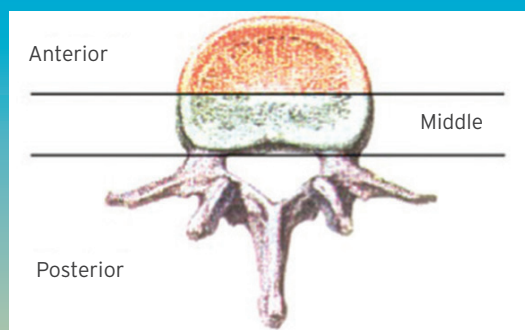
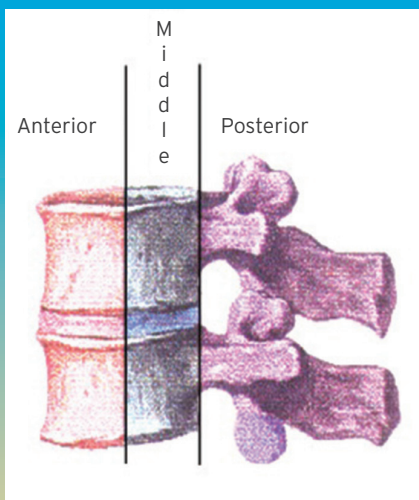
Ideally the bony level of injury should be determined by x-ray, CT and MRI. In the field it is likely that there will only be access to x-ray.

The structural stability of the spine needs to then be reviewed by the lead orthopaedic or neurosurgeon and a plan decided.

If you are in any doubt of stability, treat the patient as an unstable spinal injury; this would therefore apply until a patient had at least received an x-ray. Manual handling precautions for unstable spines will be covered later in the chapter.

At this time you also need to determine if there are any neurological deficits and the American Spinal Injury Association (ASIA) assessment is recommended on all patients with a bony injury as a baseline measure even if there are no apparent neurological deficits. ASIA can be used to identify any changes in neurology (good or bad) and is a reliable and valid outcome measure for SCI. It will be covered in detail during the SCI practical training day and an overview given later in this chapter.

## Stability



There are a number of classifications of bony spinal injury and not all surgeons and neurosurgeons use the same classification. In general the 3 column classification (anterior, middle and posterior) identifies stability or instability. Each column has

different contributions to stability, and their damages may affect stability differently. Generally, if two or more of these columns are damaged, then the spine is unstable. However, it depends on the characteristics of the fracture.



Further information on the 3 column classification can be found in the original article '**The three column spine and its significance in the classification of acute thoracolumbar spinal injuries**' on the USB

Once a decision has been made regarding spinal stability, a discussion needs to be held with the lead consultant regarding options for surgical versus conservative management, and reasoning clearly documented within the notes. Given the lack of spinal hardware and specialist surgeons available in most field hospitals, it is unlikely that surgical stabilization will be carried out immediately. A more likely scenario is for conservative management by field hospital teams and referral of the patient to a specialist facility at a later stage.

### Surgical spinal stabilisation

In the UK the consensus is to surgically stabilise 3 column fractures unless the risk of surgery outweighs the estimated benefits (Denis 1983). Surgical options are discussed following clinical review of the patient and discussion with the consultant surgeon/neurosurgeon and a consultant radiologist if available. The common practice in the UK is to perform surgical decompression by laminectomy with posterior and/or anterior fixation. Note that cervical anterior fixation often leads to more significant post op complications as you can imagine.

Johnston (2001) suggests that surgical management 'aims to minimise neurological deterioration, restore alignment, and stabilisation, facilitate early mobilisation, minimise hospital stay and prevent secondary complications'.

### Conservative management

If conservative management is chosen it can include traction, a halo brace or collar for cervical injuries; and custom or off the shelf TLSO or plaster jacket for thoracic lumbar injuries. Realistically in the immediate aftermath of a SOD in a low income country you may not be able to source TLSO braces, and may have to negotiate the best treatment option with the surgeons.

The duration of immobilisation is difficult to quantify and needs to be in discussion with the lead Surgeon/Neurosurgeon. Personal communication by the authors with Professor El Masri (2014) indicated that purely conservative management of a spinal fracture would generally require three months immobilisation to ensure healing. The potential complications of this being entirely on bed rest are well documented (Collins 1995).

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## Moving and handling a patient with an unstable spine

### ATLS guidelines

- Aim is to maintain spinal alignment, ensure “spinal protection”
- Avoid further damage or insult to the cord eg surgery may be required to relieve cord compression, evacuate bony fragments etc
- Maximise perfusion to SC (MAP monitor)
- Liaise with Orthopaedic/Neurosurgeon in charge
- ATLS guidelines ‘MASCIP/Huntleigh moving and handling guidelines’ available online

If managing a patient with an unstable spinal injury either with or without neurological deficit it is important to maintain ‘spinal alignment’ at all times in order to either prevent neurological damage or avoid further damage or insult to the spinal cord. There is some research yet to be published (authors personal communication with Professor Papadopoulos) that maintenance of the mean arterial pressure (MAP) >80mmHg can be advantageous in order to maximise cord perfusion and potential for recovery. Side

lying has been found in a few cases to have better cord perfusion than supine.

The ATLS (advanced trauma life support) course endorses the implementation of the MASCIP handling guidelines for acute SCI patients. These guidelines cover turning and transferring acute paraplegic and tetraplegic patients, as well as the application of collars and how to perform an assisted cough, and are essential reading:



The MASCIP Guidelines for **‘Moving and handling patients with actual or suspected spinal cord injuries’** can be found on the USB or online at <http://www.mascip.co.uk>



The moving and handling laid out in these guidelines will also be covered in the practical day **‘Spinal cord injury in humanitarian settings’**.

## Spinal Cord Injury - Acute Management

Advanced trauma life support training is offered in many trusts, and although directed towards medical staff there are often options for other professions to join as observers. The following links provide more information on ATLS training and advice regarding acute trauma.

[www.myatls.com](http://www.myatls.com) : an app for i-phone or android which covers interactive principles of ATLS

WHO Guidelines for essential trauma care: published in 2004, aim to set achievable

standards for trauma treatment services which could realistically be made available to almost every injured person in the world.

### Spinal precautions

Therapists involved in the care of these patients need to follow specific precautions for unstable SCI when carrying out their assessments and treatments. This will be dependent on the level of injury. The essential precautions for moving the patient in supine are as the slide below indicates.

### Precautions for unstable spine

#### T4 and above

- Shoulder hold for all UL movements above 90 degrees
- Shoulder hold for assisted cough
- Bilateral manual chest techniques in supine
- Shoulder hold for all LL movements

#### T9 and below

- No hip flexion beyond 30 degrees
- Ext rotate hip to move hip into flexion beyond 30 degrees
- Do not cross legs over midline



All members of the hospital team should be aware that ATLS and MASCIP guidelines state:

- For an injury of T9 and above a five person turn is required
- For injuries T10 and below a four person turn is required

These turns should be led by the orthopaedic or emergency medicine consultant, but all team members should be aware of the procedure. (Bromley, 2005; Paddison and Middleton, 2011 and Lennon & Stokes, 2009)

## Respiratory system and SCI

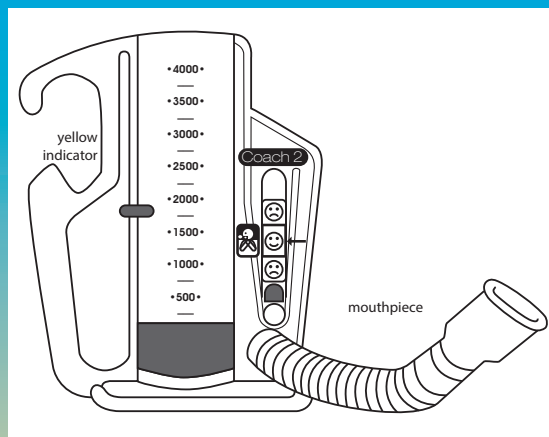
Although you are less likely to see high cervical injuries if you are responding to a sudden onset disaster, it is important to review the aspects of an SCI respiratory assessment, in particular because thoracic injuries with associated rib and lung trauma are likely to be encountered. In addition, patients treated conservatively in the supine

position or on bed rest may well develop further respiratory complications.

It is suggested that rehabilitation members interested in emergency deployment maintain core knowledge and skills in respiratory assessment and care via work based experience.

## Respiratory assessment

- RR and breathing pattern
- FiO<sub>2</sub> and Sats
- Auscultation
- ABG's
- FVC < 1 litre
- Cough
- PCF < 160 l/min
- Associated injuries
- Spinal precautions
- PMH - smoker, COPD, asthma
- Age & Fitness



The above slide highlights key aspects of the respiratory assessment. Not mentioned above, but important to note is that with SCI patients you may well observe a 'paradoxical breathing pattern' - this occurs when the diaphragm is working but the abdominals are flaccid.

### Objective measures

It is necessary - when assessing - to know the key objective measures to monitor and to be aware of the individual's level and classification of SCI in order to anticipate and hopefully prevent avoidable complications. The 2 key objective measures for SCI patients are:

- FVC - forced vital capacity - measured by spirometer (unlikely to be available)
- PCF - peak cough flow - measured with Peak Flow Meter attached to tight fitting face mask (demonstrated in SCI practical day)

These are selected as objective measures because SCI is a neuromuscular disorder that causes a *restrictive* lung problem. Depending on the level of SCI the patient will have a reduced capacity of their inspiratory and expiratory muscles. These objective measures will inform if you need to provide assistance in the inspiratory and or expiratory phases.

**Muscles of inspiration** are predominantly the diaphragm (C3-5) and corresponding thoracic level intercostal muscles. The benefit of being able to identify any drop in FVC is that this would allow a timely response to increase physiotherapy interventions or to be more aggressive in the treatment for chest infections. For example prophylactic incentive spirometry and inspiratory hold breathing techniques could be utilised in the absence of positive pressure ventilation, and the manual assisted cough (MAC) in conjunction with inspiratory and expiratory manual techniques, with adequate pain relief and repositioning.

Normally if the FVC drops below 1 litre, positive pressure respiratory support is recommended (Hough 2001, RISC Guidelines 2010). It is possible to use the principle of 'lung volume recruitment' which

uses breath stacking techniques to achieve 'maximal insufflation capacity' (MIC). Eg 'Glossopharyngeal breathing' (Webber & Pryor 1998, ), IPPB or a 'lung volume recruitment bag' (Rachel Moses personal communication 2013). There will not be the possibility for ventilator support in the UK field hospital, thus if patients need that level of respiratory support then transfer to another facility will be the only possible treatment option, and patients at risk of respiratory compromise should be prioritized for transfer.

**Muscles of exhalation** are innervated by T6-12 - i.e. the abdominals. If the level of injury is above T12 then the cough will be impaired to some degree. A cough is generated by a sufficient volume of air inhaled and sufficient power in expiratory muscles. Ask the patient to cough and listen carefully.

### Precautions when providing respiratory treatments for SCI patients

#### Respiratory Precautions

- Treat unstable SCI in supine
- Bilateral chest techniques with shoulder hold
- Manual assisted cough with shoulder hold
- Consider use of positive pressure breathing (IPPB/Cough Assist) if FVC < 1 litre
- No MAC if have paralytic ileus - shaking

As mentioned, respiratory treatments for an unstable SCI patient need to be in supine but it is important for both skin care and respiratory function that the patient is turned and spends time in side lying.

Bilateral techniques (i.e. not just performed on one hemithorax) are required for all

unstable patients - this includes shaking and manual vibrations - incorporating a shoulder hold for injuries T4 and above.

Manual assisted cough (MAC) should be performed bilaterally for unstable patients and with shoulder hold if injury T4 or above. (Bromley 1998)







The Manual Assisted Cough technique will be taught in the practical workshop 'SCI in humanitarian settings'.

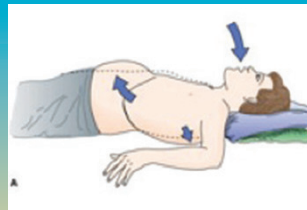
**Special considerations:** in addition to the usual contraindications for manual techniques for respiratory treatment, with SCI patients a manual assisted cough is contraindicated if there is a paralytic ileus. You should be very mindful of the

high risk of pulmonary embolism following trauma and in particular SCI, and be equally cautious with flail segments following rib fractures (Hough, 2001 & Pryor and Webber 1998).

### Respiratory treatment

#### Aims of respiratory treatment

- Reduce WOB
- Maintain lung compliance
- Aid secretion clearance



Ultimately the aims of respiratory treatment are to:

#### 1. Reduce work of breathing (WOB)

In a person with an intact neuromuscular system their WOB will be less in a seated position. In a patient with a complete SCI T6 and above their WOB will be less in supine. Ideally you would need to measure the FVC in supine and FVC in sitting in order to compare and ensure treatment is specific to the individual as with some incomplete injuries it is harder to predict. This is not possible in a humanitarian setting, therefore other observations such as oxygen saturation and respiratory rate should be compared.

#### 2. Maintain lung compliance

Depending on the level of injury the respiratory muscles will be impaired and lung volume reduced. This can lead to loss of compliance and if there is a lack of intercostal activity there is then in-drawing of the ribs on inspiration and loss of bucket handle mechanism which can cause atelectasis. Positive pressure breathing helps to minimise this. Auscultation when administering any form of positive pressure breathing is vital in order to monitor that the air is entering the lungs and not the stomach. Teaching of efficient technique is really important. Inspiratory hold breathing techniques should be used in low resource environments as an alternative.

### 3. Aid secretion clearance.

If the SCI is above T6 there will be a disproportionate amount of activity of the parasympathetic nervous system which causes hyper secretion. This is generally most noticeable between day 3-5 post injury. In addition, injuries above T6 have no abdominal activity and therefore are unable to cough effectively and need assistance to cough and clear secretions. MAC as mentioned previously is the most effective method of managing this as long as is efficiently co-ordinated with the patient.

Otherwise the principles of respiratory management are very much in keeping with the well-established principles of Active Cycle of Breathing Technique cycles, postural drainage, effective hydration and humidification with appropriate medical management of hypersecretion.

### A cough!

- Phase 1 - Inspiratory
- Phase 2 - Glottic closure and opening
- Phase 3 - Expiratory



Coughing protects the respiratory system by clearing out irritants and secretions.

There are 3 motor components

1. Inspiration (2-3litres)
2. Glottic closure and opening
3. Forceful expiration (Maximal Expiratory Pressure (MEP) >60cmH2O (Szeinberg et al, 1988)

A PCF of > 160l/min is sufficient to eliminate airway debris and secretions. (Bach & Saporito 1996) but if the PCF less than 270-300 l/min there is evidence to suggest that the cough is sufficiently impaired so as to increase the risk of secretion retention and when a patient is unwell. (Bach et al, 1997)

## The manual assisted cough (MAC)



There is a video clip of a patient having a MAC performed on the USB resource stick.



This technique will also be covered in the practical workshop 'SCI in humanitarian settings'.

We would recommend that if you see any SCI patients in your usual line of work, who require a MAC that you ask to practice on them.

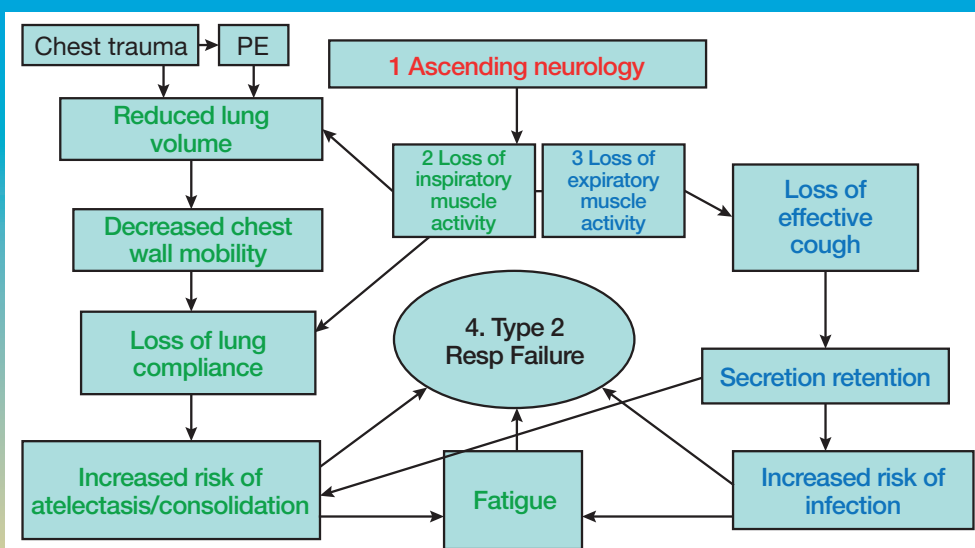
### Summary

In summary, respiratory compromise in SCI is due to all the factors on the diagram below and therefore they should all be considered during your assessment and when making your treatment plan. A treatment plan should include techniques to

minimise the avoidable complications and escalate care as required.

Respiratory complications are obviously not completely preventable but hopefully you will be able to notice the early warning signs and teach others the importance of monitoring, regular objective assessment and prophylactic treatment after careful consideration of level of injury and any additional complicating factors.

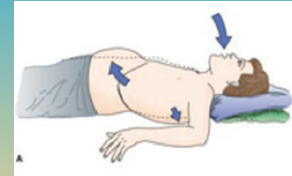
## Causes of Respiratory Compromise



Review the slide below as a reminder of the important differences in respiratory therapy for SCI patients.

### Why SCI is different

- Neuromuscular injury - level and completeness of injury is different for every patient.
- WOB less in supine, T6 and above. Check FVC supine and sitting and compare.
- Record FVC - TV 10mls/kg. If FVC < 1 litre vent support likely to be required.
- Hypersecretion increases in injury above T6
- Ineffective or absent cough T6 and above



### Neurological assessment

It is important to document the presentation of the patient as soon as able. Guidelines state that a complete initial assessment should be made within 72 hours (Brown, 1991). This gives us a baseline from which the team can monitor changes. It is worth noting that within the first few days post trauma the spinal cord swelling can cause the spinal level of injury to rise (Stauffer, 1983). If the neurological level of function deteriorates it

may result in loss of respiratory function. For example if a C5 ascends to C4/3 and patient loses ability to maintain respiratory function, they will fatigue from using accessory muscles and could lose diaphragm function.

One month post injury has been suggested as a good interval to assess for recovery (Waters, 1992), however notable changes in presentation could pre-empt reassessment.

### Terminology

Terms used to describe these patients indicate the general level of the spinal injury listing body functions and structure and a list of domains of activity and participation (*International Classification of Functioning, Disability and Health*; World Health Organization, 2001).

### Paraplegia

Paraplegia refers to the impairment or loss of motor, sensory and/or autonomic function in thoracic, lumbar or sacral segments of the spinal cord. Upper-limb function is spared but the trunk, legs and pelvic organs may be involved.

### Tetraplegia

Tetraplegic patients have impairment or loss of motor, sensory and/or autonomic function in cervical segments of the spinal cord. The upper-limbs are affected as well as the trunk, legs and pelvic organs. In high cervical injuries the function of respiration will be affected. The term does not include the brachial plexus or injury to peripheral nerves.

'Quadraparesis' and 'Paraparesis' were terms used previously to describe incomplete lesions and are now discouraged.

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## ISNCSCI (International standards for the neurological classification of spinal cord injury)

(Formerly known as American Spinal Injury Association (ASIA) assessment)

The ISNCSCI (ASIA) assessment (alongside an MRI) are usually used for diagnosis and prognosis giving for SCI in the

UK. The ASIA assessment provides an internationally standardized classification system for spinal cord injuries - giving a 'neurological level of injury' and also an 'incomplete' versus 'complete injury' classification.

### AIS = ASIA Impairment Scale

- A = Complete (consider ZPP)
- B = Sensory incomplete
- C = Motor incomplete (a bit)
- D = Motor incomplete (more)
- E = Normal but had deficits previously

**A** "complete" spinal cord injury where no motor or sensory function is preserved in the sacral segments S4-S5.

**B** "incomplete" spinal cord injury where sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5. This is typically a transient phase and if the person recovers any motor function below the neurological level, that person essentially becomes a motor incomplete, i.e. ASIA C or D.

**C** "incomplete" spinal cord injury where motor function is preserved below the neurological level, and MORE than half of key muscles below the single neurological level of injury have a muscle grade less than 3

**D** "incomplete" spinal cord injury where motor function is preserved below the neurological level and at least half of the key muscles below the neurological level have a muscle grade of 3 or more

**E:** If motor and sensation function with ISNCSCI are all graded normal (in all segments) and the patient had neurological deficits from SCI before, then the grade is E. Note: only patients with SCI receive any AIS grade.



The **ASIA forms** can be found on the following two pages of this manual. They are also on the USB.

## Spinal Cord Injury - Acute Management



It is recommended that members access the free online e-learning on the assessment and practical application of ASIA. The **International Standards Training e-Learning Program, or InSTeP**, is a six-module course designed to enable clinicians to perform accurate and consistent neurological examinations of individuals with spinal cord injury. This can be found at: [www.asia-spinalinjury.org/elearning/elarning](http://www.asia-spinalinjury.org/elearning/elarning)



There are several reports regarding SCI after the Haiti and China earthquakes on the USB. Notably in **'Spinal Cord Injury in post-earthquake Haiti: Lessons learned'** Burns et al (2012) noted that in 13 out of 19 individuals with SCI were 'complete' injuries, i.e. AISA 'A' classified.

As with all patients, but particularly given the complex nature of SCI and the longevity of rehabilitation - documentation and accurate assessment is essential. Patients may move around from facility to facility so

communication is essential for monitoring. Ensure you attach completed ASIA forms to the patient's notes - both retained and those sent with the patient.



The practical workshop **'SCI in humanitarian settings'** will review practical ASIA assessment and look at sample charts for interpretation and treatment planning discussion.

**Please familiarise yourself with the ISNCSCI/ASIA form and how to completed it on the following few pages.**

Patient Name \_\_\_\_\_  
 Date/Time of Exam \_\_\_\_\_  
 Examiner Name \_\_\_\_\_  
 Signature \_\_\_\_\_

**RIGHT**

**MOTOR KEY MUSCLES**

**KEY SENSORY POINTS**  
 Light Touch (LTR) Pin Prick (PPR)

**UER**  
 (Upper Extremity Right)

**LER**  
 (Lower Extremity Right)

**Comments** (Non-Key Muscle? Reason for NT? Pain?)

C2  
C3  
C4  
C5 Elbow flexors  
C6 Wrist extensors  
C7 Elbow extensors  
C8 Finger flexors  
T1 Finger abductors (little finger)

T2  
T3  
T4  
T5  
T6  
T7  
T8  
T9  
T10  
T11  
T12  
L1

S2  
S3  
S4-5

S2  
S3  
S4-5

S2  
S3  
S4-5

S2  
S3  
S4-5

**MOTOR**  
 (SCORING ON REVERSE SIDE)  
 0 = total paralysis  
 1 = palpable or visible contraction  
 2 = active movement, gravity eliminated  
 3 = active movement, against gravity  
 4 = active movement, against some resistance  
 5 = active movement, against full resistance  
 5\* = normal corrected for pain/disease  
 NT = not testable

**SENSORY**  
 (SCORING ON REVERSE SIDE)  
 0 = absent  
 1 = altered  
 2 = normal  
 NT = not testable

**LEFT**

**MOTOR KEY MUSCLES**

**KEY SENSORY POINTS**  
 Light Touch (LTL) Pin Prick (PPL)

**UEL**  
 (Upper Extremity Left)

**LEL**  
 (Lower Extremity Left)

**Comments** (Non-Key Muscle? Reason for NT? Pain?)

C5 Elbow flexors  
C6 Wrist extensors  
C7 Elbow extensors  
C8 Finger flexors  
T1 Finger abductors (little finger)

T2  
T3  
T4  
T5  
T6  
T7  
T8  
T9  
T10  
T11  
T12  
L1

S2  
S3  
S4-5

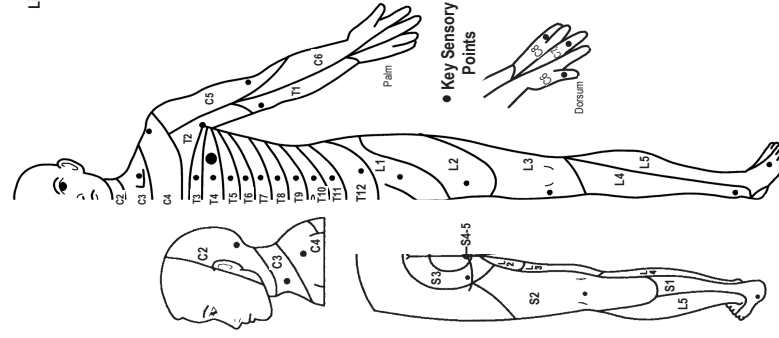
S2  
S3  
S4-5

S2  
S3  
S4-5

S2  
S3  
S4-5

**MOTOR**  
 (SCORING ON REVERSE SIDE)  
 0 = total paralysis  
 1 = palpable or visible contraction  
 2 = active movement, gravity eliminated  
 3 = active movement, against gravity  
 4 = active movement, against some resistance  
 5 = active movement, against full resistance  
 5\* = normal corrected for pain/disease  
 NT = not testable

**SENSORY**  
 (SCORING ON REVERSE SIDE)  
 0 = absent  
 1 = altered  
 2 = normal  
 NT = not testable



**MOTOR SUBSCORES**  
 UER MAX (25) + UEL [ ] = UEMS TOTAL [ ]  
 LER [ ] + LEL [ ] = LEMS TOTAL [ ]  
 LTR MAX (56) + LTL [ ] = LT TOTAL [ ]  
 PPR [ ] + PPL [ ] = PP TOTAL [ ]  
 (112)

**RIGHT TOTALS** (MAXIMUM) [ ]  
**LEFT TOTALS** (MAXIMUM) [ ]

**NEUROLOGICAL LEVELS**  
 Steps 1-3 for classification as on reverse

**NEUROLOGICAL LEVELS**  
 1. SENSORY R [ ] L [ ]  
 2. MOTOR R [ ] L [ ]

**NEUROLOGICAL LEVEL OF INJURY (NLI)**  
 3. NEUROLOGICAL LEVEL OF INJURY (NLI) [ ]

**COMPLETE OR INCOMPLETE?**  
 4. COMPLETE OR INCOMPLETE? [ ]  
 Incomplete = any sensory or motor function in S4-5

**ASIA IMPAIRMENT SCALE (AIS)**  
 5. ASIA IMPAIRMENT SCALE (AIS) [ ]  
 Most caudal level with any innervation

This form may be copied freely but should not be altered without permission from the American Spinal Injury Association. REV02/93

# Spinal Cord Injury - Acute Management

## Muscle Function Grading

- 0 = total paralysis
- 1 = palpable or visible contraction
- 2 = active movement, full range of motion (ROM) with gravity eliminated
- 3 = active movement, full ROM against gravity
- 4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position
- 5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
- 5\* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disease) were not present
- NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal range of motion)

## Sensory Grading

- 0 = Absent
- 1 = Altered, either decreased/impaired sensation or hypersensitivity
- 2 = Normal
- NT = Not testable

## Non Key Muscle Functions (optional)

May be used to assign a motor level to differentiate AIS B vs. C

Movement	Root level
<b>Shoulder:</b> Flexion, extension, abduction, adduction, internal and external rotation	<b>C5</b>
<b>Elbow:</b> Supination	
<b>Elbow:</b> Pronation	<b>C6</b>
<b>Wrist:</b> Flexion	
<b>Finger:</b> Flexion at proximal joint, extension.	<b>C7</b>
<b>Thumb:</b> Flexion, extension and abduction in plane of thumb	
<b>Finger:</b> Flexion at MCP joint	<b>C8</b>
<b>Thumb:</b> Opposition, adduction and abduction perpendicular to palm	
<b>Finger:</b> Abduction of the index finger	<b>T1</b>
<b>Hip:</b> Adduction	<b>L2</b>
<b>Hip:</b> External rotation	<b>L3</b>
<b>Hip:</b> Extension, abduction, internal rotation	<b>L4</b>
<b>Knee:</b> Flexion	
<b>Ankle:</b> Inversion and eversion	
<b>Toe:</b> MP and IP extension	
<b>Heelux and Toe:</b> DIP and PIP flexion and abduction	<b>L5</b>
<b>Heelux:</b> Adduction	<b>S1</b>

## ASIA Impairment Scale (AIS)

- A = Complete.** No sensory or motor function is preserved in the sacral segments S4-5.
  - B = Sensory Incomplete.** Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.
  - C = Motor Incomplete.** Motor function is preserved below the neurological level\*\*, and more than half of key muscle functions below the neurological level of injury (NLI) have a muscle grade less than 3 (Grades 0-2).
  - D = Motor Incomplete.** Motor function is preserved below the neurological level\*\*, and at least half (half or more) of key muscle functions below the NLI have a muscle grade  $\geq$  3.
  - E = Normal.** If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.
- \*\* For an individual to receive a grade of C or D, i.e. motor incomplete status, they must have either (1) voluntary anal sphincter contraction or (2) sacral sensory sparing with sparing of motor function more than three levels below the motor level for that side of the body. The International Standards at this time allows even non-key muscle function more than 3 levels below the motor level to be used in determining motor incomplete status (AIS B versus C).
- NOTE: When assessing the extent of motor sparing below the level for distinguishing between AIS B and C, the **motor level** on each side is used, whereas to differentiate between AIS C and D (based on proportion of key muscle functions with strength grade 3 or greater) the **neurological level of injury** is used.

## INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY



## Steps in Classification

- The following order is recommended for determining the classification of individuals with SCI.
1. **Determine sensory levels for right and left sides.**  
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.
  2. **Determine motor levels for right and left sides.**  
Defined by the lowest key muscle function that has a grade of at least 3 (on supra testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).  
Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.
  3. **Determine the neurological level of injury (NLI)**  
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.  
The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.
  4. **Determine whether the injury is Complete or Incomplete.**  
(i.e. absence or presence of sacral sparing)  
If voluntary anal contraction = **No** AND all S4-5 sensory scores = 0 AND deep anal pressure = **No**, then injury is **Complete**.  
Otherwise, injury is **Incomplete**.
  5. **Determine ASIA Impairment Scale (AIS) Grade:**  
**Is Injury Complete?** IF YES, AIS=A and can record ZPP (lowest dermatome or myotome on each side with some preservation)  
NO  $\downarrow$  **Is Injury Motor Complete? IF YES, AIS=B**  
NO  $\downarrow$  (No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side. If the patient has sensory incomplete classification)  
NO  $\downarrow$  **Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?**  
NO  $\downarrow$  **AIS=C**  
YES  $\downarrow$  **AIS=D**
- If sensation and motor function is normal in all segments, AIS=E  
Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.



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## ASIA : sensory and motor assessments

### Sensory Assessment

- Test key points C2-S5 bilaterally
- Light touch with cotton wool bud wisp
- Pin prick with 'Neurotip'
- Reference point is face/forehead
- PP = Differentiation between sharp and blunt AND if same as face
- Sensory grading - (0 = Absent, 1 = impaired, 2 = normal, NT = not testable)

### Sensory Level

- Consider left and right separately
- Most caudal segment graded 2 both PP & LT
- No 1 at bottom of chart

### Motor Assessment

- Test key points C5-T1 and L2-S1 bilaterally
- Non key muscle testing (optional)
- Oxford Scale 0-5, NT not testable
- 5\* = normal corrected for pain/disuse
- VAC = voluntary anal contraction

### Motor Level

- Consider left and right separately
- No 2 at bottom of chart
- Most caudal level graded 3 or more if everything above is 5
- If C5 or L2 are graded 3 or 4 and the sensory level above is 2 PP & LT then can be classed as the motor level
- If there is no Motor Key Muscle then Motor level = Sensory level

### ASIA: determining neurological level of impairment

#### Neurological Level of Impairment

- No 3 at bottom of chart
- Most caudal segment of cord with intact sensation AND motor power  $\geq 3$ , if levels above are all 5
- Most cephalad of the sensory and motor levels determined in steps 1 and 2

### 'Complete' and 'incomplete' injuries

#### Complete or Incomplete

- VAC = Voluntary Anal Contraction (not tone)
- S4-5 PP and light touch
- DAP = Deep anal pressure

#### If...

- (No VAC) + (PP S4-5 = 0) + (LT S4-5 = 0) + (No DAP) = **AIS A = Complete**

As you can see, if the patient has no VAC, no sensation at the S4-5 dermatome and cannot feel DAP - they are diagnosed as 'complete'. Otherwise, the patient is seen as having an 'incomplete' injury. Obviously assessing deep anal pressure and voluntary anal control are not necessarily procedures that you as physiotherapists and occupational therapists are used to carrying out. It may be more

appropriate to ask a member of nursing staff to assist this assessment during personal care for example. It is also worth noting the extreme cultural and gender sensitivity that needs to be used during the entire ASIA assessment where touch to bare skin is essential. A good explanation prior to the assessment, good translation and informed consent are essential.



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With regards to ASIA and the classification of injuries as either 'complete' versus 'incomplete' it is important to clarify these terms, depending on the context in which they are used. From a therapeutic point of view, a patient can be called functionally

incomplete when he or she presents with some motor or sensory sparing below the level of the cord lesion. The therapist should acknowledge such sparing as potential activity, which may offer important functional benefits to the patient.

### Further neurological assessments

## Neuro Assessment

- ASIA ([www.asia-spinalinjury.org](http://www.asia-spinalinjury.org))
- Proprioception JPS
- Spasticity/Spasms
- PNI

With SCI patients remember to consider other neurological injuries. There can be potential Nerve Root or Peripheral Nerve Injury (PNI) involvement: For example, cervical spine injuries are often associated with brachial plexus lesions (BPL). Also note that Joint position sensation (JPS) is not included in ASIA exam and therefore needs to be tested separately. If an incomplete injury the posterior columns may have been affected and although patient may present with good motor power and pin prick preservation functional prognosis is not as good with impaired or absent JPS.

### Syndromes

There are recognized patterns of incomplete cord injury which tend to present clinically as combinations of symptoms rather than in isolation. The signs and symptoms are related to the anatomical areas of the cord affected. Clinically, patterns of incomplete lesions are referred to as a syndrome.

A review of some of the literature available gives you an idea of what functional outcomes are likely based on the ASIA assessment and classification:

- Ninety per cent of incomplete SCI patients have some recovery of a motor level in their upper-limbs, compared to 70–85% of the complete injuries (Ditunno et al.2000).
- Pinprick sparing in a dermatome is an excellent indicator of increased recovery of motor strength (Poynton et al., 1997) and it has been found that pinprick preservation below the level of the injury to the sacral dermatomes is the best indicator of useful recovery, with 75% of patients regaining the ability to walk.
- Fifty per cent of patients who had no sacral sparing regained some motor recovery but not of functional use of their lower limbs (Kato & El Masry, 1995).

## Spinal Cord Injury - Acute Management

### Functional Level to predict functional outcome

The charts below are useful as a reminder of which muscles are innervated at which spinal level, and thus what functional

outcomes are likely for patients with lesions at these levels.

Functional Levels		
Critical Levels of Innervation	Functional Muscle Activity	Functional Activity
C1-3 Sternocleidomastoid Upper Trapezius Levator Scapulae	Neck Control	Vent Dependant Verbally Independent
C4 C3 plus Diaphragm	Shoulder shrug	Verbal Independence
C3 Biceps Deltoid Rotator Cuff, Supinator	Elbow Flexion, Supination, Shoulder Flexion, Abduction	Independent brushing teeth/hair and feeding with strap Level transfers
C6 ECRL, ECRB Pronator teres	Wrist extension, pronation	Independent ADL, Level transfers, toilet etc
C7 Triceps	Elbow Extension	Varied height transfers
C8 All upper limbs except Lumbricals/ Interossei	Neck Control	Neck Control

Functional Levels		
Critical Levels of Innervation	Functional Muscle Activity	Functional Activity
T1-T5 Varying Intercostals and Back Muscles	Trunk Support	Full Wheelchair independence Orthotic ambulation
T6-T12 Abdominals/back extensors	Trunk Control	Orthotic/Caliper ambulation Coughing
L1-L2 Psoas Major Iliacus	Hip Flexion	Caliper ambulation
L3-L4 Quadriceps Tibialis Anterior	Knee extension Ankle Dorsiflexion	Ambulation with orthoses and crutches/sticks
L5 Peroneii	Eversion	Ambulation with ankle orthoses + sticks
S1-S5 Glutei	Hip Extension	Normal ambulation Bladder, bowel, sexual function



### Spinal Shock

- Definitions can be varied
- Spinal shock is a body reaction by the central nervous system to a sudden major change. This is usually a Spinal cord Injury.
- “Depressed spinal reflexes caudal to the SCI”
- Severity of spinal shock can be related to severity of the cord injury itself
- It is a temporary state and will resolve with time. From hours to weeks. However there are always exceptions to the rule

Spinal shock is recognised as the transient suppression and gradual return of reflex activity caudal to SCI. The phased gradual return of reflexes has been put into four phases: (1) areflexia/hyporeflexia, (2) initial reflex return (1-3 days), (3) early hyper-reflexia (initial weeks and months), and (4) late hyper-reflexia (Dittuno et al, 2004). It is increasingly apparent that spinal shock reflects underlying neuroplasticity after SCI. The important point to note is that synapse growth is likely to be activity-dependent and competitive, thus with good positioning

and passive ROM therapy a beneficial environment is maintained for improving outcomes while minimizing maladaptive responses. Where possible active facilitation of functional movements will produce the most beneficial outcomes.

It is also important to note that during this time and the early stage of any new injury it is unlikely that an accurate prediction of any recovery or permanent paralysis can be made.

### Neurogenic Shock

#### Neurogenic Shock

- This is a sudden disruption of signals that maintain autonomic nervous system control over vasoconstriction leading to hypotension, this occurs after an acute spinal cord injury that blocks sympathetic activity.
- Neurogenic shock should be suspected if there is a cervical or high thoracic injury with no signs of fluid loss.

Patients with high thoracic SCI are at risk of neurogenic shock: whereby sympathetic nervous system depression or loss leads to uneven blood flow distribution. Vasodilation then causes cardiac preload to decrease, which ultimately results in inadequate cellular oxygenation. The nursing and medical team should manage the symptoms of neurogenic shock, however it is vital that you understand its underlying pathology and know to look out for it.

Secondary effects of general autonomic disturbance following SCI can include:

- Bradycardia (HR less than 60bpm)
- Hypotension (systolic <90mm/hg)
- Sudomotor changes
- Thermoregulation (poikilothermia)

(Alexander et al 2009)



The document 'What you should know about neurogenic shock' can be found on the USB and also here.

Two further references: Alexander, MS., Biering-Sorensen, F., Bodner, D. et al (2009) and Krassioukov et al (2012) can be found at the end of this chapter.

### Vaso vagal management

- If there is enough functioning sympathetic chain above the level of injury then it is possible to compensate for the low blood pressure with vasoconstriction
- Injuries at or above T6, leads to a loss of sympathetic tone to the heart, producing bradycardia and lowering myocardial contractility
- Awareness of causes (eg turning the head, stimulation to throat, suction)
- Medical management (glycopyralate/atropine)
- Postural re-training/graduated sitting programme
- Improve venous return (TEDS, binder, SCD's, active muscle pump)
- Medical Management (ephedrine/midodrine)

Unopposed vagal activity causes further disturbances of heart rate and can result in 'vaso vagal' episodes. These are common in high cervical injuries in the acute phase when in neurogenic shock. They can be triggered by postural changes, turning of the head or during suctioning. Symptoms can be light-headedness, nausea, the feeling of being extremely hot or cold (accompanied by sweating), ringing in the ears (tinnitus), an uncomfortable feeling in the heart, confusion, a slight inability to speak/form words (sometimes combined with mild stuttering), weakness and visual problems.

Vagal stimulation can lead to asystolic events so if a vagal response is noted, pharmacological options such as atropine or glycopyrolate should be administered pre treatment.

As therapists, you may be particularly aware of the issue of postural hypotension. This is when there is a symptomatic or asymptomatic drop in BP on moving from supine to upright. It is due to lack of sympathetic tone and reflex activity. It can be managed with physical methods initially (abdominal binders, graded sitting programmes, TEDs) and using short acting medications to enhance BP prior to sitting or mobilisation as symptoms dictate. Symptoms such as these usually resolve as become less acute and neurogenic shock resolves. If symptoms continue after you would expect neurogenic shock period to have ended, the patient may require a specialist cardiac review.

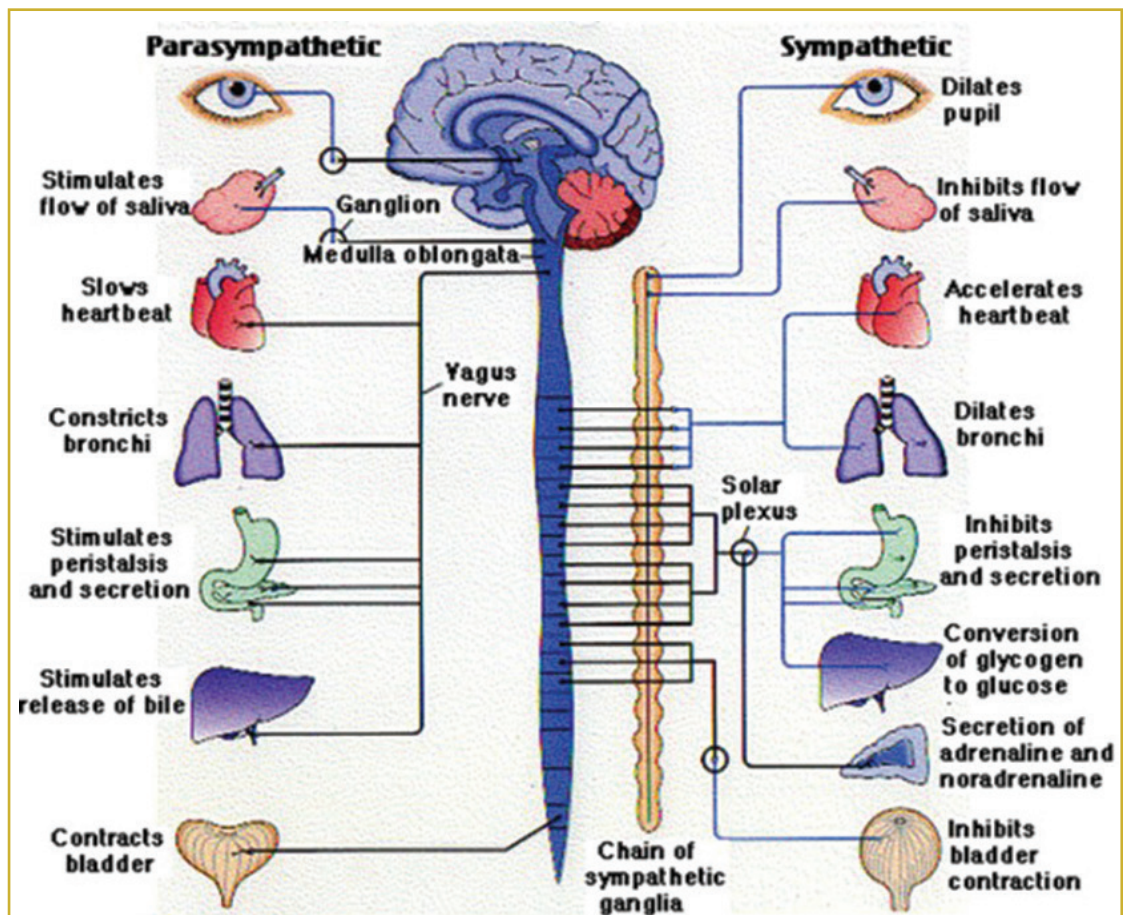
## Spinal Cord Injury - Acute Management

### SCI and the cardiovascular system

As therapists we tend to focus on the effects of the central nervous system on our patients, however with SCI patients we must consider the effects a lesion has on the autonomic nervous system. The sympathetic chain is located in the thoracic T1-L2 area, whilst the parasympathetic arises from the Cranial nerves (iii, vii, ix, x) and lumbar plexus. As mentioned previously, injuries above T6 will have an imbalance between their parasympathetic and sympathetic responses causing an imbalance of the autonomic nervous system and its ability to maintain homeostasis.

The diagram below illustrates the functions of the autonomic nervous system and should act as a reminder to you and the team in anticipating and reacting to problems in light of level and completeness of SCI.

Note that the upper body and heart are innervated by the spinal sympathetic neurons at T1-T5, but the major vasculature beds in the gut and lower extremities are innervated at T5-L2. The heart also has direct parasympathetic innervation via the vagus nerve (cranial nerve x) to the sinoatrial node (Alexander et al 2009). This is particularly relevant when we go on to discuss autonomic dysreflexia.



On the slide below are listed a number of brief points in how to avoid several of the

common cardiovascular complications that arise in patients with SCI:



## CVS Summary

- **Hypotension** - Avoid overinfusion, may cause pulmonary oedema. Mostly in high level injury
- **Bradycardia** - Parasympathetic response via the vagus nerve. Mostly in high level injuries; Atropine or glycopyrolate could be used
- **Poikilothermia** - Passive vasodilation, supraspinal control of the hypothalamus lost. Keep ambient temp.
- **VTE prophylaxis** - low molecular weight heparin, compression stockings, mechanical pumps  
(NICE guidelines 2010)
- **IV access** - Avoid cannulation into feet
- **Awareness of Autonomic Dysreflexia** - signs and symptoms and how to treat the episode  
(Consortium for Spinal Cord Medicine 2010)

### Autonomic dysreflexia

## What is Autonomic Dysreflexia (AD)?

- It is an exaggerated response of the sympathetic nervous system to a continual painful or noxious stimuli.

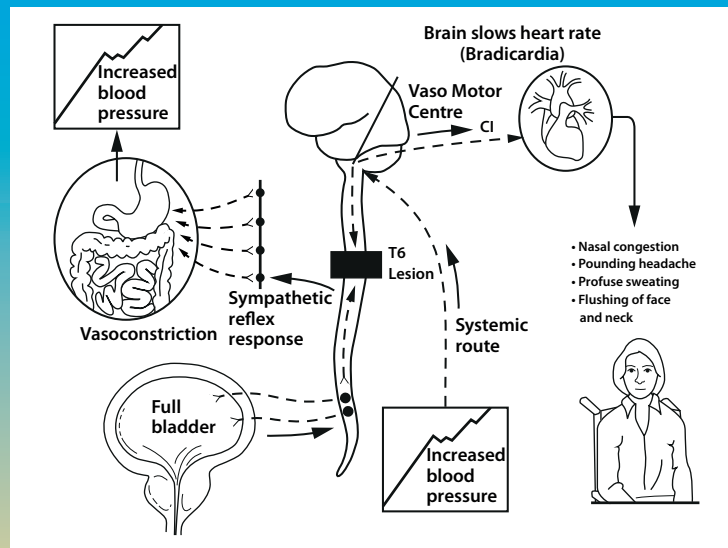
**NB: It is a Medical Emergency and can lead to a Myocardial Infarction (M.I.) or stroke leading to death, if left untreated**

In every case, AD brings on an increase in blood pressure of >20mm/hg above baseline, which may or may not be accompanied by other signs and symptoms such as pounding headache, flushing and or sweating above the injury level (Karlsson, 1999, Alexander et al 2009). Since it is a potentially life threatening event, it is very important that you are aware of the signs and symptoms,

possible causes and are able to seek help and identify the immediate treatment needed.

On the following slide are listed a summary of the points to consider when faced with common cardiovascular complications that arise in patients with SCI:

### Mechanism of AD



AD is a medical emergency and, if not properly treated, can result in stroke, heart attack, seizure and death. The most common cause of AD is a full bladder or bowel, but skin irritation (e.g. tight clothing or trauma)

and sexual or reproductive activity are other causes. You treat AD by removing the stimulus causing it, however good bowel and bladder routines and regular skin and pressure checks will decrease stimuli.



### Autonomic Dysreflexia

#### Signs and Symptoms

- Pounding headache
- Flushing and/or sweating above level of injury
- Significant raise in BP from normal
- Drop in HR (end stages)
- Cardiac arrest/CVE
- Death

#### Management

- Identify painful stimulus causing the symptoms
- Remove painful stimulus (eg/ change catheter, evacuate bowels)
- Sit patient UP to use postural hypotension to reduce BP
- Administer nifedipine 10mg sublingual

In every case, AD brings on a sudden increase in blood pressure which may be accompanied by other signs and symptoms such as headache and flushing above the injury level (Karlsson, 1999). Since it is a

potentially life threatening event, it is very important that you are aware of the signs and symptoms, possible causes and are able to seek help and identify the immediate treatment needed.

### Realities of SCI care in humanitarian settings

#### Realities of caring for SCI patients in field hospital



- Beds might not be appropriate
- Liaise with UK IETR logisticians for mattress provision
- Liaise with nursing staff / instigate turning chart
- HI Nepal guidelines suggest 'Board covered with two 10cm foam mattress is best'
- Pressure care & family education must start early

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As mentioned, deployments with the trauma register will vary in terms of the setting you will be working in, but certainly in an FMT field hospital the patient beds are likely to be camp beds. They may not routinely be supplied with mattresses, and these will have to urgently be sourced locally.

If you have a SCI patient in the hospital who requires immobilisation and spinal precautions it is likely they will be kept

on a flat surface until a suitable bed can be found. Preparation for this situation can make the situation much easier, so working with the team to locate one or two mattresses for an event such as this once you arrive will save a frantic search whilst the patients pressure areas are put at risk. The patient's family may also be able to locate you a mattress, so it is certainly worth asking them.



**Handicap International's Nepal Trauma guidelines** (2011), which are on the USB resource pack, suggest that if needs be it is best to place two 10cm thick mattresses on a hard board - which could then be placed on the existing camp bed or floor.

### Skin care for SCI patients

#### Skin

- Do not sit out on any skin lesion
- Offload any area of non blanching erythema until resolved
- Regular skin checks on every turn
- Turning 2 hourly if on non pressure relieving mattress
- Ensure adequate nutrition and hydration



- Once PU has occurred risk of higher risk of reoccurrence
- Changing terminology - now CAT pressure ulcer not sore

For SCI patients, loss of movement, loss of muscle mass and altered blood circulation put them at higher risk than others of pressure ulcers. Pressure ulcer prevention is a key element of initial healthcare for acute SCI patients, but is also part of a lifelong management strategy. The team must work hard to ensure that patients and their carers are aware of pressure ulcer prevention and identification, as well as immediate action. The onset of a pressure ulcer can severely impact rehabilitation, general health and can be life threatening.

In the acute stage, where you are most likely to have involvement with these patients, they will be turned every two hours ideally. On each turn, skin should be checked. If any part of the skin becomes reddened and non-blanching, this area must be offloaded until the redness has completely resolved.

Nutrition and hydration are also key components to good skin health.



The document '**Pressure ulcer prevention**' on the USB has useful points to remember and may help you educate patients as to what they need to do

You should be aware of the categorisation for pressure ulcers but this link to the National Pressure Ulcer Advisory Panel will remind those if required.

This patient in the previous picture has a category 4 pressure ulcer, with involvement down to bone. The patient was seen in Sri Lanka, they were treated with betadine and water and gauze for dressings, and side to side lying only with turns every 2 hours. A normal mattress was available, but no pressure relieving mattresses were accessible at the time. The team used pillow packs and positioning so that the patient was able to rest completely off the wound. This wound healed completely with the above treatment in two months, and is something to bear in mind if you are confronted with severe pressure ulcers in the field and no 'tissue viability' service to refer to as would be the case in the UK.

### **Skin care when sitting out**

*Any patient with a pressure ulcer on the lower back or buttocks should not be sat out. They may participate in physiotherapy, but should not sit out in a wheelchair until the pressure ulcer has resolved fully.*

The three photographs in the following slide indicate acceptable methods of preventative pressure relief for patients who are wheelchair users. Forward lean pressure relief for *two consecutive minutes every hour* is the optimum for allowing re perfusion to the capillaries around the ischial tuberosities (Coggrave and Rose, 2004). The patient may require assistance to perform this manoeuvre initially, but paraplegic patients should be able to become independent with this essential daily task. Cervical patients will likely need the assistance of 1-2 people to do this, and as shown in the top left photograph - a tilt in space wheelchair will also help. Lateral pressure relief (bottom left photograph) is also effective but less favourable due to the change in postural alignment which occurs.

**Pressure Relief**  
*2 min every hour (Coggrave and Rose 2004)*



## Spinal Cord Injury - Acute Management

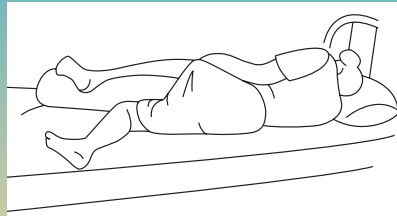
### Returning a patient to bed

This may be following a rehabilitation session, or just a routine transfer. All staff should follow the points below when returning a patient to bed. The diagram

shows the 'running man' position which is recommended for non-acute SCI patients to off load sacral and buttock areas.

### Returning back to bed

- Review skin following mobilisation
- Check for blanching
- Increase skin tolerance gradually
- Put catheter back on free drainage/night bag
- Position patient on their side to rest pressure areas



### Genitourinary system in SCI

### Genitourinary system

- Initially flaccid due to spinal shock = risk of retention
- Needs IDUC (size 12 long term PTFE coated)
- Low urine output in acute phase - ensure UO 0.5ml/kg/hr. Will improve as spinal shock resolves
- If catheter blocks change don't flush
- Rehab phase discuss options (SPC, clamping, ISC's, anticholinergics)

#### 3 p's

- Preserve renal function
- Promote continence
- Prevent complication

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The vast majority of SCI patients will have some degree of incontinence, as the level of injury will be above that of the sacral nerves which control the bladder and sexual function. Depending on the level and completeness of the injury, the bladder may empty too often, not frequently enough or in an uncoordinated way.

In the period of spinal shock, the bladder is initially flaccid and an indwelling urinary catheter (preferably PTFE coated) should be

inserted to prevent urinary retention. The team should also be aware of the possibility of priapism (although rare) in male SCI patients, and amenorrhoea for female SCI patients in the early stages. It is also worth mentioning that patients should be informed that fertility may return before the menstrual cycle returns if this has an effect on family planning. It is vital that psycho-social support around reproductive health issues taken into account local norms and is socially and culturally appropriate.



You should only work within your scope of practice, however having knowledge of the specific elements of SCI care will aid both you and your patients. There are several documents regarding **catheterisation** on the USB

### Gastrointestinal system in SCI

In almost all spinal cord injuries bowel function is impaired. The main changes to bowel function after spinal cord injury occur in the lower section of the digestive tract - the large intestine (which absorbs water from faecal mass and propels waste), the rectum (which holds faecal bulk for evacuation) and

the anus (which controls the release of faeces during defaecation).

Changes in the bowel after SCI are referred to as a 'neurogenic bowel'.

The slide below highlights some of the earlier issues SCI patients can experience in the acute phase.

### Gastro intestinal tract

- Paralytic Ileus - common in acute phase. Check for bowels sound and abdo distention. May need abdo x-ray and NG feed.
- Gastric Ulceration - Proton pump inhibitors required for up to 12 weeks post SCI. (omeprazole/lamzoprazole)
- Vomiting - emergency roll protocol
- Bowel assessment - PMH, previous habit

## Spinal Cord Injury - Acute Management

The tables below are taken from the MASCIIP guidelines and summarise the differences between upper motor neuron bowel (also known as reflexive bowel) and lower motor neuron bowel (also known as flaccid bowel). Upper Motor Neuron (Reflexive) Bowel most commonly occur in people with spinal cord injuries above the T12/L1 level.

A high fibre diet and good hydration are the core elements for both types of neurogenic

bowel, and will require the input of the entire team to ensure the patient is hydrated and that appropriate locally sourced food is available for these patients.

UKIETR field hospitals are equipped with laxatives such as senna (a stimulant) and sodium docusate (a stool softener), however movicol (a bulking agent) may not readily be available and dietary fibre may need to be increased.

**Table 3.1: Reflex and Areflexic Bowel functions**

Reflex bowel function	Areflexic (flaccid) bowel function
Positive anal reflex (anal wink) - visible contraction of anus in response to pinprick of surrounding skin	No anal reflex (anal wink)
Positive bulbo-anal reflex - contraction of anus in response to pressure on glans penis/clitoris	Absent bulbo-anal reflex
Injury/damage to spinal cord/brain at or above twelfth thoracic vertebra, reflex or spastic paralysis	Injury/damage to conus or cauda equina, at or below first lumbar vertebra, flaccid paralysis

(Source: MASCIIP, 2012)

**Table 3.2: Reflex and Areflexic bowel management**

Reflex bowel function	Areflexic (flaccid) bowel
<b>Daily or alternate days</b>	<b>Once or more daily</b>
(Aim for Bristol Scale 4 stool) Stimulant laxative 8-12 hours before planned care if necessary ↓	(Aim for Bristol Scale 3 stool) Stimulant laxative 8-12 hours before planned care if necessary ↓
Gastrocolic reflex ↓	Gastrocolic reflex ↓
Rectal stimulant suppository/microenema ↓	Abdominal massage ↓
Abdominal massage ↓	Digital removal of faeces ↓
Digital rectal stimulation ↓	Single digital check to ensure rectum is empty 5-10 minutes after last stool passed
Digital removal of faeces if reflex evacuation incomplete	
Single digital check to ensure rectum is empty 5-10 minutes after last stool passed	
Medications to adjust stool consistency (e.g. macrogols such as Movicol or Laxido, Lactulose, Fybogel or Dioctyl) should be taken regularly if needed	

(Source: MASCIIP, 2012)





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The ultimate goal with all bowel management is to establish a regular bowel routine, once this is established it can help avoid accidents, prevent constipation, diarrhoea and associated complications.

Bowel management should be a multi-disciplinary approach and is something that rehabilitation professionals and nursing staff in particular should work closely to achieve with and for the patient.



There are examples of patient information leaflets on the SCI section of the USB. **'Eating and Drinking', 'My bowel programme', 'digital stimulation', 'Stool softeners and laxatives' & 'Diet and Bowel management'** are all leaflets you will find useful when managing an SCI patient

On the USB are also the **'MASCIP Guidelines for management of neurogenic bowel dysfunction'** which provide health professionals with research and current evidence based practice in providing the best care for SCI patients.

### Positioning for SCI patients

Positioning for SCI patients requires a 24 hour approach from the acute presentation into the rehabilitative phases. You will need to balance the following principles to achieve the best possible positions for the patient:

- Possible requirement for spinal alignment
- Good skin care
- Preventing unopposed muscle groups from affecting neutral joint positions
- Provision of support where there is weak or no muscle activity

You may be working in a very resource limited environment, where you will have to adapt the equipment you have to suit your purpose. Pillows will be readily available in most hospitals, and many FMTs or rehabilitation providers will have access to pre-fabricated ankle foot orthoses and wrist splints. When applying splints to insensate skin or areas with reduced sensation, care must be taken to gradually build up tolerance and careful monitoring is required.



Issues concerning positioning for SCI patients, including 'frogging', 'running man', 'hip twist' and skin checks are all covered in the practical day **'SCI in humanitarian settings'**

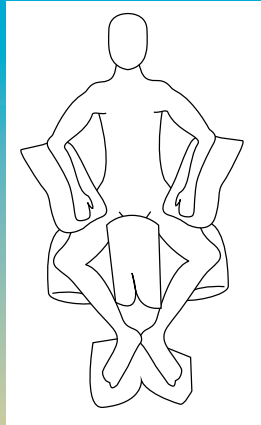
## Spinal Cord Injury - Acute Management

Generally the aim is to rest in a neutral position and to manage strong gross patterns of spasticity. Some ideas of which

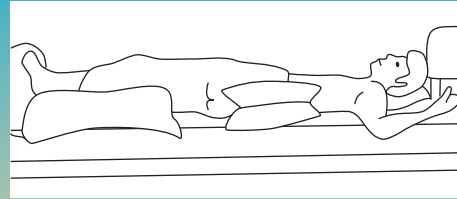
(once precautions are considered) are illustrated in the following diagrams:

### Positioning Ideas

#### Frogging

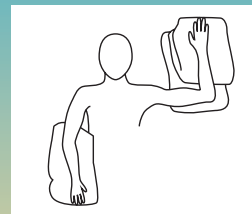
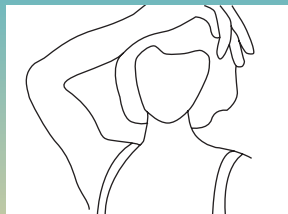
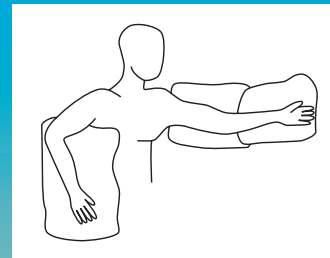
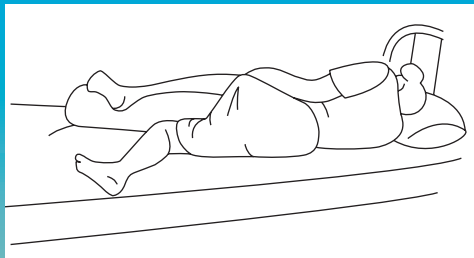


#### Hip twist



### UL Positioning Ideas

#### Running man



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## Oedema management

Spinal cord injury (SCI) patients are prone to the development of chronic oedema due to gravitational influences on dependent limbs, reduced mobility and therefore

reduced muscle pump action. The points below highlight elements that need to be considered within a 24 hour programme to address oedema management within SCI.

### Oedema Management

- 24 hour programme
- Elevation
- Positioning
- Retrograde massage
- Taping/garments
- Passive and active assisted range of movement



## Joint range of movement

Maintenance of joint range of movement will be part of the rehabilitation goals

from the outset of a suspected SCI.

### Joint Range of Movements

- Maintain joint range of movement
- Maintain soft tissue length
- Prevent deformity
- Assist circulation
- Reduce oedma



## Spinal Cord Injury - Acute Management

Passive movements will be performed for muscle groups innervated below the level of the lesion. Do refer to the precautions for

maintaining spinal stability if your patient has an unstable spine. These have been covered earlier in the chapter.

### Passive Movements

#### Precautions:

- Spinal stability
- Extreme ROM
- Neural tension
- Tenodesis



The objectives of passive movements include:

- Reducing oedema
- Assisting Circulation
- Maintaining joint ROM
- Maintaining soft tissue length
- Reducing the risk of deformity

It is important to remember that if the patient has flaccid paralysis - the joint integrity is purely reliant on passive structures only and therefore you will need to keep within normal physiological range of movement, supporting and protecting all joints appropriately when moving and positioning.



Passive movements will be covered in the practical day '**SCI in humanitarian settings**'

## Passive Movements

### Considerations:

- Spinal stability
- ASIA classification
- Muscle imbalance
- Core stability
- Posture
- Joint alignment (mid range)
- Compensatory movement patterns
- Theraband/PNF/FES?



When assisting SCI patients to move and where possible facilitate recovery of active movements, these key factors should be considered:

- Neurophysiological - discussed earlier in pain management.
- Biomechanical - note any pre-morbid issues and associated injuries. The key principle is to gain 'normal' alignment where the nervous system will 'recognise' a movement pattern. Achieve stability before attempting to gain mobility.
- Psychological
- MDT approach - remember the team may include the family and possibly key cultural members of the local area.
- Holistic considerations - the culture and environment in which the patients are managed will influence their ability to participate. Language and fear will contribute to difficulties in communication.
- 24 hour management- Use pictures and family to assist in the continuity of a plan.

**Upper limbs Movements:** It is important to maintain hand to head range to allow functional pain free maintenance of personal care. Maintenance of shoulder complex movements are essential as muscle imbalance and immobilisation predisposes the shoulder to pain and contracture. Encourage hand to head contact for sensory feedback and preservation of cortical mapping of the hand as much as possible. The head can feel a hand even if a hand cannot feel the head. Remember body schema maintenance in the facilitation of recovery. 1/3 of the sensory homunculus represents the hand.

**Lower limb Movements:** Best preserved through an appropriate standing programme with assisted device (eg tilt table, standing frame) This is not covered in this presentation as it is considered within the rehabilitation phase. However, if a patient presents with early lower limb spasms/ increased tone it is important to try and identify local resources to source suitable

## Spinal Cord Injury - Acute Management

equipment to enable a standing programme to happen asap. This will maintain hip extension range and ankle plantargrade, which will be essential for sitting posture symmetry in a wheelchair and allows for active or orthotic assisted gait.

UK SCIPLs Standing Guidelines 2013 available by contacting [www.MASCIP.co.uk](http://www.MASCIP.co.uk) and available on [www.SCIP.T.org](http://www.SCIP.T.org).

**Facilitation of active movements:** Use de-weighting to allow weak muscles to be active.

Facilitate normal movement patterns- to reinforce movement memory (PNF principles)

Engage in purposeful movement to assist re-learning of movement patterning.

Be creative and variable to keep interest and maximise participation (Use it or lose it)

### Rotator cuff re-training



If a patient is on bed rest secondary to a pressure ulcer then a routine of theraband exercises may be helpful. It is important to consider spinal alignment and trunk stability and pillows are likely to be required to provide this depending on level of injury. The photos above give an idea of some of the

exercises possible to try and maintain cuff activation in particular internal and external rotation control of the gleno-humeral joints. These are important when preparing a patient for paraplegic rehab and the required UL strength and control required for wheelchair propulsion and transfers.



Theraband exercises and rotator cuff retraining will also be covered in the practical day **'SCI in humanitarian settings'**

## Splinting and orthoses

Splinting and the use of orthoses with SCI patients may be used at various stages to achieve any of the following:

- Reduction of oedema
- Maintenance of soft tissue length and prevention of overstretching
- To support anatomical alignment and maintain the arches of the hand
- Prevention of contractures and deformity
- Maintenance of the aesthetics of the upper limb
- Provision of a prolonged stretch where needed
- Management of spasticity


- Promotion of function through positioning
- Replacing function

Below are some examples of upper limb splints and orthoses.

'Keep me' splints are easily replicated with a bandage roll and strip of Velcro in the field. Pre-fabricated wrist splints are available in the UK IETR field hospital supplies. More advanced hand splints such as the ones in the bottom pictures can be made using plaster of paris, and for those unfamiliar with this process, there is a practical workshop '**Splinting with POP**' which will cover the basic principles.

### Splints and Orthoses

- "Keep me's"
- Wrist supports
- Hand based splints with wrist supports



Ensure, as with any patient being given an orthosis, that you build up the tolerance gradually, monitoring skin closely and making regular reviews as needs change. Be aware of pressure areas, and the risk of autonomic dysreflexia if the splints are causing discomfort. Educate the patient, staff and carers on donning and doffing the

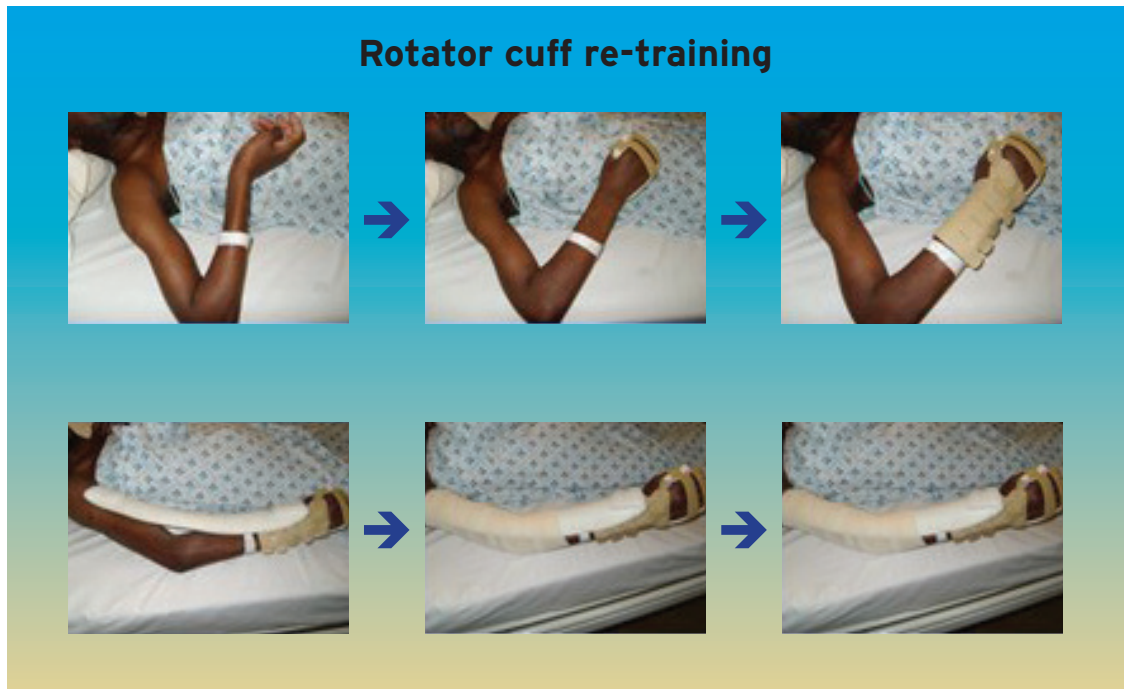
splints, and on the splint wearing regime. If the patient is being discharged with splints - make sure they have written or pictorial guidance. Always take the patients' feedback into account, as their compliance to the splinting regime will be vital to a positive outcome.

## Spinal Cord Injury - Acute Management

SCI at the level of C5 is particularly challenging presentation due to unopposed biceps activity in these patients. A modular splinting system is illustrated here. It has proved effective at managing the significant problem of unopposed biceps activity, but it is also important to educate on 'actively

switching off biceps' in addition to prophylactic splinting if any range is lost.

A hands splint is applied first, then a wrist support (available with UK IETR) and finally an elbow slab to the anterior aspect of arm (where the elbow is splinted into pronation and extension).

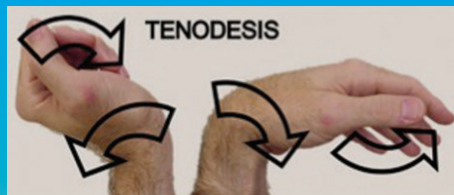




## Tenodesis

### Tenodesis

**Tenodesis - grasp/release  
NOT tenodesis contracture!**



- Only use with complete injuries where no recovery is expected
- Do not stretch the wrist into extension with extended fingers
- Careful consideration and informed consent is essential
- Used to purposefully shorten finger flexors and thumb adductors to strengthen a tenodesis grip and/or improve position
- Careful monitoring and tenodesis ranging required to prevent fixed joint contractors

Tenodesis is a functional grip that utilises activity in wrist extensors to bring about passive opposition of the thumb and finger flexion.

Tenodesis is therefore a functional grasp for C6/C7 injuries and important to understand if you will be managing patients with injuries at this level. Equally it is important to acknowledge that if the patient has an incomplete C6/C7 injury then you must assess all motor and sensory activity and treat accordingly to ensure the best possible functional outcome is gained. It is important to ensure that daily stretches are incorporated into a management programme to maintain length in long finger flexors so that a tenodesis contracture does not develop. Passive movements in the wrist should therefore include wrist extension with finger flexion and wrist flexion with finger extension.

Please note that tenodesis taping is not recommended.

### Dealing with pain in SCI

Following a spinal cord injury, pain is a common occurrence both immediately following an injury, and long term, sometimes for life. The type of pain experienced can vary widely, be difficult to locate and may be a symptom of a variety of different problems. Pain can be experienced in areas of the body with normal sensation and areas with no sensation. Understanding the different types of pain experienced is key to finding a method of pain control, be this therapeutic or pharmacological as pain can have a very negative impact on a SCI patients' quality of life, lead to depression and cause anxiety and stress. Comprehensive pain management requires multi-disciplinary input.

Pain in a person with a spinal cord injury can still help diagnose an underlying problem such as a bladder, bowel or skin issue. Pain can also be caused by over exertion, physical fatigue, stress, tiredness or depression. Even changes in room temperature can affect the levels of pain experienced.

## Spinal Cord Injury - Acute Management

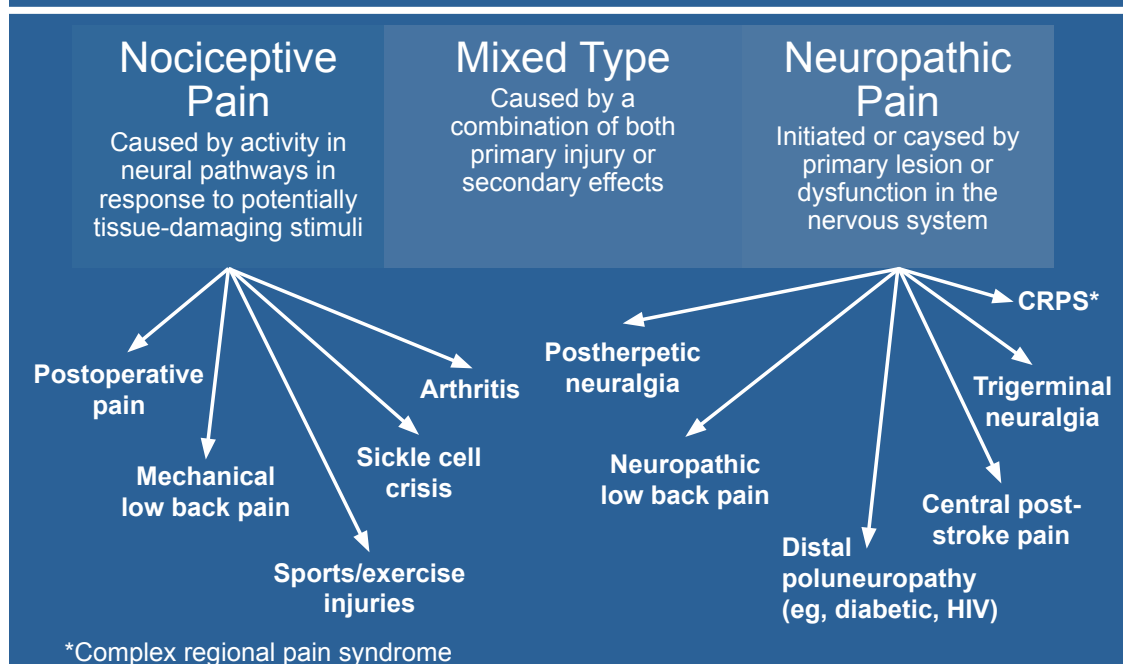
The most common type of pain following a spinal cord injury is *neuropathic pain* due to damaged nerve fibres.

The other pain experienced immediately following an injury may be musculoskeletal in nature due to muscular damage, fractured vertebrae or additional broken bones (*nociceptive pain*). Individuals who have

been paralysed for a number of years may also experience pain caused by postural changes, musculoskeletal degradation and neurological changes (Nepomuceno, 1979).

The differences between neuropathic and nociceptive pain are highlighted in the diagram below (Butler and Moseley, 2013).

### Nociceptive vs Neuropathic Pain



### Pain

- Neuropathic/Nociceptive
- Analgesia review
- TENS
- Acupuncture
- Posture review
- Neural dynamic mobilisations
- Spasms - WB options
- Stiffness/immobility -
- Fatigue
- Pacing

Management of pain is an essential part of the management of SCI patients. They may not be aware of their pain but the noxious stimulus can influence central sensitisation (Butler D, Moseley L, 2013). This explains the concept of the incoming messages being amplified at the dorsal horn and above. This can result in an increase in spasticity. There are many options available to manage pain and the sources of pain.

It is important to ensure that the patient has adequate analgesic cover to enable them to mobilise. Treatment modalities such as acupuncture and TENS may be helpful in managing musculoskeletal and peripheral nerve pain. Bear in mind that

neural structures such as the brachial plexus can also be traumatised and they will be a further source of pain. Neural dynamics should be considered and may contribute to severe limb pain if care is not taken during passive movements and stretches. Joint pain and postural pain will contribute to spasticity and may result in altered movement patterns and asymmetry. Patients that experience chronic pain become fatigued and less able to manage their daily functional activities. Use of pacing techniques can provide a controlled framework to assist patients in coping with the demands of rehabilitation and in managing their pain.

## Shoulder pain

Incidence range 30-73%  
(SIA 2009)  
Tetras>paras

### Consider-

- Muscle imbalance
- Neuropathic pain
- Immobility/stiffness
- PNI/Nerve root referral
- Impaired core stability
- Altered biomechanics
- Overuse
- Preventative approach
- Avoid contractures
- Address muscle imbalance
- Optimise posture/trunk control
- Pre function training
- OP Musculoskeletal approach combined with neuromuscular approach

The incidence of shoulder pain ranges between 30 and 73% (Consortium for Spinal Cord Medicine 2005, being higher in tetraplegic than paraplegic patients. In the acute phase, up to 75% of individuals reported shoulder pain (Silfverskiold & Waters 1991). It is therefore worth considering from the outset of a rehabilitation programme.

The shoulder is not well designed to handle the higher intra articular pressures required for both weight bearing and mobility (Apple 2001) In tetraplegic patients, partial innervation, muscle imbalance, impaired trunk control, overactivity of trapezius and joint stiffness are all factors in increasing

the risk of individuals developing shoulder pain. These are listed in the slide above and in more detail on the SCIRE website [www.scireproject.com/book/export/html/885](http://www.scireproject.com/book/export/html/885)

A preventative approach to identify impairments and treat them to prevent development of shoulder pain in both tetraplegic and paraplegic patients is paramount to maximising their ability to achieve full functional independence in accordance with their level of injury. Stretching of anterior structures and strengthening of posterior shoulder musculature was found to be beneficial in reducing shoulder pain over a 6 month period. (Curtis et al 1999)

## Spinal Cord Injury - Acute Management

### Heterotrophic Ossification (HO) and SCI

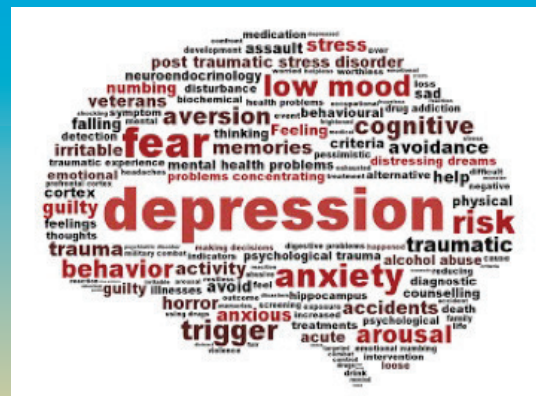
Rehabilitation professionals should be aware that HO can develop at any point post SCI, but its peak incidence is at 2 months post injury. Clinical signs (pain, erythema, reduced range of movement or increased spasticity) are often first observed at around

3 weeks post injury. It occurs below the level of injury. Rehabilitation as part of multi-disciplinary management can include the modification of vigorous activity and gentle exercise to maintain range of movement until acute inflammation settles.

### Psychological impacts of SCI

- Anxiety/depression
- Cognitive ability
- TBI
- Language barrier
- Previous MH issues
- Grieving

### Psychological



This a topic by itself and any training you already have in dealing with 'breaking bad news', 'psychological first aid' (covered in UK core rehab training) and 'counselling skills' will be invaluable when working with patients with SCI.

The added complicating factors or working in a humanitarian setting cannot be underestimated and use of local support services in providing support to people grieving for multiple reasons, will be essential. Those with already pre-existing mental health conditions will be most

vulnerable and it is important at an early stage to involve local support groups and family members and friends where they are available. A language barrier is common in humanitarian situations and appropriate use of interpreters especially in the early stages, is vital in order to gain consent and an adequate patient history. You will need to take time to explain your role, gain an understanding of what knowledge they and their family have regarding their injury and its implications on their life, and also to give them the opportunity to ask questions and have them answered satisfactorily.

## Early Rehab Considerations

- ISNCSCI to inform treatment plan
- Objective measures to identify changes
- Joint ROM - prevent contractures
- Motor impairments - weakness, spasticity, spasms
- Sensory impairments - pin prick, proprioception, light touch, vision, hearing
- ICF - impairments, compensations, activity limitations, participation limitations, hypothesis, treatment plan

The ISNCSCI assessment and resulting ASIA Impairment Scale will provide a picture of neurological activity and function in SCI patients. This will assist in setting goals and planning further management for these patients. An understanding of the neurological level of activity will indicate the functional expectations for the patients. The quick reference table of Functional Levels will provide a baseline for the complete patient.

Use of outcome measures will be essential when evaluating progress and guiding further intervention needs.

A priority of the physical management of SCI patients will be to prevent loss of joint range wherever possible, as this will lead to loss of postural symmetry and hinder function. If allowed to develop further contractures may result in skin breakdown and prevent self care.



### Further resources you may wish to use to explore early rehabilitation of SCI are:

#### Recommended Outcome Measures:

SCIM - Catz A et al (2007)

Modified Ashworth Scale: Haas BM, et al (1996)

#### Rehabilitation Evidence and Outcome Measures :

<http://www.scireproject.com/rehabilitation-evidence>

#### Spasticity:

Satkunham LE, Rehabilitation medicine: 3. Management of adult spasticity. CMJA NOV 25, 2003; 169 (11) 1173-1179

**Royal College of Physicians 'Spasticity in adults: management using botulinum toxin: national guidelines'** (ISBN: 9781860163500 Published 2009)

This publication can be also downloaded from the website:  
<https://www.rcplondon.ac.uk/sites/default/files/documents/spasticity-in-adults-management-botulinum-toxin.pdf>

## Spinal Cord Injury - Acute Management

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Sensory assessment can provide indications of further recovery and inform decisions when planning further rehabilitation. This will also identify considerations when applying splints and using positioning systems.

Use of the ICF structure will facilitate a holistic view of the patients needs, as it considers the effects of impairments in the patient's environment and limiting factors to participation in the varied settings where the patients will be managed.

### Onward referral and transfer of SCI patients in a humanitarian context

#### Onward referral from UK IETR facilities

- Are you able to manage the patient and their relative complications in your facility?
- UK IETR is FMT Type II (ie no ventilator)
- May be necessary for high level patients to be transferred to higher level care facilities
- Importance of linking with existing rehab/specialist facilities - using health cluster



The realities of dealing with SCI patients in a sudden onset disaster context will be covered in the one day workshop '**SCI in humanitarian settings**'

Having read this chapter, and with an understanding of the scope FMT hospital deployments, you will be aware that some SCI patients, especially those requiring ventilation, would be better managed acutely in Type III FMTs (Foreign medical teams), or in more advanced health facilities whose services are undisturbed by the disaster. Such services may or may not

be accessible at that time, and if they are - may be a distance away from where your field hospital is situated. Additionally, there is growing consensus that SCI patients in emergencies are best managed in specialist units - where such facilities exist, FMTs should seek to coordinate transfer of patients meeting admission criteria's as soon as possible.

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As mentioned in chapter one of this manual – Foreign Medical Teams should be part of the humanitarian co-ordination system – normally their own WHO coordination body as part of a ‘health cluster’. This is an essential way of establishing who the other health and rehabilitation actors are locally, what referral mechanisms there are, and vitally who is providing inter-facility transport for patients.

In a short stay emergency medical team, the whole team should be looking towards onward referral as soon as possible for a spinal injured patient likely to need long term inpatient care and rehabilitation. It may be necessary to stabilise the patient in a field hospital, but ultimately the deployments will not be able to support long term care and it will be necessary for the patient to transfer to another facility staying beyond the initial emergency response phase.

The transfer of a spinal patient from a field hospital will need to balance risks. Does the risk of transporting an unstable patient in the midst of infrastructural chaos and poor health systems organisation outweigh the benefit of having early surgical stabilisation? If the patient can maintain their own respiratory effort, then managing them conservatively in the facility with good quality nursing and rehabilitation care may provide them with the best long term outcome. The team can then agree on a transfer to a facility offering spinal surgery and long term rehabilitation once referral mechanisms and systems capacity are clearer.

Ensure that all documentation is transferred with the patient, and translated if appropriate. If possible have a verbal handover of past events and current treatment goals to the rehabilitation team taking over the patient, and ensure that contact details of the patient and family are taken and handed over.

It is generally not acceptable that an SCI patient with ongoing needs is discharged home or to another centre lacking the skilled staff to care for them. Examples exist of catheterised patients with unstable injuries being discharged home with no plan for follow up – something which places them at extreme risk. In other scenarios, as documented on several occasions in Haiti, examples exist where a patient has been returned temporarily home as there are no facilities to provide the necessary in-patient rehabilitation. In such cases, carer training, a home environment assessment and discharge planning will need to be actioned and teams need to ensure that there is a confirmed plan for follow up in place.

### Finally

The developing team from ACPIN are happy to be contacted, via the rehabilitation programme manager at Handicap International, for clinical support on SCI patients who are being treated by UKIETR staff. As well as the literature on the USB device to support your learning, they also recommend the following websites as sources of useful information on spinal cord injuries:

[www.asia-spinalinjury.org](http://www.asia-spinalinjury.org)  
[www.aspire.org.uk](http://www.aspire.org.uk)  
[www.spinal.co.uk](http://www.spinal.co.uk)  
[www.bsrm.co.uk](http://www.bsrm.co.uk)  
[www.scireproject.com](http://www.scireproject.com)  
[www.bascis.org.uk](http://www.bascis.org.uk)  
[www.physiotherapyexercises.com](http://www.physiotherapyexercises.com)  
[www.mascip.co.uk](http://www.mascip.co.uk)  
[www.backuptrust.org.uk](http://www.backuptrust.org.uk)  
[www.spinalresearchnetwork.org](http://www.spinalresearchnetwork.org)  
[www.pva.org](http://www.pva.org)  
[www.risci.org.uk](http://www.risci.org.uk)  
[www.elearnsoci.org](http://www.elearnsoci.org)

### Core Recommended Texts

*The British Association of Spinal Cord Injury Specialists* www.bascis.org.uk

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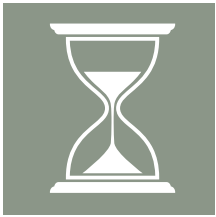




## Peripheral Nerve Injury

This module was developed by British Association of Hand Therapists (BAHT) members working in collaboration with Handicap International.

The presentation and manual content aim to provide an *overview* of peripheral nerve injuries (PNI), and by no means replaces the thorough anatomical and physiological knowledge which you should have. To this note, at the end of the chapters the authors have recommended texts to use as a reference for this key knowledge.



The cheat sheets on lower and upper limb peripheral nerve injuries are a useful guide to motor and sensory innervation. It is recommended to review these prior to continuing this chapter.

The content is pitched at a core level of knowledge in acknowledgement that some therapists may have minimal PNI experience. It emphasizes the importance of assessment techniques and provides alternative methods to be used in difficult situations such as minimal medical handover or communication difficulties.

### Sudden onset disasters

Peripheral nerve injuries are a common but frequently neglected group of injuries in sudden onset disasters (SODs). Hazards such as earthquakes and storms can commonly lead to large numbers of PNIs - either due to complex limb trauma and crush injuries, or those which incur deep soft tissue injuries from flying debris. Often PNIs can be missed early on in these situations - particularly with complex limb trauma, where life-saving vascular repair and orthopaedic stabilization are the priorities. It is often the rehabilitation professional who recognises the injury once emergency surgery has been completed, the patient is entering the rehabilitation

phase and function is assessed fully. It is also common to discover nerve compression or transection due to the pin insertion of external fixators - thus this should always be a consideration for your assessment of these patients.

Peripheral nerves injuries, if left untreated, are a significant cause of disability. It may be the case that there is no nerve surgery available locally for those patients with neurotmesis that require surgical repair, however prevention of associated complications and increasing function can and should be addressed by all members of the team, and surgical options explored.

### Learning Outcomes

To gain an awareness of assessment of peripheral nerve injuries  
To be aware of the 3 fundamental splinting roles

- Protection
- Prevention
- Promotion of function

To be aware of the importance of advice for patients with peripheral nerve injuries, and be able to give basic advice to patients using UK IETR resources as an adjunct

### Why are PNIs a problem?

Without nerve supply the patient has to contend with motor and sensory issues and dependent on injury level this could involve gross movement of the limb, mobility, grip and fine dexterity; ultimately a significant functional limitation.

The most perfect movement and strength may not translate into normal function as without the ability to feel what you are doing it is difficult to determine how much pressure to apply when picking something up.

Secondary complications are also a significant issue:

- Pain and hypersensitivity
- Numbness
- Swelling
- Contracture
- Further injury; e.g. burns and infection, slow healing wounds

### Classification of PNIs

#### Classification

##### Seddon 1943

- Neuropraxia
- Axonotmesis
- Neurotmesis

##### Sunderland 1978

- Grade I
- Grade II
- Grade III preserved perineurium
- Grade IV preserved epineurium
- Grade V complete transection

The 2 most commonly used classification systems highlighted above which will help you define/determine severity of injury and realistic "ballpark" recovery timelines.

Remember that neurotmesis (Grade V complete laceration) requires surgical intervention for regeneration to occur. Primary repairs (micro-surgery to re-



connect the neuron) has a better outcome but must take place within 2 weeks of the initial injury to be successful. Grafting can take place at a later stage, but must allow for regeneration to occur before the motor end plate degenerates, normally at around 2 years.

Once the affected nerve is in continuity it will regenerate at roughly 0.5mm to 2mm per day. Bear this in mind when you think about realistic re-assessment timeline and education to patients. This regeneration will occur from the site of injury and moves distally. It will continue for roughly a maximum of 2yrs no matter what level of injury.

### Gathering subjective information on a peripheral nerve injury

#### Gathering info - ideal scenario

##### Pre-patient

- Nature of injury
- Associated injuries
- Surgical intervention
- Past medical history
- Drug history
- Language
- Religion

##### With patient

- Pain levels
- Dominance
- Role
- Sensation

**The pre-patient information** (what you gather from the MDT, medical and theatre notes) can help you decide what structures may be injured, whether you are expecting recovery (e.g. nerve laceration and repair), what structures may need protecting, if there are any reasons healing/recovery may be slow (e.g. diabetes, vascular conditions which include blood pressure issues) or elements that may make assessment difficult/challenging (language, age, gender, religion). Bear in mind there are some areas of the world where loss of a hand can be extremely significant in terms of religion or where amputation is used as a punishment for crime, therefore a patient may have opted to keep a hand rather than go for amputation.

**With the patient**, pain level assessment is key and needs controlling as much as possible to make treatment more comfortable and meaningful. Pharmacological treatment will depend on the type of pain, but neuropathic pain responds to gabapentin, amitriptyline, and pregabalin. Hand dominance can be key in terms of function and will be more significant when linked to the patient's role within the family, community and employment. It is important to ask the patient about their sensation.

## Peripheral Nerve Injury

### Objective assessment of peripheral nerve injury



This is a crush injury in an industrial accident where the hand was crushed and trapped for 30mins before the patient had to pull himself free (avulsing flexor and extensor tendons from their musculotendinous junctions)

In the slide above, think about what elements of assessment you need to include in this scenario. Consider:

What structures may be injured (replantation)

- Carpal and metacarpal fractures +/- phalangeal fractures
- Full arterial and venous injury
- Ulna and median PNI plus crush to digital nerves
- All extrinsic flexor and extensor tendons avulsed
- All intrinsic muscles crushed and non-viable (necrotic)

Timescales of recovery

- With such a significant injury you could be looking at 2 years minimum with a high possibility of further reconstructive procedures such as tenolysis, arthrolysis and-or secondary tendon reconstruction.

Scar tissue

- Bear in mind superficial and deep scar which will have a significant impact on mobility and function. Scar management in the form of massage and pressure will be essential plus splinting to keep scar in its longest position and prevent contracture.

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### Contracture patterns

- ─ Consider swelling and scar contracture. Dorsal swelling will cause extended MCP joints and flexed IP joints, a non-functional position and to be avoided at all costs.
- ─ Position Of Safe Immobilisation should be encouraged if safe to do so, including an abducted 1st web space.

### Healing times

- ─ Remember nerve regeneration times of 0.5mm-2mm every day in ideal conditions. This recovery rate may be slower/restricted in this case due to the crush nature of the injury.
- ─ Consider any skin coverage and keep grafts and flaps still for 5-10 days to allow take.

### What structures to protect

- ─ Skeleton - dependent on surgical fixation but need stable skeleton to commence movement
- ─ Vascular - no tension or pressure on anastomoses
- ─ Skin coverage - no shearing forces or spot pressure
- ─ Muscle/tendon - least important in an injury of this severity so protect the other structures then consider possible contracture patterns (see above). Tendons can be reconstructed if ruptured whereas all other structures above have a significant impact in both integrity or viability of the limb.

## Pause . . . . . Look

- ─ Posture
- ─ Wounds / infection / scar
- ─ **Skin texture**
- ─ Oedema
- ─ Muscle wasting
- ─ Deformity



The use of observation will be key to your assessment.

- ─ Posture can indicate contracture and nerve injury.
- ─ The area of the wound will allow you to work out which structures may have been involved in injury plus an evaluation of presence of infection and scar.

- ─ Skin texture can provide signs of Complex Regional Pain Syndrome (CRPS) for the less acute patient but will also show signs of PNI injury. A peripheral nerve will supply sweat glands to the glabrous skin therefore an area of denervation will be dry.

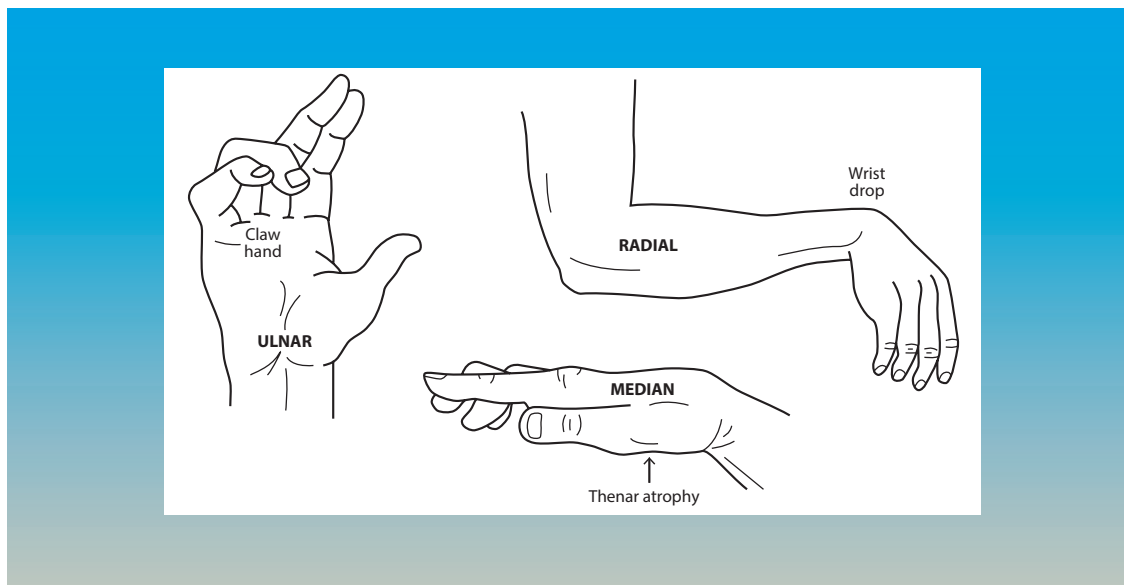
## Peripheral Nerve Injury



What do you observe from the images above?

- Bilateral groin pedicle flaps to volar wrists.
- Mild clawing *left* little and ring fingers (ulnar nerve injury) and tethered Flexor Pollicis Longus (FPL) tendon.
- Thenar and hypothenar wasting *right* hand
- Thumb sitting in adducted posture on *right* side and clawing index and little fingers (median and ulnar nerve injuries).
- Lack of active flexion *all digits right hand*, particularly middle and ring fingers (Flexor Digitorum Superficialis (FDS), Flexor Digitorum Profundus (FDP) and Flexor Pollicis Longus (FPL) injuries; FDP to index and middle may be intact but tethered).
- Stiffness into supination *right* forearm.

## Deformity



The slide above demonstrates classic deformities of upper limb peripheral nerve injuries.



Nerve Injury	Deformity
Ulnar	Hypothenar atrophy
Radial	Wrist drop
Median	Claw hand deformity

Remembering this will alter for higher level injuries, for example a high level ulnar nerve injury will not demonstrate a claw until the

Flexor Digitorum Profundus (FPD) muscle is re-innervated.

### Manual muscle testing

#### MMT - key points

- Observation
- Know your anatomy
- Look at active first and check passive
- Remember hand intrinsics are not powerful
- Palpate the muscle belly if you can
- Use of Oxford Scale useful

Manual muscle testing using the oxford scale is a basic assessment technique but is reliant on your knowledge of individual peripheral nerve motor supply (see cheat sheets). It is ideally combined with observation initially (look for wasting and deformity). Do remember the intrinsics are

relatively weak and therefore do not require much pressure when testing. Think about eliminating gravity and if you need to do a very quick assessment or screen of a patient pick one distal muscle from each peripheral nerve that is definitely supplied by that nerve (see table below):

Nerve Injury	Quick Test Muscle	Movement
Ulnar	Abductor Digiti Minimi	Abduction of little finger
Median	Abductor Pollicis Brevis	Abduction of thumb
Radial	Extensor Digitorum Communis	Extension of medial 4 digits with PIPs and DIPs in flexion

Remember other structures may be involved and any be aware of any contra-indications to movement when doing these tests.

### Assessment of sensation

#### Sensory

- Hot / cold or sharp / blunt (protective)
- The 10 test (moving light touch)
- 2 point discrimination (threshold testing)
- **Semmes-Weinsten monofilament of The West**

**The 10 test** uses an area of normal sensation (rated as 10) and compares it to other sensation areas which the patient then rates out of 10 (less sensation represented by a lower number down to zero which is no sensation). It is quick and easy to use in almost all patient including young children.

**Two point discrimination** is widely used and gives well accepted objective data. It provides information on the shortest distance between two points that the patient can perceive as being touched with two versus one point. Normal values for the fingers include < 6mm for static

two point. It can be tested by unfolding a paperclip and changing the distance between to the 2 points as well as moving between 1 or 2 points. The distance of accurate differentiation can be mapped on a chart (draw round your hand on paper and add notation) with better sensation demonstrated as a smaller distance of accurate differentiation.

**Monofilaments and The Weinstein Enhanced Sensory Test (WEST)** can be used in higher resourced settings, but are expensive, take time and will certainly not be available in the field.

#### Special Tests

#### Moberg Pickup Test



- 10 similar objects
- Timed test to place objects in pot
- Can be modified to focus on identification of objects or used as sensory retraining exercise

#### Moberg pickup test

This is a test for functional sensation. The patient is shown number of small objects on table & asked to place them in a box. It

involves timed testing the ability to perceive constant touch (to locate), precision grip (to pick up) and cutaneous feedback (to grip).

Ideally you should use 10 standard objects of same temperature e.g. metal & sounds to prevent clues such as 50p piece, 10p piece, paperclip, safety pin, bolt, nail, washer, wing nut, small key etc.

Later the patient is asked to do the test blindfolded to test stereognosis (the ability to perceive and understand the form and

nature of objects by sense of touch).

This is not a true test for sensation, more dexterity, but is significantly affected by PNI from a motor and sensory perspective. It is quick, inexpensive and very easy to reproduce in the field with whatever small objects are to hand and may be used as something a patient could continue with as a treatment technique.

## Testing tricks

### Sensory

- The biro test
- The wrinkle test

### Motor

- Opposition
  - O not D
- Froment's test

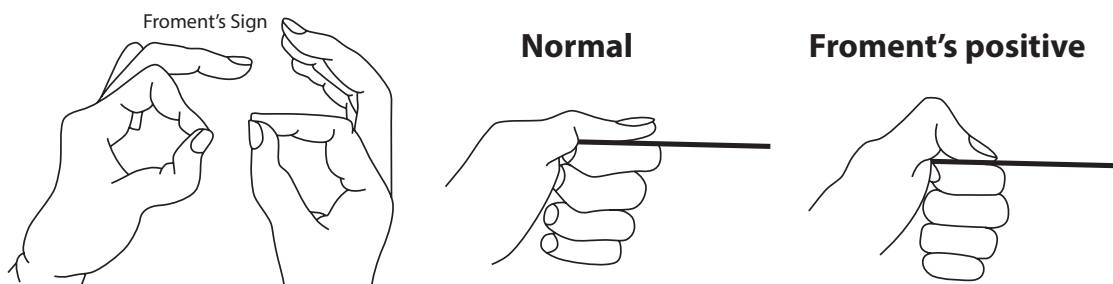
Further special tests are highlighted below:

**The biro test** Sliding a biro over the skin in an area of denervation will move smoothly as sweat glands are not innervated compared to sweating skin.

**The wrinkle test** Where the hand is submerged in water to the point where wrinkles normally appear. Wrinkles will not be present in denervated skin.

**Opposition** Looking for true opposition where a circle is formed between the thumb and the finger rather than a flat D shape (Froment's sign)

Froment's test, as shown in diagrams below from two separate angles, is where paper is pinched (lateral pinch position) between the thumb and forefinger. In a median nerve injury the patient will over use flexor pollicis longus to maintain grip on the paper.



### Treatment

#### Treatment

##### Inclusion essentials

- Advice and education
- Appropriately graded exercise
- Sensory re-training
- Splinting

##### Nightmare scenario

- Infection
- Poor wound healing
- Secondary injury
- Late identification
- Joint contracture
- Lack of regeneration
- Hypersensitivity
- Trick movements
- Complex Regional Pain Syndrome (CRPS)

Appropriate advice and education is essential particularly in relation to timescales of recovery, use of splints, reasons for exercises to prevent contracture and the secondary risks of loss of sensation.

Core physiotherapy skills of appropriately graded exercise and sensory re-training should be used, along with consideration for contraindications to movement and other structures damaged (eg skin/burns).

Splinting is a useful modality for treatment of PNI and will be covered in more depth later, and in a practical workshop.

The aims of your treatment are to avoid everything in the nightmare scenario list much of which could be avoided by appropriate advice and education initially.

### Sensory Integration

#### Sensory Re-education

- Initial acute advice essential
- Maintain cortical representation
  - Bilateral influence
  - Overlay of other senses
- Texture retraining
  - Grading
- Dexterity and differentiation
  - Moberg pick-up test



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Advice regarding regeneration and risks of lack of sensation such as burn injury.

Maintaining cortical representation can vastly improve recovery following PNI and using other senses and/or bilateral influence can assist this. This could include texture retraining which should be graded.

This sequence of cortical exposure has become known as graded motor imagery. Clinicians wishing to add this programme to their treatment repertoire can find resources at <http://www.noigroup.com>



Further reference to graded motor imagery can also be found in the amputation chapter of this manual, and in the document '**Graded Motor Imagery**' by Moseley on the USB

## Educating patients

### Things they should know

1. Realistic recovery timescale
2. They can't feel ANYTHING . . . the risks
3. Why a splint is important and how to care for it
4. Why the exercises are important even if it feels like nothing is changing
5. Why smoking is bad . . . not just the obvious

These are the five key elements you should aim to cover with your advice and are all fairly self-explanatory from the slide above.

The interesting point is that smoking has general health implications but research evidence suggests it reduces nerve regeneration significantly to reduction

in blood circulation to the periphery (30% reduction to hands for each puff of cigarette). For many low income countries where smoking is still very prevalent, this may be an important consideration for out-patients who are recovering slower than anticipated.

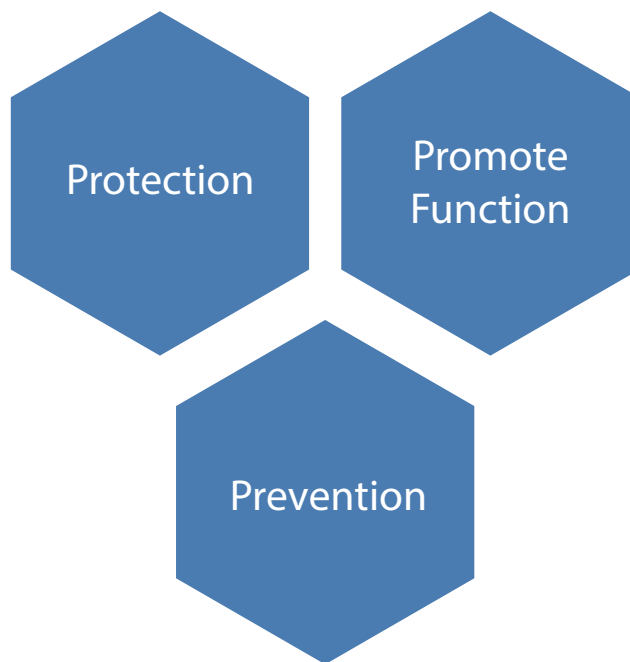


The UK IETR leaflet '**PNI patient information booklet**' has a lot of information which is essential to include in your education

## Peripheral Nerve Injury

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### Splinting



The three roles of splinting are detailed in the diagram above and should be considered in your treatment of PNIs.

You may be required to provide splints in both phases of recovery:



When deploying with the UK field hospital you will have access to pre-fabricated wrist splints and AFOs plus POP.



The principles and practicalities of splinting with plaster of paris (POP) will be covered in the practical workshop '**Splinting with POP for peripheral nerve injuries**'



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## Lower limb peripheral nerve injury



### Lower limb

- Most commonly injured peroneal, tibial and sciatic nerve
- Important to control ankle / foot position to allow mobility

The most commonly injured lower limb peripheral nerves are the peroneal, tibial and sciatic nerves.



Further information on innervation can be found on the '**Lower limb cheat sheet**'

These injuries are likely to present as part of lower limb trauma - whether this is complex open injuries or perhaps closed displaced fractures. You should also be aware of the high incidence of nerve compression/ transection with external fixators. This may not be such a problem with external fixators sited by experienced surgeons, but perhaps those sited by less experienced responders to the emergency.

It is difficult to treat and control a high level pelvic/femoral level injury but at whatever level of injury - control of foot position is

essential to promote mobility and prevent contracture.

Loss of active dorsiflexion causing foot drop can be a highly disabling injury. Field hospitals or rehabilitation providers often have Ankle Foot Orthoses (AFOs) which can be used, although compliance is often a challenge particularly where patients may not have appropriate footwear. In patients with external fixators currently in situ, it may be necessary to advise or adapt positioning and stretches to ensure contractures do not form whilst the patient is non-weight bearing.

## Peripheral Nerve Injury

### Peripheral Nerve Injuries as part of complex limb trauma

The following photographs demonstrate the most common presentation of PNI, not

in isolation but as part of a more complex injury.

### Radial Nerve



The patient in the image above is affected by a Buruli Ulcer (an infectious disease caused by *Mycobacterium ulcerans*, most common in rural sub-saharan Africa), and as a result also has a radial nerve injury. This radial nerve injury has affected all extensors to the wrist and digits causing a wrist drop.

Provision of a wrist extension splint will both promote function (functional grip requires

roughly 30 degrees wrist extension) and prevent wrist flexion contracture.

Obviously this is an infectious disease pathology and not trauma related, as you will see in sudden onset disasters. However, with this image you should bear in mind the addition of extensor tendon injuries, necrotic fingers and ongoing infection in your patients and how they will affect your treatment approach and options.



## Ulnar Nerve



This image shows an ulnar nerve injury with the addition of significant tissue coverage loss, tendon, muscle and bone injury. It resulted from a road traffic accident injury where the hand was outside the vehicle as it rolled, added to this it was also a late presenting injury. Late presentation is quite a likely scenario if you are deployed to a sudden onset disaster several days after the impact to treat the 'second wave' of patients.

The patient above presents with a very mild claw deformity consistent with ulnar nerve injury but this is less evident due to intrinsic muscle injury.

When splinting this patient, you will need to consider the other tissues involved (wounds/healing) but for the ulnar nerve it will be important to maintain MCP joint flexion and IP joint extension of the little and ring fingers.

## Median Nerve



The image above is not an immediately obvious median nerve injury. However, your knowledge of anatomy within the area of injury and identifying this as a deep burn injury (electrical burn) would both raise your awareness when assessing.

This is possibly the most functionally limiting upper limb PNI due to loss of the

intrinsic to the thumb. It will be important to protect the acute nerve repair by keeping the wrist in neutral for 3 weeks (if it is not repaired you do not need to protect it). It will also be important to maintain the 1st web space abduction and provide some support to the thumb into opposition to promote function.

### Outcomes of peripheral nerve injuries

#### Outcome

- Past medical history and associated injuries
- Type of nerve injury
- Level of injury
  - Regeneration rates of 0.5mm-2mm per day in ideal scenarios
- Maintenance regime

The outcome of PNIs will be directly associated with everything included on the slide above, plus patient understanding. Advice and education regarding the injury, timescale and any rehabilitation you have provided is essential as the patient will have to continue without you for what may be a significant period of time dependent on their level of injury. They may not notice any immediate benefit as many of the treatments for PNI are preventing further complication while awaiting regeneration if the nerve is in continuity.

#### Reassessment

Due to slow regeneration rates remember re-assessment of motor and sensory function is not necessarily going to demonstrate anything if done to regularly.

- 6-8 weeks is a reasonable timescale between sensory and motor reviews.
- If you miss the period when a motor end organ can be reinnervated (within one year of injury if the nerve is *completely* in discontinuity with the muscle fibers), then you will be unable to regain function in that particular muscle by any procedure attempting to re-innervate because the muscle will not respond.
- Timeline of treatment varies by type of injury (open/closed/gunshot wound) and by time of presentation of the patient. Preferably, you see patient at time of injury, then 6 weekly until a treatment decision has been made or recovery has occurred.

#### KeyPoints

- Take time to assess
- The 3 fundamental splinting roles
- Importance of advice for short and long term



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### Core Recommended Text

Rehabilitation of the Hand and Upper Extremity (Skirven, Osterman, Fedorczyk, Amadio) 6th Edition; Mosby ISBN: 978-0323056021

### References

Moseley, G (2004). Graded motor imagery is effective for long-standing complex regional pain syndrome: a randomised controlled trial. *Pain* **108**: 192-198. doi:10.1016/j.pain.2004.01.006

Seddon, H.J. (1942) A Classification of Nerve Injuries, *BMJ*, **2**, 4260, 237-239

Sunderland, S. (1951) A classification of peripheral nerve injuries producing loss of function, *Brain*, **74**, 4, 491-516.



## Fractures

**This module was developed by members of ADAPT, the Chartered Society of Physiotherapy group of physiotherapists with an interest in international health and development, who worked in collaboration with Handicap International.**

**The chapter aims to provide an overview of possible fracture pathologies in sudden onset disaster situations, likely management strategies and possible complications. It is not designed to replace basic orthopaedic anatomical or physiological knowledge, but rather should act as a prompt for further learning. The aim is to give rehabilitation professionals the foundations so that they have a basis from which to clinically reason and adapt their practice as required.**

**The fracture management e-learning modules offer further interactive learning in more depth on specific fractures, their management and complications as well as case study work and an opportunity to test your knowledge.**

### Fracture management in sudden onset disasters

From a rehabilitation perspective, orthopaedics is normally fairly straightforward. What makes it more complicated in the context of sudden onset disasters are the co-morbidities, aftercare, follow-up, environmental conditions and resources available within a local or field hospital setting and also the wider community.

The prevalence, variety and severity of fractures in the patient population will be influenced by the hazard type, and a number of other factors. Considering prior to deployment the types of injury patterns you may see will help you better prepare for response. Typically in earthquake

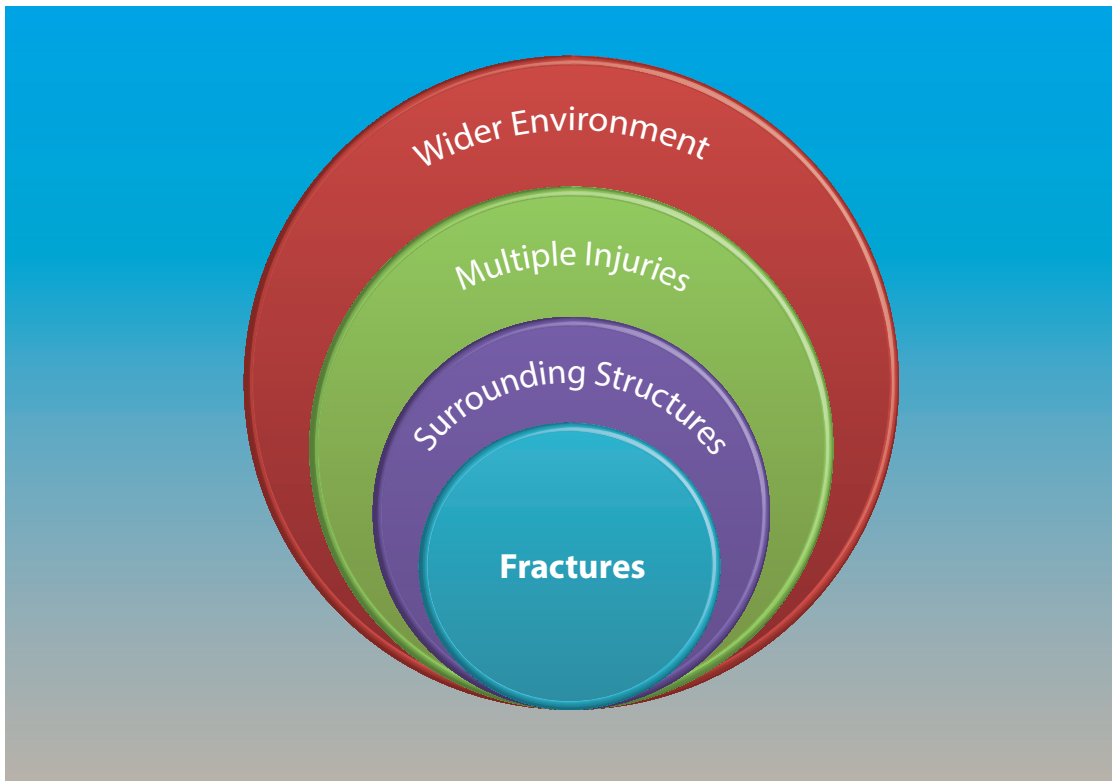
responses fractures form a high proportion of patients, often more long bone fractures than complex pelvic and spinal trauma due to poor immediate extrication and survival rates of these patients. With tropical storm and flooding scenarios, victims may have been injured by debris and contamination of open fractures will be a worrying concern. Working within an FMT, fracture management in an emergency setting will aim for the best possible functional outcome for the patient, based on the resources available and critically minimising the risk of complications within an environment where infrastructure and health services are likely to be disrupted.



## Introduction

### Learning outcomes

To understand clinical features and healing pathways of fractures  
To have an awareness of classification systems for fractures  
To understand the differences in management for adult and paediatric fractures  
To be able to prevent, identify and react appropriately to common fracture complications



The purpose of this chapter is to provide you with the foundations of fracture management. As we said, orthopaedics is fairly straightforward - what makes it more complicated is the context. So a few points to consider while exploring this topic:

### 1. More than just a bony injury

Fractures will impact upon the surrounding tissues and structures including, but not limited to: muscle, ligaments, nerves, organs and vascular supply.

## Fractures

### 2. In this field of work, patients are unlikely to have isolated injuries

Fractures are commonly combined with soft tissue injury, nerve injury, head injury, multiple limb involvement etc, depending on the mechanism of injury. Therapists may be the first to get someone moving, to analyse how they are moving or to assess their 'unaffected' limbs. It's not uncommon for therapists to find secondary injuries such as peripheral nerve injuries during this process.

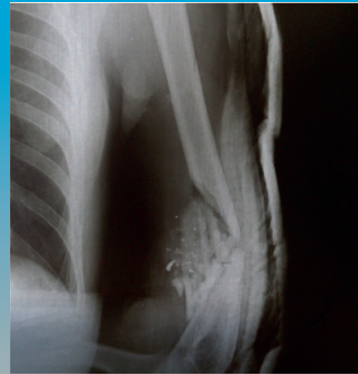
### 3. Consider the wider context

This should include culture, resources (or lack of), local community and the effect of the disaster on food, shelter, water, support networks and infrastructure. It is also important to understand local medical and rehabilitation professionals approach to rehabilitation, what the 'go-to' treatments are and what level of training have they had.

### Clinical features of fractures

#### Clinical Features

1. Pain
2. Deformity
3. Oedema, bruising, bleeding
4. Limited range of movement
5. Impaired function



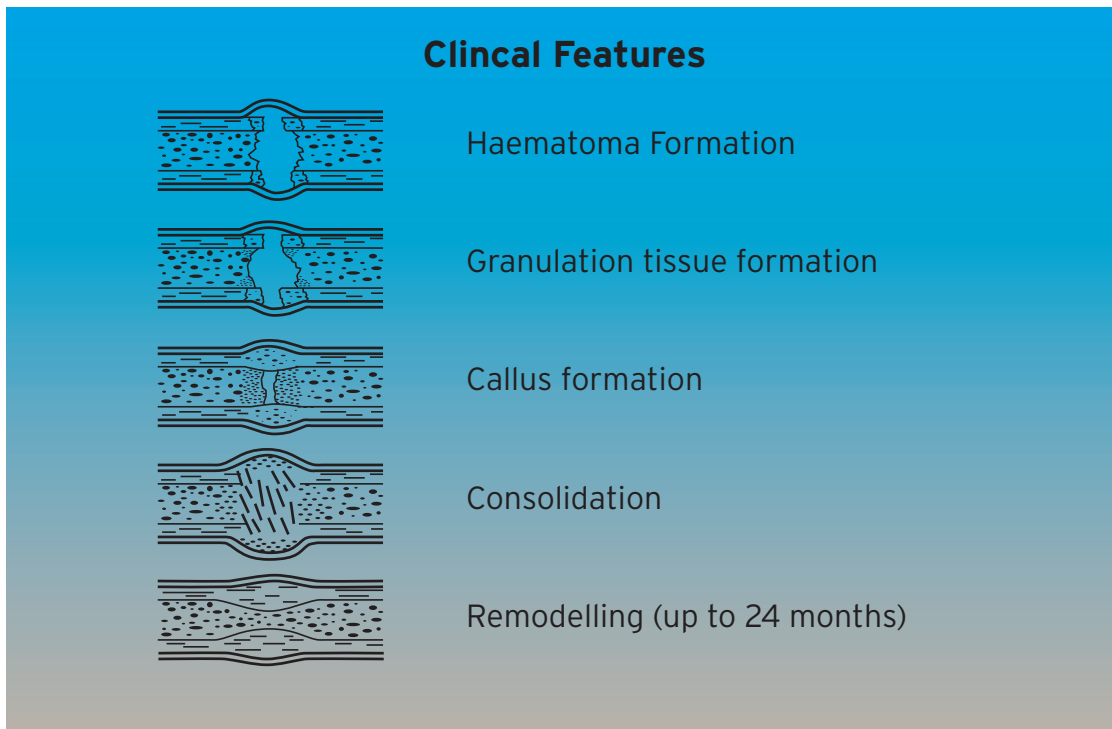
Acutely with a fracture you will see:

- Pain
- At rest and/or on palpation, movement and/or weight bearing
- May result in muscle spasm
- Deformity
- Altered limb shape or position e.g. hip fractures - external rotation and shortening
- Open fractures

With severe injuries the patient may also present in shock due to complications such as excessive bleeding. Bear in mind when mobilising patients for the first time that sometimes injuries may have been missed on initial assessment, especially if the patient was critically injured and has received life-saving treatment. Most teams offering orthopaedic surgery will have the capacity for x-ray, so be sure to liaise with the team about your concerns.



## Fracture healing



It is important to recognise the phases of fracture healing and time scales to inform your progression of rehabilitation - e.g. weight bearing status.

### A. Haematoma

- Initial bleeding forms a clot
- The hormone prostoglandin triggers a process of infiltration of inflammatory cells and fibroblasts. NSAID's limit the activity of prostoglandin so shouldn't be given acutely.

### B. Granulation tissue formation

- This is from fibroblast activity
- Vascular/capillary ingrowth occurs at this stage and it should be noted that nicotine is known to delay this.

### C. Callus formation

- The haematoma is reorganised and vascular ingrowth continues

## Clinical Features

Haematoma Formation

Granulation tissue formation

Callus formation

Consolidation

Remodelling (up to 24 months)

- A soft callus forms initially thanks to the laying down of a collagen matrix.
- Soft callus is weak during the first 4-6 weeks of healing.

### D. Consolidation

- This is where the soft callus ossifies to become hard callus or woven bone which bridges the fracture fragments.
- Without appropriate immobilisation or protection this phase does not occur - instead an unstable fibrous union is present. (see complications later on in the chapter)

### E. Remodelling

- This occurs over months and years, aided by stress and load to bone.
- Healed bone is remodelled to original shape, structure and strength
- Adequate strength achieved in 3-6 months (depending on fracture).

## Fractures

### Wolfe's Law

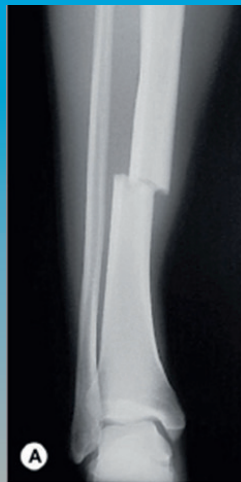
This is the principle that every change in the form and the function of a bone or in the function of the bone alone, leads to changes in its internal architecture and in its external forms.

Key points include:

- Bone is continuously being removed and replaced
- New bone is being laid down in response to stress
- Patterns of stress through the bone dictate the way the new bone is laid down
- Removing stress results in reduced bone density and weakness and delays healing

### Stages of Healing

# Tibia



# Tibia with callous



Note the healing process over 8-12 weeks in the series of x-rays of the tibia fracture above.



## Factors detrimental to healing

General	Local
<ul style="list-style-type: none"> <li>- Smoking</li> <li>- Malnutrition</li> <li>- PVD</li> <li>- Diabetes</li> <li>- Age</li> <li>- NSAID</li> </ul>	<ul style="list-style-type: none"> <li>- Vascular trauma</li> <li>- Infection</li> <li>- Inadequate immobilisation or protection</li> </ul>

The slide above highlights the factors which will slow or prevent adequate healing.

Smoking	Delays capillary ingrowth therefore slowing down healing (studies have shown 40% delayed tibial healing time).
Malnutrition	Such as inadequate minerals and proteins for bone repair
PVD	Poor vascular supply to healing bone
Diabetes	Leads to slower healing rate
Age	Children have a more active periosteum (outer layer surrounding bone) which includes essential blood vessels and cells involved in bone development. As a result, healing is faster. Conversely - it is slower in older age.
NSAID's	These limit hormones responsible for cell infiltration in acute inflammatory response of healing process.
Vascular trauma	May lead to poor blood supply, resulting in reduced cell infiltration and oxygen delivery.
Infection	At a more local level, the clearance of toxins or waste products can slow healing

Inadequate immobilisation or protection relates to Wolfe's law on the previous page. That is, too much stress overloads the weak	repair, without stability the bones will not heal. Conversely, too little pressure will delay healing.
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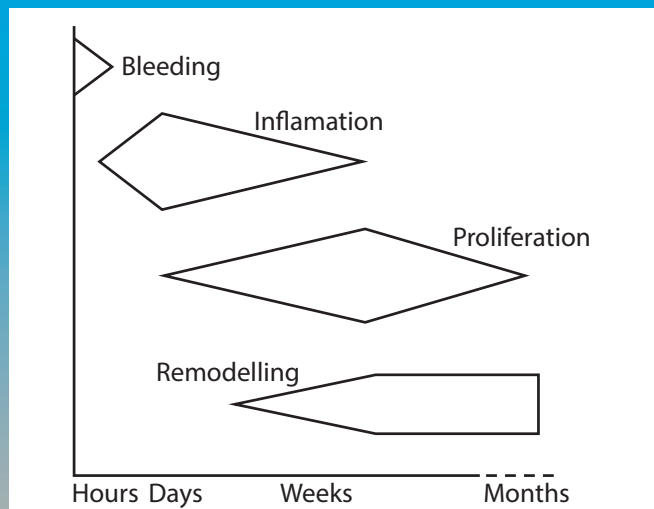
### Healing Times

- Varies depending on fracture type / location, complications, PMH, and management.
- Textbook scenario:
  - Adults
    - Upper limb: 4-6 weeks
    - Lower limb: 8-12 weeks
  - Children
    - 3-6 weeks

The slide above indicates the textbook scenario for fracture healing timescales, however do also note the variable factors which will have a huge impact in a sudden

onset disaster setting, where as we know fractures are unlikely to be found in isolation.

### Stages of Healing

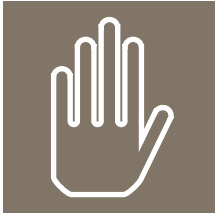


Soft tissue injury follows a natural sequence of events to repair the damaged tissue to restore homeostasis and normal function, where possible. After the initial bleeding the inflammatory reaction initiates the proliferation of cells as shown in the diagram above.

Timescales are indicated below:

<b>Bleeding</b>	10 hours
<b>Inflammation</b>	0-4 days
<b>Proliferation</b>	1- 10 days
<b>Remodelling</b>	10 days onwards





Wound management is often key in fracture care, but therapists should only work within their scope of practice. Training may be offered by the UKIETR at a later date. Gaining practical experience in this area can be a major advantage. An introduction to the reconstruction of soft tissue injuries, such as grafting and flaps can also be found in chapter 6 of this manual.

### Classification of fractures

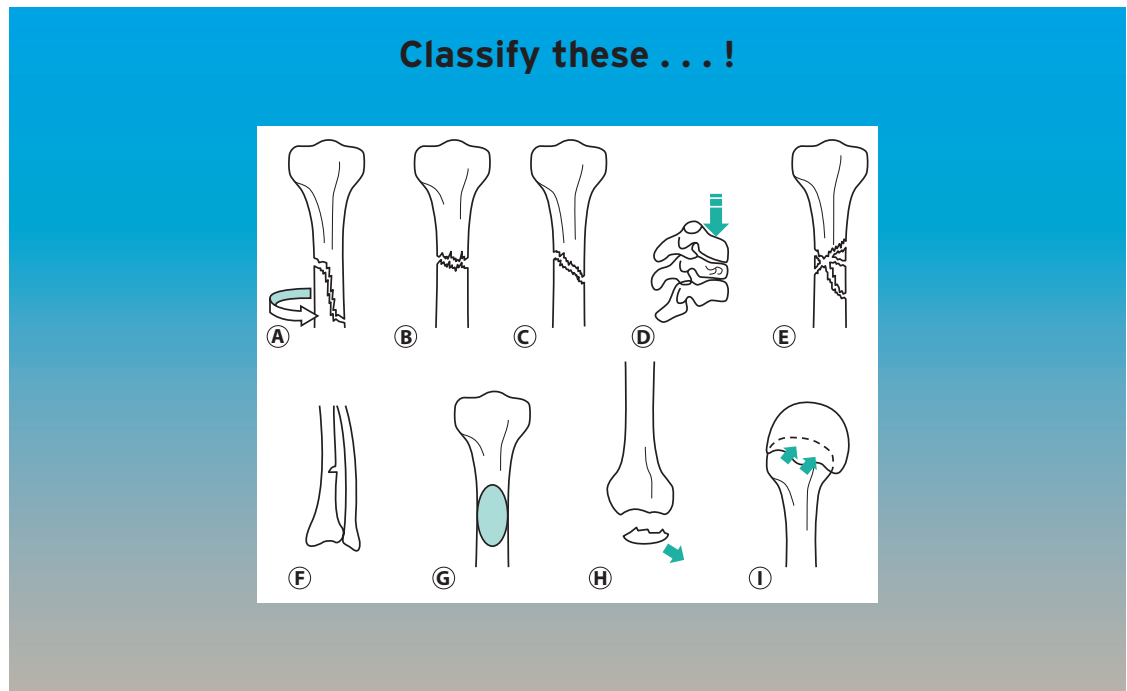
There are many different classification systems used around the world to categorize fractures. Most of these systems are specific to one joint or bone.

Each system has a common grounding in the basic principles of interpreting and understanding fractures. These are:

- Direction:** The more complex or multi-fragmented the fracture pattern; the more challenging they can be to manage, especially in the disaster setting.
- Alignment:** Some fractures may maintain good alignment, but others may be displaced, angulated or rotated. The alignment of a fracture will influence the management plan and how well it heals. This may be difficult to see on a plain x-ray as it only provides a 2D image. Bear in mind that more in-depth imaging may not be possible in a disaster scenario.
- Location:** By noting the location of a fracture we are able to anticipate any potential complications. These may be caused by the position of the fracture in relation to bone anatomy and the surrounding structures. Location can be described as intra- or extra-articular, distal, mid or proximal, and can include growth plate involvement. The important thing here is to consider the implications of location on healing and rehabilitation prognosis.
- Associated Features:** Noting associated features of a fracture can help you to pre-empt complications, for example open fractures have increased risk of infection.

## Fractures

Classifying the fractures on the following slide should provide some helpful revision for you.



There are a number of more specific classification systems (some of which are mentioned in the slide below) - it is not necessary to have in depth knowledge

of them all, they are non-essential if you understand your anatomy and therefore the implication of where the fracture lies.



Much further in depth learning on classification **of joint specific fractures** can be found on the **fracture e-learning** modules.

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## Classification: Joint Specific

- Tibial Plateau - Schatzker
- Ankle - Weber
- Pelvis - Tile, Young and Burgess
- Acetabulum - Letournel-Judet
- Spinal Fractures - Denis 3 Column System

Acetabular, pelvis and spinal fractures are slightly more complex. The classification systems are useful as they are closely linked to mechanism and also give an indication of fracture stability - important for planning of fracture management. Many of these injuries result from high energy trauma and therefore internal injury to organs, blood vessels and nerves is probable. Unfortunately in a sudden onset disasters, where rapid access to expert medical care is lacking, many of these patients do not survive. As such the number of these injuries may be lower than expected. If surgery is required, definitive treatment may require internal fixation which may not be readily available in the immediate aftermath.

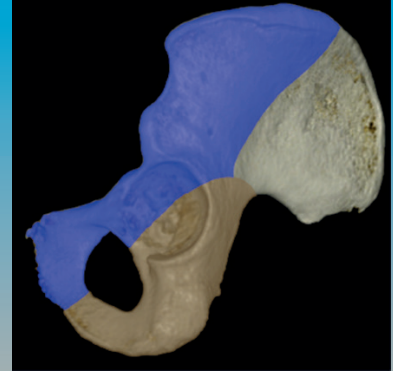
### Acetabular fractures

Classification of acetabular fractures is based on the column principle as shown below. The anterior column includes the iliac crest, the symphysis pubis and the anterior wall of the acetabulum. The posterior column includes the dense bone of the greater sciatic notch, the ischial spine and the ischial tuberosity - its surfaces form the posterior wall of the acetabulum.

This column structure allows load to be transferred through the lower limb, to the pelvis, and on onto the axial skeleton

### Acetabulum Fractures: Column Principle

- Columns act as struts, transferring force
  - LL → hip SIJ → axial skeleton
- Blue - Anterior column
  - Pubis and large portion of ilium
  - Anterior acetabular wall
  - Isolated injuries caused by force through externally rotated femur
- Brown - Posterior column
  - Ischium and small part of ilium
  - Posterior acetabular wall
  - Isolated injuries caused by force through internally rotated hip



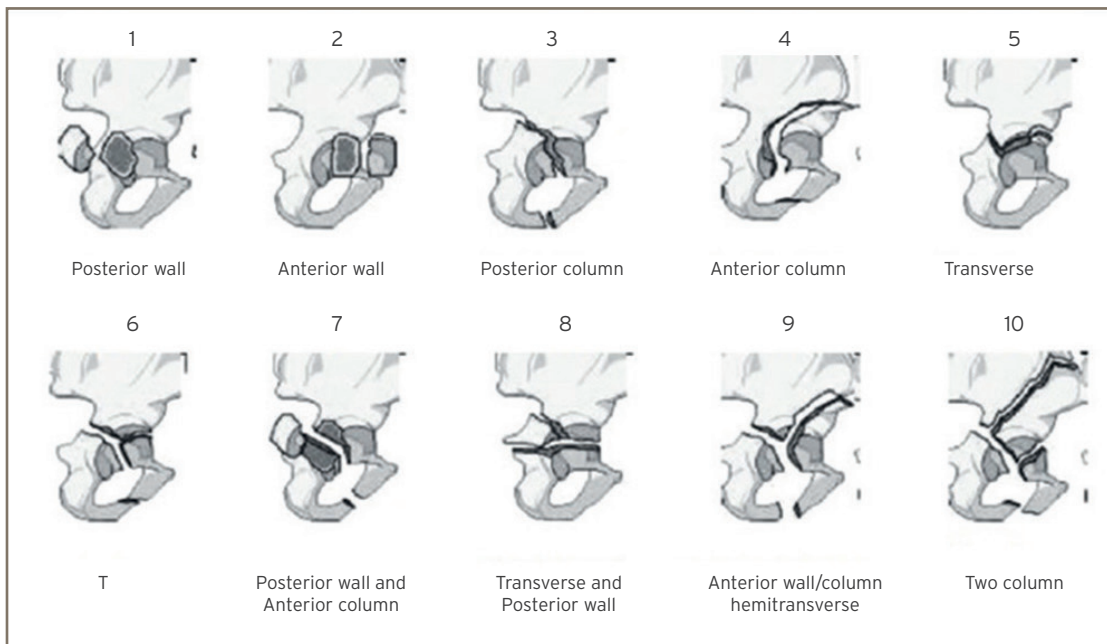
The mechanism of injury, including the magnitude and direction of force, and the position of the lower limb will affect the fracture pattern and its complexity. Trauma that results in a two column or transverse pattern leaves the pelvis very unstable.

The simplest classification system for the acetabulum is Letournel-Judet (figure 5.1). There are four basic fracture patterns - posterior wall, anterior wall, posterior column and anterior column. 90% of fractures are the following classifications: isolated posterior wall, both column, transverse, transverse-posterior wall and t-type fractures.

When a patient presents with an acetabulum fracture, consider the implication of the fracture on the inherent stability of the pelvis, the weight bearing surface of the acetabulum, associated trauma and the effect of muscle pull on fracture fragments. If the fracture falls through a load bearing aspect of the acetabulum then weight-bearing will need to be at least restricted, if not eliminated. The surgeon may also request limited hip flexion.

The fracture pattern and management plan will inform your rehabilitation. In a humanitarian setting fractures are likely to be managed conservatively or with external fixation initially. Ensure the doctor is clear in defining limits to range of movement and weight bearing.

Figure 5.1: Letournel-Judet classification for acetabulum fractures



Source: Letournel, E and Judet, R (1993) *Fractures of the Acetabulum*

### Pelvic ring fractures

The functions of the pelvis give an insight to the potential implications of sustaining a pelvic fracture. Mechanically, the pelvis transmits load through the skeleton. Importantly, the pelvis also has a protective role in preventing trauma to organs and neurovascular structures. Where force is significant enough to destabilise the pelvic ring, concern should be shown for the risk of life threatening internal injury. Haemorrhage is the leading cause of death in unstable pelvic injuries, and sadly a reason why you may not see many severe pelvic fractures in the days following a sudden onset disaster.

The pelvis is described as having two arches:

- The posterior arch is behind the acetabulum. It includes the sacrum, posterior ilium, sacroiliac joints and SI ligaments.
- The anterior arch is in front of the acetabulum. It includes the pubic rami and the pubic symphysis joint.

Stability of a pelvis fracture is largely determined by the integrity of the posterior arch. Tile's Classification system is based on this principle. The Young and Burgess classification has three categories. Within each category the fractures become progressively more unstable, this also corresponds with increasing involvement of the posterior arch of the pelvis.






More in depth explanations of both the Tile and Young and Burgess Classification of pelvis fractures can be found on the fracture e-learning modules

## Fractures

The following slides give a description of each fracture pattern, with several examples of x-rays to demonstrate these and common management techniques.

Source: Burgess A, Eastridge B, Young J et al (1990) Pelvic ring disruptions.

### Pelvic Ring Fracture: Young and Burgess Classification

Anterior Posterior Compression (APC)			
APC I	Symphysis widening <2.5cm Anterior SI ligament stretch Stable Mech: Low-mod AP force		Non-operative Protected weight bearing
APC II	Symphysis widening >2.5cm Anterior SIJ diastasis SI ligaments tear, sacrospinous and sacrotuberous ligament tear Unstable - "open book fracture" Mech: High energy AP force		Anterior symposeal plate or Ex-fix x ± posterior fixation
APC III	SIJ dislocation with tom sacrotuberous, sacrospinal and anterior/posterior SI ligament Associated with vascular injury Very unstable Mech: Very high energy AP force		Anterior symposeal plate or Ex-fix and posterior stabilisation






### Pelvic Ring Fracture Classification

#### APC III Fracture





## Pelvic Ring Fracture Classification

Lateral Compression (LC)			
LC I	Oblique/transverse rami fracture ipsilateral sacral compression fracture Stable Mechanism: LC to sacrum		Non-operative Protected weight bearing
LC II	Rami fracture Ipsilateral posterior iliac fracture Usually stable Mechanism: LC to ilium		ORIF
LC III	Ipsilateral LC I/II Contralateral APC fracture "Windswept pelvis" Unstable Mechanism: rollover, ped vs car		Internal posterior stabilisation

## Pelvic Ring Fracture Classification


- LC Type 2



- LC Type 3

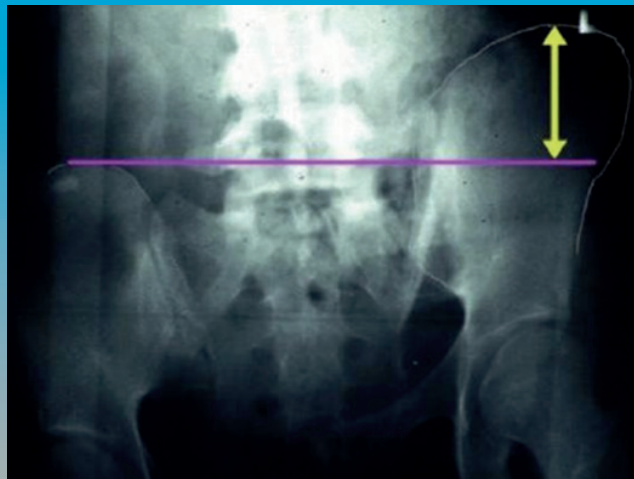


### Pelvic Ring Fracture Classification

Vertical Shear			
Vertical Shear	Ruptured anterior SI, posterior SI, sacrotuberous and sacrospinal ligaments. Fractured Rami. Unstable Mech: Posterior and superior force Highest risk of hypovolaemic shock and mortality rate 25%		Internal posterior stabilisation

### Pelvic Ring Fracture Classification

- Vertical Shear



## Spinal fractures

For spinal fractures, the primary concern is the integrity of the surrounding neurological structures and the potential for further injury due to physiological processes or instability of the fracture. The risk of neurological compromise is increased where spinal fractures are unstable.

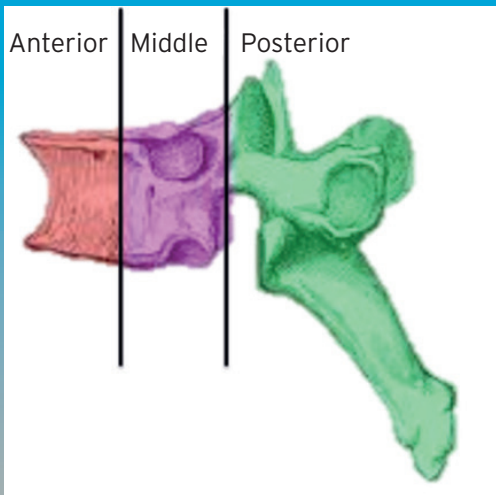
As with other bones - there are many classification systems for the spine. The

basis for many of them is the Denis 3 column principle

Stability is determined using a column principle. The stability of a fracture is reduced if 2 or more columns are affected. Where the middle column is involved in combination with any other column, the incidence of neurological compromise is higher.

### Spinal Fractures

#### Denis Three Column Principle



Anterior | Middle | Posterior

#### Specific Fracture Patterns

- **Compression**
  - Common with osteoporosis
  - Includes wedge fracture
- **Burst**
  - High energy trauma
  - Multiple fracture fragments that spread out
  - Increased risk of SCI
- **Fracture-distraction**
  - Acceleration/deceleration injuries
  - Normally post + middle column
- **Fracture-dislocation**
  - All 3 columns - unstable

The three columns are described as:

**Anterior** The front half of the vertebra (faces in towards your body) and intervertebral disc, it also includes anterior longitudinal ligament.

**Middle** Back half of the vertebral body and intervertebral disc, includes the posterior longitudinal ligament. This is the key portion for maintaining spinal stability - a fracture in this portion is of concern especially if combined with either anterior or posterior. It is more common to have a stable fracture without nerve involvement if this portion remains intact.

**Posterior** Includes the pedicles, lamina, facet joints, and spinous process.

## Fractures

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There are many different fracture types - some specific to individual spinal levels. The general fracture patterns are detailed in the

slide above (compression, burst, fracture-distraction and fracture-dislocation).



Moving and handling a patient with an unstable spine is covered in the practical workshop **'SCI in humanitarian settings'**

### Paediatric fractures

#### Paediatric Fractures

- Differences in fracture pattern due to characteristics of bone structure:
  - Elasticity is relatively high
  - Periosteal sleeve is thick, giving resistance
  - Bone will fail before tendon or ligament rupture
- Compared to adults there is greater potential for remodelling of deformity to a normal alignment.

The anatomy and biomechanics of paediatric bone differ from that of adult bone, leading to unique paediatric fracture patterns, healing mechanisms, and management.

The major differences in the bone structure in children are a high elasticity, thicker and more resistant periosteal sleeve and because a child's ligaments are stronger in relation to bone than those of an adult,

forces which would tend to cause a sprain in an older individual will be transmitted to the bone and cause a fracture in a child.

As with adults, the mechanism of injury will change the fracture pattern - in conflict you'll see more gunshot/blast injuries which will be an uncommon fracture pattern in comparison to UK patients.



The three main paediatric fracture mechanisms are described below:

<b>Paediatric Features</b>	
<b>Buckle</b>	<ul style="list-style-type: none"><li>■ Compression failure usually at the junction of the metaphysis and diaphysis</li><li>■ Inherently stable</li><li>■ Heals in 3-4 weeks with immobilisation</li></ul>
<b>Greenstick</b>	<ul style="list-style-type: none"><li>■ Bone bends with failure on the convex aspect</li><li>■ Fracture may not extend to the concave aspect</li></ul>
<b>Complete</b>	<ul style="list-style-type: none"><li>■ Crosses the whole bone</li><li>■ Classified by direction of fracture</li><li>■ Less common</li></ul>

### Physeal fractures

The other type of paediatric fracture you may see are physeal fractures. These are fractures to the growth plate can be caused by crushing, vascular compromise of the physis or bone growth bridging from the metaphysis to the bony portion of the epiphysis.

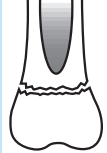
Damage to this growth plate may result in progressive angular deformity, limb-length discrepancy or joint incongruity.


Most physeal injuries heal within 3 weeks. This rapid healing provides a limited window for reduction of deformity.


## Fractures

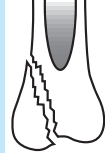
The Salter Harris Classification system is commonly used to classify physeal fractures:

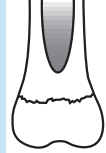
### Factors detrimental to healing











Type I	Type II	Type III	Type IV	Type V
<ul style="list-style-type: none"> <li>▬ Transverse fracture through physis</li> <li>▬ Separates epiphysis and metaphysis</li> </ul>	<ul style="list-style-type: none"> <li>▬ Transverse fracture through portion of physis</li> <li>▬ Exits through metaphysis</li> </ul>	<ul style="list-style-type: none"> <li>▬ Transverse fracture through portion of physis</li> <li>▬ Extends through the epiphysis and into the joint</li> </ul>	<ul style="list-style-type: none"> <li>▬ Fracture across metaphysis, physis and epiphysis</li> </ul>	<ul style="list-style-type: none"> <li>▬ Crush injury to physis</li> </ul>

Physeal or 'growth plate' fractures:

- Type 1** Growing cells of physis remain in epiphysis, wide displacement is uncommon due to periosteal attachment, prognosis is good unless blood supply is disturbed. Complication - early closure of physis (meaning growth is delayed/stunted).
- Type 2** Most common fracture type, periosteum torn on the open side, prognosis is good if the blood supply to the epiphysis is intact (it normally is).
- Type 3** Intra-articular, accurate reduction is essential to prevent osseous bar forming within physis and growth being impaired. Prognosis is good if the blood supply is maintained and there is accurate reduction.
- Type 4** Intra-articular, perfect reduction is essential for growth to be restored, open reduction is usually necessary.
- Type 5** Protected weight-bearing may be required.

Children are at risk of the same complications as adults. However complications unique to children may arise when fractures involve the physis or growth plate such as the fractures above. The two main concerns are:

- ▬ A bony bridge formation within the growth plate. This prevents growth and causes curvature of the bone.

- ▬ The fracture can stimulate growth, resulting in the injured bone being longer than the uninjured side.

Both these complications require surgery to correct them.



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## Fracture complications

There are many potential complications post fracture.

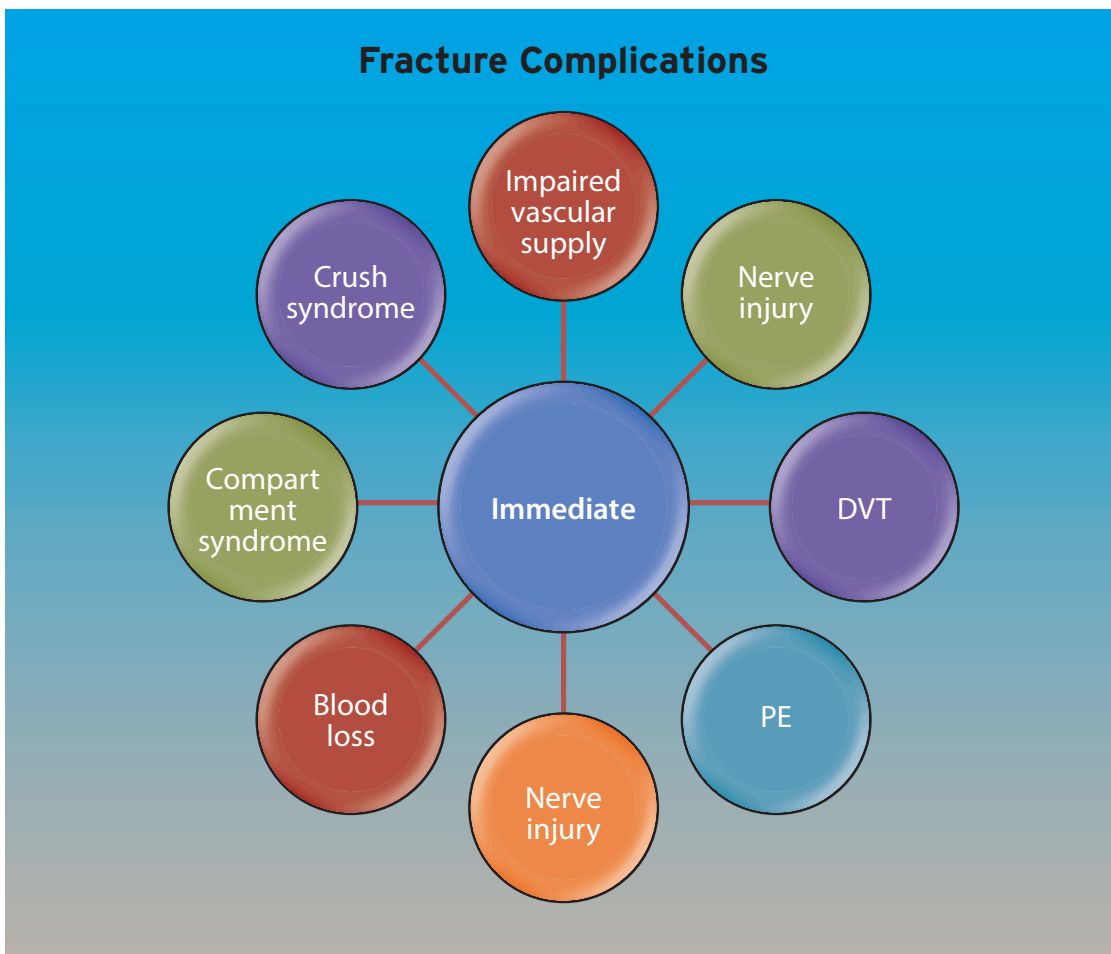


Immediate, sub-acute and chronic complications of fractures are covered in more detail in the e-learning modules on fractures



The cheat sheet 'fracture complications' within this manual is also a highly useful summary resource for the field.

Some of the possible immediate complications are highlighted below.



## Fractures

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### Compartment syndrome



#### Signs and symptoms are:

- Skin tightness
- Intense pain disproportional to injury
- Skin paraesthesia
- Paralysis/numbness (late stage)

**Treatment is:** fasciotomy - which will be left open until swelling reduced, potentially for 6 weeks. A graft may then be needed.

### Deep vein thrombosis (DVT)





**Signs and symptoms** are:  
Heat, swelling and redness  
increased pain on dorsiflexion of foot

**Prophylaxis:** For at risk patients, low molecular weight heparin will commonly be available in field hospitals.

Outside of pharmacological prophylaxis the whole team is responsible for preventing DVT with oedema management, hydration, mobility/exercise

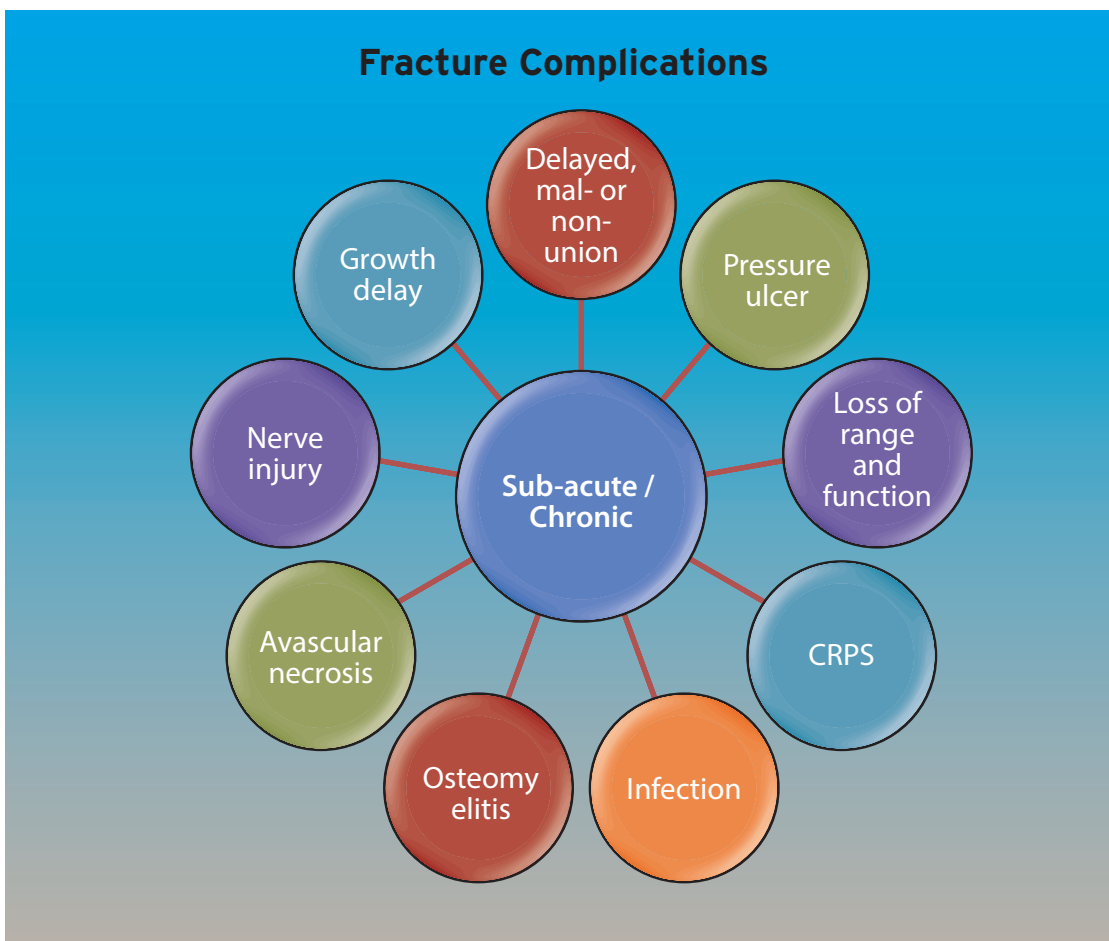
### Crush Syndrome

This is significant risk when a patient has been trapped for a long period (particularly in earthquake scenarios). Injury results from direct trauma, compression of the area and occlusion of blood vessels. After 4-6 hours of ischemia soft tissues become necrotic.

When the pressure is relieved, blood supply returns and toxins produced by necrosis are released into the body. This can result in acute renal failure and can lead to sepsis.

Medical intervention should begin prior to extrication if a crush injury is suspected - even when a patient appears stable, however this is very unlikely in a situation of mass casualty in SODs and you therefore are unlikely to see many survivors of crush syndrome in such settings.

Fracture complications in the sub-acute and chronic stages are listed but not limited to those below.



## Fractures

You should be able to identify the signs and symptoms of all of these complications. (CRPS = complex regional pain syndrome and is covered in detail on the fracture e-learning).

### Pin site infection

One particularly important area to highlight to all rehabilitation professionals working particularly in emergency situations is that of risk of infection. Infection is of particular concern where the skin is broken due to open fractures, surgery or pin sites. Risk is

increased with complex injuries or where the mechanism means wounds have been exposed or contaminated.

Observation for signs of infection should continue throughout rehabilitation. Signs and symptoms may include redness, heat, swelling, pain and discharge from a wound. Systemic symptoms may also be seen such as temperature or increased heart rate.

Extensive education of staff and patients is required to prevent pinsite infection as shown in the following picture.



### Signs and symptoms of pin site infection

- Pain, possibly limiting rehabilitation
- Over-granulation
- Deeper infection - skin pulling down around the site
- Tenting

**Suspected pinsite infection should be raised with the MDT or referred for treatment.** This is to clean, cover, and prescribe antibiotics.



The UK IETR patient information leaflet on 'being discharged with an external fixator' is a useful educational resource.

## Management of fractures

### Learning outcomes

To have an understanding of the core management options for fractures in an emergency setting

To be able to identify the key elements of an assessment for a patient with a fracture in an emergency setting, and balance context and resources to plan appropriate treatments

Here we will look at the most common management options for fractures following a sudden onset disaster. These are **conservative management** and **external fixation**. You may also see skin or skeletal **traction** being used.

In the UK, fractures requiring surgical stabilisation are commonly fixed internally.

This is not routinely possible in this context due to the specialist surgical equipment and skills required, the risk of complications and the lack of established follow up pathways. You may however see patients who have been treated with internal fixation abroad or by other surgical teams.

### Management of Fracture in Disasters

Conservative	Surgical - Internal	Surgical - External
Closed fractures Non-displaced (or alignment restored manually) Simple Stable or able to adequately stabilise externally	Used for majority of cases in UK Not used in the field due to: <ul style="list-style-type: none"> <li>➤ Equipment</li> <li>➤ Complications</li> <li>➤ Infection</li> <li>➤ Lack of follow appropriate up</li> </ul>	Open wounds/ extensive soft tissue damage Complex comminuted fractures Preliminary pelvis fixation Used preferentially in the field

## Fractures

### Conservative management

This is fracture immobilisation via a non surgical approach: i.e. restricted use (sling, bed rest, protected weight bearing), casting or splinting.

The indications for conservative management are: closed, simple fracture patterns, satisfactory alignment of fractures and that a fracture is inherently stable or adequately stabilised by splinting or casting.

For patients with casts it is essential to give thorough cast care and weight bearing instructions, both verbal and written if appropriate.

Without adequate reduction and stabilisation, healing and the functional outcome will be compromised.

### External fixation

External fixation is an external structure that maintains alignment of a fractured bone through the use of percutaneous wires or pins that pass through one or both cortices of the bone.

External fixation is widely used to manage trauma patients, especially those with multiple

injuries or open fractures. The indications for external fixation are listed below:

- Definitive Fracture Care:
  - Complex fractures (such as comminuted/bone shortening/open fractures)
  - Significant soft tissue trauma
  - Limb salvage and reconstruction
- Temporary fracture care:
  - Fixation while awaiting definitive treatment.
  - Peri-articular fractures
  - Pelvic ring injury
  - Correction of poorly healed fractures (Infected non-unions or correction of mal-alignment)

### The components of external fixators

There are several different types of external fixator. If you are deployed with a FMT field hospital you are more likely to see configurations such as the Hoffmann and Rail (below) which looks relatively straightforward with one or more straight rod holding pins in place. They can also be adapted to more complex arrangements by clamping several bars together.



The main components of most external fixators can be found below:



### Pins

The pin is the critical link between the bone and the frame. Threaded pins or screws of various lengths, diameters and sizes (such as top left in diagram) are inserted into both cortices of a bone in varying configurations to stabilise the fracture and allow effective healing.

Pin insertion technique should respect bone and soft tissue and comprises of the following:

- Incise skin
- Spread soft tissues to bone
- Use sharp drill with sleeve (unless using self tapping screws)
- Irrigate while drilling
- Place appropriate pin using sleeve

### Rods

There are two general varieties of rods:

- Single pin to bar clamps
- Multiple pin to bar clamps

### Clamps

These are used to attach the internal pins to tubes that create the external frame, or to connect tubes to each other in building the frame itself.

Clamps placed closer to bone increases the stiffness of the entire fixator construct

### Bars

These provide the main structure for a basic external fixator frame. Added bar stiffness will equate to increased frame stiffness.

### Ring Fixator

These rings allow for multi-planar configuration of external fixator frame, and are characteristic of the Ilizarov external fixator system.

With a ring fixator there are multiple tensioned thin wires, it is possible to maintain purchase in metaphyseal bone, dynamic axial loading and joint motion may also be allowed.

### Pros and cons of external fixation

#### External Fixation - Pros (1)

##### **Mechanical:**

- Multiple applications
- Quick
- Appropriate use can give excellent results
- Allows early recognition and treatment of complications
- Minimally invasive
- Flexibility (build to fit)
- Either a temporary or definitive stabilisation device
- Reconstructive and salvage applications



#### External Fixation - Pros (2)

##### **Biological:**

- Fracture healing by stable yet less rigid systems
- Dynamisation = load-sharing construct that promotes micromotion at the fracture site
- Micromotion = callus formation
- Controlled load-sharing helps to "work harden" the fracture callus and accelerate remodelling



## External Fixation - Cons



### **Mechanical:**

- Distraction of fracture site
- Inadequate immobilization
- Pin-bone interface failure
- Weight/bulk
- Re-fracture (paediatric femur)

### **Biological:**

- Infection (pin track)
- Pin loosening
- Neurovascular injury
- Tethering of muscle
- Soft tissue contracture
- Mal and Non union

## External Fixation



### Skin and skeletal traction

#### Skin and Skeletal Traction

##### ■ Purpose:

- To treat fractures, dislocations, to prevent or correct deformities
- Either for short-term (scene of accident) or long-term (in a hospital setting)

##### ■ Aims:

- Align the bone fragments by pulling the limb into a straight position
- Relieve muscle spasm, helping to restore alignment
- Reduce pain

Traction is usually applied to the arms and legs, neck, spine, or pelvis. It is used to treat fractures, dislocations, and long-duration muscle spasms, and also to prevent or correct deformities.

Traction can either be short-term, as at an accident scene, or long-term, when it is used in a hospital setting.

Traction serves several purposes:

1. It aligns the ends of a fracture by pulling the limb into a straight position
2. It ends muscle spasm
3. It relieves pain
4. It takes the pressure off the bone ends by relaxing the muscle

With all traction, positioning the extremity so that the angle of pull brings the ends of the fracture together is essential. Elaborate methods of weights, counterweights, and pulleys have been developed to provide the appropriate force while keeping the bones aligned and preventing muscle spasm. The patient's age, weight, and medical condition are all taken into account when deciding on the type and degree of traction. Education of the patient, carers and nursing staff is critical for a good outcome.

There are two main types of traction: skin traction and skeletal traction.

**Skin traction** is where forces are applied to the bone by anchoring the skin. Skin traction rarely causes fracture reduction, but reduces pain and maintains the length of the bone.

- Indication are both in adults and children, mainly short term use and when less than 5kg force is required to achieve treatment aims.
- In skin traction, traction tapes are attached to the skin of the limb segment that is below the fracture or a foam boot is securely fitted to the patient's foot.
- At weights greater than 5Kg, superficial skin layers are disrupted and irritated.
- Because most of the forces created by skin traction are lost and dissipated in the soft-tissue structures, skin traction is rarely used as definitive therapy in adults; rather, it is commonly used as a temporary measure until definitive therapy is achieved.
- In sudden onset disasters the use of skin traction may be necessary if surgical capacity is limited for a period of time.





## Skin Traction



In **skeletal traction** the force is applied directly to the bone either by wires or pins. It is less common in children. Generally this is for longer term use, when over 5kg of force is needed to achieve treatment aims, or when skin or soft tissue damage preventing skin traction

- In sudden onset disasters, where surgical bed capacity is limited, and risk of bed-bound related complications is increased, skeletal traction is not the preferred long term management strategy of choice.

### Common traction used

## Common Traction

### Dunlop's Traction

- Humeral fractures in children



### Buck's Traction

- Involve skin traction
- Femoral and acetabular fractures as well as low back pain



## Fractures

### Dunlop's Traction

Used for paediatric supra-condylar and trans-condylar elbow fractures

Realistically in a field hospital environment, the benefits of this method of management and the pressure on surgical beds in the facility would be assessed

### Buck's Traction

Used for pre-operative management of femoral and acetabulum fractures.

It is not used to obtain or hold fracture reduction

No more than 10lb weight should be used

## Common Traction

### Russell Traction

- # femoral fracture



### Bryant's Traction

- Paediatric femoral fracture
- CDH



### Russell (Hamilton Russell) Traction

Mainly used for femoral fractures.

It is important that rehab maintains knee and ankle movement and strength.

### Bryant's Traction

Mainly used in young children who have fractures of the femur or congenital abnormalities of the hip (CDH).

Both the patient's limbs are suspended in the air vertically at a ninety degree angle from the hips and knees slightly flexed.

Over a period of days, the hips are gradually moved outward from the body using a pulley system. The patient's body provides the counter-traction.

---

### Rehabilitation of patients on traction

Rehabilitation of patients on traction should start as early as possible. Consider the risks of particular complications - particularly pressure areas, respiratory compromise, loss of independence, loss of power in unaffected limbs - and develop your treatment plan accordingly.

Whilst traction is in place it is vitally important to maintain range of movement and strength at all joints, wherever possible. Multiple limb involvement and polytrauma

makes this more complicated - therefore you must know each injuries management plan and restrictions before clinically reasoning your intervention.

Unless you are competent to do so in the UK, it will not be your role to set up, adjust or maintain traction apparatus. However it is useful to be familiar with traction and it's components. We would therefore recommend that you seek opportunities in the UK to see traction in use.



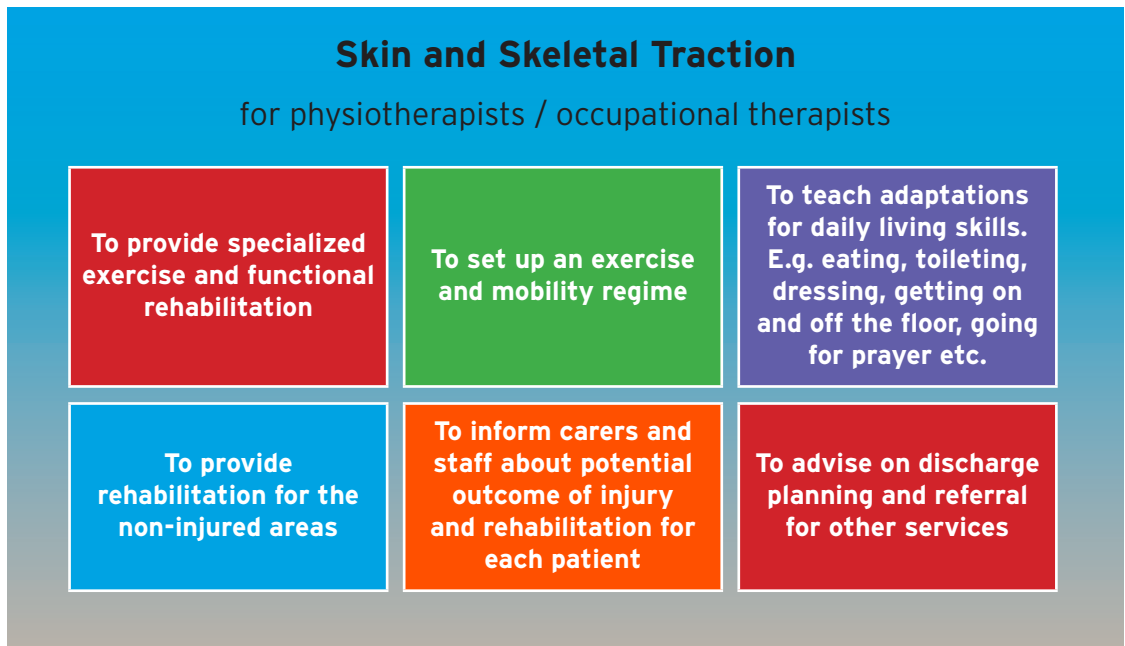
The Traction module on the UKIETR **Fractures E-learning** provides more information on traction patient care and progression.



For more information on traction as management for fractures in low resource settings, the **AO Foundation website** has some useful resources.

## Fractures

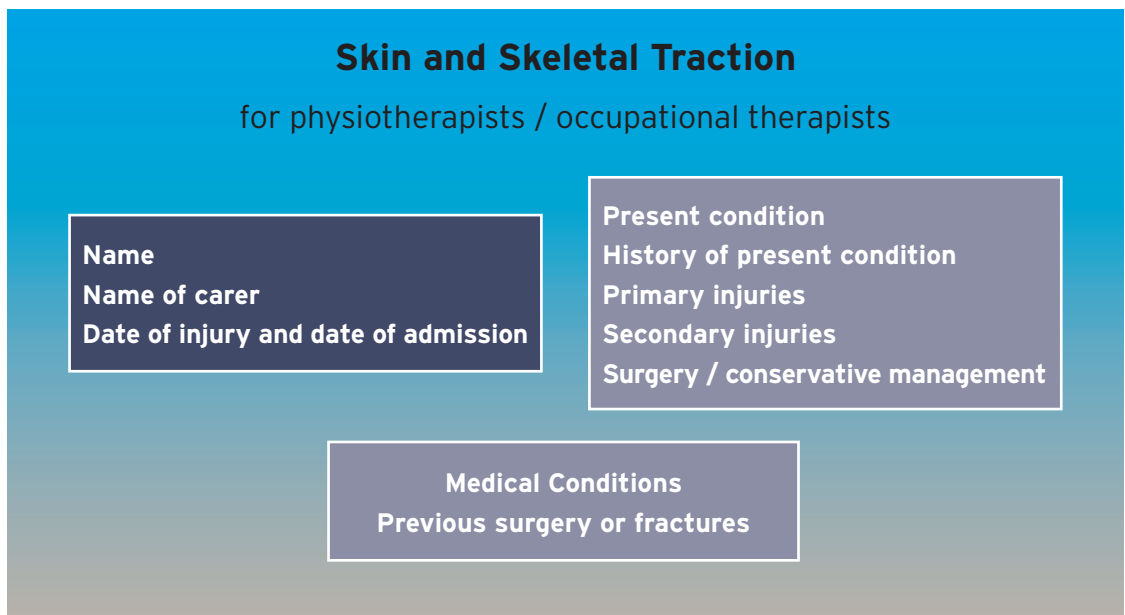
### Rehabilitation of fractures



The above slide highlights the main aims of orthopaedic rehabilitation. In addition both physiotherapists and occupational therapists should consider their role in:

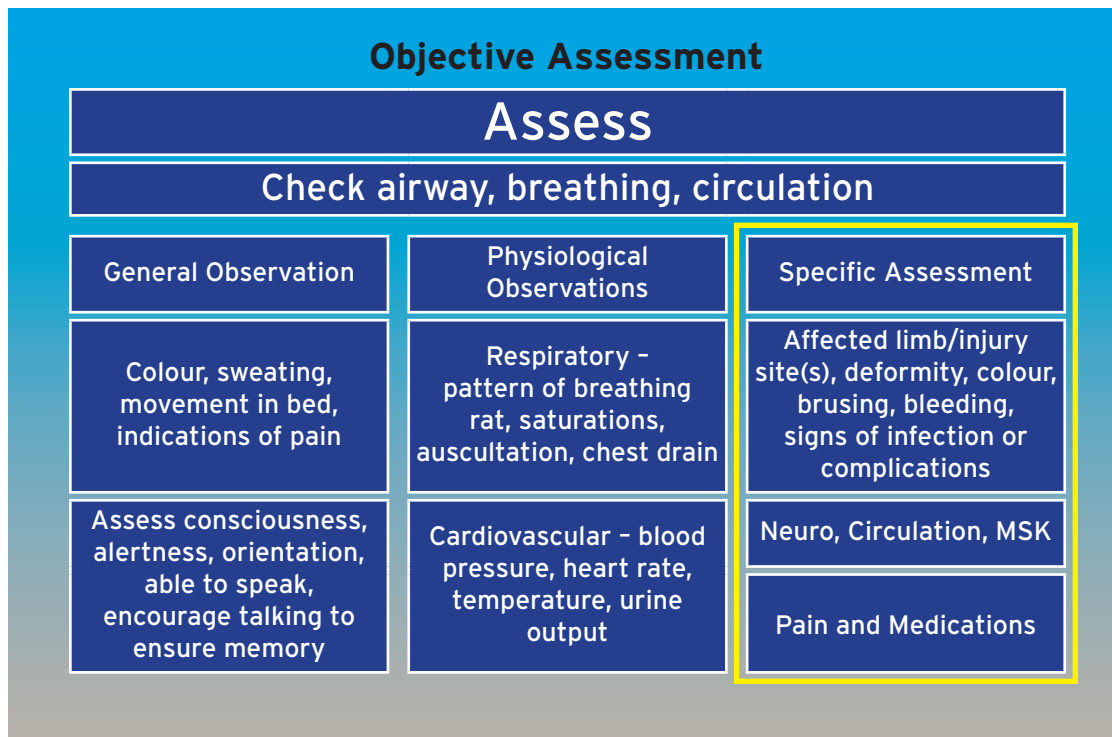
- Providing specialized rehabilitation - especially to aiming to regain function to an optimal level in order to rebuild their lives
- Reducing risks of primary and secondary complications
- Providing psychological support

### Assessment of patients with fractures



The subjective assessment will include the same elements as you would do in the UK. Remember you may be a point of linking people up to other aid or support, so

understanding the patients' needs in full is vital. It is this knowledge (of shelter, sanitation access, family situation) that will inform your rehabilitation and discharge planning.



Again the objective assessment for an orthopaedic patient in the field is exactly as you would do so in the UK. Starting with basic observations, and moving on to general and physiological observations,

before looking at the areas specific to orthopaedic assessment (in yellow) such as deformity, signs of infection, neurological status, circulation, pain and medication review.

### Safety and Monitoring

- Monitor observations throughout assessment
- You are looking for indications of systemic instability or inability coping with activity
- Recommendations
  - Pain relief prior to assessment and treatment
  - Ensure adequate oxygenation
  - Monitor for signs of RR increasing and not stabilising
  - Monitor HR
  - Monitor BP

## Fractures

Your assessment continues throughout your therapy session. Of particular importance is monitoring their observations - especially on initial assessments when injury/surgery has been recent or where there may be risk of deterioration or complications.

The temptation in orthopaedics is to get people out of bed and moving as soon as possible. However close monitoring of physiological observations is important to inform what we do and when to stop, especially for trauma patients.

Studies have shown that oxygen consumption increases by 30% in hospitalised patients, and by 52% during physiotherapy intervention for unwell patients. It also increases by 10% for every 1° of temperature rise (particularly relevant when responding to SODs in tropical climates). We need to be aware that unwell patients who already have an increased oxygen demand may struggle to meet the oxygen demands of the activity we are

doing. The effect would be that we push a patient into hypoxia which has negative effects on tissue healing. Rehabilitation professionals need to be able to adapt the level and nature of interventions accordingly - it may be that bed based exercise are sufficient acutely, or that patients need supplementary oxygen for rehabilitation.

Heart rate (HR) is another indication of when to stop rehabilitation - in outpatients we calculate a target training HR as 60-80% of you max HR in order to improve CV fitness. If your patient is tachycardic at rest and then they exceed their training heart rate during your rehabilitation session, the activity needs to be reduced (and stopped if it doesn't settle) so that it is within safe and appropriate limits.

Blood pressure gives you an indication of tissue perfusion and systemic hydration - again important when mobilising and progressing a patient.

## Rehabilitation treatment planning

### What Next?

Each trauma patient is unique - one protocols doesn't fit all!

ADAPT and HI 'cheat sheets' available to aid your treatment planning

Emphasis needs to be on your **CLINICAL REASONING** (knowledge of anatomy, healing times, biomechanics and principles of rehabilitation)



In the UK and other countries trauma and orthopaedics relies on protocols for injury management. Often different surgeons will request different care for the same injury/ surgery. Trauma patients will be variable in their injury presentation, their surgery outcomes and as a result variable in their management.

Protocols are difficult to use in the disaster setting due to this variety - the emphasis when working in the field with orthopaedic trauma patients is on your own clinical reasoning and liaison with the surgical team.

### Injury Summary

Injuries	Management Plan (conservative or surgical)	Restrictions or Instructions
Fractured right femur	08/5/2014 Internal Fixation	PWB 6/52
Fractured Right Calcaneum	POP 6/52	NWB 4/52, then WB as pain allows
Left distal ulna fracture	POP 4/52	Weight bear as tolerated

PWB = partial weight bearing    NWB = non weight bearing

Following your assessment it may be useful to document each injury, management plan and restrictions to help your clinical reasoning.

The table above gives an example of how you can do this. You can see that the 2 injuries of

this patients' right lower limb have different weight bearing status' and progression plans. It's important that each injury has a clear plan. In the case above the patient would be NWB for 4 weeks due to the calcaneum fracture, then PWB for 2 weeks.

### Clinical Reasoning

Problem list	Rehab Plan
Poor right quads activation (grade 1 MRC)	
Swollen right leg	
Unable to stand NWB due to poor forward weight transfer	
Unable to feed himself	
Low saturations and poor thoracic expansion	

## Fractures

Creating a problem list helps to make sure that rehabilitation is specific. You can consider breaking your problem list into functional limitations and then impairments. It is easy in busy environments to use the same, generic approach.

In the example above the patient has difficulty activating quadriceps - you can then make a specific and progressive exercise plan to address this problem. If we prescribe something unachievable or something that does not adequately address the issue we risk losing patient motivation and slowing the patients rehabilitation.

Remember to look at all problems, not just range and strength - for example functional activity, requirement for chest physiotherapy or swelling management.

A problem list should help you to reason your way through complex patients and make sure you are being specific when developing a rehabilitation treatment plan.

The slide above highlights several key points to consider when developing your treatment plan.

### Treatment Plan

- Find out restrictions and limitations
- Use your problem list - what is your aim and what are the potential complications?
  - Specific: Strength, ROM (Stiff, Tight, etc.), Chest
  - Functional: adapted techniques, practice equipment
- Try to make rehab functional, meaningful and fun
- Be specific in your rehab plan:
  - Exercises: How many reps/sets? How often? Family helping?
  - Progression plan: set the patient a goal; e.g. achieving a task, use of incentive spirometry, or "when you can do 'x' start the next exercise"
  - Use pictures, diagrams, demonstration, films etc.

Restrictions and limitations will include weight bearing status and functional limitations (e.g. no lifting for 6 weeks). When aware of these you must also inform your patient and their carer.

Consider also what the risks are for this patient. Do you need to prophylactically treat their chest if they are likely to be immobile for long periods?

If you are able, under the circumstances of SOD, then try to relate to sport/hobbies and occupation if possible to help patient motivation.

In trauma and orthopaedics exercises progress from bed based, to sitting, to standing.





## Exercise Programme

- Aim of exercises in orthopaedics:
  - Restore range
  - Restore strength
  - Restore 'normal' movement
  - Return to independent function
- Regularly review any prescribed exercises
  - Vary and progress them so they have a new challenge
  - Measure so that you can give feedback - e.g. ROM
- Develop a progression plan for home rehabilitation - include weight bearing!

The aim of exercises in orthopaedics are reviewed in the slide above. Although it is beyond the scope of this manual to discuss individual exercise plans, it may help you to look at basic upper limb and lower limb exercise sheets for ideas - and then clinically reason what to include and what not to include for a patient in emergency setting. When deployed with the UKIETR trauma hospital you will have access to theraband, bandages, foam wedges for positioning and mobility aids. You will also need to be inventive in creating adjuncts for therapy and exercises for your patients (for example water bottles as hand weights).

The progression plan should include exercises as well as all other adjuncts or advice they will need (e.g. changes in weight bearing status, progression to active movement).

### Finally

Due to different resources and mechanisms of injury, in a SOD response deployment you will undoubtedly encounter injury patterns and surgeries you are unfamiliar with. Use your core rehabilitation skills and the information and advice provided here to work your way through the problem list and treatment plan. Ensure that you refer the 'fracture complications' cheat

sheet provided in this manual. In particular, ensure that you liaise with the surgical team regarding contraindications and precautions. Orthopaedic specialist physiotherapists are available to consult through Handicap International and the UKIETR if you have specific rehabilitation related queries.

### Core texts

WHO (2007) Best Practice Guidelines on Emergency Surgical Management in Disaster Situations. Available at <http://www.who.int/surgery/publications/BestPracticeGuidelinesonESCinDisasters.pdf>  
<http://www.wheelsonline.com/>

### References

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## Rehabilitation of Burns and Soft Tissue Injuries

This module was developed by Interburns in collaboration with Handicap International. Interburns is an international network of expert burn care professionals seeking to transform burn care and prevention in low and middle income countries (LMICs) through education, training, research and service delivery. [www.interburns.org](http://www.interburns.org)

The presentations and corresponding manual chapter aim to give an overview of the burns, immediate burn treatment as would be likely in an FMT facility and burn rehabilitation including graft and flap procedures. The latter part of the chapter focuses on general soft tissue reconstructive procedures and introduces members to the key concepts of each. Throughout the chapter, resources on the USB are referenced for further learning opportunities. The content will also be supplemented by interactive e-learning modules.

The content in this chapter is pitched at a core level of knowledge in acknowledgement that some therapists may have had very little exposure to the field of burn rehabilitation, or plastic surgery and reconstruction.

### Learning outcomes

To understand the key basic medical and surgical therapy relevant management issues when providing rehab to patients with burn and soft tissue injuries.

To understand how to provide basic therapy to patients with burn and soft tissue injuries in the acute and sub-acute stages.

To understand the basics of scar management for patients with burn and soft tissue injuries.

### Introduction to burns

The rehabilitation of burn injuries is a very broad subject. Therapists working in this specialty have the opportunity to treat critically ill patients with life changing injuries through to patients with less

significant burns which, if well treated, will leave little legacy for the patient. Burn injuries affect all ages and therefore the therapist should be confident working with all ages. Rehabilitation for burn injuries starts on day 1 of the injury right through the period of scar maturation and often

for years after the injury and through periods of reconstruction. Effective rehab is based on understanding the medical and surgical needs of the burns patient, on skill and appropriate timing in the application of therapy treatment, on a focus on preventing problems and a focus on harnessing the skills of the multi-

disciplined team for the benefit of the patient. In addition to their physical impact, burn injuries can have a huge psychosocial impact on the person and their family. The good news is that effective rehabilitation can have huge impact on improving quality of life for burn survivors and preventing life altering deformities and disfigurements.

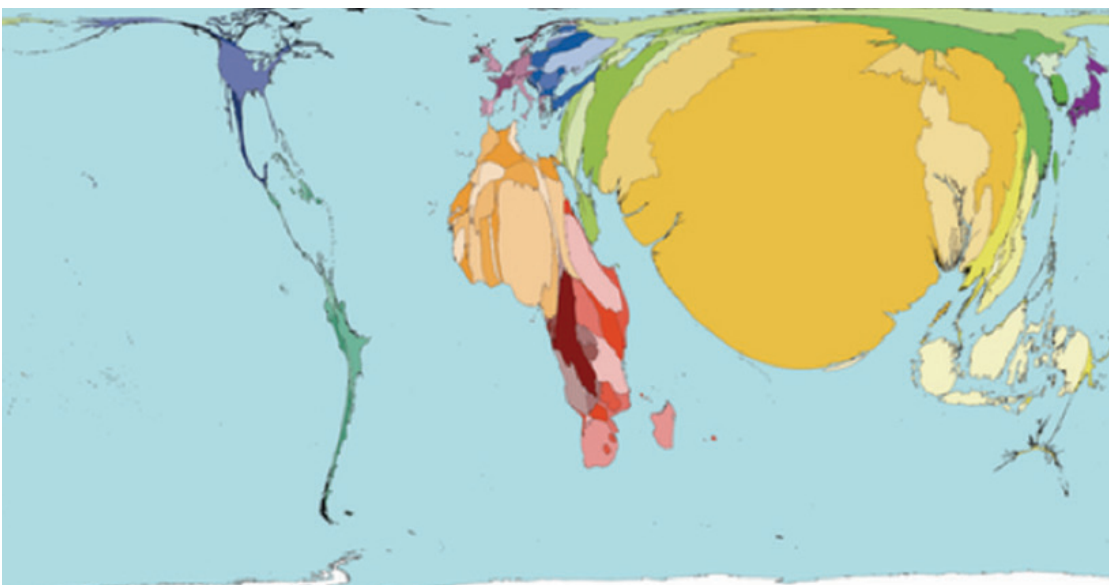


Use the two '**burns and soft tissue injury**' cheat sheets as a quick reminder of the key points to remember when you are in the field

The key factor is to be *confident* in your ability to treat burn patients. Often when treating patients in considerable pain and with wounds, unless you feel confident with your interventions you are likely to under treat a patient or miss opportunities to improve final outcome.

There is a **self-assessed confidence rating sheet** within this manual to help you ascertain which of the core burns and soft tissue rehabilitation skills you may need to build confidence in.

### Incidence



This map of the world is re-scaled not by size of landmass but by the global incidence of burn injuries. It is clear where the vast majority of burn injuries occur. 95% of all global burn injuries occur in LMICs and 75% of these occur in children.

- Nearly 11 million people a year suffer burns severe enough to require medical attention.
- More people are burnt each year than are infected with HIV/AIDS and tuberculosis combined.

## Rehabilitation of Burns and Soft Tissue Injuries

- Burns in India are the most common cause of death of women between 15-30 years
- Fire-related burns are the sixth leading cause of death among 5-14 year olds. Burns are in the top 5 causes of injury that impact child mortality and morbidity and after the age of five, and injuries are the biggest threat to a child's survival.

Figures for high-income countries are radically different. In the UK for example, about 250,000 people are burnt each year. Of these, 175,000 attend accident and emergency departments, and 13 000 of these are admitted to hospital. 1000 patients have severe enough burns to warrant formal fluid resuscitation; half of these are children aged less than 12 years. In an average year 300 burn deaths occur.

### Disparity and outcomes

In addition to huge disparities in the incidence of burn injuries across the world, there is huge disparity in the human resources and burn care facilities between HICs and low and middle-income countries (LMICs).

The significantly lower incidence of burn injuries, better level of facilities, care and human resources etc. in HICs compared to LICs, correlates with much better patient outcomes in HICs. The disparity in patient outcomes between HICs and LMICs is often huge. Disabilities commonly found in LMICs would be totally unacceptable as a result in HIC's e.g. slide below.

### Disparity of Outcomes



A contracture is an impairment caused by replacement of skin with pathological scar tissue of insufficient extensibility and length resulting in a loss of ROM or tissue

alignment of an associated joint or anatomic structure. Scar contractures, with secondary contracture of other structures produces these debilitating outcomes.

In LMICs burn injuries most commonly affect the lowest socio-economic groups. This is very problematic as burns care is long and expensive, often with non-productive outcomes. Burn injuries are in many ways like other public health conditions - the cause of injury is often related to socio-economic and cultural factors, treatment decisions are often guided by non-medical factors and ultimately the person who has the burn injury must try and return back to their community - due to disability and disfigurement from the injury, this can be a very difficult and sometimes impossible transition. We can prevent the injury happening in the first place (primary prevention), provide awareness and knowledge on appropriate first aid to lessen the extent of injury (secondary prevention) and tertiary prevention delivered throughout the healthcare system and in communities to treat burn injuries appropriately to avoid preventable morbidity

and morbidities such as joint contracture. Tertiary prevention is where therapists can have the biggest impact.

The injuries already seen in the following slides are not all dramatically different injuries although they do show dramatically different outcomes. The outcomes seen in these photos are due to the course of treatment rather than the initial injury. These photos comparing outcomes of 2 patients with neck burns and 2 patients with axilla burns all have the same full thickness injuries but what has determined the difference in outcome is the treatment pathway. Treatment choice and prevention has a huge impact. The patients with a better outcome have had early surgery to close the wounds (split skin grafting) and physiotherapy / OT starting on admission and continuing on discharge. We can make a huge difference with the care we offer.

### Patient Destination



### Patient Outcomes



We have a choice - to provide an effective pathway of care or to allow substandard care. Depending on the path we take, and the path we encourage the patient to take the outcomes will vary significantly and

this will impact the future of the survivor and that of their family. Providing effective care is a particular huge challenge in low resource settings - but it is not impossible.

### Rehab Tools

- Positioning
- Range of movement exercises
- Exercise and training
- Mobilisation
- Stretching
- Functional activities
- Prosthetics and adaptations
- Strengthening



The slide above shows a list of the treatment tools we have to treat burn patients. These tools are very basic to our professions

and used in the treatment of many other conditions. We will learn how to apply them in the situation of a burn patient.

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As therapists if we apply our tools, most of them aimed at preventing contractures, will we be able to prevent these disabilities and deformities? The answer is unfortunately not as burns care is dependent on team work and there are certain other medical and surgical issues that we need to understand so that we are not neither unrealistic about what we can achieve in terms of preventing deformity and disability and also so that we do not accept deformities that are not necessary.

The context of care is very important in determining what is possible. For purposes of your deployment you may find yourself in a field hospital with a team of experts in burn care, or you may find yourself in a local hospital where there are limited resources and maybe expertise (a lack of therapy expertise is probably especially likely). This chapter focuses on the low resource setting and deals with some of the barriers to effective rehabilitation. These barriers or resource limitations may not exist in the field hospital but your patient will still need to be discharged into a low resource environment and as much of rehab is most relevant following discharge treatment provision within the low resource environment remains important to maximize as effective follow up as possible.

Treating burn injuries often requires a battle by the team, the patient and their family - not just fighting for the life of the patient but fighting scar and other morbidities for the maximum quality of life for the patients. As therapists we are involved in both fights.

### **Cause of burn**

It is important to know what the various causes of burn injuries are. Burns are caused by flame, scald, electrical, chemical and contact. The cause of the burn can give us important information for the management of a burn injury.

**Flame burns** are the most common type of burn generally, and the most common type of burn in adults. Flame burn can cause smaller burns but can also cause huge burns (large total body surface area (TBSA) burns). Flame burns can be very deep and tend to produce deep partial and full thickness burns. Flame burns can be associated with inhalation injury. Flame burns may also be associated with other traumatic injury such as bomb blasts (head injury), other explosions and RTA's. Unfortunately in some countries homicidal and suicidal burns are not uncommon and mostly occur amongst young married women. The prognosis of these burns is often not good.

**Chemical burns** represent about 3% of all burns; they tend to be smaller but are often deep. Chemical burns often affect the eyes. After effective first aid (copious irrigation of the eyes with water) eyes need special care ideally by ophthalmologist. Chemical burns can continue burning post contact and therefore it is important to remove any soaked clothes and continue water irrigation, litmus paper can be used to assess the PH of the area. Both acids and alkaline chemicals will burn - alkalis tend to penetrate deeper than acids. Acid attacks are more common in some countries and usually target the face.

Hot liquids such as hot tea, water, and daal cause **scald burns**. Scald burns are most common in children; scalds cause 70% of all paediatric burns. These burns tend to be less deep, causing more superficial and partial thickness burns. Scald injuries can also be common in the elderly.

3-4% of burns are **electrical burns**. An electric current will travel through the body from one point to another, creating "entry" and "exit" points. The current can damage the tissue between these two points, which

## Rehabilitation of Burns and Soft Tissue Injuries

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may not be visible on the outside. Injuries are categorized by low voltage (less than 1000 volts) and high voltage currents (more than 1000 volts). High voltage injuries cause extensive tissue damage and often limb loss. There is usually a large amount of soft and bony tissue necrosis. Muscle damage gives rise to rhabdomyolysis, and renal failure may occur with these injuries. Electrical burns require more aggressive resuscitation and debridement than other burns. Contact with voltage greater than 70 000 V is invariably fatal. 'Flash' injury can occur when there has been an arc of current from a high-tension voltage source. The heat from this arc can cause superficial flash burns to exposed body parts, typically the face and hands. No current actually passes through the victim's body. Post electrical burn cardiac monitoring is used initially to check for any disturbances.

### First aid

First aid will vary slightly depending on the cause of burn. Remove the person from the source of the burn if it is safe to do so.

Burning clothing should be extinguished using water or the 'drop and roll' method. Immediately flush the burn with water for at least 20 minutes (cooling can be effective up to 3 hours post injury so even if there is delay cooling is important). Ensure the person is not getting too cold from the exposure and cool water (the water can be room temperature, or any temperature that does not further warm the area). Remove jewelry (due to likelihood of oedema developing) and clothes if not adhered to the wound. Nothing should be applied to the wound, cover the area loosely with cling film (not on the face) if available if not then with a clean sheet and if necessary transport ASAP to the nearest appropriate health center. Encourage the person to drink and eat (unless surgery is anticipated) - drinking is especially important to avoid dehydration, for larger burns full resuscitation is needed (this is covered further on). Each burn injury is an opportunity to educate the person and their family on how to apply appropriate first aid next time if an injury was to happen in their community.



For further information please see the **British Burn Association, First Aid Statement** online and on the USB

### Depth of burn

As therapists we need to understand the depth of burn so that we can deliver appropriate intervention and assess the potential scarring and possible contractures that may develop, so that we can work from the outset to prevent them. Seeing the patients burn wound regularly is important to guide us in the points noted on this slide.

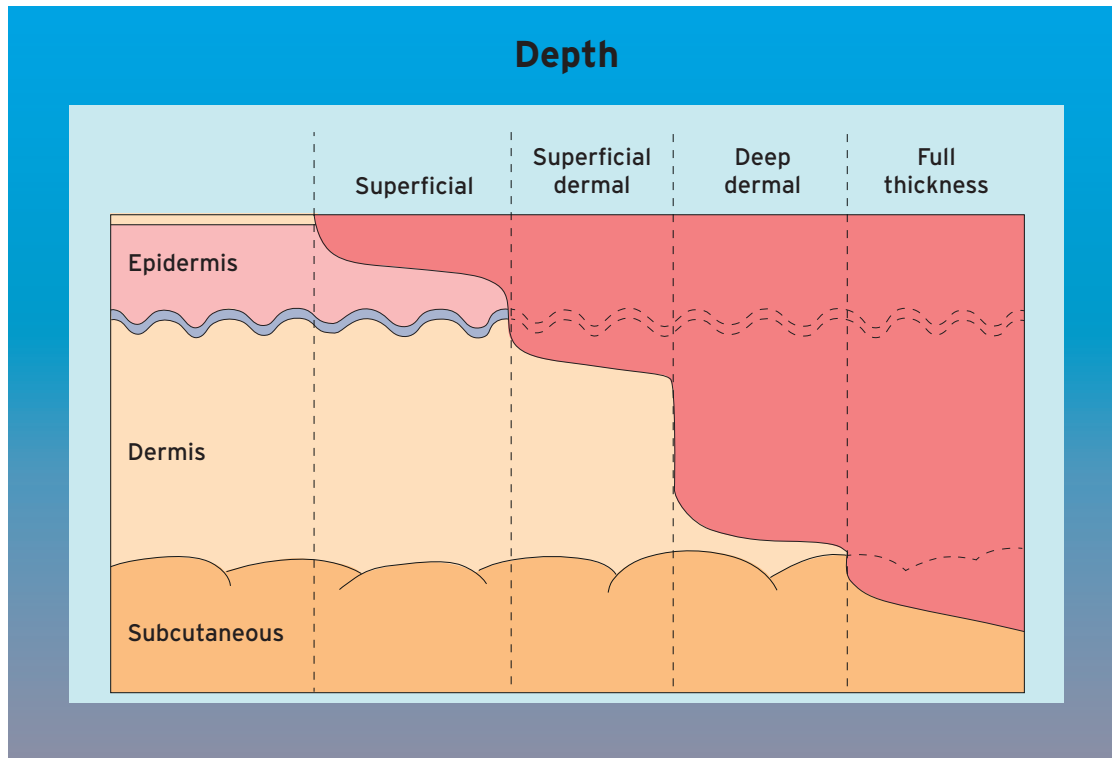
The skin is the largest organ in the body and is 20% of our body weight! The skin has a

number of important functions listed here. A burn, whether caused by flame, scald etc. will damage the skin due to heat. Cell death occurs at 41°C and protein coagulation at 50 °C. The depth of skin damaged depends on the nature of the burning agent, the temperature of that agent, the length of time the agent is in contact with the skin, how thick the skin is, how vascular the area is - very vascular areas can dissipate heat faster than other areas.



The ability of the skin to recover and the functions of the skin lost by the burn depends on the depth of the burn. In simplest terms the skin is made up of two layers - the epidermis and the dermis. Under the dermis is the subcutaneous layer. The main function of the epidermis is to prevent water loss and to protect the body from invasion of microorganisms.

The dermis is composed of extracellular matrix that is mostly collagen and glycosaminoglycans. The dermis gives the skin its strength and durability. The dermis contains hair follicles, sweat glands, nerve endings and blood vessels that are lined with epithelial cells that have the potential to regenerate. The epidermis is 0.3-1.5 mm thick, dermis 1-4 mm thick.



This slide shows what layers of skin the various depths of burn destroy. The depths of burn are superficial (epithelium is damaged), partial thickness burns that involve some of the dermis (superficial partial thickness burns - upper layer of the dermis is destroyed) or more of the dermis (deep partial thickness burn). Full thickness burns damage all layers of the skin - all the dermis is destroyed.

The chart below outlines the layer of skin lost, the look of the various depths

of burns so that depth can be identified, the time to healing and the likely result in terms of scarring. It can be difficult to be sure on the depth of a burn on admission but with experience this becomes easier. Full thickness and superficial burns are easiest to diagnose correctly, partial thickness burns can be more difficult to differentiate between superficial and deep burns. Often burns are of mixed depth. The depth of burn will dictate the treatment of choice.

**Depth**

DEPTH OF BURN	TISSUES DESTROYED	APPEARANCE OF BURNS	SENSITIVITY TO PAIN	HEALING TIME + PROGNOSIS
Superficial	OUTER LAYER OF EPIDERMIS (STRATUM CORNEUM)	* ERYTHEMA * NO BLISTER * SLIGHT OEDEMA BLANCHES WITH PRESSURE	INTENSE PAIN	* 3-10 DAYS * NO SCARRING
Partial thickness SUPERFICIAL	*ALL OF EPIDERMIS *UPPER LAYERS OF DERMIS *SOME HAIR FOLLICLES AND SWEAT AND SUBACEOUS GLANDS INTACT	* RED * BLISTERS * MOIST SUBCUTANEOUS * OEDEMA * BLANCHING	PAINFUL AND HYPERSENSITIVE	* 7-20 DAYS * CAN SCAR * PIGMENT CHANGE
Partial thickness DEEP	*EPIDERMAL AND SEVERE DERMIS DAMAGE *MOST NERVE ENDINGS, HAIR FOLLICLES, AND SWEAT GLANDS DESTROYED	* VARIABLE IN COLOUR * (WHITE WITH RED) *WET OR WAXY DRY * NO BLISTERS * NO BLANCHING * ESCHAR FORMS	GENERALLY INSENSITIVE TO PAIN DUE TO DESTROYED NERVE ENDINGS	* 21-35 DAYS * SEVERE SCARRING * RISK OF CONTRACTURES * MAY NEED GRAFTING
Full thickness	ALL SKIN LAYERS DESTROYED DOWN TO FAT OR BONE	WHITE, CHARRED, DRY, INELASTIC	NO PAIN	* VERY SEVERE SCARRING * RISK OF CONTRACTURES * NO SKIN REGENERATION * WILL NEED GRAFTING * PROLONGED HOSPITALISATION



Full thickness burn (FTB)



Partial thickness burn (with some FTB)



Superficial burn

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A burn wound is dynamic and will look different over time. The zone of coagulation is the area that was in the most direct contact with the source, and injury to the tissue is complete with no chance of recovery. In the zone of stasis, microvascular injury and oedema of the surrounding tissue result in decreased tissue perfusion.

This zone is at risk for progression of the injury during the resuscitation period unless adequate tissue perfusion is provided. In the outer zone of hyperemia, cells usually will be able to recover from the injury within 7 to 10 days. Rough handling and infection can also cause a burn to convert to a deeper burn.



For practice at identifying different depths of burn, refer to the burns **e-learning** resource.

As dressings influence our rehab intervention and planning significantly, a few points are made here. Washing of a burn wound is very important; in HICs shower trolleys are often used. There are often less ideal options for washing and dressing burn injuries in low-income countries. In theory dressing changes are a good time for physiotherapy because the area is free of dressings, however in reality change of dressing (COD) is often a stressful and busy time and if pain is not well controlled exercising during this time can be unproductive. Hand burns can be an exception as this is a small area that can be focused on and doing active exercises without dressings is often easier than with dressings on.

The environment where the dressing is being done should be considered, if it is not a clean environment then it is not wise to delay the dressings. However even if

exercise is not appropriate, COD is a very important time to assess the wounds, as it will direct your treatment plan. Communication with the nursing team is important so that the dressings are not too restrictive to movement or circulation, this is especially important for hands. All hand dressings wherever possible must involve single finger dressings rather than a boxing glove style - which is quick to administer but far too restrictive. In the acute stages are when a burn is infected, wounds tend to have a lot of exudate so there is a balance between a thick enough dressing to absorb this and prevent strike through (exudate on the outer layer of the dressing which gives an access point for bacteria) and one which does not unnecessarily limit movement. Dressing of the trunk and upper arms is another area that needs to be done keeping in mind the ability for full shoulder range of movement.

## Rehabilitation of Burns and Soft Tissue Injuries

### Total body surface area (TBSA) burnt

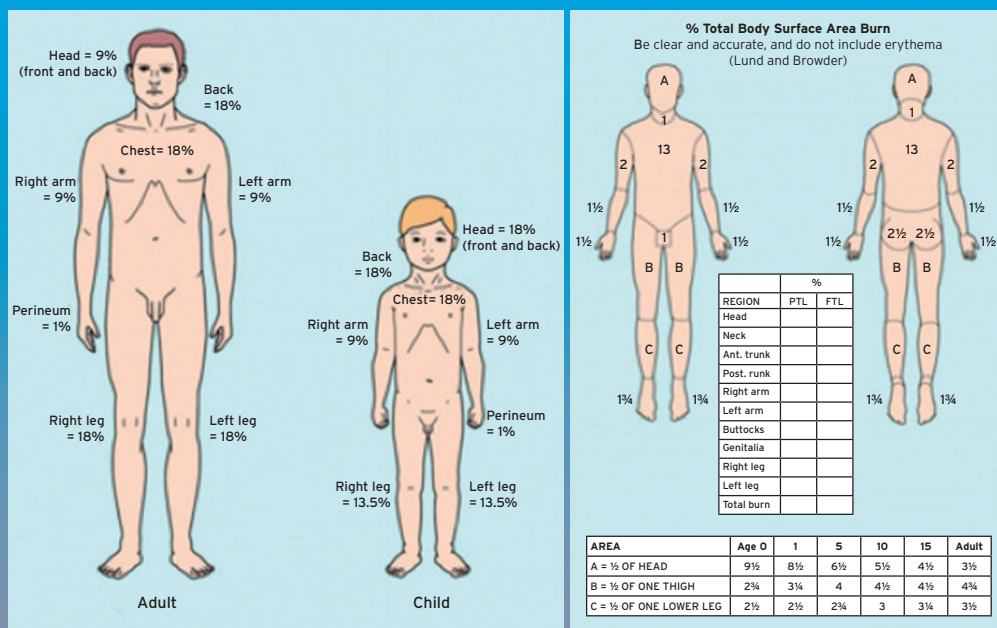
It is important to know the extent of a burn injury. This is calculated by the total body surface area (TBSA) that is burnt, and is expressed as e.g. 15% TBSA burn. This would mean that 15% of the total surface area of the body is burnt. To calculate the TBSA the following methods are used:

- 1) Rule of Nines - this breaks the body down into divisions or multiplications of 9 i.e. 4.5, 9 or 18 (apart from the perineal area which represents 1%). If for example a whole arm was burnt and the front of one leg was burnt the total area burnt would be  $9+9 = 18\%$  TBSA. It is unusual for complete body segments to be burnt

in entirety and therefore it is not totally straightforward to calculate.

- 2) Lund and Browder Chart - this is the gold standard for TBSA measurement as it takes into account the difference in body part proportion with age i.e. children have a bigger head in proportion to the rest of the body.
- 3) The palm of the patients hand (fingers and palm) = 1% - this method works well with scattered burn areas
- 4) If the burn covers a large surface area it is easier to calculate what is not burnt and subtract it from 100.

## Extent of Burn - TBSA



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## Emergency management

It is important to know the TBSA of the burn injury because it will dictate management. Fluid resuscitation is based on the % of burn, without appropriate resuscitation patients with larger burns can die of hypovolemic shock. Adults over 15% burn and children over 10% TBSA burn need fluid resuscitation. Small burn injuries are classified as burns under 15% for adults and 10% for children, moderate burns = 10 or 15% to 30% TBSA and major burns = all burns above 30% TBSA. % of TBSA also impacts expected mortality and morbidity. In HICs it is possible to save burn injuries of more than 90% TBSA in LMICs burns of 40% are most commonly fatal. Larger burns are also more difficult to manage in terms of preventing morbidities such as contractures. In addition to TBSA depth of burn is crucially important. A 30% superficial burn in LMICs should survive but a full thickness burn of 30% may pose too great a challenge to save and if they survive they are likely to suffer significant morbidities.

As indicated a burn injury may not just affect the local area but if more than 20% TBSA the burn has systemic affect and can be fatal. Initially the risk of death (with larger burns) relates to loss of circulating blood volume and hypovolemic shock caused by widespread vasodilation and intravascular protein and fluid loss into the interstitial compartment. Corresponding peripheral and splanchnic vasoconstriction occurs. The capillary leak initiated by the release of inflammatory factors usually closes at 48 - 72 hours post injury. Later larger, especially deep burns can be very susceptible to sepsis and multi organ failure. It is important for the therapist to understand the critical nature of a burn injury so that our treatment plan and interventions are appropriate and fit with the various patient priorities.

Unlike in HIC settings where a significant burn injury will probably be admitted to hospital within a very short time frame, in LMICs presenting at an appropriate healthcare facility is often very delayed. In disaster or war scenarios this delay could be further compounded. It is rare for burn patients in HICs to succumb with hypovolemic shock due to rapid and appropriate resuscitation; this may not be the case in low resource environments. It is also common in low resource environments for patients who would be expected to need either ventilation for an inhalation injury or fluid resuscitation managing to survive, but presenting later on with septic wounds and very malnourished. However, for all admissions of burn patients with anything other than clearly small isolated burns it is important to receive the patient as an emergency case and go through the primary survey used in emergency medicine.

It is important not to focus immediately on the burn but to start with the issues most likely to cause death - the A, B, C, D, E, F system of primary survey is followed. Airway and circulation problems can be common in larger flame and electric burns; concurrent trauma may exist such as a head injury and fractures if the patient was involved in a blast or RTA etc. The issue of airway compromise relates to the presence of an inhalation injury that can cause direct thermal damage to the upper airways and damage to the lungs through toxicity of chemicals inhaled. There is upper airway oedema that puts the viability of the airway at risk, intubation becomes very difficult if there is delay and therefore intubation may be done as a precaution. If an inhalation injury is suspected 100% oxygen is administered due to the likely presence of carbon monoxide that binds preferentially to oxygen to hemoglobin. The basic signs and symptoms and treatment for inhalation injury are covered later in slides.

### Escharotomy and fasciotomy

Escharotomy and fasciotomy relate to ventilation and circulation risks and require treatment in the emergency management stage of a burn injury to avoid problems. These procedures are only relevant if a patient has a full thickness circumferential burn to their limbs or chest. Any deep or full thickness circumferential extremity burn can act as a tourniquet, especially once oedema develops after fluid resuscitation. This may not occur until some hours after the burn. If there is any suspicion of decreased perfusion due to circumferential burn, the tissue must be released with escharotomies. The escharotomy involves cutting through the eschar (dead tissue left by a full

thickness burn) with a scalpel. The incision site is predetermined; the surgeon will know where to cut to avoid important nerves and blood supply. This cut releases the pressure and allows improved circulation (if a limb) and improved ventilation (if around the chest wall). This procedure is sometimes done without sedation as the eschar is deemed to be pain free; however there is some extension of incision into healthy skin and due to general distress pain medication is important. It is important for therapists to be vigilant if they see the burn is deep and circumferential - they will be able to see if pulses are normal or if chest expansion is poor and can notify the surgical/medical team if they spot this.

### Escharotomy



Fluid resuscitation not only corrects the intravascular loss of volume but also ensures adequate tissue perfusion, which prevents deepening of wounds. How the fluid is given and what fluid depends on the situation, experience of the staff and what is available. Ideally 2 large bore cannulae should be inserted preferably through non-burnt tissue. If this is not possible a central

line can be used either in the femoral or internal jugular or subclavian vein. Fluid given should be crystalloid ideally ringers lactate or if not saline. Dextrose is not appropriate for a resuscitation fluid but can be used for maintenance. The Parkland formula ( $3-4 \text{ ml} \times \% \text{TBSA} \times \text{Wt (Kg)}$ ) is a guide only and the volume given should be titrated according to the clinical picture.

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Half of the volume of the Parkland Formula is to be given in first 8 hours post injury and the rest in the subsequent 16 hours. If the patient is delayed in presenting then there is catch up necessary on fluid resuscitation. The best and simplest indicator of resuscitation and hydration is urine output. Usually urine output should be approximately 1ml/kg/hr. If you see an IV line blocked/misplaced or not running properly

it is important to alert the nursing team to this. Sometimes in positioning the patient the lines can become misplaced. In LMICs many patients arrive late at appropriate health care facilities, they still require intensive input but in this scenario it will be more common to be dealing with problems of infection, dehydration and possible sepsis and organ failure. Regular monitoring of vital signs is important.

### Immediate pain management



See the article on '**Pain management in burns**' on the USB for further information

Pain relief is an important part of the emergency management of the burn patient and ideally should be given intravenously to a level that controls the pain, watching any impact on respiratory rate. It has been shown that if there is good control of pain and discomfort in the very early stages, it is much easier to control pain later on. On the contrary, if the initial experience of the patient has been extremely distressing, it will become increasingly difficult to control pain and distress later. It is essential to clean wounds before dressing, in particular remove any unknown potions, lotions or ointments. If the patient is presenting delayed or with chronic wounds they may need to have a surgical debridement followed by antimicrobial dressings. Wound cultures should be taken at this stage. In burns care, even in the LMIC context, antibiotics should only be commenced if there are signs of severe infection and these should be based on local microbiology guidelines. All wounds more than a few hours old will be contaminated, this does not mean they are infected. Contaminated wounds are best dealt with by surgical debridement and topical antimicrobials. In contrast war wounds, from blasts, shotguns normally do produce a dirty wound that will require antibiotic cover.



See the '**ICRC War Surgery**' guidelines here and on the USB for further information on wound management and dressings in low resource settings

### Admission or transfer?

#### Admit? Transfer?

- All FTB
- > 15% TBSA in adults
- > 10% Children and elderly
- Burns to face, neck, hands, feet, armpits, popliteal region, genitals
- Circumferential burns
- Burns associated with inhalation injury, trauma or disease
- NAI
- Surgery available?
- Therapy available?

The criteria listed on this slide are the common criteria used in HICs under which to admit a burn injury. These criteria may vary considerably in low resource contexts. It will be important to decide if your facility has the level of care necessary to give the patient the best chance, if not and it is possible, transfer the patient to a higher level facility. For example if you have a patient with full thickness burns to the hands and have no surgeon who can skin graft it will not be appropriate to keep this patient as the outcome without skin grafting is likely to be a pair of very dysfunctional hands. If a transfer is not appropriate to a better facility, as may be the case in some low resource settings, the team does the best it can for the patient, within their limitations.

In this initial phase of emergency management it is likely that the therapist will not be involved and would possibly even be 'in the way' if she/he got involved other than if required as an extra pair of hands. Early chest physiotherapy may be needed if inhalation injury exists. Correct positioning is important at this early stage, especially for oedema control therefore it is important that the nursing / medical team should be well briefed in knowing good positioning - most often required for facial and hand burns. In facilities with a high volume of patients the

need of a therapist with general awareness of these issues can be very relevant as if there are large numbers of admissions and less staff the therapist can be useful in alerting the team to potential life threatening issues such as restricted circulation or ventilation due to a deep circumferential burn, IV's not working and also in assisting with secretion clearance and correct positioning.

#### Prognosis

It is not too difficult to get an idea of the prognosis for the patient on admission as prognosis is based largely on extent and depth of burn, the presence of an inhalation injury and any other co-existing injuries or disadvantageous past medical history - all evident on admission. The very young and old are also more difficult to treat if a burn injury is significant. An inhalation injury can increase the risk of mortality significantly - an inhalation injury adds another 10% to the TBSA.

It is common for patients who would be in intensive care in HIC with high levels of input to be treated as one of many patients on a normal ward in LMICs, due to lack of resources. It is often unlikely that patients requiring ventilation will receive it. Certainly a patient would be unlikely to be ventilated in a field hospital setting. Transfer would be the only option.





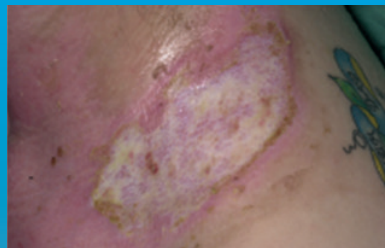
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## Burn wound and scarring

It's been established that the longer a burn wound takes to heal the more scarring there will be. Deep, slow healing wounds will scar and can cause severe disability and deformity. Wounds that will take longer than 3 weeks to heal should ideally be excised and grafted. This section looks in brief at the wound healing process and how it relates to scarring.

Wounds that take more than 21 days to heal have a 78% chance of developing hypertrophic scarring (HTS). This is frequently quoted to demonstrate the effect of slow healing on hypertrophic scar formation. More recent studies have reinforced this message and common practice in HICs is to skin graft wounds that are expected to take longer than 3 weeks to heal.

### Burn Wound



- Burned tissue causes inflammation
- Eschar contains bacteria and is an 'open' wound
- Inflammatory cells are attracted
- Enzymatic breakdown and separation
- Granulation tissue
- Inflammatory response in large burns becomes generalised

Dead skin (slough or eschar as shown here on the photos) is dead tissue delays healing and can become necrotic and can lead to sepsis. The dead tissue also prolongs the inflammatory stage that exacerbates hypertrophic scarring. This dead tissue needs to be removed by debridement or excision and grafting.

Ideally after wounding we want re-epithelisation - this is only possible where enough of the dermis has been preserved and healing can come from the epithelium lining the adnexa of the dermis such as the hair follicles, sebaceous glands.

As we have learnt this is only going to happen when there is a superficial or partial thickness burn. There is also healing by migration of epithelial cells from the margins of the wounds. This type of healing is called regeneration and produces a result that is very similar to surrounding skin. If regeneration is not possible then the body will attempt to repair the area and basically fill the area through scarring - the end result will never produce a good as a result as through regeneration - the end result will be of inferior quality with excessive production of collagen by fibroblasts.

## Rehabilitation of Burns and Soft Tissue Injuries

Wound healing, and therefore scar formation, involves three distinct phases:

**Inflammation:** (the first 48-72 h after trauma) the body responds quickly to any disruption of the skin's surface. Within seconds of the injury, blood vessels constrict to control bleeding at the site. Platelets move to the site to control bleeding and begin clot formation. Platelets also release factors that attract cytokines - neutrophils enter the wounds to fight infection and attract macrophages, they break down the necrotic debris and activate the fibroblast response.

**Proliferation:** (which may last for up to 6 weeks) involves proliferation of fibroblasts, which produce collagen.

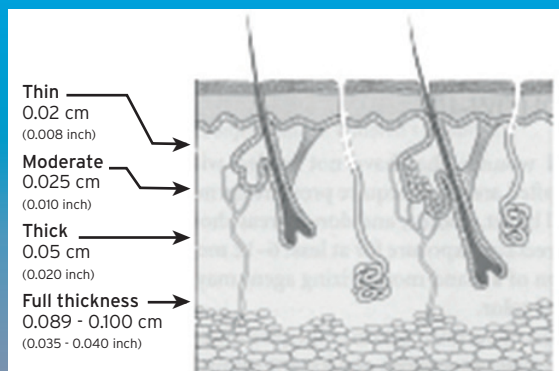
**Remodeling or maturation** continues over a period of at least 1 year - up to 2 years. During maturation the inflammatory response should down regulate to lead to a decrease in cellularity in the wound. Normally there is a balance between collagen synthesis and degradation so that no net increase in collagen occurs but with slow healing wounds, there is prolonged stimulus from inflammatory cells and excessive collagen production leads to HTS.

Another type of wound healing is via wound contraction. The contraction is from the muscle like action of wound fibroblasts - "myofibroblasts". The fibroblasts grasp on to the extracellular matrix in the wound and then contract to shrink to the size of the wounds. Most contraction takes place within 2-3 weeks. This type of healing is helpful in closing small wounds of approx. 2-3 cms but if burns are deep and healing is slow then allowing myofibroblasts to be the main actors in shutting the wound will cause huge contraction. However, myofibroblasts are not the main or only cause of contractures - it is the overproduction and collagen that results in hypertrophic scarring.

Scar is initially weak and has a thin epithelial layer that can break down easily with minor trauma. Hypertrophic scars (HTS) are most common in areas of high tension (tension can exacerbate fibroblast proliferation) and most movement. HTS usually develop 1-3 months after an injury week post epithelisation and reaches a peak at 3-4 months. HTS can be very active for the first 6 sometimes 9 months. There is also a genetic and ethnic predisposition to HTS - black and Asian skin types can scar more than white skin types (very fair/red headed people may scar more). A scar is devoid of dermal appendages and never reaches the same tensile strength as the surrounding skin.

### Skin grafting

## Skin Grafting



Deeper wounds are going to have necrotic tissue because of the dead layers of skin. Debridement is used to remove the necrotic tissue. This may be appropriate if there is hope of the wound healing in an appropriate time frame or if grafting is not available. Slough can be debrided by repeated dressings, eschar needs debridement to be removed. Eschar is a feature of a full thickness burn and therefore ideally should not be allowed to develop but rather the full thickness burn should be excised and grafted if at all possible.

This photo shows a split skin graft (SSG) to a face and a diagram showing the depth of various skin grafts that are used. Here we will refer to split skin grafts only. The advantage of a thinner split skin graft is that it will take easier to the underlying bed than a thicker split skin graft. However, a thicker split skin graft will contract less than a split skin graft.

The following images show some full thickness wounds at different stages, all requiring split skin grafts (SSG).

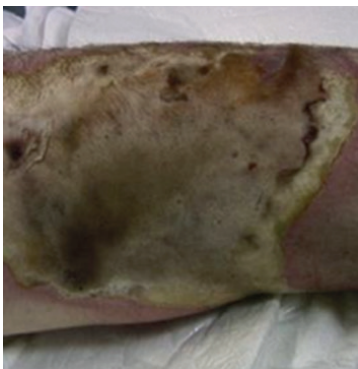


Photo A



Photo B



Photo C

The photo of the thigh (**photo A**) shows a FTB that needs to be excised and grafted - it is not a fresh a wound as the wounds on **photo B** of the lady on ventilation is.

Ideally a FTB should be excised and grafted within the first few days of injury. In HICs this is usually done on admission or within the first 5 days. If the wound is partial and there is uncertainty if it will heal in an acceptable time frame then the 'wait and see' approach is taken and the grafting is delayed depending on how healing progresses. However, in low resource settings it is more common for full thickness and deep burns to be left until the eschar separates (which takes about 3 weeks).

Under this will be granulation tissue, they wait for this granulation tissue to be clean and then it is grafted (as in the photo of the man on the bed in photo C). You can see the red granulation tissue and a few strips of SSG (the brown strips). This scenario of granulating tissue and delayed grafting and wound healing is pretty much a recipe for disaster in terms of preventing significant scarring and being able to prevent contractures.

### Donor sites

#### Donor Sites

- With large burns - take what you can get
- Smaller burns - from covered areas
- Small children-buttocks
- Thighs - excellent site
- Lower back
- Scalp for face, neck
- Posterior trunk - premier donor site, esp in the elderly



The image in the slide above shows a donor site that has been shaved with a 'Humby knife'. The text outlines the common areas for donor sites. Donor sites bleed a lot and create a superficial partial thickness wound.

They are dressed and left for 2 weeks by which stage the area should be fully healed. The donor site is often very painful post op, but should not prevent the patient getting up.

### Split skin grafting (SSG)

#### SSG Surgery



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This slide shows excision of donor skin with an electric dermatome and excision of a burn wound with a manual Humby knife. Either instrument can be used for either excision or donor harvesting.

Once the donor skin has been harvested from the patient, the skin is usually meshed or fenestrated. This involves putting mechanised or manual 'holes' in the skin. This allows expansion of the skin, which is important if donor sites are limited and large areas need excision; it also allows exudate to escape so it does not collect between the wound bed and the skin, this can cause the newly grafted skin to lift off. For cosmetically important areas such as face and hands, if there is sufficient skin, then skin grafted to these areas are not fenestrated or meshed - this is called a sheet graft. As the area between the mesh or fenestrations heals by secondary intention these grafts scar more and leave a certain pattern. Sheet grafts don't have this pattern but they take with less certainty than meshed grafts.

**The first phase of 'graft take' is serum imbibition** - the graft sticks to the wound bed by weak fibrin bonds. At this time the SSG can be easily detached and is usually held in place with sutures or staples. The graft survives by diffusion of nutrients from the wound bed to the graft, any barrier between the wound bed and the graft can lead to death of the graft and it is therefore important to prevent collections of blood or serum from collecting under the graft.

**The second stage is revascularization**, which involves the growth of new blood vessels into the skin graft and requires approximately 24-48 hours for the endothelial cells from the wound bed blood supply to penetrate the skin graft. Face grafts can revascularise in 24 hours. Since there is no strong connection shearing of the graft can lead to haemotoma and graft loss.

**Lastly the organisation phase** where collagen bridges form across the wound bed to the graft - this starts at 4-5 days and matures over months. Typically SSG will stay red and thicken for 3-4 months. Skin grafted skin does not regrow adnexa as they remain in the donor. If the wound bed is not vascular, e.g. exposed tendons/bones a split skin graft is not a viable option and we will consider other options later on. Some small areas can be left to granulate and epithelise without grafting but only small areas and those not near joints.

In high resource environments large areas of burn can be excised and grafted in one sitting. In low resource settings, skin grafting is done a lot less and often is not possible apart from smaller areas of around 10%. If there is a big deep burn injury and limited ability to graft large areas then smaller areas can be grafted over time, prioritizing the most functionally and cosmetically important areas. Another option is to excise the dead tissue and cover the area with a temporary cover such as cadaver skin or allograft. The burn patient is usually immunosuppressed so it takes 4-8 weeks for the graft to be rejected. In HIC options such as biobrane, Integra are used but these are often not available in low resource settings.

### **Pain in burn management**

Pain is complex and isn't the sum of physical pain (which can be very significant in burn injuries) but also includes feeling of fear, worry, general discomfort, distress and the possible guilt/anger/depression over a possibly life changing and devastating injury. A burn injury can be a very traumatic experience for the patient and their family. In low resource set-ups the facilities, staff and equipment to increase the comfort of the patient often do not exist; this makes the experience potentially very traumatic, especially for children who have limited understanding of the reason for this interruption to their normal life and the pain they are experiencing.

## Rehabilitation of Burns and Soft Tissue Injuries

Pain can be classified as

- i) **Background pain** which is pain from the initial injury that is on-going and present even in the absence of activity or procedures, it is usually addressed by long acting analgesic agents which aim is to limit breakthrough pain
- ii) **Breakthrough pain** is more intense episodic pain associated with activities of daily living and moving
- iii) **Procedural pain** is associated with invasive procedures such as dressings and physiotherapy.

Opioids are the cornerstone of pain control for burns, and ketamine is commonly used for children and adults. However, in many low resource settings, access to opioids is limited or not available. There is also often a perception that patients may get addicted to powerful pain medication, however there is no evidence that opioid addiction occurs more often in burn patients than in other populations requiring opioids for acute pain (approx. 1 in 3000) (Faucher and Furukawa, 2006).

### Route Pharmacological and Non-Pharmacological

- Oral
- Sub lingual
- Intravenous
- Intramuscular
- Rectal
- Transdermal
- Inhalation
- Local / regional block
- Communicate - talk to your patient, explain what you are going to do
- Distraction therapy
- Reduce anxiety
- Be prepared and be efficient
- Build trust

There are numerous routes of administration. Some are more appropriate in certain situations, for example intramuscular injections in children should be avoided when possible, as they are extremely painful. A painful finger may benefit more from a local anaesthetic block than oral medication, and a transdermal patch (if available) may provide excellent long-lasting background analgesia. It is not always possible to prevent pain, because evidently a burn injury causes immense physical discomfort. A superficial partial thickness burn will be physically much more painful than a full thickness burn, however,

it would be wrong to imagine that someone with an extensive full thickness burn is not in a state of severe 'distress'.

Anything that might contribute to pain or that might precipitate pain such as dressing changes, post operatively etc. should be anticipated so that action can then be taken to try and minimise this, either by increasing analgesia or utilising other pharmacological and non-pharmacological methods.

Treatment should be 'multimodal' and tailored specifically for each patient having analysed exactly what his or her needs are.



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Studies show that untreated pain in children can cause irreversible damage to both body and soul! Children are more sensitive to pain and can also get permanent damage due to strong pain. Recent research also shows that pain slows down wound healing.

In a field hospital setting, the MDT will discuss appropriate analgesia. However in other low resource settings there can be a limited approach to pain medication. Medication is often prescribed PRN, which often means it is not given on busy wards. If pain medication is not included in the care then many families struggle to afford additional medication. Staff can be more distanced to the experience of pain suffered by the patient and it is not uncommon for pain meds to be given after a painful procedure rather than beforehand. Methods of distraction, especially in children can be very effective. Again these methods may be less commonly utilized in low resource settings.

In many low resource settings patients are bed bound because mobilising or mobility is too painful - this situation clearly needs reversing and discussion with the medics and nurses to encourage use of what is locally available to reduce pain will help. If your patient is in excessive pain, therapy is not going to be effective and very little therapy will be happening when the patient is alone as there will be a reluctance to move. Reassurance and explanation go a long way to help reduce fear and anxiety around pain. Therapy in low resource settings due to lack of comfort increasing measures is often painful or even limited by pain, ways to reduce pain will produce better outcomes. Therapy techniques to reduce pain will help as will gentle persistent encouragement of movement.

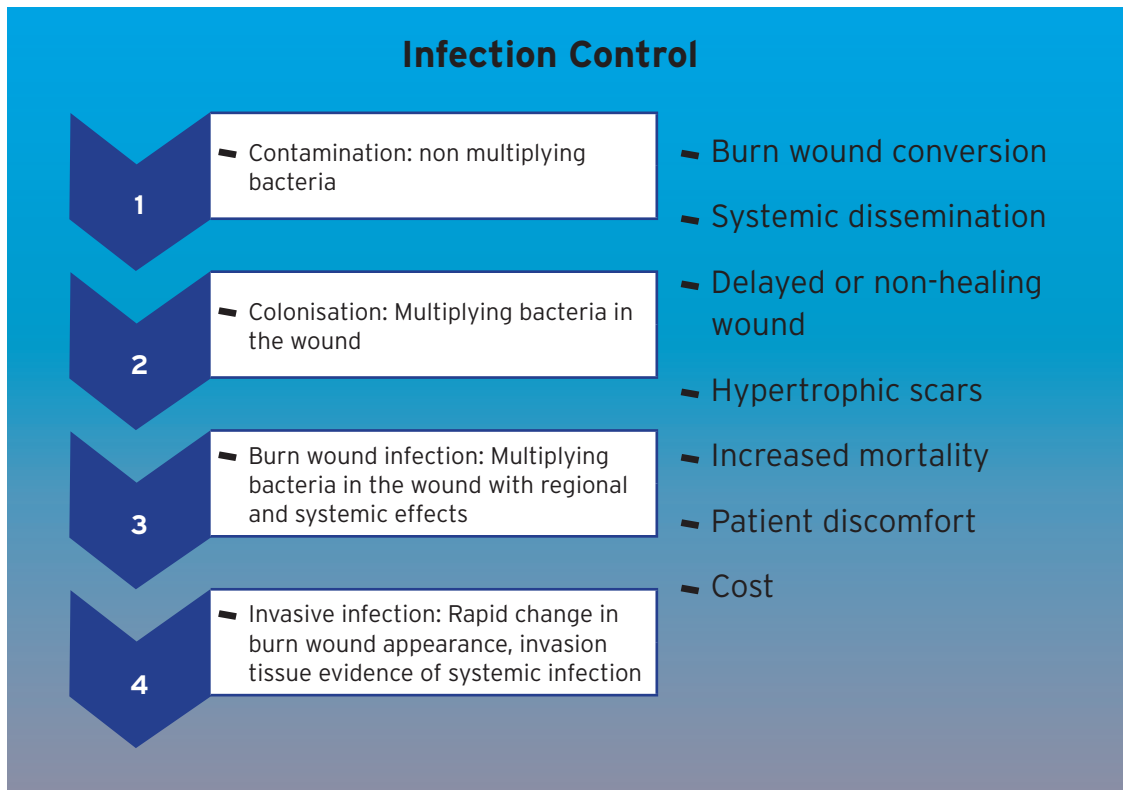
## **Nutrition**

Nutrition is very important in burn injuries for a number of reasons. Early feeding (starting when the patient is admitted) helps to prevent gut ulceration that can lead to bleeding. It also helps prevent bacterial translocation, which is when the normal bacteria in the gut pass across the gut mucosa and ends up in the blood stream causing sepsis. All burns will cause an increased metabolic (by 2-3 x normal) rate, which increases with the size of the burn. There is breakdown of protein that leads to muscle wasting. Skin loss and muscle breakdown also leads to deficiencies in vitamins and minerals. Children are growing and therefore require relatively more.

Exercise and therapy will also increase nutritional requirements. Without good nourishment response to rehab will be poor. Poor nutrition will very significantly delay wound healing. An adult with 40% TBSA will lose 30% of his body weight in less than 21 days and will possibly die without nutritional support. If the patient has lost 10% from his pre-morbid weight then he is likely to develop complications. NG feeding, starting on admission is important for patients over 30% and children over 20%. Local high protein and high calorie foods can be used - for example the banana lassi. On top of NG feeding oral feeding is encouraged.

Burn patients very often lose their appetite for one reason or another. Diarrhoea is unfortunately common, which adds to the challenge of patients retaining enough nutrients - this is particularly common when the patient is in sepsis. Routine weighing of the patient is important to capture any weight loss.

### Infection



Therapists can be prime vectors of cross infection as they move around a lot from patient to patient and location, and often have close contact with patients. The burn patient has lost skin cover and therefore has lost much of their natural defense towards infection. The systemic effects of burns also lower the patient's immunity. Although

initially sterile, burns become contaminated within a matter of hours, when the number of bacteria reaches a certain level (10<sup>5</sup> organisms per gram of tissue) the wound becomes infected. If not treated this can then lead to invasive infection, septicemia, septic shock and death (the commonest cause of death in burns).





## Risk Factors for Burn Wound Infection

- Delayed initial care
- Type of burn - flame electricity
- Extent of burn 30% TBSA
- Depth of burn - FTB
- Prolonged open wounds - delayed closure
- Inhalation burn - mortality increases by 40%
- Co-morbidities e.g. diabetes, HIV, obesity
- Organism type
- The wound - devitalized tissue
- Systematic antibiotics
- Invasive devices



Much can be done to reduce the risk of invasive infection by ensuring appropriate care of the patient. Avoiding contamination and colonisation of the burn wound is virtually impossible. However, by maintaining the patient in a clean state, changing soiled dressings in a clean environment and using topical antimicrobials the risk of invasive infection leading to septic shock is significantly reduced. Lines should be kept to a minimum and feeding should be started as soon as the patient is admitted. Regular

feeding helps maintain the integrity of the gut and reduces infection with the patient's own organisms as well as safeguarding general non-specific immunity. Antibiotics should be reserved for patients with invasive infection who are systemically unwell. Effective and regular hand washing can be the one most significant intervention in preventing cross infection. It can be more of a challenge to control infection in low resource environments - imagination, innovation, teamwork and dedication will be needed to ensure solutions are found.

### Prevention & Control of Infection - Patient

- Personal hygiene
- Clean patient and wound
- Catheters, IV lines
- Change soiled dressings
- Topical antimicrobials
- Encourage nutrition



### Signs of Infection or Sepsis

- Feeling unwell
- Shivering / Shaking
- Unwilling to eat / drink
- Lethargic
- ↑ Pain
- Dressings soiled / smelly
- Spreading cellulitis (red, warm, tender)
- Extensive slough
- Temperature
- ↑ Pulse rate
- ↑ Respiratory rate

### Therapy assessment of burns patients

Assessment of the burn patient will follow many similarities to any other patient; however there are specific differences as

well. In the following folder you will find example assessment forms and outlines of assessment.



Please also see the '**Therapy assessment of burn patient**' folder in the USB for assessment sheet examples

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## Burn Injury Specific Assessment

### SH

- Smoker
- Job
- Hand dominance

### PMH

- V relevant
- Comorbidities

## Burn Injury Specific Assessment

### Subjective

- TBSA
- Depth and wounds
- Cause
- Type
- IV / catheter etc.
- Respiratory system
- Oedema
- Other injuries

### Objective

- ROM - active and passive
- Strength
- Function and mobility
- Sensation
- Pain
- Psychological

### Outcomes

There are a number of outcome measures relevant to burn injuries.

Health Scale (BSHS), SF-36, Quick Dash, ICF, EQ5D, POSAS and the Vancouver Scar scale.

These include goniometry, the Timed Up and Go, The Tandem Walk Test, The Burn Specific



A number of these outcomes are described and evaluated in articles within the '**Outcomes**' folder of the Burns file on the USB.

In the authors' experience in low resource setting there is reliance on goniometry and observation mainly.

## Rehabilitation of Burns and Soft Tissue Injuries

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### Therapy treatment of burns

Much of burns rehabilitation and scar management is based on clinical

experience rather than robust evidence base.



Articles and documents in the USB resource file provide give key articles outlining available evidence and also documents regarding any existing standards or guidelines

### Inhalation Injury

#### Effects of Inhalation Injury

- Direct thermal injury to the upper airways
- Smoke inhalation and / or chemical injury to the lower airways
- II injury worsens mortality by 40%
- Pneumonia can increase mortality by 70%

Inhalation injury can occur if a person is involved in a fire within an enclosed space (e.g. house fire). If a patient has a history of being burnt by fire in an enclosed space, has singed hair, hoarse voice, high respiratory rate, stridor and facial oedema, an inhalation injury should be suspected. Inhalation injury involves

- Direct damage by heat to the upper respiratory tract (rarely gets beyond the larynx) which causes mucosal oedema, erythema and ulceration of the airways
- Chemical irritation through the inhaled gases - these products of combustion

act as direct irritants to the lungs and lead to bronchospasm, inflammation, and bronchorrhoea. Ciliary action is impaired and surfactant production inhibited which exacerbate the situation. The inflammatory exudate created is not cleared, and atelectasis or pneumonia follows. Carbon monoxide is a commonly released gas in fires - carbon monoxide binds preferentially to O<sub>2</sub> (by 40x) and causes hypoxia, this can affect consciousness and can cause confusion. 100% oxygen is administered.

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## Diagnosis

- Signs and symptoms: hoarse voice, facial burns, FTB to mouth and nose, stridor, singed hair, visible oedema of pharynx
- ABG's
- Bronchoscope
- Carbohaemoglobin levels
- Physio

Due to massive inflammatory reaction in response to the burn injury, and more specifically to the inhalation injury, vascular permeability and oedema formation occur over 6-72 hours post injury (peak at 12 hours). This leads to a large increase in

the extravascular lung fluid - pulmonary oedema and concern of the viability of the airway - intubation is usually done early in case the oedema worsens making intubation no longer possible.

## Post Injury

- Pulmonary oedema
- Sloughing of respiratory epithelium
- Loss of cilia
- Increase hyperactivity of airway
- Ulceration
- Loss of surfactant
- Increase mucous production
- Casts which can be occlusive
- Atelectasis
- Bacteria colonisation
- Pneumonia - 1 week post injury

Patients in low resource settings may not have access to ventilation. Aggressive chest physio becomes more important to increase lung volume and clear the excessive

secretions. Positioning is important to reduce oedema, remove secretions and match ventilation and perfusion maximally.

### Medical Management

- Humidified O2
- Ventilation if the airway is or is likely to be compromised and elective tracheostomy
- Non invasive ventilation
- Escharotomy
- Nebulised heparin
- Bronchodilators
- Regular chest PT

Humidification and keeping the patient well hydrated is important so that secretions don't thicken. Post SSG to the chest area, vibrations and percussion should be left for 5 days if possible, and if necessary done over gamgee pads. Chest physiotherapy whether the patient is ventilated or not is similar to any other condition where there is

loss of volume and retained secretions. The main differences are the significant excess secretion (often sooty in colour) which is often not evident for the first day or two and the need to be vigilant over positioning and starting passive or active ROM. The slides below indicate the techniques that can be used.

### Physiotherapy Aims:

- Maintenance of the airway
- Removal of excess bronchial secretions
- Improvement of gaseous exchange
- Prevention and / or treatment of atelectasis
- Maintenance of thoracic expansion and general mobility
- Positioning

## How?

- Positioning
- Vibs
- Percussion
- Positioning
- Manual Hyperinflation
- Suction
- Saline / Humidification
- Active Cycle of Breathing
- Oxygen Therapy
- Mobilising
- Manage Pain



## Oedema

### Oedema Management

#### Acute

- Oedema develops over 4-5 days
- Elevate
- Mobilise - active

#### Sub Acute

- Elevate
- Mobilise - active and passive to soft tissue
- Compress
- Splint



We have discussed the presence of oedema in the early stages of a burn injury. We can see that oedema is a normal response to the injury and to the fluid resuscitation. The oedema peaks at around 48 hours and should decrease by 72 hours. The presence of oedema can compromise wound healing.

Acute oedema can become more chronic and stay in the tissues, especially after skin grafting and especially in hands. In the acute stages therapists can manage and limit oedema by appropriate positioning and encouraging the muscle pump through active movement.

There is some controversy as to whether splinting can assist in limiting oedema. Some therapists will splint hands in the early stages to assist in reducing oedema, others want to keep the hands free to utilise active movement to reduce oedema. A combination of splinting and active movement may be beneficial in the early stages.

Hands should be elevated above the heart level. Inverted pillow cases can be helpful to elevate hands, although the ideal is bedside

tables with a couple of pillows so that hands can be elevated without elbow flexion as oedema often gets trapped at the elbow if hands are elevated in the traditional ways. Patients with facial oedema must be sat up at least 45 degrees even at night. For more chronic oedema effleurage techniques may help to encourage movement to lymph nodes and some elastic bandaging for example with coban. This can be particularly useful for hands.

### Positioning



See folder on the USB - **'Positioning and Splinting'** for further articles

Proper positioning is very important for the burn patient. Positioning is used prophylactically when there is no sign of loss of range and can be used to increase ROM if there is a loss of range. Burn patients especially in low resource environments where pain management is minimal will adopt positions of comfort; generally this is in a pattern of flexion. Joints will literally get stuck in the position of comfort over time as the developing scar adapts to the shortened position.

The general principle is to think of what contracture is expected due to the location of the burn, and then place the limb / area in the opposite position. E.g. a deep burn on the flexor surface of the leg around the knee joint will produce a flexion contracture of the knee and therefore the knee should be placed in full extension. The areas most

crucial for good positioning are hands, neck, axilla, knees and ankles. If a patient has an anterior neck burn it is important for the patient not to use pillows as this pushes the neck into flexion. It is possible to place the pillow from the scapula up so the patient has a pillow but is not forced into flexion- however the pillow invariably will move up and gets behind the head.

Good positioning can be achieved using whatever is available locally. When the patient is at rest the patient should be in the correct position. Small sustained changes of e.g. hand position can make a big difference. The benefit of positioning is that it is a sustained position, which is important when working to stretch structures and scar wanting to contract. It is often quite a comfortable way to gain range or prevent loss of ROM.



## Anti-Deformity Positioning

- ✓ Shoulders abducted to 90 degrees, horizontally adducted 20 degrees, encourage ext. rotation
- ✓ Scapula - retraction, depression
- ✓ Arms in neutral rotation, forearms supinated
- ✓ Elbows in extension
- ✓ Wrist 30-40 extension, with MP 45-70 flexion, IP extension, thumb abducted and opposed
- ✓ Neck slightly extended (no pillow)
- ✓ Hips in slight abduction with full extension, block ext rotation
- ✓ Ankles in neutral plantar / dorsiflexion, with subtalar neutral



Positioning should take in to consideration pressure areas. The burn area is very prone to progressing in depth if under continual pressure and the non burned areas are also prone to breakdown as many burns patient in low resource settings are often malnourished. The 'donut' is used under the occiput to relieve pressure or over the ear. A donut can be made by rolling up a large tubigrip. Burned ears are prone to chondritis if pressure is put on them - the donut can be used at the occiput to keep the ears free of pressure from the pillow.

### Splinting

Splinting can have a key role in burns rehab throughout the continuum of care - at the acute stages right through to reconstruction. Splints are used for protection of anatomic structures, prevention n or correction of deformity, immobilisation of skin grafts, and

restoration of function. Splints may be used prophylactically, before a problem exists or only once loss of range exists.

In HICs splints are used less now in the acute stages. However, in low resource settings splints are often still very useful as pain is less well controlled and a splint may be the best way to achieve and sustain ROM. In HIC it is often possible to maintain and gain ROM through active and passive exercises and function, in LMICs this can be less easy due to higher pain and slower healing. There is little research to support splinting in burns patients; it is more a tradition based on clinical experience. Wearing times are also unproven, sometimes splints are worn at night, sometimes regimes of 2 hours on and 2 hours off are employed - again this may be more difficult to apply in certain situations where considerable effort and pain is needed to get back into the splint.

## Rehabilitation of Burns and Soft Tissue Injuries

Sometimes it can be beneficial to splint in theatre so a range that cannot be achieved on the ward due to pain limitation can be achieved. Static splints employ the biomechanical principle of stress relaxation - the amount of force required to maintain tissue at a given length decreases with time. Dynamic splinting applies the principle of creep - a continual elongation of tissue over time with the application of a constant force.

Serial casting is rarely necessary in HICs but can be very useful to stretch out

contractures in low resource settings. It should be recognized that splints could cause problems such as pressure areas, circulation restriction, infection risks and loss of joint range. Correct splint manufacturing and fitting is important as well as close monitoring. Generally only deep burns are splinted. In low income countries thermoplastic splint material is usually not available, however plaster of paris (POP) is normally available even in a field hospital setting.



Further principles and practice in working with plaster of paris can be gained from the UKIETR practical workshop 'Splinting with POP'

As shown in the following image, neck collars can be made using suction tubing (bind 2 together and another 2 together and build up to the width needed) or POP. For POP the area

is well padded then the neck is fully circled by POP - this is best used once healing has occurred to get a stretch on the neck and maintain the cervical mandible angle.

### POP Collar



A scarf can be used to stretch across the pectoral area and counteract the

protraction and elevation of the shoulder girdle.

## POP Collar



Ladies scarf makes an excellent postural support



### Mobilisation

Early mobilisation in burns is very important both in getting patients up and mobile and active mobilisation of joints. Burn patients should be out of bed unless they are unstable. The only contraindications to mobility are: combined flexion of fingers if tendon damage over the dorsum expected or obvious, exposed tendons, excessive pain and immediately post - op for SSG and reconstruction.

### Stretch

Stretching of areas is important to maintain tissue length. As scar is developing or has developed, stretches need to be

**low load and long in duration.** Scar will take longer to stretch than muscle, to be effective **sustained stretches of minutes, increasing range as resistance decreases** is important. Generally reduced range is due to scarring in the dermis and limited length there rather than in any underlying tissue - however other structures will shorten secondarily. For example with a lot of scarring around the shoulders and upper thorax pectoralis major can quickly shorten. Generally stretches for 20 minutes are useful. Stretching too far can cause tissue breakdown but without stretch to the end of available range, increase in range is unlikely to be achieved. Pain control is essential.

## Rehabilitation of Burns and Soft Tissue Injuries



The slide above shows the effect of stretching on scar - when stretching scar it will blanch - **going to the point of blanch is necessary**. Going too far can cause tissue breakdown.

Again there is very little evidence on how to stretch, how long etc. However, there is emerging evidence that stretch along lines of tension can exacerbate the production of collagen by fibroblasts, hence exacerbating hypertrophic scarring. Often tightness in one area will impact ROM more distally. Research showed skin involved in joint movement

extended far beyond the immediate proximity of the joint skin creases themselves (although maximum movement does occur there) - for example shoulder abduction: 80% of skin down to pubic bone, and neck extension: 80% of sternal notch to pubic bone. Healthy skin can lengthen up to 60% of its original length whereas scar tissue is approximately 15% extensible in its immature state of repair. This means we may have to work on scar at quite a distance to the joint where range is limited to improve flexibility.

### Likely scenario



The image of this young patient shows a common scenario found in low resource settings, one that you would be very unlikely to find in HIC. The patient probably has a deep burn that has not been grafted, and is possibly infected. There has been no input to position or mobilise the patient. The likelihood is that the lower limbs are

already contracted and have lost full knee extension and probably dorsiflexion, maybe hip extension. In this case stretching into extension with a low load, sustained stretch is important, for this, the help of splinting is probably needed and it will be difficult to achieve much without adequate pain medication.

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## Complications

Neuropathy and heterotrophic ossification (HO) are possible complications, neuropathy is more common than HO, but thankfully both are not common.

### Neuropathy

- Damage during escharotomy or fasciotomy and deep debridement
- Intramuscular injections
- Prolonged oedema
- Inappropriate positioning
- Tight dressings over superficial nerves
- Incorrect splinting
- Aggressive exercise programmes and medication
- Long ITU stay
- Electrical burn
- Most common = brachial plexus and peroneal nerve

### Heterotrophic Ossification

- Incidence of HO in burns varies between 0.2 and 4%
- It is more frequent in patients with burns >20% TBSA
- May occur in joints unrelated to burn injuries but usually develop in joints underneath full-thickness burns, especially in the elbow
- Is associated with prolonged loss of consciousness (i.e. mechanical ventilation), long-term immobilisation, burn wound infection or delayed wound closure, loss of skin graft and recurring local trauma (i.e. forceful joint manipulation)



Further information on heterotrophic ossification can also be found in **chapter 2, amputation**, within this manual.

## Functional rehabilitation and mobility aids



Sometimes adaptive devices are needed to help the burn patient with functional tasks. Prosthesis may be necessary for patients

who have had amputation, usually due to very deep electrical burns. Mobility aids may be needed but are not commonly necessary.



With children the objectives of maintaining and gaining ROM, stretching etc. must be achieved

through play. It is always worth remembering that as children grow, scars do not.

## Delivery of Care

	Mardi	Manzrelli	Jessie	Veronica
Medication	medication	medication	medication	medication
BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2
Physical condition	Physical condition	Physical condition	Physical condition	Physical condition
BOI	BOI	BOI	BOI	BOI
Eye Schedule	Eye Schedule	Eye Schedule	Eye Schedule	Eye Schedule
Salto Fango Cap 2	Salto Fango Cap 2	Salto Fango Cap 2	Salto Fango Cap 2	Salto Fango Cap 2
Com. Faciale	Com. Faciale	Com. Faciale	Com. Faciale	Com. Faciale
BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2
Ergotherapie	Ergotherapie	Ergotherapie	Ergotherapie	Ergotherapie
Salto Ergo Capus II	Salto Ergo Capus II	Salto Ergo Capus II	Salto Ergo Capus II	Salto Ergo Capus II
Medication	medication	medication	medication	medication
BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2
Physical condition	Physical condition	Physical condition	Physical condition	Physical condition
BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2	BOI 1 SR 2
Ergotherapie	Ergotherapie	Ergotherapie	Ergotherapie	Ergotherapie
Salto Ergo Capus II	Salto Ergo Capus II	Salto Ergo Capus II	Salto Ergo Capus II	Salto Ergo Capus II



In the acute stages individual treatment is often most appropriate but at later stages group work may be successful in achieving aims. Burns rehab often needs

to be intensive - with large burns there is much that needs to be achieved and if it is possible running a program for the patient throughout the day can be productive.

## Scarring

### Scar Management



Hypertrophic scarring (HTS) (photo on left, above) in the early stages during maturation will often be **red, raised and rigid**. The photo on the right is a keloid scar rather

than a hypertrophic scar; a keloid has different features from hypertrophic scars. HTS are those that we will focus on, as they are common post burn injury.

### Hypertrophic scarring

Hypertrophic scars have a range of symptoms that can be very distressing for

the patient in how the scars feel and look.

### Look and Feel

- Hypo pigmented
- Hyper pigmented
- Atrophic
- Restrictive / distorting
- Hypersensitive
- Insensate or altered sensation
- Pruritus
- Uneven in Texture
- Painful
- Broaden scars
- Unstable scars

Hypertrophic scars usually develop within one to three months after injury



### Scar Characteristics

- **Colour:** vascularity and pigmentation
- **Sensory:** pain, pruritus and other
- **Function:** contraction, stiffness, thickness, adhesions
- **Form:** volume, thickness



Please see the USB folder '**Scar management**' for all key articles on the scar management - including evidence for each modality.



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**Scar massage** is a standard treatment once a wound has fully epithelized, despite no real evidence on its effectiveness or when to start, how long to do it for, or what techniques to use. A recent meta-analysis including 144 patients from 10 different publications who received scar massage concluded that although scar massage is anecdotally effective, its evidence is weak, regimens used are heterogeneous, and outcomes measurements are subjective and not standardized. A recent article is the first demonstrating significant improvements with massage; objective measurements are used.

What is important for scars is hydration - this is achieved by creaming scars with an appropriate cream. In low resource countries it can be hard to find an appropriate cream, many have irritants and chemicals in and should not be used on young scars. An option is coconut oil; it is cheap and easily available. Traditionally massage is applied with 3 fingers applying pressure to the tissue and then moving in a circular fashion. It is important not to cause friction on the new scar/skin i.e. the fingers should not rub over the skin, as the epidermis can be fragile and this action can irritate the area - the level of mobilisation needs to be at a deeper level. Other massage techniques involve making gentle skin folds between the index fingers of both hands. Once the scar is not in the inflammatory phase then more aggressive scar massage can be used. If capillary refill on pushing the scar (blanch) is less than 3 seconds this is an indication that the scar is in the inflammatory stage and massage that rubs or is aggressive will only exacerbate hypertrophic scarring. Please refer to the articles in the scar management folder for more information on massage.

**Itching**, known as pruritus, is a common and distressing problem for burn patients - release of histamine by mast cells is abundant in the healing wound. Studies report an incidence of between 25-87% for adults and 57-100% for children incidence,

most common in the proliferative and remodeling phase of healing, it can be peak at 6 months and is usually decreased by 1 year. Acute pruritus is from wound healing to around 6 months, it affects the majority of patients and is irrespective of the depth of injury, chronic pruritus persist up to 2 years post injury in survivors with deep dermal injury having undergone a number of surgical procedures and those with early post-traumatic stress disorder. Itching the scar can also cause epidermal breakdown and can aggravate HTS, so apart from issues of discomfort it is important to try and control itching. Keeping the area hydrated with creams and using pressure garments can reduce itch. Medication with antihistamines or centrally acting medications such as gabapentin is the mainstay of treatment.

**Pressure garments** are often routinely used in HICs if an area has been grafted or takes longer than 3 weeks to heal. Pressure garments can reduce the height and possibly increase softness of the scar more quickly. Research again is not strong to support the use although they have become standard practice.

Pressure garments do come ready made but generally need to be made for the individual. They are used within weeks of healing, as soon as the area new epithelium can tolerate the pressure / material. The garments should be worn 23 hours a day; they give a pressure of 20-40mmHg, generally around 24mmhg. They are worn for 6-24 months, up until scar maturation. The garment's fit needs review regularly (every 6-8 weeks for children and 3 months for adults) to maintain its pressure, which can lessen through the material become lax with time, and for children alteration is needed to accommodate their growth. Some areas, especially concave areas such as the sternum (especially in women) can be hard to achieve sufficient pressure.

Often pressure garments are not realistic in low resource settings. The material may not be available, if it is it is often totally out of the budget for the family. If the material is available it may not be of a good standard (low % of lycra in the material). Additionally wearing pressure garments in hot and humid climates is a real challenge.

**Silicone** is also often standard treatment in HICs but again is unlikely available in low resource settings. Silicone in HICs is available in sheet form, gel form and as a spray. The mechanism of action is thought to be not directly related to the silicone but to the silicone's ability to provide an occlusive layer which helps hydrate the epidermis and this down regulates collagen synthesis. Silicone can reduce the redness and height of maturing scars but again evidence is not definite. A recent Cochrane meta-analysis including 20 clinical trials found that although silicone gel sheeting decreased scar thickness and improved scar color with statistical significance, the analyzed studies had poor quality and were highly susceptible to bias, with weak evidence of the efficacy of silicone gel sheeting to prevent abnormal scarring in high risk patients.

Silicone sheets are recommended to be worn for 12-24 h a day for at least 2 months, beginning 2 weeks after wound healing (never before). The usage of the silicone is built up slowly to check for any irritation or allergy - 4 hours a day for 2 hours, and then 8 hours a day 2 days then increase by 2 hours. The silicone sheets should be washed daily with soap and dried, they usually last 14-28 days before replacement is needed. Folliculitis and skin maceration is a possible adverse effect, especially for silicone sheets. Often silicone is worn in combination with pressure garments.

**Corticosteroids** can reduce scar formation by affecting the collagen remodeling and inflammation phase of wound healing. This can improve scar pliability; diminish volume and height of the scar. This treatment can often be used in low resource set-ups, as all that is needed is the appropriate steroid. These injections are usually used on red and rigid HTS; the injections can be extremely painful and need to be repeated approx. every 6 weeks. Side effects can be skin atrophy, depigmentation, telangiectasia.

**Sunscreen** is always important to protect the new skin; skin can be further damaged without it and can become very hyperpigmented.

Newly healed skin and scar can be **hypersensitive - desensitization** programs may be needed. Nerves grow into the SSG innervation - there is variable length of time and extent of sensory return. There is more complete recovery in full thickness graft and less in thin split skin graft.

There are other **non-surgical options** for improving scar such as laser. These will be not covered as they are not often realistic / available in low resource settings.

Scarring of burns in comparison to other soft tissue injuries

Burn wounds tend to scar a lot more than wounds from other soft tissue injuries, however, the principles of scar management outlined above can apply to all scars. There are some differences between soft tissue injuries and burn injury scarring that are useful to consider below:

War Wounds	War Wounds
Prophylactic antibiotics	Antibiotics as required
War wounds usually v contaminated	Burn wounds usually clean to start with
Delayed closure necessary	Wounds are shut asap whether through SSG or encouraging healing
Damage to many structures	Damage to the skin
Scarring often at many levels and planes incl. vertical	Scarring limited to dermis - horizontal
Less of a inflammatory response in the resulting scar tissue - can be more aggressive in treatment	Inflammatory response in scar - overtreatment - e.g. scar massage can cause exacerbation of HTS



Please also see the document '**War wounds**' on the USB for further information

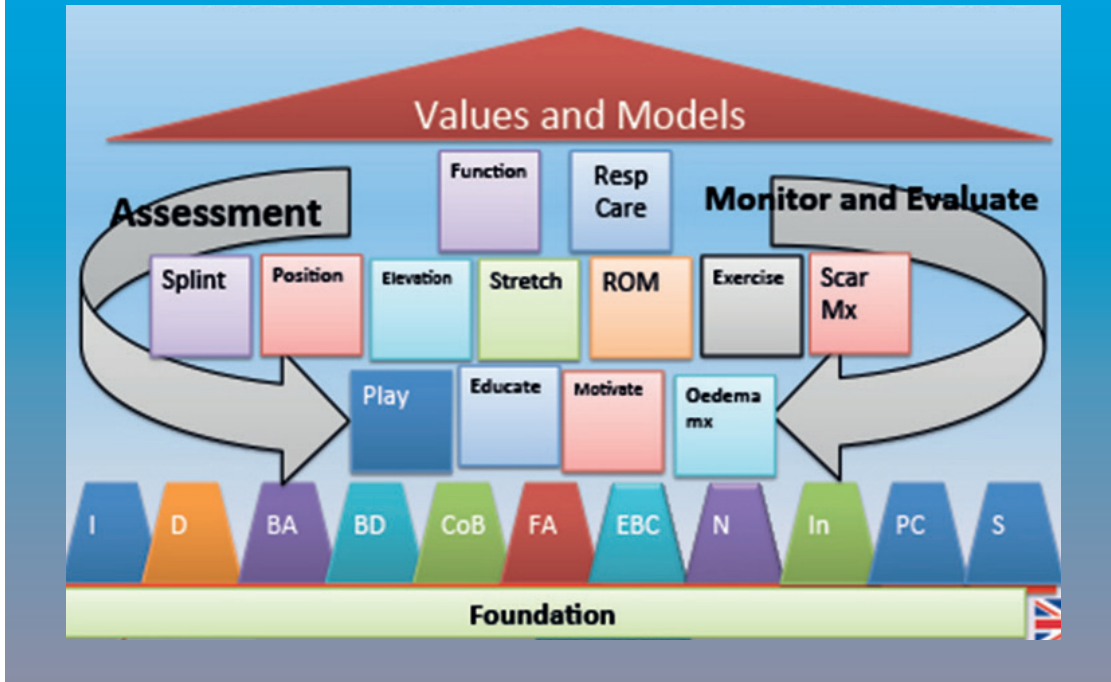
### Important general concepts regarding delivery of care for burns patients

1. **It is important to think ahead.** We need to predict the likely contractures and extent of scarring on admission so that our treatment plan works aggressively to prevent these possible problems. The patients range will remain normal initially and we may therefore think, because of full range of movement there is no need for input - this will allow a loss of movement to occur rapidly so in anticipation we should position and exercise to full range of movement the joint and splint if necessary.
2. **Our approach is very important.** The patient can be fearful of movement and what we want to achieve so we need to develop a rapport with the patient and help them understand the importance of therapy. A gentle but firm attitude is often vital.
3. **Education and motivation** is a major part of our work. Especially in a stretched service we will have limited time with patients, we must empower them to understand why we are doing what we are doing and what the consequences are of not following the treatment. We need to encourage them to work on their exercises throughout the day even when we are not present.
4. **All the basics of stretching and range of movement etc.** are simple for therapists. The skill is in knowing what is going too far (over treating and possible tissue breakdown, unnecessary pain) and what is under treating - stopping short of the range we could achieve. This is built through experience and handling skills and this teaching should have given you clues as to how to manage this. Sometimes we will have a green light to push a scar or a range further but the patient is resisting we need to unpick

the reason for the resistance and see if there are ways around it which allow an increase in range and function.

5. **Expectation.** This is very important. If we expect to get contractures we will get them. In low resource settings it can be out of your power to prevent contractures. It is easier to accept contractures ('expectation can be dangerous') but if it is realistic we should aim to prevent morbidities such as contracture. In HICs this mantra by Dale Edgar (physiotherapist) would definitely be a realistic aim to have.
  6. A lot of times in burn care it does feel like one step forward and two back (or hopefully more often 2 forward and 1 back). **Persistence is important** and having the expectation and hope that at some point there will be improvement helps us to persist and not give up when we face set backs
  7. **A correct perspective on timing** is important - it's important to remember that therapy input is needed from day one through to possibly years post injury. Treatments will also vary with the stages of healing. In the early stages for example there will be more focus on positioning and active movement, later more stretching and exercise through function is relevant. Remember that effective therapy can often take time, treatment sessions of half an hour or one hour are often required apart from when simple advice is adequate.
  8. **Prioritisation** is very important especially in low resource settings with possibly an unfriendly ratio of patients to staff and large numbers of patients. It may be more effective to treat a few patients really well rather than lots of patients a bit; effective input can often take time. With smaller and isolated burns a bit of advice can go a long way - e.g. how to position the area, the importance of moving, but with more significant injuries input and time will be needed.
  9. **Remember small things can make a big difference** - a small position change, an encouragement to walk, or simply a smile!
  10. Often in low resource settings patients are discharged early and **follow up can be particularly challenging**. However, after discharge is when many contractures and disfigurements occur and follow up needs to be a key part of the treatment continuum. It is likely that patients will need to come regularly as an outpatient. If this is not possible or the injury is manageable with home exercises less attendance is needed but patient review is still advised, patients often accept a loss of range rather than come back for help until it is too late and surgery is the only effective remaining option.
  11. **If a burn patient can meet another survivor** it can give them much needed hope and support in ways that healthcare professionals can't often help. There are some challenges with this but survivor support should be incorporated wherever possible.
  12. **Teamwork** is another cornerstone of burns care - burn care without good teamwork is very difficult.
- The 'House of Rehab' summarises these principles of burns care. The foundation is a commitment and desire to want to achieve the best possible outcomes for burn patients and to reduce their suffering as much as possible. The rehab tools are built on a number of medical and surgical issues of relevance to the burn patient, all outlined in this manual and the presentation:

## The Rehab House of Burn Care



I = incidence  
 D = disparity  
 BA = burn assessment  
 BD = burn depth  
 CoB = cause of burn  
 FA = first aid  
 EBC = emergency burn care  
 N = nutrition  
 I = infection control  
 PC = pain control  
 S = surgery

The roof is made of the values and methods of rehab treatments such as thinking ahead, prioritization. As always assessment, monitoring and evaluation is an inherent part of delivering appropriate and effective care.

***Let's fight to win and prevent contractures and disability from burn injuries.***

## Rehabilitation of Burns and Soft Tissue Injuries

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### Rehabilitation following reconstructive and plastic surgery

This section will cover reconstructive surgery not only for burns, but for other soft tissue injuries you are likely to see during deployment in an emergency. Extent and severity of wounds you may see will be dependent on the type of sudden onset disaster you are responding to. For example in an earthquake scenario, you may see crush wounds and open complex fractures with deep soft tissue involvement. With tsunami scenarios, wounds can be caused by passing debris, but are far more likely to be deeply contaminated. In tropical storms people are often struck by debris at speed - resulting in minor injuries or deep

lacerations. Considering the length of time between incidence and arrival at a health facility, and the wound care and sanitation in the interim are all highly relevant both in terms of risk of complication, but also best treatment method. Surgeons will aim, with the resources available to gain the best functional and cosmetic result possible.

Generally within a level two FMT you will be deployed with surgeons experienced in ortho-plastic surgery, and will be able to discuss individual patient protocols on a case by case basis. The essentials however are set out here.



The document '**Practical plastic surgery**' found here and on the USB is a useful document to introduce you further to the principles laid out below.



The '**Rehabilitation following burns and soft tissue injury**' cheat sheet is a useful reminder here

### Burns

Often due to limited follow up and difficulty of patients returning to healthcare centers, burns patients don't come back for scar management and outpatient care but return when they have a problem such as a contracture, which at that stage often only has a surgical solution. Before any reconstructions surgeons usually wait 1-year post healing so that most of the scar will have matured and settled. However, if

a procedure is *urgent* than it may not be possible to wait.

**Urgent** procedures may be to correct a deformity or if vital structures are exposed or can be severely damaged e.g. eyelid release to protect an exposed cornea, correction of distracted or entrapped neurovascular bundles, severe fourth degree contractures and severe microstomia.

**Essential** procedures are such as burn scar contractures that do not respond to rehab and hypertrophic scarring and contractures that prevent a patient from eating bathing moving or performing everyday activities.

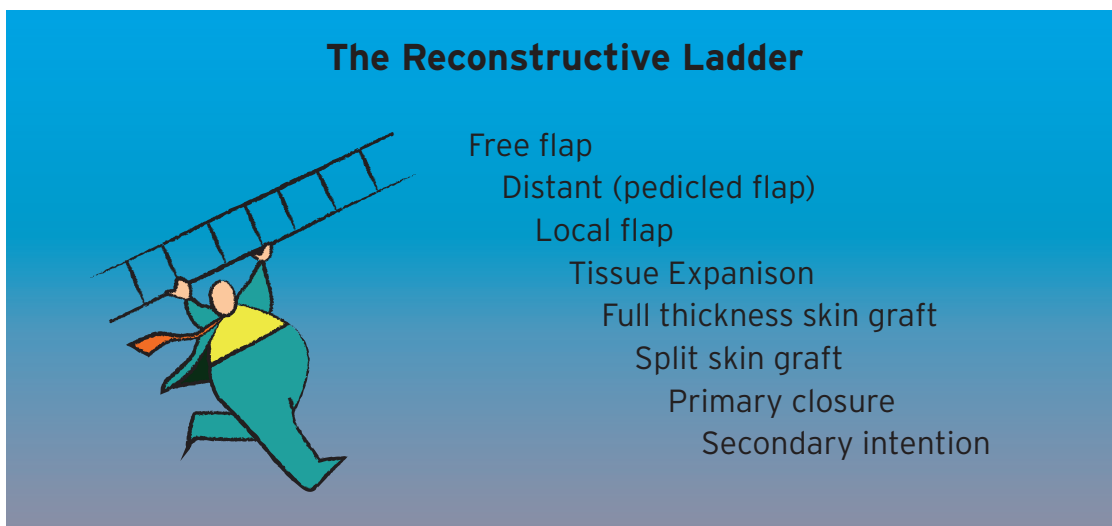
**Desirable** needs for recon are aesthetic problems and scars contractures that although not prominent produce great discomfort. For all desirable procedures it is good practice to wait until all red and immature scars have disappeared before starting any kind of surgery.

### The reconstructive ladder

When it comes to reconstruction, surgeons have what they call the reconstruction ladder which means to repair a defect they

first consider the simplest option (bottom of the ladder) and then move up the ladder as needed depending on the nature of the defect and what method will work best filling the defect with **the best functional and cosmetic result possible**. This will depend a lot on the size, depth and location of the defect.

It is important that you are familiar with each step of this ladder, and the implications that each has to a patients' rehabilitation. In situations of sudden onset disasters bear in mind that the patients you see with amputations, fractures and burns may well also have had some reconstructive surgery, and your treatment techniques will need to take this into account.



### Secondary intention

The skin edges of the wound are not sutured together; the wound is left "open." Dressings are applied regularly to either keep the wound clean or help clean it; the wound gradually closes and heals on its own. This is obviously the simplest and best option IF the wound is appropriate for regeneration and healing with a result that is acceptable cosmetically and functionally. If a wound is

left to heal by itself but ideally did require a surgical intervention than the final outcome may be poor. If a wound is healing by secondary intention (and is a wound appropriate for this method of healing) therapy is not affected unless pain is an issue or if the wound is on a weight bearing surface some walking aid may be beneficial while healing is taking place.



See the file '**Secondary intention**' in the reconstruction folder on the USB for more information

### Primary closure

This does not play much of a role in burn injuries but is more utilized with lacerations. It is important to realign tissue along the along lines of least minimum resting tension as tension on a scar has shown to increase HTS formation through stimulation of fibroblasts. Placing the scar if possible in natural lines makes the scar less noticeable.

The wound edges are sutured together to close the defect. Whenever possible and practical, primary closure is the best way to close an acute open wound. Advantages are that it heals quicker and has a better cosmetic outcome, and simplifies wound care for the patient, who simply needs to keep the suture line clean and dry (in disaster settings infection risk must be minimized at all costs).

The main reason primary closure would not be chosen is an unacceptably high risk of underlying infection, alongside continual oozing of blood from the wound or too much tension.

We covered '**Delayed primary closure**' in the amputation chapter. In sudden onset disaster situations, and particularly conflict injuries, this is a common closure method.

Debridement of necrotic tissue is vital ideally within 6 hours, foreign bodies that are visible are removed, healthy planes of tissue are not disrupted to find all foreign bodies. Once excised the area is irrigated thoroughly, left open without any suture

of skin or deep structures and covered by a bulky absorbent dressing made of dry fluffed-up gauze and held in place with loose crepe bandage. The aim is to avoid any tension/pressure in the tissues and to draw inflammatory fluid out of the wound, into the dressing. Some exceptions to delayed primary closure: wounds of face, neck, scalp, genitals and open chest wall injuries (muscular layer has to be airtight closed). This dressing should not be changed until formal closure. Limb wounds should be elevated to reduce oedema. Delayed primary closure is usually performed after 5 days when the surgeon is confident that all necrotic tissue is debrided and the area is clear of infection.

### Split skin grafting

Earlier in the burns chapter we have looked at the method of taking the graft and the reasons for it. In terms of securing the SSG it will either be sutured or stapled, glue is also available. Suture is best but staples can be applied more quickly, which may be necessary in larger burns. The graft may be secured by a tie over which is a very secured bulky dressing packed onto the surface of the SSG, to encourage take and offer some immobilization.

**!** Post-op a SSG should be immobilized especially if the SSG crosses the joint or is near a joint. With children this can be achieved by very thick dressings at the time of surgery. Other options are a POP slab applied in theatre by the surgeons or a therapist made splint.



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- ! There should be no movement (shear is particularly dangerous for a graft) of the grafted area for 4-5 days (this is standard but discuss with surgeon).
  - ! If a SSG is to the lower limb then in HIC mobilisation is often started early (at 48 hours if not before) - elastic bandages are applied to the lower limbs for support prior to mobilisation. In low resource settings it is generally advised to mobilise at day 5 but discuss with your surgeon.
  - ! Change of dressing is normally at 5 days post op. It is always useful to be present at the first change of dressing so you assess the state of the SSG and plan your treatment, in discussion with the surgeon.

### Full thickness skin grafting

A full thickness skin graft (FTSG) includes the epidermis and entire dermis but no subcutaneous fat. This procedure therefore removes any potential for the donor site to heal and therefore the donor site is usually directly closed with sutures (this means that the size of the FTSG is usually small - so that the defect can be closed). As with SSG's a FTSG cannot be used over avascular structures as unlike flaps SSG's and FTSG's do not carry their own blood supply but are dependent on a viable wound bed.

FTSG are more commonly used for reconstructive purposes rather than in acute care. However, in burns care if the eyelids are full thickness in injury FTSG may be performed in the acute stages. Common donor sites are behind the ear and from the groin. FTSG will contract less than SSG's and have a better cosmetic outcome, but like SSG's they can fail if the wound bed, surgical technique or follow up is not adequate (FTSG can have a higher rate of failure than SSGs). Unlike SSG's FTSG's are not meshed - this is part of the reason why they are more likely to fail than SSG's.

Follow similar post-op therapy as for SSG but unless the FTSG is directly over a joint such as in the hand there is less focus on immobilisation through splinting. Discuss post-op care with the surgeon (ideally prior to the procedure!). Location of the FTSG will be a significant variable determining post-op care; due to the smaller areas involved with FTSG compared to SSG (especially when covering joints) therapy input is usually less intense / crucial than with input for SSGs.



This **weblink** details full thickness skin grafts for nose reconstruction in a patient with skin cancer

### Tissue expansion



Tissue expansion can be used for burn reconstruction and also to increase a hair bearing area on the head if there is some burn alopecia. A balloon is put under the skin and periodically over time filled up with

saline through injection via a port in the balloon. This stretches the skin. It creates skin that matches the color, texture, and thickness of the surrounding tissue and is used to 'replace' the adjacent scarred area.



Please see the article on '**Burn reconstruction**' on the USB

### Flaps

Flaps are different from skin grafts in that they retain their own blood supply rather than rely on the blood supply of the recipient bed. Therefore if necessary certain flaps can cover avascular structures such as tendons. The simplest flap is the local flap and the most complex the free flap.

Flaps can be classified in a number of ways:

#### 1: By location:

**Local flaps** involve moving local (adjacent) tissue into a defect. Examples are

advancement flaps, rotation flaps and transposition flaps.

Various z-plastys are commonly used in burn reconstruction to release tension. Two triangular skin flaps are interchanged in position to gain length along a scar; the direction of the scar can also be changed to make it less visible.

**Regional flaps**, in contrast to local flaps, move tissue not immediately adjacent to the defect. The tissue is moved on an 'island' while keeping attached to its blood supply (a pedicle).

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**Distant flaps** are used when the donor site is far from the defect. These are the most complex class of flap. Direct or tubed flaps involve having the flap connected to both the donor and recipient sites simultaneously, forming a bridge. This allows blood to be supplied by the donor site while a new blood supply from the recipient site is

formed. Once this happens, the “bridge” can be disconnected from the donor site if necessary. A free flap has the blood supply cut and then reattached microscurgically to a new blood supply at the recipient site. This requires a high-powered microscope and is often beyond the facilities in many low resource settings.



A case study of a patient with complex '**open lower limb fractures receiving a free flap**' from latissimus dorsi can be read here and on the USB

## **2: The section of tissue that is used - single or multi components:**

**Cutaneous flaps** contain the full thickness of the skin and superficial fascia and are used to fill small defects.

**Fasciocutaneous flaps** add subcutaneous tissue and deep fascia, resulting in a more robust blood supply and ability to fill a larger defect.

**Musculocutaneous flaps** further add a layer of muscle to provide bulk that can fill a deeper defect.

**Muscle flaps** can provide bulk or functional muscle. If skin cover is needed, skin graft can be placed over it.

**Bone flaps** are used to replace bone, such as in jaw reconstruction.

## **3: The blood supply to the flap:**

**Axial flaps** are supplied by a named artery and vein which enters the base and runs along the axis. This allows for a larger area to be freed from surrounding and underlying tissue, leaving only a small pedicle containing the vessels.

**Random flaps** are simpler and have no named blood supply. They are supplied by generic vascular networks. This limits the dimensions of the flap that can be used (length / breadth ratio).

Within trauma surgery almost all flaps will be different in some way, and associated trauma will affect the rehabilitation afterwards, therefore it is *vital* that you discuss post-operative instructions with the surgeon.

Questions to consider what rehabilitation approach to take are tabled below (*adapted from Hale, O'Donovan, Diskin et al, 2013*):

Table 6.1: Questions to consider in the rehabilitation of reconstructive surgery	
What structures are being repaired?	Contractile vs. Non-contractile tissues Healing times for various tissues
Does the repair need to be immobilised?	Duration of daily immobilisation Mode of immobilisation: cast or removable splint Weight bearing status Position of immobilisation to unload the repaired structure vs. Sustained stretch of the repaired structure Elevation to minimise swelling Positioning a to encourage full ROM
When and how should mobilisation be introduced?	Strengthening: specific to the impaired structures and general to the limb/body ROM: passive and active Flexibility: of the soft tissues and scar Proprioception: to minimise risk of re-injury and return to higher level activity/sport Circulatory exercises (anti-DVT exercises) Mobility and balance Postural exercises Donor site (this is very important) Exercise prescription is continuous throughout the period of rehabilitation and must be regularly prescribed and revised
What does the patient need to be educated about?	Patient education is essential throughout the entire rehabilitation process to optimise patient outcomes. Education encompasses: <ul style="list-style-type: none"> <li>▀ Safety precautions to consider, e.g. ROM and weight bearing, return to previous function</li> <li>▀ What the rehabilitation process involves</li> </ul> Pain relief The clinical reasoning behind each component of the rehabilitation programme Wound care and hygiene Advice regarding return to normal activities Possible complications following repair, and what, if anything, needs to be monitored What the patient can do to aid rehabilitation, e.g. massage to scars, exposure of the scar area to different textures for altered sensation

Source: Adapted from Hale, O'Donovan, Diskin et al, (2013)

There are some general principles regarding post-operative care and rehabilitation following flap surgery:

! Areas that have been grafted or flapped should be elevated post op (not over elevated which can compromise circulation to the area).

! The area may be immobilised depending on the flap and area and underlying structures also repaired.

! Whereas minimizing friction and shear is still important, not disturbing *blood supply* is vitally important here. It is important therefore not to have tight dressings



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or put pressure around the flap, not to position the part in a way that may kink or overstretch the blood supply (both arterial and venous). A flap achieves 90% of its final circulation at 3-4 weeks. As well as preventing any infection the crucial thing is ensuring a good blood supply to and from the flap. This is less of an issue with local flaps but very important with distant and free flaps. The pedicle is the lifeline

for the newly placed flap and needs to be protected until the local blood supply or the pedicle blood supply is established - usually a 3-week period.

Flaps (more relevant to distant flaps) must be monitored very closely post operatively by the nursing and surgical teams. The box below shows what they are looking at.

- **Colour** - the flap should remain pink. Dusky blue = venous insufficiency, pale or white = arterial problem
- **Temperature** - the flap should remain warm. Cold = perfusion failure, too warm = infection
- **Texture** - it should feel soft, firmness can indicate haematoma
- **Blanching** - should be 1-3 seconds, more than 3 = poor arterial supply likely, less than 1 = congestion

### Core recommended texts

Both the core texts below are on the UKIETR USB resource.

1. Australian and New Zealand Burn Association (2007) Burn survivor rehabilitation; principles and guidelines for the allied health professional. ANZBA.
2. Burn therapy standards working group (2005) *Standards of physiotherapy and occupational therapy practice in the management of burn injured adults and children*. British Burn Association.

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## Acquired Brain Injury

This module was developed by Association of Chartered Physiotherapists in Neurology (ACPIN) members with a special interest in brain injury, working in collaboration with Handicap International.

The acquired brain injury chapter aims to provide an *overview* of how to provide acute rehabilitation for patients with brain injury in an austere, emergency situation, when working as part of a medical team. It is based on best available evidence in the UK, with consideration for particular challenges seen in a humanitarian environment.

### Introduction

The focus of the chapter will be on acquired brain injury (ABI) and therefore covers patients who have had a traumatic brain injury as well as those whose brain injury occurs from other circumstances (e.g. hypoxia). An acquired brain injury (ABI) is defined as:

*“Damage to the brain, which occurs after birth and is not related to a congenital or a degenerative disease. These impairments may be temporary or permanent and cause partial or functional disability or psychosocial maladjustment.”*

The term Traumatic brain injury (TBI) is used to specifically describe a brain injury that has occurred when a sudden trauma causes damage to the brain. This can be as a result

of the head suddenly and violently hitting an object, or when an object pierces the skull and enters brain tissue. (World Health Organization, 1996). As such, an acquired brain injury will include TBI, hypoxic brain injury, brain tumour, brain haemorrhage and inflammatory diseases of the brain, such as encephalitis. For the purpose of this chapter, the term ABI will be used in order to encompass all aspects of brain injury that may be found in a humanitarian setting. The term Stroke (or Cerebrovascular accident (CVA)) is often excluded from ABI in literature as it has its own specific guidelines. For the purposes of this manual, only where there is a clear distinction to be made will stroke management be discussed separately from ABI management otherwise ABI and stroke will be discussed together.

### ABI in sudden onset disasters

#### Learning outcome

To understand the aetiology and incidence of brain injury in a humanitarian situation.

There is often a lack of clarity around the presentation of brain injury patients in disasters, particularly in the data and available research, often with little differentiation made between head injury (such as simple lacerations) and brain injury. As a result, there is very limited useful data on the number or severity of brain injury following disasters, and almost no data on the long term outcomes of patients with brain injuries.

Traumatic Brain injuries can result from falling debris, such as in earthquakes, or falling or flying debris in wind storms. Hypoxic injuries may result from near drownings from Tsunamis or windstorms. Mild injuries may frequently be missed due to focus on other life threatening injuries and polytrauma, while in areas where rescue is slow and pre-hospital care poor, there is a low likelihood of severe traumatic brain injury cases surviving extraction/evacuation.

A review in the Lancet by Batels et al found that brain injuries were a leading cause of death in disasters. For example, 30% of people affected by the earthquake in Taiwan in 1999 reportedly died from head injuries. In survivors, scalp lacerations account for between 43% and 65% of head injuries, while 4% are concussions. Most earthquake-induced head injuries were mild (55%) or mild-to-moderate (85%) in severity, while skull fractures were seen in between 8% and 28% of people with head injuries. Basal skull fractures have a reported frequency of 11%. Because many injuries are minor, surgical intervention is not usually required.

Bhatti et al (2008) examined cases received in a major trauma centre following the Pakistan earthquake. Of significance, they had intensive care and ventilator capability and were a key referral centre. They found that delayed evacuation contributed to high number of deaths (only 35% of head injuries were received in first 72 hours). 8.5% of all patients received had head injuries, and the majority of wounds were contaminated. The overall mortality increased from 3.3% to 7% in one year follow-up.

Where health care systems are overwhelmed, rescue is difficult or there is limited access to ventilators, the low survival rates of severely injured patients is likely to be exacerbated. In addition, a lack of ventilators in low income countries, coupled with limited access to specialists, means that the quality of acute and after care for patients with severe injuries is likely to be limited. For example, in Indonesia there are 140 neurosurgeons for 250 Million people, while in the USA there are 3,500 neurosurgeons for 299million.

Disasters also disrupt existing health care systems, limiting access to medication and normal care for non-communicable diseases such as hypertension, while at the same time increasing stressors in populations. As a result, it is very likely that there will be an increase in CVAs following disasters (e.g. Mateen et al 2010).

While the purpose of this manual is to cover sudden onset disasters, it is worthy of note that those working in conflict situations may see a significantly higher number of ABI due to penetrating trauma and blast injury.

## Classification of ABI

### Learning outcomes

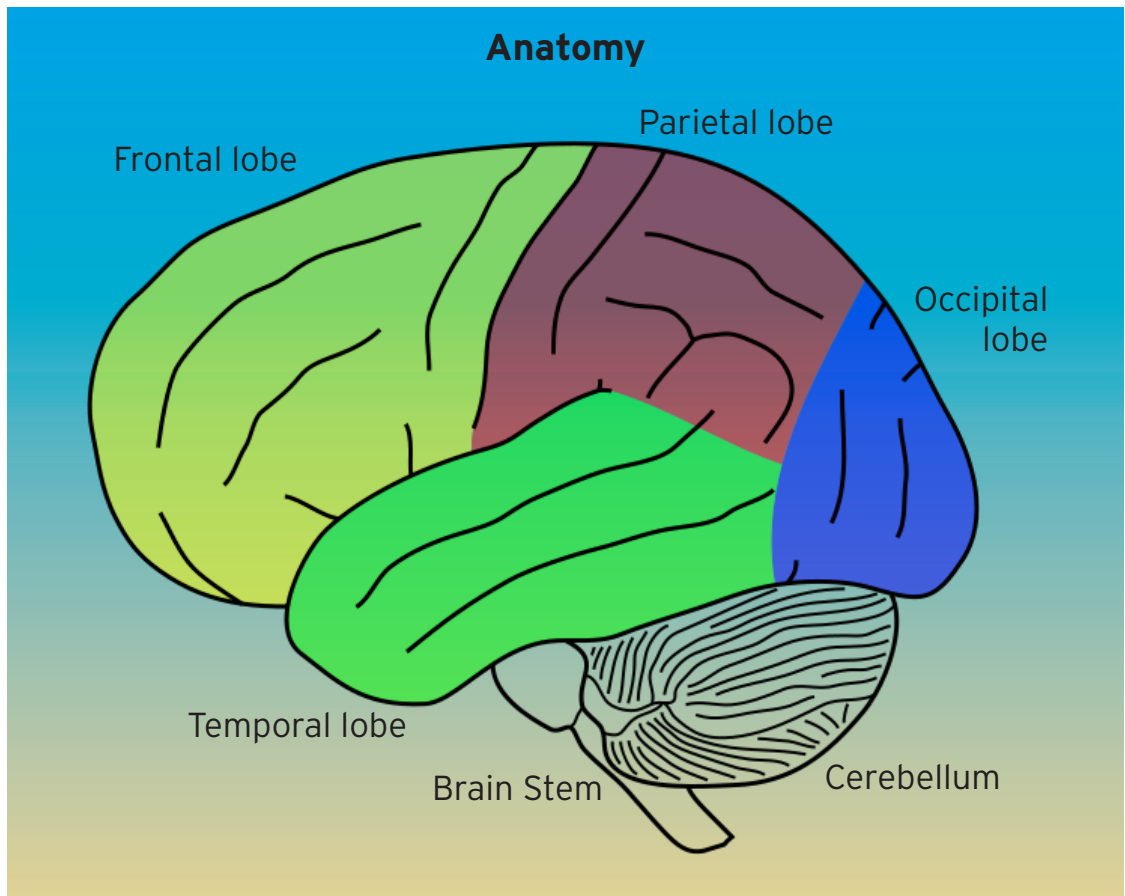
To understand the classification of ABI

To be able to identify a deteriorating patient and know what action to take

To be able to identify some possible differential diagnoses

## Acquired Brain Injury

### Recap of Anatomy



There are two cerebral hemispheres (right and left) of the brain. Each cerebral hemisphere is comprised of four lobes: frontal, temporal, parietal and occipital. The two cerebral hemispheres are separated by the great longitudinal fissure which contains the corpus callosum. The corpus callosum is made up of commissural fibres that connect corresponding regions of the two hemispheres.

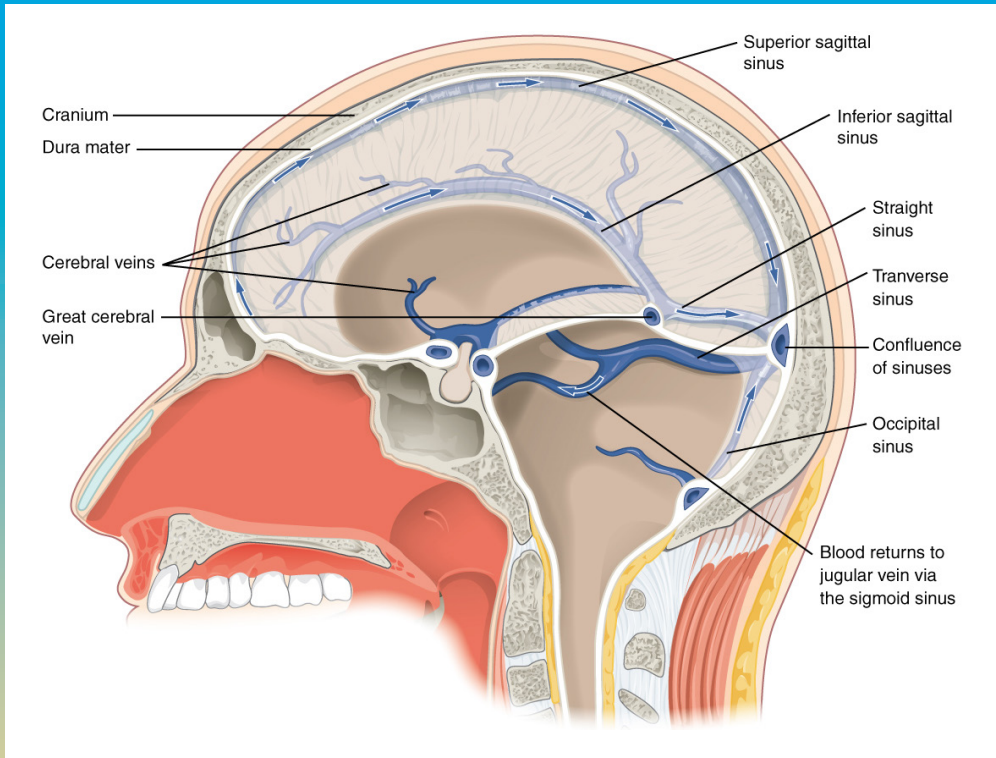
The brain also has the following other important structures: brain stem (comprised of the medulla oblongata, pons and midbrain); cerebellum and the ventricular system.

The ventricles are chambers within the brain that connect with the spinal cord. It is here where cerebrospinal fluid (CSF) is produced and circulates.

The brain and spinal cord are covered by a 3 layers of protective membranes, collectively called the meninges. These layers are: dura mater (the most external layer lying between the brain and skull); arachnoid mater (the middle layer), and the pia mater (the closet lining of the brain).



## Anatomy



These layers enclose capillaries and CSF and provide a cushion and protection to the delicate brain tissue.

The skull acts as a 'closed box' which exerts a normal pressure referred to as Intracranial Pressure (ICP). This ICP is normally finely controlled to ensure adequate brain tissue perfusion with oxygen and nutrients. Any insult to the brain tissue such as a bleed would disrupt this normal ICP, causing a rise in ICP. This rise results in the compromise of brain tissue perfusion and thus can cause further insult to brain tissue.

With a head injury of a traumatic nature you should always consider there may be an insult to the cervical spine. NICE guidelines recommend you consider the mechanism of injury and nature of neurological limb deficit or paraesthesia; and see how this may fit with a corresponding injury. For example, following the Haiti earthquake the patient

below, with a history of a closed head injury was referred to physiotherapy for massage due to a torticollis:



## Acquired Brain Injury

### Causes of Acquired Brain Injury (ABI)

### Acquired Brain Injury

<p><b>Traumatic caused by:</b></p> <ul style="list-style-type: none"><li>– Blow to head</li><li>– Blast to head</li><li>– Fall</li><li>– Crush injury</li><li>– RTC (non-humanitarian incidence accounts for 50% of HI)</li><li>– Assault</li></ul>	<p><b>Non- Traumatic:</b></p> <ul style="list-style-type: none"><li>– Stroke (haemorrhagic/ embolic)</li><li>– Hypoxia</li><li>– Encephalitis</li><li>– Cerebral malaria</li><li>– Meningitis</li><li>– Infection / Brain abscess</li><li>– Other less common tropical diseases can lead to symptoms similar to acquired brain injury</li></ul>
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In an area of Humanitarian crisis vehicle accidents (RTC's) may still occur. These may be pedestrian vs vehicle, vehicle vs vehicle, isolated vehicle incident (vehicle rolling, hitting object etc.).

### Head Injury and Classification

Head injury is defined as: "any trauma to the head, with or without injury to the brain". The description of a head injury is based on the symptoms after injury:

- Minimal: trauma to head, no LOC, no symptoms of HI
- Minor: GCS score 13-15 after HI
- Moderate: GCS 9-12
- Severe: GCS <9

### Traumatic Brain Injury (TBI)

Traumatic brain injury (TBI) describes a head injury where injury to the brain has occurred.

TBI classification is not well standardised and a number of methods are used to describe TBI:

- By severity
- By aetiology
- By area involved
- By injury progression
- Other

#### By severity:

- Mild / Minor: GCS 13-15 (mortality 0.1%)
- Moderate: GCS 9-12 (mortality 10%)
- Severe: GCS < 9 (mortality 40%)



### Glasgow Coma Scale

Best eye response (E)	Spontaneous - open with blinking at baseline	4
	Opens to verbal command, speech, or shout	3
	Opens to pain, not applied to face	2
	None	1
Best verbal response (V)	Oriented	5
	Confused conversation, but able to answer questions	4
	Inappropriate responses, words discernible	3
	Incomprehensible speech	2
	None	1
Best motor response (M)	Obeys commands for movement	6
	Purposeful movement to painful stimulus	5
	Withdraws from pain	4
	Abnormal (spastic) flexion, decorticate posture	3
	Extensor (rigid) response, decerebrate posture	2
	None	1

Best response: 15

Comatose patient: 8 or less

Totally unresponsive: 3

### Severity of TBI

	GCS	PTA	LOC
Mild	13-15	< 1 day	0-30 minutes
Moderate	9-12	> 1 to < 7 days	> 30 mins to < 24 hours
Severe	3-8	> 7 days	> 24 hours

#### By aetiology:

- Blunt: external mechanical force leads to rapid acceleration / deceleration with brain impact (e.g. RTC / falls / crush / assault)
- Penetrating: object pierces the skull and breaches the dura mater (lining of the brain) (e.g. gunshot / stab wounds)

#### By Area Involved:

- Diffuse includes: Diffuse Axonal Injury (DAI), diffuse cerebral oedema, diffuse vascular injury
- Focal includes specific lesions: contusion, intracranial haemorrhage (ICH), infarct, axonal shearing, cranial nerve avulsion, skull fracture, vascular dissection

## Acquired Brain Injury

### By Injury Progression

- Primary: due to immediate forces (occurs at time of injury, cannot be altered) e.g. skull fracture, contusion, haemorrhage, axonal shearing
- Secondary: due to evolving pathophysiological processes and their consequences, the multitude of neurobiological cascades that are altered or initiated at cellular level in response to the primary injury e.g. cerebral oedema, raised ICP, haemorrhage, seizure, ischaemia, infection

### Other:

Open: penetration to the brain / breach of the dura mater

Closed: no breach of dura mater / skull

Skull fractures may be open or closed. They most commonly involve the temporal,

occipital or base of skull due to the initial impact and / or transmission of forces through the skull.

Generally GCS is used as a measure of severity of Brain Injury at the time of incident but also any persisting change in GCS (SIGN guidelines).

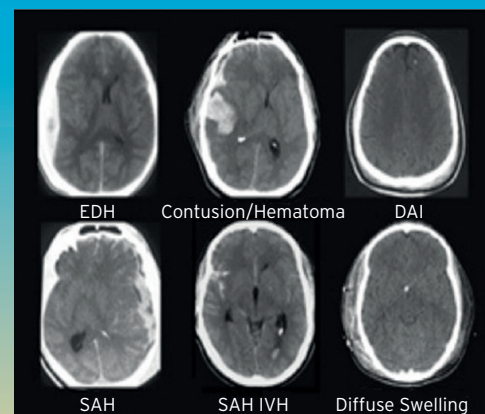
It is very unlikely that you will see patients in the severe category, as these patients will not survive. Usual levels of mortality for moderate TBI is 10%, this is likely to be much higher in humanitarian areas due to difficulty gaining access to specialist units.

Using LOC as a guide within your initial subjective assessment may be a useful indicator of potential deficits even if these are not immediately apparent.

### Types of injury and relevance

#### TBI: Types of Injury and relevance

- Skull fracture
  - Haematomas (EDH/SDH)
  - Haemorrhagic injury (SAH / intracerebral / contusions / IVH)
  - Diffuse Axonal Injury
  - Hypoxic / Anoxic / Cerebral oedema (diffuse swelling)
  - Blast / penetrating
- \* Concussion



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**Skull fracture:** A number of different types may occur: simple (small linear fracture, tend to be closed); compound (comprised of many pieces of bone, open or closed); depressed (fracture has indented so that the shape of the skull is lost).

Skull fractures may be: Open (more likely) or closed (only if dura is not breached). If open they be compromising the brain tissue underneath and causing contusion / haemorrhage and the fracture should be elevated if this is occurring.

Base of skull - may be associated with CSF leak from nose (rhinorrhoea) or ears (otorrhoea), and are of relevance due to incidence of infection that may occur sometime later, presenting either as meningitis or cerebral abscess

Skull fractures may be identified by extracranial bleeding, swelling and pain, obvious deformity, bruising (of significance for complex facial / BOS fractures are Raccoon/Panda eyes or Battles sign)

**Haematomas:** Haematoma lying above dura (extradural) or within the dura (subdural): Injury is caused by pressure effect on surrounding areas of an expanding haematoma, leading to ischaemia and structural deformity rather than direct damage to the brain parenchyma. Haemorrhagic injury can also lead to ischaemia / infarct.

Of note is that a patient with minor HI, particularly in the elderly, can present a few weeks later with a Chronic SDH which causes a slow onset of neurological deficit, as bleeding can continue to occur within the subdural space.

Haematoma within brain parenchyma: Haemorrhagic injury that occurs to the brain parenchyma directly by damage causing contusions (bleeding into / bruising of brain tissue), can be coup (same side of impact) or contre-coup (opposite side of impact).

Often contusions / haemorrhage are seen in frontal and temporal areas due to the brain being forced forwards against the skull vault and the bony prominences that make up the inner surface of the skull.

These result in swelling and ischaemia of the focal area of brain tissue, and as they enlarge may cause pressure effects on surrounding areas of the brain. Therefore subsequent neurological deficits may occur.

**Other Haemorrhagic injury:** Traumatic subarachnoid haemorrhage (SAH) is common, where there is bleeding within the sub-arachnoid space. Intraventricular haemorrhage (IVH) is bleeding into the ventricles. Both SAH and IVH can cause secondary hydrocephalus and is frequently associated with other injuries, and both can cause neurological deficit.

**Diffuse axonal injury:** disruption of axons (shearing of white matter) usually caused by acute deceleration injury (RTC). Commonly associated with more severe TBI, and significant neurological deficit.

**Hypoxic injury / Anoxia:** Hypoxia (reduced oxygen levels to the brain) caused by inadequate respiration / ventilation possibly as a result of reducing conscious level or other severe injuries to the thorax

**Cerebral oedema:** a secondary injury, related to hypoxia, increased CO<sub>2</sub>, and the secondary pathological processes that occur following primary brain injury

### Concussion / Mild TBI

A term used interchangeably with mild TBI and minimal / minor head injury. There is no consensus regarding a definition. There appears to be general agreement that mild TBI / concussion is due to a blunt or mechanical force that results in some type of transient confusion, disorientation or loss of consciousness lasting not more than 30 minutes, and possibly associated with transient neurobehavioural deficits and a GCS no worse than 13-15.

## Acquired Brain Injury

It is likely that the majority of patients who suffer TBI have minor TBI / concussion but will not require admission.

Mild TBI can be described as 1 or more of the following:

- any loss of consciousness up to 30 min
- any loss of memory for events immediately before or after the accident for as much as 24 h
- any alteration of mental state at the time of the accident (eg, feeling dazed, disoriented, or confused)

OR:

- focal neurologic deficits that might or might not be transient, but where the severity of the injury does not exceed loss of consciousness exceeding 30 min
- posttraumatic amnesia longer than 24 h
- a Glasgow Coma Scale score falling below 13 after 30 min.

Even with a mild brain injury, there is still an interruption in the physiology of the brain and this can lead to a number of symptoms.

### Signs and Symptoms of Mild TBI

- Headache
- Sleep disturbance
- Disorientation
- Dizzy/nauseous
- Fatigue
- Irritability
- Altered mood
- Difficulty concentrating
- Difficulty remembering



Symptoms of a mild TBI can be physical, behavioural, emotional or cognitive and may be missed in patients with other significant traumatic injuries (such as crush / limb fractures)

Persistent symptoms following mild TBI might occur in 10% to 15% of patients and can include post-traumatic headache, sleep disturbance, disorders of balance, cognitive impairments, fatigue, and mood disorders.

Although these symptoms should resolve, persistent post-concussive symptoms can

result in functional disability, stress, time away from work / school and reduced quality of life (Marshall et al, 2012). This can be exacerbated by the patient attempting to return to "normal" too quickly, which often results in the symptoms worsening.

It is important that all patients suspected of having a head injury undergo an assessment in order that these potential symptoms can be highlighted to the patient and their families and management strategies commenced as early as possible where necessary.

It is also important that the patient and their family are provided with information, advice and reassurance at the time of their brain injury, as unless they have other injuries requiring medical management they will be discharged.

As some of the symptoms of mild TBI are associated with stress, people who are caught in a humanitarian crisis could be misdiagnosed as having a stress response to the event and their mild head injury is missed. This is where your observational

skills will be necessary. Don't dismiss someone as medically well if they are distressed but appear uninjured. Look at their face, is there any bruising? This could be a sign of an underlying head injury, particularly those with black eyes (panda eyes) who could have a simple broken nose or a more serious fractured base of skull.

Do they have any wounds to the head or, if they will allow you to feel, can you feel any lumps or bumps? Again, these could be signs of an underlying head injury.

### **Signs and Symptoms of TBI of concern Deteriorating: Mild / Moderate / Severe**

- Increased drowsiness (feeling sleepy for >1hr when normally would be awake)
- GCS: Sustained drop of GCS / drop of 3 points / GCS < 13
- Altered respiratory pattern / signs of aspiration
- Problems with eyesight / double vision / photophobia / nystagmus
- Deteriorating unremitting/ headache significantly worse in mornings
- Vomiting (being sick)
- Seizures (also known as convulsions or fits)
- CSF leak / sign of infection
- Double incontinence
- Onset / worsening of neurological deficit:
- Weakness of one or more limbs (pronator drift)
- Communication problems (difficulty with speech or comprehension)
- Behavioural / cognitive changes
- Changes in size / reactivity of pupils , failure of upward gaze
- Changes in CVS / Respiratory status: HR / BP / RR
- Loss of balance / co-ordination, or problems walking



Patient information leaflets are included for those with concussion and mild to moderate ABI.

## Acquired Brain Injury

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### Deterioration following TBI

Anyone with a mild head injury is at risk of deterioration as the brain starts to swell. Signs and symptoms that indicate deterioration in their condition include:

- unconsciousness, or lack of full consciousness (e.g. having difficulty keeping eyes open)
- drowsiness (feeling sleepy) that goes on for longer than 1 hour when they would normally be wide awake
- problems understanding or speaking
- loss of balance or difficulty walking
- weakness in one or more limb
- problems with eyesight
- painful headaches that won't go away
- vomiting
- seizures (also known as convulsions / fits)
- clear fluid coming out of the ear / nose
- bleeding from one or both ears

The onset of any of these symptoms should be treated with concern, and necessitate discussion / review by a medical member of the team.

Therefore, following a mild TBI the family need to be provided with information about signs to look out for that indicates a patient is showing early signs of deterioration of their brain injury. They also need information on their longer term strategies to overcome the effects of a mild TBI.

In the UK, all A&E departments or GP practices will hand out a head injury alert card for signs and symptoms to look out for following a mild brain injury. A leaflet based on these has been developed for the UKIETR. If any of the symptoms occur, the advice is to seek medical assistance immediately (e.g. NICE 2014).

As well as observing for signs of deterioration, the patient is also advised: not to be alone in the first few days (NICE, 2014); to make sure they have a phone / a method available to contact medical help quickly; they have plenty of rest and avoid stressful situations; not to take alcohol or social drugs; not to take any medication that has not been prescribed (especially sleeping pills / sedatives / tranquillisers).

In a humanitarian crisis where the patient may be separated from family or friends, it is important to consider where they can be looked after that doesn't mean that they are using an acute bed that a more seriously injured patient needs, but they are still safe.

It is best practise for someone who has suffered a mild TBI to be followed up by a specialist (in the UK it is usually a specialist head injury nurse), at one week post injury. These are used to review symptoms, identify ongoing problems and initiate referrals to appropriate services (often neuropsychology). Access to such specialist services is unlikely to be available in a Humanitarian situation, and therefore the team will need to decide how to / who requires follow up.

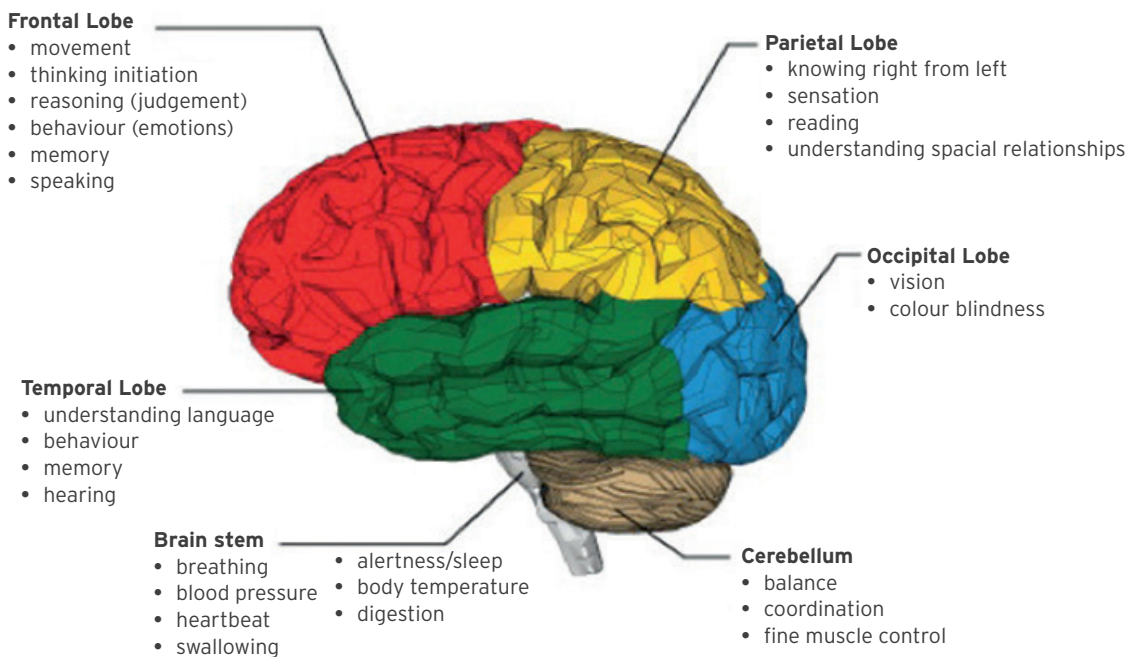
### Functional Anatomy

To assist your assessment, identification of problems and clinical reasoning it is useful to understand basic functional neuroanatomy as specific areas of the brain control and regulate specific functions (physical and cognitive).





The diagram below summarises these areas, and their related functions:



### Non Traumatic ABI

Working outside of your normal work environment, it is helpful to be aware of some common differential diagnosis seen more commonly in low and middle income countries that can cause symptoms similar to TBI.

### Stroke

Commonly there is an increased incidence of stroke in the weeks following Humanitarian disaster.

Stroke: classified as a rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin (WHO)

Causes of stroke:

- Cerebral infarction due to occlusion of vessels
- Intracerebral haemorrhage (non-traumatic, usually hypertensive, can be due to vascular malformation such as AVM)
- Sub-arachnoid haemorrhage (non-traumatic, usually caused by aneurysm, but also AVM, intracranial artery dissection, vasculitis, moyamoya\*,

bleeding disorder and substance abuse). Ischaemia appears to be related to the vasoconstriction of vessels surrounding the focal area affected.

- Central venous thrombosis (CVT). Occlusion of the intracranial venous sinuses, deep venous system and cortical veins that drain into the major intracranial sinuses leading to ischaemia, infarction, raised intracranial pressure and secondary haemorrhage
- \*moyamoya: rare progressive cerebrovascular disorder caused by blocked arteries at the base of the brain in the basal ganglia. Often presents in children with stroke or recurrent TIA's. Less commonly occurs in adults who most often present with haemorrhagic stroke. Seizures may also occur. Mainly in USA, Europe, Australia and Africa, may be genetic links.

Also to consider is the onset of TIA's. (no agreed definition): transient episodes neurological dysfunction caused by focal brain (spinal cord) or retinal ischaemia, with clinical symptoms typically lasting less than one hour (although some definitions include up to 24 hours), and without evidence of acute infarction, of vascular origin, leaving no residual neurological deficit.

The signs and symptoms of stroke are as follows in the diagram below:

### Signs and Symptoms of Stroke

<p><b>Non haemorrhagic</b></p> <ul style="list-style-type: none"><li>– FAST:<ul style="list-style-type: none"><li>Facial weakness</li><li>Arms</li><li>Speech</li><li>(Time) / time since onset</li></ul></li><li>– Weakness of one side of body</li><li>– Blurred vision / loss of sight</li><li>– Confusion</li><li>– Dizziness / unsteadiness</li><li>– Headache</li><li>– Swallowing problems</li><li>– LOC</li></ul>	<p><b>Haemorrhagic</b></p> <p>As non haemorrhagic but also:</p> <ul style="list-style-type: none"><li>– characterised by sudden onset of severe persistent headache</li><li>– vomiting</li><li>– LOC</li><li>– Stiff neck</li><li>– Irritability</li><li>– Poor memory</li><li>– Fluctuating neurological deficit</li></ul>
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Of relevance for your assessment are the following:

Time: Time since onset may be relevant in humanitarian settings as the patient may have travelled a distance before receiving medical attention. Also relevant to time and the differential diagnosis is:

- the order of onset of the symptoms
- since the onset of symptoms have these remained constant, or have they progressed, or are they fluctuating?
- Is the level of consciousness remaining the same, or does it fluctuate, or is it worsening?
- Were there are any signs of TIA

previously?

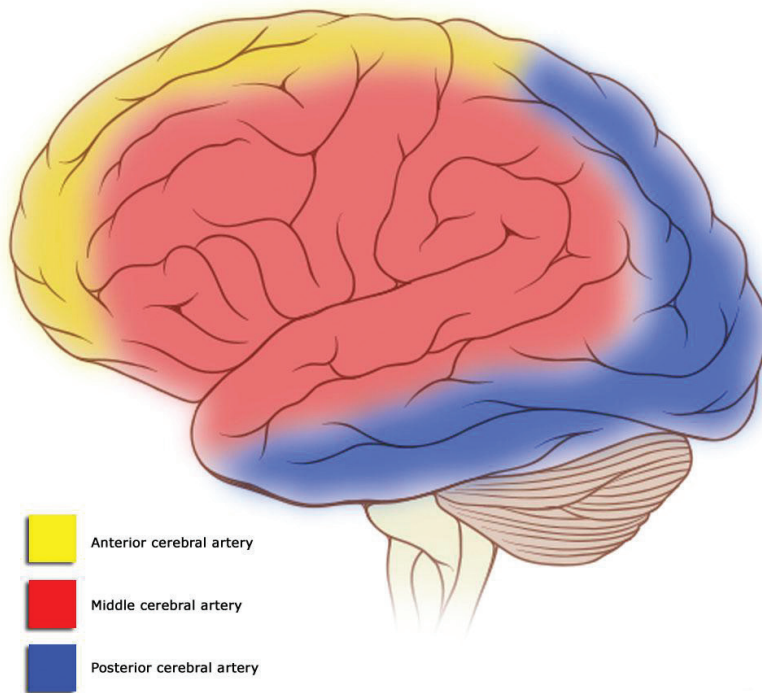
- Was headache sudden worst headache ever (SAH often described as if hit on the back of the head)
- Is headache remaining constant or increasing?
- Is headache worse in the morning?

#### **Vascular functional anatomy relevant to Stroke**

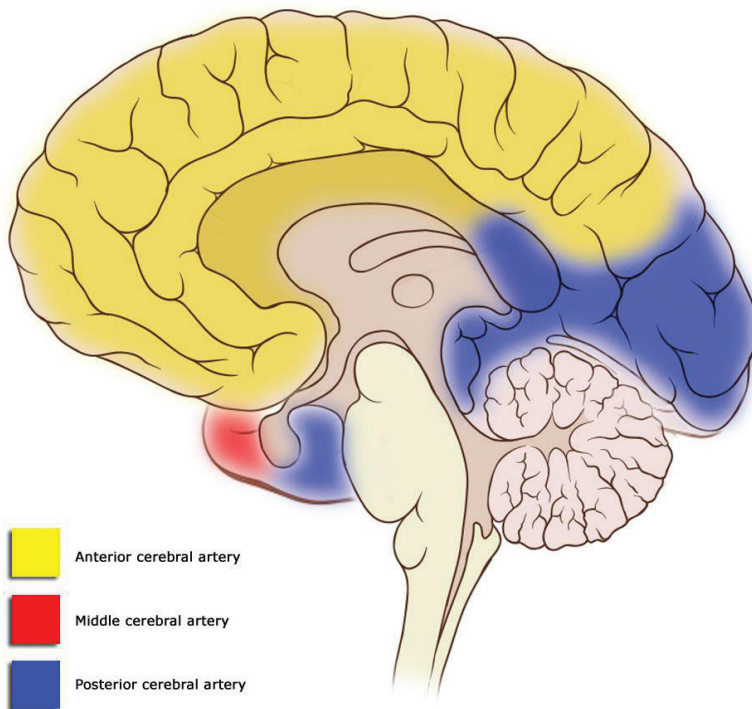
As Stroke is commonly related to the vascular circulation a brief overview of the functional impact of certain vessels may be useful (especially when considering signs and symptoms when predicting outcome).



Cortical vascular territories



Cortical vascular territories



**Middle Cerebral Artery (MCA)**

The middle cerebral artery is the largest cerebral artery and is also the vessel most commonly involved in stroke. Strokes involving the middle cerebral circulation tend to result in major / diverse deficits as it supplies most of the outer convex brain

surface, nearly all the basal ganglia and the posterior and anterior internal capsules. Specific functions, related to the affected areas of the brain, by the loss of circulation from the MCA include:

## Acquired Brain Injury

- Frontal lobes: Insight / Mood / Judgement / Motor synchronisation: eyes / Motor initiation of Face, Arm, Trunk and Hip / Speech production (Brocas area)
- Parietal Lobes: Understanding / Symbolism / Writing and names
- Temporal Lobes: Hearing / Speech recognition and comprehension (Wernickes area) / Orientation / Naming
- Insular cortex: autonomic function and taste

### **Anterior Circulation / Anterior Cerebral Artery (ACA):**

Specific functions, related to the affected areas of the brain, by the loss of the anterior circulation to the brain include:

- Frontal Lobes: Insight / Mood / Judgement / Motor synchronisation / Motor activity of Leg, Pericollosal area: Memory and emotion
- Parietal Lobes: Sensory interpretation

### **Posterior Cerebral Artery (PCA):**

Specific functions, related to the affected areas of the brain, by the loss of the anterior circulation to the brain include:

- Parieto-occipital: Sensory / Emotion and memory
- Occipital: Involvement in eye functions and seeing / visual comprehension
- Temporal: smell / naming

### **Posterior Inferior Cerebellar Artery (PICA) / Vertebral artery:**

Specific functions, related to the affected areas of the brain, by the loss of the anterior circulation to the brain include:

- Cerebellum: Balance and co-ordination
- Brainstem: regulation of CVS / swallowing / motor function of face (cranial nerves) / Horners syndrome (constricted pupil, ptosis, decreased sweating on affected side of face) / ipsilateral trunk weakness

### **Other Non-Traumatic ABI's**

The following conditions should also be considered in Humanitarian situations, as they may also cause similar signs and symptoms as TBI, sllthough will require very different medical management.

## Other Non-Traumatic ABI's

Depending on the location of a humanitarian incident other relevant local medical conditions may need consideration:

- Cerebral malaria (*Plasmodium falciparum*)
- Meningitis (TB meningitis)
- Encephalitis (Japanese B)
- SSPE (sub acute sclerosing pan encephalitis)
- Brain abscess
- Weils disease
- Other less common tropical diseases can lead to symptoms similar to ABI



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The most common are described below:

**Cerebral malaria:**

There are 3 strains of malaria: Faciparum, Vivax and Malariae.

Cerebral malaria is a complication of the infection Plasmodium falciparum (and not the other strains). It is only found in areas where malaria is endemic and is most common in children. It is part of a multi-organ disease. Little is known about the actual pathogenesis.

It is most common in children and leads to reduced consciousness, vomiting and behaviour change along with the high fever associated with malaria. If treated with anti-malarials then the symptoms are reversible, but if the malaria is left untreated then permanent brain damage is possible.

**Meningitis: bacterial (worse type) or viral**

The presentation of meningitis is similar to cerebral malaria and other forms of acquired brain injury (reduced consciousness, vomiting, increased tone, seizures, paralysis, cognitive and behavioural change) but, unlike stroke or TBI, will be associated with high fever and photosensitivity.

TB meningitis should be suspected if the patient has had contact with TB and has a history of night fevers, cough and weight loss - it will also not respond as well to standard antibiotic or antiviral treatment - TB treatment is required. Again swift diagnosis and treatment will reduce the possibility of lasting brain damage

**Encephalitis:**

Japanese encephalitis may be common in humanitarian areas, and is spread by mosquito bites.

Commonly symptoms start with flu like symptoms with high fever, headache, nausea, vomiting, and joint pain. This is

followed by the onset of some / all of the following: confusion, disorientation, seizures, LOC, photophobia, inability to speak, inability to initiate movement, stiff neck, hallucinations, loss of vision, involuntary eye movements, rash (which may be specific to the virus (herpes simplex virus causes characteristic blisters on the skin, around eyes and in the mouth)

As this is usually viral in nature, treatment is more difficult. Again if a fever is present then encephalitis should be on your differential diagnosis list.

**SSPE:**

SSPE is caused by the measles virus, and there is commonly a long time period between the occurrence of measles and the onset of SSPE. Initially symptoms may include mild mental deterioration such as memory loss and changes in behaviour (irritability), followed by: disturbances in motor function; myoclonus (involuntary jerking movements of head; trunk of limbs); and seizures. There is a progression to the loss of ability to walk due to spasticity / spasms, blindness may occur and eventually there is a progression to coma, Persistent Vegetative State (PVS) and death (1 - 3 years prognosis).

**Brain abscess:**

A brain abscess is a local collection of infected material from either a local (usually ear, nose, tooth - linked to poor dental hygiene), remote, or direct (secondary to infected skull fracture / following cranial surgery) source of infection

Presentation is similar to meningitis and encephalitis and often escalates over a period of 2-4 weeks, with fever, headache, vomiting and neurological symptoms. Treatment is with antibiotics (IV) if the source is bacterial. However abscesses can be caused by parasites, protozoa and fungi.

### Other pre-existing Neurological Diagnoses

#### Other Non-ABI Neurological Conditions to consider

- Functional CNS disorders / response to shock
- Cerebral palsy
- Spina bifida
- Guillain Barre Syndrome (GBS) / Myaesthesia Gravis type syndromes
- Other central and peripheral neuropathies (which may be related to nutrition, diabetes or excess alcohol)
- Polio / post polio
- Mental Health Conditions
- PD / MS / MND / previous ABI
- Brain tumour
- All the other rare and amazing neurological conditions

There are many other diagnosis that lead to lasting neurological impairment. It is worth being aware of these diagnoses as those people with pre-existing neurological conditions may be more vulnerable in a situation requiring humanitarian assistance.

A list of possible diagnoses includes: Functional CNS disorders / response to shock; cerebral palsy; spina bifida; Guillain Barre syndrome; Myaesthesia Gravis; other central and peripheral neuropathies (which may be related to nutrition, diabetes or excess alcohol); polio / post-polio syndrome; mental health conditions; PD; MS; MND; previous ABI..., plus an endless list of other diagnoses

It is important to consider / be aware of the signs and symptoms you may see with these conditions.

- Functional: may present as a stroke, but history or presentation may not appear consistent, and recovery may occur spontaneously as shock resolves
- Cerebral palsy: brain injury sustained under the age of 5 - a days training in itself!
- Spina bifida: congenital abnormality of the spine associated with hydrocephalus and spinal cord injury. Treatment is required at birth to correct the defect and prevent infection. But if corrected people can survive but often have disability usually affecting lower limbs, bladder and bowel function
- GBS: ascending weakness usually starting at peripheries progressing more centrally, that usually resolves but can require respiratory support if severe enough. Often happens in clusters and may be related to the exposure to certain viruses. Diagnosis is often difficult in countries without good access to biochemistry and haematology so is often diagnosed from clinical features (as are most of these conditions!)
- MG: think central weakness (respiratory and swallowing) to periphery
- Neuropathies: Nutritional related central and peripheral neuropathies can be



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related to excess alcohol but also lack of Vitamin B12 in the diet. Signs include ataxia, peripheral weakness characterised by foot drop / loss of hand dexterity and strength and sensory loss

- Polio: peripheral neurological weakness following exposure to the polio virus, now rare as new onset but may find patients post-polio.
- Mental Health Conditions: Following a sudden onset disaster people may present with behavioural changes, mood changes

or cognitive problems – be aware this could be a pre-existing mental health problem, a newly acquired brain injury or an acute (and common) psychological stress response to the situation they are in.

PD/MS/MND/ABI - People in a sudden onset disaster or humanitarian crisis may well be suffering with these long term progressive conditions already. Therefore evaluation of any recent alteration / recent deterioration may be required.

### Medical Management of ABI

#### Learning Outcome

To understand potential medical and surgical management of ABI in disasters

### Medical Investigations

- In the UK the gold standard for a patient with suspected TBI or stroke is a CT Scan of the brain, initially, within 30 mins of admission. If required admission to a neuro-surgery / hyper acute stroke unit, and initiation of interventions should occur within 4 hours of injury. In a disaster setting this is unlikely to be possible!
- In the field, x-ray can help identify skull fractures and clear the Cx spine.
- Close monitoring of the CVS and regular neurological observations are critical (GCS and limb function).
- Blood tests where available may be useful to monitor infection markers, sodium/potassium levels, and malaria testing

Monitoring of levels of sodium and potassium following TBI is important as these commonly can be deranged due to pituitary / endocrine dysfunction. Symptoms can include Diabetes Insipidus (DI) (diabetic type S/S with high urine output (which is dilute), and thirst.

Sodium and potassium levels may also become either excessively high / low. This can cause cardiac arrhythmias, confusion,

loss of consciousness or muscle tremors / fasciculation and weakness. In severe cases which are uncorrected this can lead to death.

Other results of importance are Hb (anaemia may affect levels of fatigue), and other trace elements such as magnesium and selenium which are becoming increasingly recognised as important for neuroprotection post-injury and for normal CNS function.

## Acquired Brain Injury

### Surgical Management

In the trauma field hospital setting, there is unlikely to be neurosurgery specialty, although Burr hole procedures may be possible in a field hospital setting with a surgeon with the right experience. Normally however, acute ABI patients should be

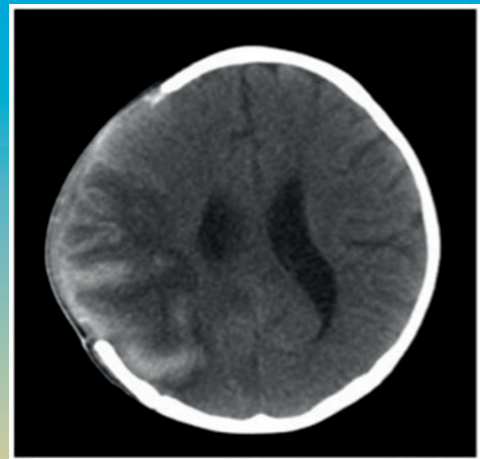
triaged appropriately or transferred to a local facility or to a specialist (type 3) field hospital. As rehabilitation professionals may still come across patients who have received more complex interventions, they should therefore still be familiar with the following:

### Non-specialised Neurosurgical management

- Burr Hole
- Craniotomy
- Decompressive craniectomy

What you are unlikely to see:

- ICP bolt
- External Ventricular Drain
- Shunt
- Ventriculostomy
- Clipping or coiling of aneurysm



Burr Holes - used for drainage of CSDH / as emergency evacuation of SDH / EDH: 2 holes drilled into the skull and haematoma is evacuated by irrigation through the holes

Craniotomy - opening made to allow for removal or evacuation of any space occupying clot/lesion. The bone flap is then replaced.

Decompressive craniectomy - section of skull is removed to reduce pressure in the skull and thus reduce ICP. This is not replaced immediately and allows an extended time period for raised ICP to resolve.

In the UK it would be replaced at later stage by a titanium plate that has been specifically manufactured. In other areas of the world

the piece of skull that has been removed maybe frozen, or can be stored into the abdomen wall (maximum of 40 days), so that it can be retrieved and used in the future to cover the defect. In many cases in humanitarian settings the skull defect will not be repaired. This puts the unprotected brain under the skin at risk of further injury. In the UK patients are provided with a protective hat / baseball cap / helmet.

There is Level 1 evidence that in adults, standard trauma craniectomy is more effective than limited craniectomy in lowering elevated ICP and leading to better outcomes at 6 months. There is Level 1 evidence that in children, decompressive craniectomy reduces elevated ICP but does not significantly improve clinical outcomes post-ABI.



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There is Level 3 evidence that resection of a larger bone flap results in greater decreases in ICP reduction after craniectomy, better patient outcomes and leads to fewer post-surgical complications.

You may rarely see “salvage” bifrontal craniectomies.

You are unlikely to see the following as these are specialist interventions, but it is still useful to have a basic understanding:

ICP bolt: device which monitors ICP via a burr hole into the subdural space. Normal 7-15mmHg in supine.

External Ventricular Drain (EVD): enables temporary external drainage of CSF thus can reduce ICP, divert infectious or blood stained CSF. Specific instructions will be present: for the level the EVD is positioned at, above or below, the zero point (usually the external auditory meatus) the time periods it will be draining / closed. During any respiratory treatments, position change or mobility practice you must follow specific restrictions given.

There is Level 1 evidence that cerebrospinal fluid drainage decreases intracranial pressure in the short term.

\*If a patient has had an LP for CSF removal there may be a period of bed rest recommended immediately following (usually up to 4 hours). This is usually to reduce the onset of low pressure headache caused by the ICP change. However in cases of raised ICP removing CSF will reduce pressure, and headache may resolve so earlier mobilisation may be allowed.

Longer term management of hydrocephalus:

1) Shunt; long term internalised drainage method of CSF. Not often considered in acute early stages.

2) Ventriculostomy; small drainage hole placed within the third ventricle, acts as a secondary drainage or diversion for CSF around any blockage.

Clipping or coiling of aneurysm: Method to block off an aneurysm in order to reduce potential risk or further bleeding or rupture of the aneurysm

### Medical Management

During the initial stages of any brain injury, the primary injury to the CNS is irreversible. However the brain remains extremely vulnerable to secondary complications, most of which will result in ischaemia, which may / may not be reversible.

TBI and stroke can result in raised Intracranial Pressure (ICP). High intracranial pressure is one of the most frequent causes of death and disability following severe head injury. It is defined as an ICP reading greater than 20 mmHg within any intracranial space (subdural, intraventricular, extradural, or intraparenchymal compartments) (Sahuquillo & Arkan, 2006).

An uncontrolled increase in intracranial pressure results in: compression / shift of brain tissue, compromise of vascular and CSF circulation and ultimately ischaemia and infarction. In the worst case this leads to “coning” where the pressure causes the brain to herniate downwards through the foramen magnum causing brainstem death.

There is a relationship between ICP and Cerebral Perfusion Pressure. Cerebral perfusion pressure is the net pressure gradient causing adequate cerebral blood flow to the brain. Normal CPP is 70-90 mmHg, and must be >70mmHg in adults and > 60mmHg in children to prevent ischaemia

In the humanitarian environment changes in ICP and CPP can be monitored through neurological observation: specifically GCS, pupil size / reaction to light, and motor deficits.

## Acquired Brain Injury

The medical management in the field hospitals will be supportive, and should aim to reflect / follow appropriate guidelines where they exist, for example NICE guidelines for Stroke / TBI, as far as possible within the limitations of the environment and available medical specialties.

Overall Aims of medical management:

- To identify if a patient requires transfer to a specialist unit if one is available and arrange as appropriate / possible
- Determine prognosis (will medical care be supportive, palliative, rehabilitative)
- To maintain / stabilise neurological status
- Prevention of neurological deterioration / maintenance of neurological status

### Medical Management

The aim of any ABI management is to minimise the damage arising from secondary complications. Optimal management in a field hospital environment involves:

- Control of cerebral perfusion (For TBI:  $CPP = MAP - ICP$ )\*
- Oxygenation
- Temperature regulation
- Hydration and nutrition
- Prevention of infection
- Optimise Positioning if raised ICP is suspected- head up 30-60 degrees (If cleared cervical spine).
- Reduce stress / agitation (pain)

Prevention of neurological deterioration and maintenance of the neurological status is achieved by ensuring an environment maintaining homeostasis in the following ways:

Management of Blood Pressure: management regime will depend on diagnosis and either a set figure for MAP may be used (90mmHg), or a target "range" for systolic pressure (>180mmHg)

Fluid management: to maintain hydration and yet ensure excessive hydration is prevented (maintenance of neutral fluid balance)

Nutrition may be difficult to achieve effectively. Following ABI there is a significant increase in metabolic rate due to autonomic dysfunction, and the increased need for energy to assist the brain to recover. Metabolism may increase by over 100%. There will be difficulty optimising



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nutritional intake if there are swallowing deficits. Ng tubes may be available, however specialist feeds are unlikely therefore you may need to be inventive in how foods are turned into liquids.

Positioning: 30° - 60° degrees head up (to optimise cerebral circulation and perfusion)

Maintenance of adequate oxygenation: the ideal range is SaO<sub>2</sub> > 95% (in the UK PaO<sub>2</sub> should be > 12)

Maintenance of temperature within a normal range

Maintenance of blood glucose concentration between 4-11mmol/litre

Prevention of secondary complications: infection - swallowing, early mobilisation\* post-stroke; pressure area damage - early / appropriate mobilisation

Treatment of infection: might include debridement of wounds

Use of medication: particularly for pain, seizures, temperature, blood pressure management, antibiotics, sedation in situations where a patient's behaviour is putting them / others at risk

\*Mobilisation:

Some types of ABI may require a more conservative approach to mobilisation for example non-traumatic / spontaneous SAH due to: potential for re-bleeding (most likely day 0-1, following this significant risk continues, although reduces gradually with time. By 4 weeks chance of re-bleed is 3%). Vasospasm is most likely to occur between days 5-21

Therefore an initial period of bed rest may be advised for 7 - 10 (possibly up to 21) days, followed by a structured and gradual progression in mobility while monitoring neurological status.

## Rehabilitation Assessment

### Learning outcome

To be aware of specific rehabilitation assessment considerations for patients with ABI.

Just as in the UK, you are only expected to work to your level of expertise, knowledge and competence. The following is a guideline to remind you of some of the basic assessments and problems that you may identify.

If an assessment is needed that you are not competent to complete, ask and see if

there is anyone else available / who will be available in the future to complete it.

One of the first steps may also be to evaluate where else there may be neuro rehabilitation facilities / specialists, or to identify they don't and may not exist for some time.

### Assessment: Database - key factors

- HPC :
  - How long ago, mechanism / onset of symptoms
  - Other relevant history: progression of symptoms / deterioration, morning headaches, vomiting, photophobia or seizures,
- PMH :
  - any previous major illnesses or surgery
  - any current illness/surgery
- DH :
  - on any CVS or diabetic medications?
- SH: includes relevant cultural information
  - Previous lifestyle: family role (where are other members of family now), work/ education, daily routine, drug or alcohol use, level of independence, language and literacy, home environment/ location (check if still able to return)

The assessment of a patient in a humanitarian crisis where possible should still be the same as the assessment you would complete in the UK and include:

- HPC - mechanism of injury can potentially help ascertain area of brain damage, for example an obvious blow to the side of the head would indicate likely temporo-parietal lobe damage; a high speed injury (eg RTC) can result in a diffuse axonal injury which leads to more non-specific impairment; a cardiac arrest or history involving someone being trapped for any length of time could lead to a hypoxic brain injury, again this has a less defined pattern to it. Knowing the nature of the injury can go some way to predicting rehab potential.

- PMH - as with all major trauma, premorbid status will affect rehab outcome
- DH - these can give you an indication of any PMH that hasn't been disclosed, for example patients may fail to report high blood pressure, but are on beta blockers, or they may have lost their medication / forgotten about it. Also anticoagulants such as aspirin may be indicated if embolic stroke, but contraindicated if TBI or brain haemorrhage

Amending medication isn't our role as AHPs, but an awareness of medication and their actions / interactions is useful and you need to be aware why someone on aspirin may be continuing to deteriorate



- SH: What is the next step will it be D/C to a temporary camp, their home or onto another hospital?

What outcome are we aiming for (function vs quality)? If we don't achieve the functional outcome required for them to return to their normal role / lifestyle, what will the psychological effect be on them or their family? If they are the main wage earner, how will the family manage?

What cultural implications are there re:

- disability - family desire or obligation to take over care / "look after" patient rather than encourage return to independence, impact on them of having someone with a disability in the family

- motivation - to participate in rehabilitation

Other social factors that may impact on physical symptoms include:

- Smoking / alcohol / drug use: Are they agitated, shaky and / or confused?
- Do they have ABI / cerebral irritation or are they just withdrawing from nicotine and a nicotine patch but are unable to express this?

Can we support this medically e.g alcohol withdrawal protocol / basic support with multivitamins etc?

### Objective Assessment and the ICF

#### Objective assessment

- Impairment
- Function
- Independence
- Ability to participate in activity



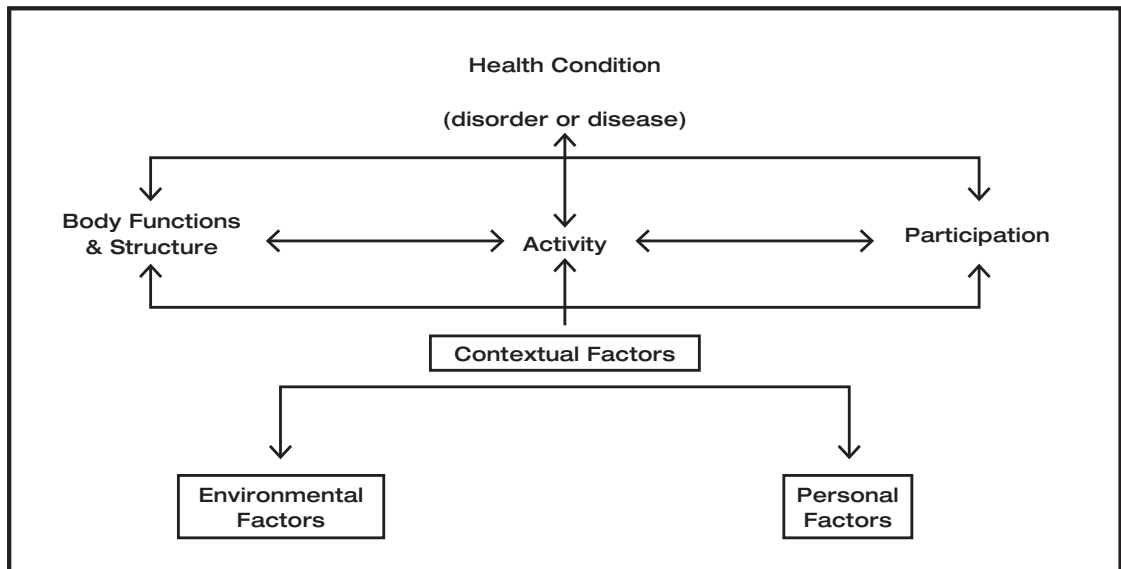
The International Classification of Functioning, Disability and Health, known more commonly as ICF, is a classification of health and health-related domains (WHO, 2001).

The ICF allows the clinician to look beyond the diagnosis and biological or medical dysfunction and assess the impact on quality of life through the ability to carry

out certain activities, such as walk, or feed oneself, and whether the patient is able to continue to participate in social activities.

The ICF also helps the clinician to help set patient-centred goals and identify barriers to participation that might be easily overcome, such as providing a grab rail so the patient is able to continue to take a shower independently.

International Classification of Function Model (ICF)



**All components of the ICF are interlinked and should all be considered in order to provide a holistic approach to rehabilitation and allow the patient to regain or maintain the life style that they enjoyed before sustaining their ABI.**

### Outcome measures

In the early stages of an emergency response, the use of detailed outcome measures may not be appropriate, but as you enter a rehabilitation phase you still need to be able to demonstrate change in your patient's abilities in order to help shape future therapy sessions and rehab goals. The use of outcome measures can also facilitate discharge planning in later stages of the rehabilitation process. Many outcome measures are culturally or context specific, so be careful what you chose.

### Pre-Assessment Observations

A large amount of information may be gained as you approach the patient which may guide where you focus your initial assessment.

The following are observations that may guide you towards specific assessments:

- Obvious signs of trauma: deformity, bleeding from the skull, fluid leakage from the nose / ears, bruising (e.g panda / racoon eyes, Battles sign, under hairline).
- Alertness / apparent level of consciousness and ability to remain awake
- Respiration: respiratory rate and pattern of breathing
- Sweating: signs of fever
- Symmetry: eyes / facial / trunk / limb position
- Headache and associated symptoms: do they look in distress holding their head, vomiting, photophobia or seizures
- Function: what do they appear able to do?
- Behaviour: are they taking in the surroundings / looking distracted

## Assessment

This is a brief overview of basic assessments which will help identify: the main problems quickly; developing complications and progress

### ■ Primary survey:

Airway

Breathing: RR / pattern / rhythm / cough / Ausc / expansion

Circulation: HR / BP / SaO<sub>2</sub>

Disability: GCS / Pupils / Neuro Ax

Exposure: observation / inspection



### Airway:

If the patient has a low GCS, is having a seizure or is post-ictal they are at risk of obstructing their airway. A decision will have to be made re: protection of airway as intubation and ventilation is unlikely to be available. Assessment of the presence of a cough reflex is useful as an absent cough reflex may indicate severe neurological compromise. If the patient is unable to protect their airway use positioning (place on their side in recovery position) and / or if you have one, and are competent, then use a guedel airway or NPA.

Airway obstruction may also occur if someone has low GCS and has vomited / is unable to clear secretions, has a reduced cough reflex or has aspirated due to swallowing difficulty.

Therefore you will need to identify if suction is available? If so, is it appropriate, and who else is able to carry this out / who can be trained? If suction is not available, discuss with the team what other methods are there to maintain a clear airway if needed?

### Breathing:

Respiratory pattern gives a large amount of information, it can indicate respiratory distress, and it can also indicate compromise of the CNS. Altered respiratory patterns due to neurological compromise or associated problems include: reduced RR; increased respiratory rate; waxing / waning patterns of breathing; large sighs; altered I:E ratios that vary in cyclical patterns e.g. a large deep breath followed by apnoea followed by fast shallow breaths followed by slower ramping breaths followed by a deep breath to repeat the cycle; hiccoughs and periods of apnoea can be an indication of seizure activity or brainstem dysfunction and may be due to raised ICP.

Paradoxical patterns can be a result of reduced intercostal innervation due to central neuropathies such as MG, or in the case of severe GBS. Paradoxical patterns can also be seen with dense hemiplegia or post-SAH.

## Acquired Brain Injury

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You may also need to identify with your assessment if the patient is in respiratory distress due to a primary respiratory problem (pneumonia) or due to respiratory muscle fatigue?

Other useful information includes: are they able to cough and clear secretions effectively? If yes, prompt them. If no, is it because they don't have the strength? Is their cognition impaired and therefore they don't realise that they have a problem? Or are they too drowsy?

Easy interventions:

If there is respiratory distress, you need to make an immediate intervention consider the following:

- Use of side to side / semi-prone positioning if safe to do so.
- With TBI avoid head down positioning, 30-60° head up is optimal.
- Manual techniques such as vibrations / percussion may not be tolerated as well as shaking.
- Should they be / can they be moved to a critical care unit, or a higher level field hospital?

Circulation:

Identify if the cardiovascular system appears stable. Is the systolic pressure staying consistently within set limits set by the medical team (if these exist) / within acceptable limits (usually ...), or is the blood pressure variable particularly if this is not linked to other interventions. Also observe the heart rate: is this consistently within normal limits, or is there reduced or increased heart rate?

Signs of instability in the cardiovascular system may be an indication of early brainstem compression, or sepsis secondary to infection or may be a result of severe fever.

Disability: GCS / pupils / Neurological examination

The main methods to assess neurological disability include:

- Assessment of GCS
- Assessment of pupils
- Neurological examination



The primary method of assessing consciousness is the Glasgow Coma Scale (GCS). This is available at <http://www.glasgowcomascale.org/> It is useful to monitor trends, which can alert the clinician as to whether the patient is better, worse or the same.



### Glasgow Coma Scale

Best eye response (E)	Spontaneous - open with blinking at baseline	4
	Opens to verbal command, speech, or shout	3
	Opens to pain, not applied to face	2
	None	1
Best verbal response (V)	Oriented	5
	Confused conversation, but able to answer questions	4
	Inappropriate responses, words discernible	3
	Incomprehensible speech	2
	None	1
Best motor response (M)	Obeys commands for movement	6
	Purposeful movement to painful stimulus	5
	Withdraws from pain	4
	Abnormal (spastic) flexion, decorticate posture	3
	Extensor (rigid) response, decerebrate posture	2
	None	1

**It is important to recognise and respond to a reduction in GCS. It is a medical emergency and urgent help must be sought.**

Make sure the patient is safe while you do this, e.g. their airway is protected, they are in the recovery position and ideally someone is with them to continue to monitor their vital signs.

When you are asking for help, it is important to be able to state what the GCS was and what it is currently, so the medical professional can establish how serious the situation is decide how to prioritise the patient within their current caseload.

Be aware that a deteriorating patient may present with increasing agitation due to cerebral irritation rather than reducing levels of arousal. This means that the increasingly angry person that you may have mistaken for being stressed may actually have a worsening brain injury. You should check for other signs of brain injury

such as dizziness and confusion and alert a medical colleague if you have any concerns.

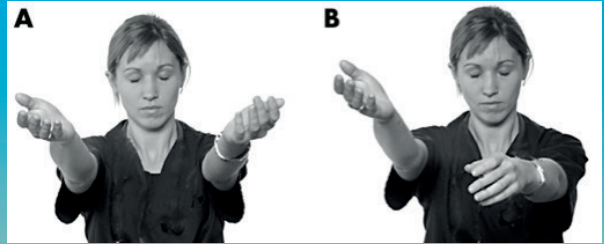
Pupil assessment is used to assess compromise of the cranial nerves due to raised ICP and brainstem dysfunction. The pupils are assessed for:

- Size: small pupils may indicate overuse of certain drugs such as morphine, large / dilated pupils may be due to increasing ICP
- Comparison of right vs left: pupils should be equal in size. If they are unequal this may indicate raised ICP, or direct damage to the optic nerve
- Reaction to light: pupils should react briskly in response to light, by constricting. A slowed response / no response may be an indication of raised ICP, or damage to the optic nerve.

### Neurological assessment:

#### Neuro Assessment

- Motor Function:
  - Pronator drift test
  - Tone
  - Muscle strength
  - Co-ordination
  - Reflexes
- Sensation:
  - Sensory neglect
  - Light touch / pin prick / temp
  - / 2 point discrimination
  - Proprioception



The use of clinical reasoning following the initial subjective and observational assessments should direct you towards choosing the most appropriate assessments for the likely diagnosis / immediate needs of the patient. More specific and formalised testing may be required for certain conditions such as SCI.

Using your basic skills a neurological / neuromusculoskeletal assessment of the following should be completed:

**Motor Assessment:** A "pronator drift" test is a quick method to identify if there is a subtle onset of neurological weakness as a result of CNS injury.

**Method** - ask patient to hold both arms up in front of them, turn palms towards ceiling and then close eyes and keep arms still and

steady. If there is CNS deficit causing subtle weakness, on one side (possibly both sides) the arm will pronate and drift downwards

This can be used at every assessment to identify progression / improvement of symptoms. If there is progression of weakness then the planned mobilisation / completion of a rehabilitation session may need to be re-evaluated, and medical review may be required.

**Tone:** Identify if there is low / increased tone evident. Assess by feeling how a limb feels as you hold and move it (heavy and easy to move / heavy and resisting). Indicates how relevant strength testing may be.

Muscle tone can be measured with the Modified Ashworth Scale:

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch or by minimal resistance at the end of the range of motion (ROM) when the affected part(s) is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) rigid in flexion or extension
9	Unable to test

Muscle strength: The Oxford MRC scale should be used to assess strength in both upper and lower limbs. Trunk strength can be assessed using a bridging exercise, or completion of a sit up type task.

Co-ordination: The following basic co-ordination test can be completed: Upper Limb - finger to nose test (past pointing); Lower Limb - heel slide along shin from ankle to knee

Sensation: Is useful to assess first for Sensory neglect.

A quick test to identify inattention and possibly global problem is as follows:

Eyes shut. Stroke a section of one arm - can they feel sensation? Stroke same section of the other arm - can they feel the same

sensation? Stroke same section of both arms together - can they identify sensation on both sides equally?

Repeat in another section then complete the test on the lower limbs.

For assessment of light touch and pin prick use dermatomes. These tests may be difficult with a language barrier. Remember to ask patient to close eyes during testing

Proprioception: There are a variety of methods used to test proprioception. The easiest are using the distal phalanx of thumb and hallux: move the distal section and ask if the patient can identify if the movement is up or down; a larger position test of joint / limb proprioception: place the limb which is affected into a position for unaffected side to copy.

### Other physical elements of Neuro Ax:

- Swallow - check with patient/family for difficulties
- Speech / comprehension
- Sensory elements:
  - Vision: visual acuity / visual field loss
  - Hearing
- Vestibular:
  - Gaze stability / smooth pursuit
  - Saccades
  - Herdmanns

### Other Physical Elements of a Neurological Assessment

These elements are important to identify additional rehabilitation problems and to form a holistic approach to treatment.

Swallow: If you do not feel able to assess swallow identify if there is anyone in the team trained to carry out a swallow assessment. If not, evaluate if you think the patient is either exhibiting signs / likely to show the following signs of aspiration:

- Facial weakness
- Drowsiness
- Are they maintaining / coping their own secretions?
- Do they cough / struggle / alter respiratory rate or pattern if you observe them taking a drink
- Evidence of chest infection (which may be recurrent)

If there appear to be swallowing problems you will need to discuss with the team appropriate management options. "Risk" feeding / drinking may continue with close observation if signs of aspiration / development of chest infection

Speech: Simple methods to evaluate if there are speech problems include: is patient attempting to speak, or is speech affected by facial injury or reduced consciousness; is the speech slurred? (family may be helpful in identifying problems)?

You may need assistance from locals to identify if patient is talking sense / comprehending the spoken word

Expressive dysphasia: Understanding is retained and patient will follow commands, but not speak, or speak using nonsensical words/sentences. Reading and writing may also be impaired.

When testing comprehension in patients with expressive dysphasia, you should ask them to carry out non-verbal tasks, such as 'stick your tongue out'.

Receptive dysphasia: Able to talk fluently, but out of context to the conversation, or jargon, indicating that they haven't understood the words spoken to them. Do not obey simple commands.



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Some people may have expressive and receptive dysphasia, and this is usually associated with hemiplegia and visual field deficit.

To test for dysphasia assess:

- spontaneous speech through general conversation. Use simple questions like 'What is your name?' and 'Where do you live?'
- naming objects by pointing to objects you want the patient to name (use items familiar to them with local help if required)
- Ask them to follow a 3 stage command: "with your right hand, touch your right knee, and then your nose"

Other assessments may depend on level of literacy as these involve spelling words, reading, or writing

Vision: Does the patient have a pre-morbid visual field deficit? Do they usually wear glasses? If so, where are they? If they are lost/broken, is it possible to get a new pair? Do they have a new visual deficit? If so can they explain it e.g. blurring / double vision (diplopia)

Visual field loss: \*do not confuse with visual neglect (discussed in section on cognition)

- Homonymous hemianopia - physical loss of visual field to the same side, in both eyes, in the vertical plane.
- Quadrantanopia - visual field loss in one quadrant, in both eyes
- Other field loss / altered perception of vision

Simple testing for visual field loss: Use index finger of right and left hand. Start with them either side of the patients head, behind their visual field, then as you begin to move your fingers forward towards the front of the patient, ask the patient to tell when they can see you fingers but all the time they must look at your nose. Someone with a hemianopia will only see both fingers when they are in the same half of the visual field.

Testing for a quadrantanopia is the same, but you will have to start with your fingers higher up or lower down. Cognitively intact people can be taught compensatory strategies to overcome this.

Other field loss / altered perception of vision:

Diplopia: if they have double vision, they may benefit from an eye patch. Remember to advise the patient to swap eyes so they don't develop dependency on one eye.

Are the eyes deviated to one side? Can the patient follow an object and bring their eyes beyond midline to the opposite side? If not, they have a visual inattention. You may be able to identify this through function e.g. ignoring items to one side, attending only to one side, bumping into things

If there is altered vision / perception compensatory strategies will need to be taught. People who aren't able to learn compensatory strategies will be unaware of objects on their affected side. This has safety implications if the patient is able to mobilise independently. It will be important to educate caregivers about the visual field deficit and teach them strategies to help keep the patient safe.

Vestibular: It is useful to be aware that a patient with a skull fracture may have no specific limb deficit but can experience dizziness and balance problems. This is more common in temporal, occipital and base of skull fractures. It is useful to complete a vestibular screen to identify any issues. Be aware of any changes of hearing as a result of the injury and follow up to ENT specialists may be warranted.

Presentation of dizziness may be due to:

- Disruption of otoconia causing BPPV
- Interference with the ear canal due to the site of fracture
- Disruption of the neuronal networking as a result of TBI

## Acquired Brain Injury

Vestibular assessments include the following tests for: Gaze stability; Saccades and Herdmanns.

Gaze stability - if they focus on a point in front of them and you observe them: are their eyes still, is there any convergence or divergence of the gaze of each eye

Can they move their eyes from side to side in the horizontal plane, vertically up and down, and in an "H": Is the movement smooth or jumping? Do they have a nystagmus (an involuntary to and fro, or in a rotary movement in any plane? May indicate a problem with the cerebellum / vestibular systems

Saccades - head stays still while they move their eye horizontally from side to side as quickly as they can for 1 minute: can they complete for 1 minute, do they feel dizzy / nauseous / vomit, does the head remain still

Herdmanns - focus on a point in front while turning head from side to side as quickly as possible for 1 minute: can they complete one minute, do they feel dizzy / nauseous / vomit, does the head remain in a horizontal plane during the movement or does it "wobble".

## Functional Neurological Assessment

Assessments of function such as ability to balance, move and complete activities of daily living should also be undertaken.

Functional and / or specific outcome measures can be used to complete an objective assessment of functional ability.

## Neuro Assessment: Functional

- Balance:
  - Sitting: static / dynamic
  - Standing: static / dynamic
- Moving / Mobility:
  - Moving in bed
  - Moving in/out of bed
  - Sitting to standing
  - Walking
- ADL's
  - Eating and Drinking
  - Washing/ Dressing/ Toileting
  - Cooking, Childcare,
  - Ability to complete other usual tasks

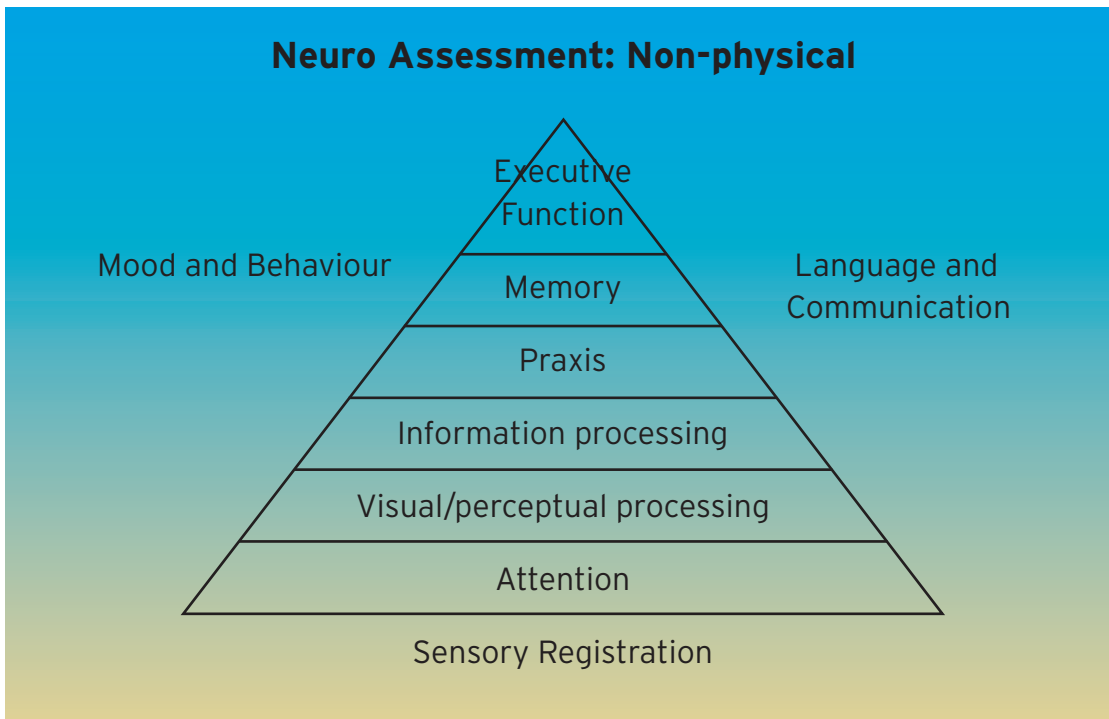


## Non-physical Neurological Assessment

These include assessment of the higher cognitive, executive and perceptual functions on the brain. When assessing cognitive skills it is helpful to consider them as a hierarchy, alongside mood, behaviour, language and communication. For example

if someone is having great difficulties maintaining sustained attention during an assessment or rehabilitation session, and is constantly distracted / asking repeated questions, this will likely impact on the cognitive skills higher up the hierarchy.

### Cognitive Hierarchy:



Non-physical assessments can be divided into assessments of:

- Cognition
- Psychological
- Perception
- Behavioural

Dyspraxia / apraxia are also commonly included within these groups of tests although they are an evaluation of the quality of a movement, which is closely linked to perception of movement.

### Neuro Assessment: Cognition / Perception / Behavioural/ Psychological

#### Cognition

- Attention / concentration
- Speed of processing information
- Memory
  - Recall: immediate STM/ delayed LTM
  - Anterograde/ Retrograde
  - Amnesia
- Executive function
  - Insight into condition/ deficits
  - Ability to initiate/ terminate
  - Planning and organization
  - Problem solving and abstract thinking
  - Safety awareness/ Judgement

#### Psychological

- Mood

#### Perceptual problems

- Sensory / Visual inattention:
  - Visuo-spatial loss / spatial awareness
  - Visual inattention
- Agnosia:
  - auditory / visual / body / tactile

#### Dyspraxia / apraxia

#### Behavioural problems

- Agitation / Apathy / Fatigue
- Aggression / Lability
- Personality change
- Disinhibition

Cognition is an encompassing term for a variety of higher mental processes, such as thinking, imaging, speaking, acting and planning (Ward, 2010).

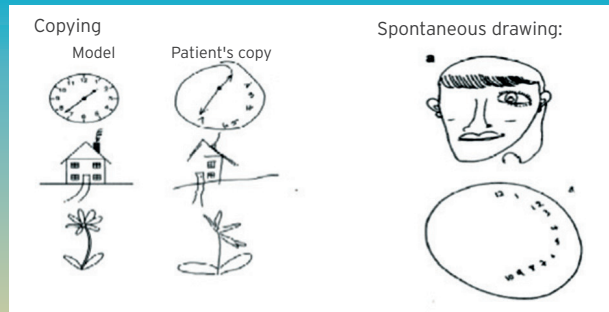
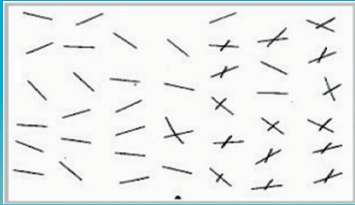
Attention is the process whereby certain information is selected for processing while other information is discarded. If you have a patient who has impaired attention,

they will find therapy difficult in a noisy environment because they won't be able to filter out other stimuli and so won't be able to give therapy their full attention - sensory overload. Even in a quiet environment, they may have trouble sustaining attention, so you need to make your treatment sessions short to maximise on learning opportunity.





## Assessments for inattention



At the top left is the cancellation test, where the patient has to put a line through all the lines on the piece of paper. As can be seen, none of the lines to the left have been crossed through, indicating a left-sided visual inattention.

At the bottom right are examples of copying pictures and also drawing freehand, all which show a left-sided visual inattention.

Memory:

There are many different types of memory:

Short term memory refers to information that is currently held 'in mind'. It has limited capacity. STM is important for long-term learning. In other words, if you have an ABI patient with poor STM, their recovery is likely to be slow and their prognosis is poor as they can't retain information and build on it between treatment sessions (i.e. no carry over).

Long term memory is information that is stored. It may not be presently accessed or consciously accessible. LTM has unlimited capacity.

Following a brain injury, patients may be unable to recall events leading up to the injury (retrograde amnesia) or have difficulty forming new memories, and therefore be unable to learn new tasks (anterograde amnesia).

ABI patients could present with post-traumatic amnesia; a period of amnesia occurring after the injury (anterograde amnesia). This can last days or weeks and the longer it lasts, the more severe the brain injury.

Perceptual problems:

Sensory / visual inattention: Can be assessed / identified during function

Hemispatial / visual inattention: An attention disorder that prevents a patient attending to stimuli on one side (usually affecting ability to attend to the left side). Can be inattentive to sensory stimulus of any kind on the affected side, for example touch, sound, recall or memory of objects / places that would normally be on one side of the body, or visual.

## Acquired Brain Injury

Examples: ignoring items to one side, attending only to one side, bumping into things

Can occur with / without homonymous hemianopia

Identify the following: Are the eyes deviated to one side? Can the patient follow an object and bring their eyes beyond midline to the opposite side? If not, they have a visual inattention.

Homonymous Hemianopia (HH) - a loss of visual field to the same side in both eyes where compensation can be made for loss of vision e.g. turning head to shave both sides of face

If both HH and visual inattention occur together the prognosis is worse as

compensatory strategies are difficult to put in place.

Agnosia: loss of ability to recognise objects, people, shapes, sounds, smell even though there is no loss of the specific sense, or evidence of memory loss. For assessment use locally sourced items that the patient would normally recognise.

Dyspraxia: reduced ability to co-ordinate, perform, plan and carry out movements even when there is no movement / motor disorder. E.g. difficulty dressing in the right order

Below are some examples of cognitive and perceptual tests that can be modified and adapted depending on the setting that you are in and the patient's circumstances.

### Severity of TBI

Domain	Examples
Orientation	<ul style="list-style-type: none"> <li>Time: Age, Day/night, Month or Season (dry/rainy), Year, LOS/days post-op</li> <li>Place: Name of town</li> <li>Person: Ability to identify accompanying NOK or familiar staff member</li> </ul>
Attention	<ul style="list-style-type: none"> <li>"Recite months of years backwards"</li> <li>Difficulties complying with simple 1 or 2 step commands during session</li> </ul>
Memory	<ul style="list-style-type: none"> <li>I am going to tell you a list of items that I usually get from the market, you must try and remember them for me. They are: <i>cooking oil, soap, rice and eggs</i> (replace with culturally appropriate equivalents). Now repeat this list to me three times "Ask again after 5-10 mins."</li> <li>No carryover between therapy sessions e.g. use of transfer board technique</li> </ul>
Perceptual	<ul style="list-style-type: none"> <li>"Show me your right foot/left hand/with your right hand touch your left shoulder"</li> </ul>
Language	<ul style="list-style-type: none"> <li>"Tell me the names of as many different animals as you can in 1 minutes"</li> </ul>
Executive function	Often hard to identify on a bedside screen but observed through function. For e.g. person appears indifferent or surprised when experiencing difficulties during fx tasks, difficulties problem solving in a novel task, family reporting personality change, apathy etc.



Refer to the ABI cheat sheet for more information on what to be aware of during your assessment

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Behaviour:

Behaviour may change as a result of the head injury, particularly if the injury is in the frontal lobes. Behavioural changes can be anything from disinhibition (e.g. taking clothes off in public), swearing when previously did not do this, and aggression, to apathy and 'laziness', or someone who was previously aggressive / motivated becoming childlike

It is important to establish what is normal for the patient, and remember that the family may find the patient's behaviour distressing.

Don't forget the individual may also have experienced significant psychological trauma! Access to psychology, neuropsychology or psychiatry is likely to be limited initially, but may become available at a later date. Educating and supporting the patient and family members is critical.

It is important that you try and educate the patient to exhibit behaviour that is socially acceptable, rather than let them do as they please just because they have had a brain injury.

Patients who are agitated often attempt to wander around and may inadvertently be a danger to themselves or others. They frequently will also be in a confused / disorientated state; have memory problems; and will not be aware they have had a TBI, they won't remember they can't walk and so are at risk of falls as they try to get up.

Agitation may increase when they have a basic need to do something: for example to toilet, have a drink / eat; when in pain, and they may become aggressive and hit out at other people trying to stop them from moving around.

They usually need 1:1 supervision and a quieter environment. Often it may be safest to initially nurse on the floor and to establish a regular toileting / daily regime of activities, and consistent team of staff involved in their care.

It is important to note whether the agitation is getting worse, or if the patient is getting significantly quieter/drowsy as these are signs that the patient is deteriorating as the brain swells. The first 48 - 72 hours post-ABI are most crucial for monitoring this.

Overstimulation may make them worse. Therefore limit attempts to reason, and work with / alongside them as long as it is safe to do so. In the early stages concentration will also be reduced and often the effort and physical effects of attempting to get up, will quickly lead to a return to bed.

As well as being unable to concentrate on the task or being unable to motivate themselves to complete the task, patients may also be too tired to complete the task.

Remember the brain is healing, and will be using lots of calories to do this as the metabolic rate increases significantly (the autonomic reaction is likened to that of someone with severe burns).

#### Outcome measures / standardised assessments

##### Physical

- TUG
- Modified Rivermead Mobility Index
- PASS
- Modified Ashworth Scale
- 10 metre timed walk
- Berg balance

##### Cognitive / Perceptual

- Screening tests:  
MOCA (translations available on <http://www.mocatest.org/paper-tests/moca-test-full> ),  
MMSE, AMT
- Impairment-based ax:  
O-Log, CAM, WHIM, CRS, COTNAB, Rivermead Perceptual Assessment Battery, BADS
- Functional ax:  
Observation of function, AMPS, Multiple Errands Test

Outcome measures commonly used in the UK are presented above; however therapists should adapt them as required according to their circumstances, also taking in consideration the equipment available to you.

The modified Rivermead mobility index (mRMI) and the postural assessment scale for stroke (PASS) are both scales that are valid for stroke patients. However there are few brain injury specific measures and therefore can be used for other forms of acquired brain injury if it is felt there

is no other way to perform consistent measurement.

Other outcome measures include:

- Berg balance
- Timed unsupported steady stance
- Timed up and go
- 10m walk test

Formal cognitive/ perceptual testing using standardised assessments such as those mentioned above is often challenging due to language, educational and cultural differences.



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## Rehabilitation Treatment

### Learning outcomes

To be aware of specific rehabilitation treatment considerations for patients with ABI

As with all good clinical practice, your assessment should lead to your problem list, which in turn will shape your treatment plan and help you set short and long term goals.

These will obviously vary depending on the severity of the brain injury, social and family roles of the patient and the culture that you

are in. (For example, in Gaza we encountered several SCI patients who were fully independent, but their culture meant that that, where the patient was male, everything that could be done was done for the patient and they weren't expected or given the opportunity to be independent).

## Treatment

- The aim of any treatment should be to allow the patient to achieve their maximum potential
- Mild TBI may only need advice, help setting expectations and relatively simple interventions
- Severe TBI need specialist rehabilitation where possible

Rehabilitation is described by the World Health Organisation as a way of assisting an individual with a disability to achieve and maintain maximum physical, cognitive, social and psychological function, participation in society and quality of living. (WHO, 2011)

Where the patient has suffered from a mild TBI, the treatment may be limited to assessment, giving advice and setting expectations, and possibly organising relatively simple interventions. (BSRM core standards, 2013)

There is now a substantial body of trial-based evidence and other research to support both the effectiveness and cost-effectiveness of specialist rehabilitation. Despite their longer length of stay, the cost of providing early specialist rehabilitation for patients with complex needs is rapidly offset by longer-term savings in the cost of community care, making this a highly cost efficient intervention (eg Turner-Stokes et al 2005)

A key component of the rehabilitation should be that it is multidisciplinary approach with regular ward rounds, MDT meetings, case conferences and provision of support to family and carers (BSRM, 2013). Being multidisciplinary also means that the patient will have all aspects of their rehabilitation addressed within the same facility (Turner-stokes et al, 2005) with all partners working to the same patient centred goals.

### Treatment and Rehabilitation

It is unlikely that patients will present only with an acquired brain injury following a sudden onset disaster so before commencing rehabilitation ensure that any contaminant injuries have been treated/ stabilised and consider what influence these may have on your treatment choices. Likely other injuries are fractures, amputations and especially spinal cord injury that can be easily missed.

The first choice of treatment may be positioning to prevent postural problems,

## Acquired Brain Injury

contractures and pressure sores. Positioning will be very difficult in a field hospital but can be vital so it is important that you consider it and educate the family carers if the situation is likely to be on-going (Edwards 1996).

In terms of on-going seating and postural management - refer on if you can to follow up services. If you don't have this luxury then think outside the box - how can you get this person in a good position with a basic chair or using local resources? Do you have access to a Motivation wheelchair?

Patients who are presenting with increase in spasticity will need input in terms of casting, stretching, positioning, education and if possible medication but this may not be readily available (RCP Guidelines 2009). There is very little research to show that daily passive stretches that are not prolonged are of any benefit. Prolonged stretches with casts, splints and positioning are appropriate with some patients (Splinting Guidelines

2015). You will normally have access to Plaster of Paris to make basic splints to prevent contractures but be aware of the potential for pressure sores especially in tropical environments. If patients require longer term splinting then you may need to work with local materials or artisans to fabricate something appropriate, or refer to a local specialist provider if available.

Use the skills you have and adapt these to the needs of the patient.

Often function is the main rehab goal, and quality may need to be sacrificed / left until the future when there are teams of more specialist rehab staff and there is time available.

Rehab is an MDT approach and you may need to be all the members of the MDT!

Below are the main principles for neurological rehabilitation:

### Treatment Principles

- Respiratory: to maintain respiratory status and prevent respiratory deterioration
- Holistic approach if there are other limiting associated injuries: e.g. be aware of WB status
- Prevent soft tissue problems:
  - Pressure areas
  - Soft tissue shortening
- Encourage a return to independence
- Optimise potential functional outcome
- Provide routine and structure
- Educate

There are many different treatment strategies that can be used within the field of neurology and acquired

brain injury. Many of these cross over with the strategies used in the field of musculoskeletal rehabilitation.



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Rehabilitation should be aimed at improving postural control, muscle activity and balance (RCP 2012). This can be achieved through prescription of specific exercises to address the underlying problems but patients with brain injury respond particularly well to exercises that enable them to work against gravity (sit them up, and stand them as soon as possible, and work in these positions) and to experience movement. Specific exercises are not described in this manual, but the principles of exercise prescription should be adhered to and trying to make exercises as functional and meaningful as possible will help with recovery, motivation and compliance.

Exercises that allow repetition of specific functional tasks have good research to back them up (e.g. repeated reach to grasp in a standing position) (French et al 2007). Physical fitness training and strengthening are not contraindicated in brain injury (NICE 2013).

Repeated task practise with assistance and guidance of functional tasks is appropriate.

Use aids and equipment to enhance function where appropriate - again use local resources if possible. If you are the sole rehabilitation provider it is likely that in an austere environment your treatment will need to involve treatments combining PT and OT tasks. Upper limb treatment may be essential to improving functional ability.

There is good research to back up the use of low tech treatments to improve upper limb function including mirror box treatment and mental imagery treatment. For patients with reasonable upper limb activity modified constraint induced movement techniques are a possibility but this requires a very specific set of circumstances (Thieme et al 2012, Zimmerman 2008, Wolf et al 2006) that are unlikely to be available early after a sudden onset disaster.

Specific treatment of sensory impairment is important as this can lead to long term problems - research suggests that you should try to enhance impaired sensory mechanisms (e.g. Light touch or proprioception) rather than working on sensory mechanisms that have been totally lost (e.g. Pain) (Carey et al 2011).

## Physical Treatment strategies

Physical: main principle is to regain postural control and movement

- Use whichever treatment principles you are familiar and confident with: strengthening/facilitation/repeated tasks/combination of techniques/exercise therapy/stretching/splinting/aping/sensory rehab/vestibular rehab/core stability/balance/encourage movement
- Positioning/postural management
- Seating
- Use practise of functional tasks such as transfers / sitting to standing/squatting
- Identify equipment that is required/available/can be constructed safely
- For high muscle tone, MDT management including pharmaceutical management should be considered
- For low muscle tone, be aware of subluxation risk of shoulder and wrist.

## Acquired Brain Injury

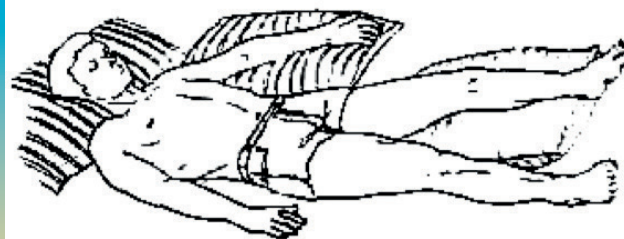
### Postural Management

#### Supine

When positioning in supine pillows can be used to support the hemiplegic upper and lower limb. Be aware of sacral and heel sores if the patient is in this position for too long.

Try to sit the patient up as much as possible for their respiratory status and to use the benefit of gravity in rehabilitating midline perception and postural control.

### Postural management: Supine positioning



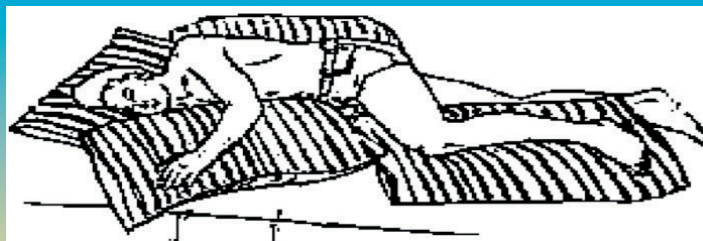
#### Side lying

When positioning in side lying the use of pillows to prevent the patient rolling backwards is useful. If pillows are hard to come by then the use of rolled blankets/clothes or foam will be a good substitute. Ensure side lying is side lying and not just a slight tilt from supine.

Beware of lying on a painful hemiplegic shoulder.

There is no evidence to back it up but clinical experience seems to suggest that side lying on an overactive side may help quieten down the overactivity.

### Postural management: Right Side Lying



### Postural management: Left Side Lying





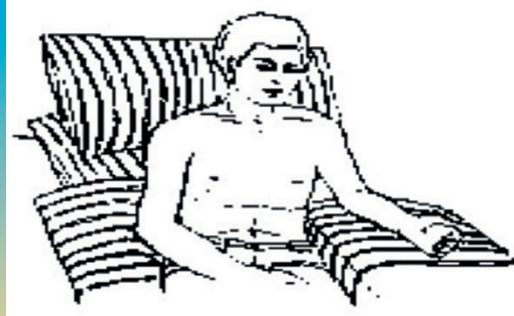
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## Sitting

Sitting is a good position to help with reorientation of midline and balance. Care

needs to be taken to ensure the hemiplegic shoulder is well supported.

### Postural management: Sitting



### Cognitive Treatment Strategies:

#### Cognitive Treatment Strategies

Cognitive: main principle is to establish some normality and provide a daily structured regime

- Integrate ADL's into daily rehabilitation
- Practise tasks
- Grade / pace level of activity
- Teach compensatory strategies
- Consider impact on physical and sensory deficits e.g. ability to use mobility aids, manage UL weakness, visual loss
- Consider physical and cognitive fatigue leading to performance fluctuations
- Educating the patient and their family is key!!

The main principle of addressing cognition is ensuring the patient and family are given information on their impairments and how this may impact on their everyday routine/ activities. External compensatory strategies are key and need to be used consistently and understood

by the wider family, as not only can there sometimes be unhelpful cultural beliefs surrounding cognitive impairments in certain cultures, cognition also impacts on the ability of the patient to engage in the treatment and management of their physical impairments.

## Acquired Brain Injury

### Other Treatment Strategies:

#### Swallowing and Nutrition:

You may need to work alongside the medical and nursing teams as well as family to identify an appropriate treatment plan. Physical activity and rehabilitation may need to be modified if nutritional needs are not being met.

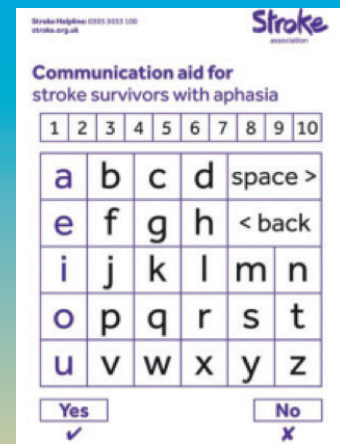
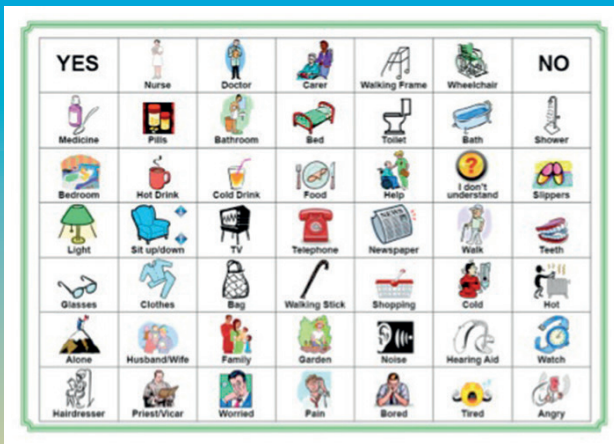
able to produce something similar that is more relevant to the patient in the context of their location and family life etc. A "This is Me" booklet could also be produced in conjunction with family members to assist the patient and the rehabilitation team.

#### Communication:

Examples of communication boards can be given to family / locals who may be

Education is important to the family and anyone else who is available to assist with rehabilitation.

## Examples of communication aids for people with aphasia



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Emotional:  
Reassurance and motivation may be key rehabilitation strategies that are required for both the patient and family members.

Key to rehabilitation is communication and provision of advice for the patient and their family. Examples of the types of information leaflet and advice that may be required are below:

### **Education and Patient Information**

- Mild TBI: Concussion leaflet
- Advice on where to go / who to contact if a patient deteriorates
- HI Advice leaflet
- Home exercise / Structured Activity programme
- Information for family:
  - Seizures
  - Secondary complications such as hydrocephalus
  - Spasticity management
  - Postural management
  - Pain and sensory rehabilitation
  - Management of the shoulder
  - Speech and communication
  - Swallow
  - Cognitive, emotional and behavioural problems
- Contact details for future appointments

### **Discharge**

#### **Learning Outcomes**

To be aware of deficits of brain injury that are not physical

To be aware of the challenges when discharging a patient with an ABI in a post disaster setting

To feel confident to give advice and information to patients and their families/carers on discharge from the field hospital or other care environment

### Treatment and discharge planning

- Establish likely goals to be achieved in the timeframe you are available
- Establish the next step in the patient journey and the most likely discharge destination (long term goals)
- Identify problem list
- Choose appropriate outcomes measures
- Set and implement treatment plan
- Arrange equipment if possible
- Plan for discharge

Discharge planning should be considered at first contact with the patient as this will give you time to find out what resources are available locally in terms of equipment and on-going treatment. There may also be pressure in an emergency setting to move medically stable patients on from acute facilities.

Ensuring safe follow up and ongoing rehabilitation is the gold standard. Options in the UK usually include specialised or generic inpatient rehabilitation units, community based or outpatient rehabilitation programs. However these may not exist, or the services may yet be operational. Early identification of available options is important, and will determine the length of stay of the patient in your facility.

UK best practice dictates that when leaving an inpatient facility, patients should have access to out-patient or community follow-up (Turner-Stokes et al, 2011) however in an austere emergency environment this may be challenging.

Discharge planning in an emergency setting is key to this, due to the high risk that patients will be lost to follow up. Ensuring appropriate equipment and care provisions for patients on discharge is also difficult - liaison with local disability organisations or governmental or non-governmental service providers will be key.

Where possible patients need to be put in touch with local services that can offer on-going support (if available). It is important to keep their details for future referrals should services become available in the future.

When planning discharge for patients with a brain injury there are some important factors to remember. There are many sequelae of brain injury and in the circumstances of a sudden onset disaster/humanitarian crisis some of the more subtle symptoms may go unrecognised.

Therefore the education of the patient and their carers is vital.

## Discharge

- Educate and give as much advice to the patient/family/carer as possible. The need for the patient to be actively engaged in the rehabilitation process must be stressed.
- Awareness of possible longer term complications and how to prevent/manage these
- Refer to on-going rehabilitation if this is possible
- Awareness of the 'hidden' difficulties of brain injury
- The safety of the patient and their family is paramount. Consider their likely discharge environment and the impact on their family, paying particular attention to protection issues.

Try to maximise functional abilities and understanding of the condition prior to discharge. Other factors to consider at discharge include:

- Ensure appropriate aids and adaptations are provided or recommended to assist with functional independence.
- Sensory problems - education and advice will be required to prevent pressure sores and other injuries.
- Appropriate follow up in terms of rehabilitation, spasticity, posture management and self-management will depend on what local services are available. Vocational rehabilitation may be appropriate if available. Refer on if you have the luxury of a service - quite often there are workshops or schemes for people with disabilities that may already be established that you can tap into - obviously first choice is to try to get them back to their pre-morbid function if possible
- Low awareness states - again unfortunately these patients may not survive, but if they do they require a huge amount of input and care and are associated with many complications - the families will need as much support as you can get them.
- Family education around possible complications - these may not occur at the time of the injury but could present late on and family members need to know how to spot these problems and what action to take if they occur:
  - o Seizures - seek medical advice
  - o Hydrocephalus - swelling in the head, sundowning of the eyes, slowing of cognitive processes, drowsiness - seek medical advice
  - o Spasticity - increase in tone and stiffness of muscles leading to difficulty with functional tasks and positioning - seek medical advice and rehabilitation for stretches, splinting, casting and positioning advice
  - o Postural management - adoption of abnormal postures and difficulty in seating patients or lying them - seek rehabilitation advice
  - o Pain (neuropathic, MSK, Shoulder and subluxation) - seek medical and rehabilitation advice
- Provide information and websites/leaflets where appropriate.
- Alcohol consumption advice - following brain injury you are more susceptible to the effects of alcohol.

Finally there are aspects of brain injury that may fall outside of the domain of the rehabilitation professional in normal practice but that should be covered prior to discharge. These may not always present acutely and should be discussed with the patient/carer/family and advice given on how to manage these impairments or if possible who to contact for on-going care or advice:

**Visual problems** are common and often beyond the scope of an optician - specialist referral to orthoptics or ophthalmology would be the gold standard but this is unlikely to be feasible in many situations.

**Psychological support** to manage changes in emotion or behaviour as well as issues with anxiety and depression would be ideal but simply acknowledging that this may occur may be as good as it gets depending on the situation.

**Cognitive deficits** are often missed or overlooked in the rapid acute stages of brain injury and are either too subtle to be noticed or are not assessed for. Again ideal intervention would be a combination of on-going OT and psychology input with local services. If this is not possible then education around the impairments and the use of basic strategies to overcome them (e.g. Memory strategies) is important.

**Aspiration risk and malnutrition:** SLTs and dieticians tend to be few and far between in less developed countries - refer on if possible, if not then masses of education around aspiration risk and modified diets may fall to you. Unfortunately in patients with severely impaired swallows in very poorly resourced environments the long term prognosis is poor as they are likely to suffer from aspiration pneumonia or malnutrition. If the patient is being fed, check the position - it is common that carers will feed the patient in supine, greatly increasing the risk of aspiration.

**Speech impairments** can have huge cultural implications so giving as much understanding and any strategies you have to the patient are likely to be of benefit.

**Incontinence** - education is the key especially in settings where equipment and adaptations to prevent or manage bowel and bladder incontinence may be difficult to access. The importance of hygiene is vital in order to prevent pressure sores developing

**Fatigue** - perhaps one of the least well know but most debilitating aspects of brain injury (especially mild injuries with only limited other symptoms) - this does tend to improve but can be all encompassing so should be addressed with education/advice prior to discharge

**Mental capacity and vulnerability** - patients who have sustained a brain injury may lack the capacity to make certain decisions (capacity is assessed on a decision by decision basis; so a patient may have the capacity to decide if they want to drink tea or coffee but not have the capacity to decide on a suitable discharge destination). Capacity is assessed by the patient's ability to take on board information, retain that information, weigh up the consequences of a decision and to communicate a decision. If a person lacks capacity they are vulnerable and can be easily exploited so family may need to support them with certain decisions (be aware family are often the ones that exploit!). There have been situations when people with brain injury have been exploited to join extremist or military organisations.

**Sexual Dysfunction** - a real taboo topic and it may be that in the fleeting circumstances and culture that you are in it would be inappropriate to address this subject with certain patients. But where appropriate information and advice is important as is the reassurance that their symptoms are related to their brain injury. Specialist referral would be great but very unlikely to be widely available.

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Finally if nothing else is possible when it comes to discharging patients with brain injury at least try and reassure the patient or their family that the symptoms they are reporting are not unusual and are likely to be

as a result of their brain injury. Simply having this knowledge can be empowering. But where possible refer on to local rehabilitation services/Community based Rehabilitation teams or to DPOs for ongoing support.

### **TWO Key Messages from the training:**

- 1.** How to spot a deteriorating patient
- 2.** The importance of educating the patient and their family about the long term consequences and complications of brain injury

## Acquired Brain Injury

### Core Recommended Texts

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## Appendix

**This section of the manual contains clinical cheat sheets, patient information leaflets, and self-rated competencies. They cover the 5 clinical areas covered in the manual. All the materials, plus supporting information like guidelines, images and the latest research, are also contained in the accompanying USB resource.**

### Patient Information Leaflets

These leaflets have been developed by the UK Professional Networks and Handicap International to provide basic information to patients in an austere setting. They contain key information for the patient, as well as space to allow translation. They are designed to be copied or printed directly from the manual, but are also available separately on the USB drive. The focus of the leaflets has been around reducing the risks that patients face following being injured in a disaster, such as wound infection, the development of pressure ulcers, or the accidental damage of an insensate arm.

### Self-Rated Confidences

We have worked with each partner organisation to identify key experiences and skills that you need to work effectively in each particular clinical area. We also track the confidences of participants after each training, and use the data to refine our

training. As the information is self-rated, we do not use it to assess competency or suitability to deploy. You can use these forms to evaluate the suitability of your own skills and experiences in each area. You can then use the accompanying action plan to structure your own professional development to build the skills you may require when working in a humanitarian emergency.

### Cheat Sheets

We recognise that no one therapist will be a specialist in all clinical areas. These sheets have been developed as a quick reference guide to support you in the field. They are not prescriptive, nor are they protocols, as every disaster and every individual is different and it is not possible to prescribe treatment in such a way. However, they are an ideal reference point if you are treating an injury you have not seen for a while, and provide prompts and ideas to help you guide your treatment.

# Patient Information Leaflets

2. In sitting or lying, keep your knee straight and push it down. Hold 20 seconds. Repeat X\_



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### Strengthening

3. Lie on your side. Lift your top leg up, keeping it in line with the body. Slowly lower. Repeat X\_

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4. Lie on your back with a rolled up towel under your residual limb. Bend your opposite leg. Push down with your residual limb, lifting your bottom up. Slowly lower. Repeat X



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## Upper Limb

### Stretching

1. Support the elbow on a table. Straighten the elbow. Hold 20 seconds. Repeat X\_



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2. Lift your arm upwards using the other hand. You should feel a stretch just below the armpit. Hold 20 seconds. Repeat X\_



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### Strengthening

3. Sit with your arms by your side. Stretch your arms back as far as you can. Slowly lower. Repeat x\_



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4. Lie flat. Lift your arms up so your shoulder blades come up off the surface. Slowly lower. Repeat X\_



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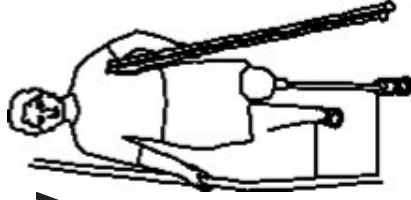
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# Information for You and your Family Following Amputation Keeping Active



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This is some information to help you understand what to expect after amputation and how to avoid complications. Ask your physiotherapist or doctor if you have any questions.

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## Regaining Independence

After an amputation, moving around is more difficult. Your muscles become weaker and tight and joints become stiff.

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It is important to move around as much as you can to keep your muscles strong and your joints moving.

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Practice the following activities. You may need someone to help you when you first start.

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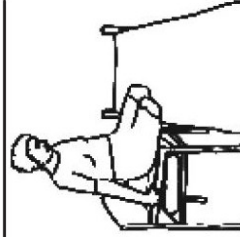
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- Rolling to the left and right

- Lying on your front

- Moving from lying into sitting

- Moving from the bed to a chair/wheelchair



- If you sleep on the floor, practice getting up from the floor by using a chair or other furniture. Take care to avoid pulling on your wound and the skin.



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You may have other injuries that may make these activities difficult. Ask for advice from your physiotherapist

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## Exercises

Tight and weak muscles can make using a prosthesis more difficult. It is important to do stretching and strengthening exercises

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**Stretching** helps to prevent the muscles around your remaining joints from shortening and becoming tight.

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**Strengthening** helps to make your muscles stronger. They can become weak after an amputation as they are not used as much.

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## Lower Limb

### Stretching



1. Lying on your front. Keep your hip (and knee) straight. Place a rolled up towel under your limb. Hold 20 seconds. Repeat X \_\_\_\_\_

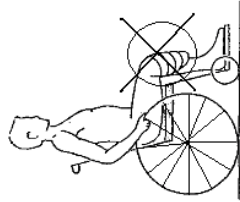
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## X Positions to avoid:



## Pain

It is common to feel pain in your limb and sometimes in the limb that is no longer there (called phantom limb pain).

Tell your doctor if you are in a lot of pain. You may need more painkillers.

## Residual limb pain

Your wound may be painful, which normally improves as it heals.

If it feels hot or red and you feel unwell, tell your doctor - you may have an infection.

## Phantom Limb pain

This is because your brain has not adjusted to the amputation yet.



You may also have feelings such as itching or tingling.

This is normal and is known as 'phantom limb sensation'.

These feelings can be worse if you feel stressed or for other reasons e.g. dressings.

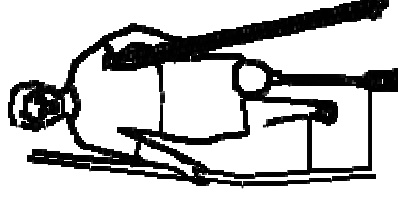
They can be hard to treat. Medication and touching or massaging your limb (not the wound) can help.

Some people can imagine moving the missing limb – try it, it may ease the pain.



# Information for You and your Family

## Following Amputation



## Controlling Your Swelling and Pain

This is some information to help you understand what to expect after amputation and how to avoid complications. Ask your physiotherapist or doctor if you have any questions.

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## Taking Care of Your Residual Limb (Stump)

It is important to keep your residual limb clean to avoid infection.

Check your limb regularly to make sure there are no sores.

When your wound has healed:

- Wash your limb daily with soap and water and rinse and dry it well.

- Use lotion at night to moisten your skin.

- Massage your scar so that it does not become tight.

## Swelling

Your limb will become very swollen. This can make fitting a prosthesis (artificial limb) difficult.

Swelling is normal but it is important to control this as much as possible.

### Wearing a compression sock

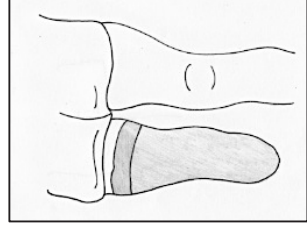
This is an elastic stocking, worn on your residual limb.

It reduces swelling and shapes your limb to help the fitting of a prosthesis.

Wear it during the day and take it off at night.

Avoid wrinkles. If your limb feels numb or tingling, remove it and speak to your physiotherapist/nurse.

Wash it daily and leave it to dry overnight before wearing it.



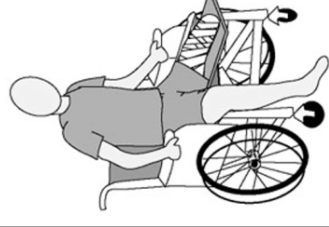
*If you do not have a compression sock, bandages may be applied to reduce swelling. It is important that this is done by someone who has been taught.*

**Elevating your limb** (keeping it up)

## Positioning

Sitting, lying or standing in a good position is important to reduce swelling in your limb and prevent your muscles becoming tight.

## 9 Positions that are good:



## Things to Remember when Bandaging

Wrap fabric snugly to prevent loosening and wrinkles

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Don't wrap in circles, wrap in a diagonal pattern

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Spread layers out evenly top to bottom

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Make sure the bandage is firmer at the bottom than the top

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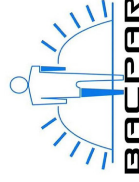
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Replace and reapply the bandage every four hours

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## Applying an Elasticated Bandage following Amputation

It is important that the person who is applying the bandage has the skills to apply the bandage.

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If the bandage is not applied correctly, it may be more harmful than if there is no bandage at all (e.g. it is difficult to make sure the pressure is distributed correctly).

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Make sure the bandage is changed every 3-4 hours and the limb is monitored. They must be kept clean.

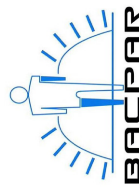
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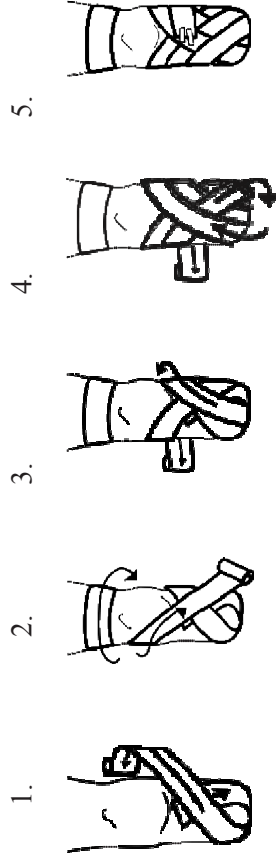
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## Following Lower Limb Amputation

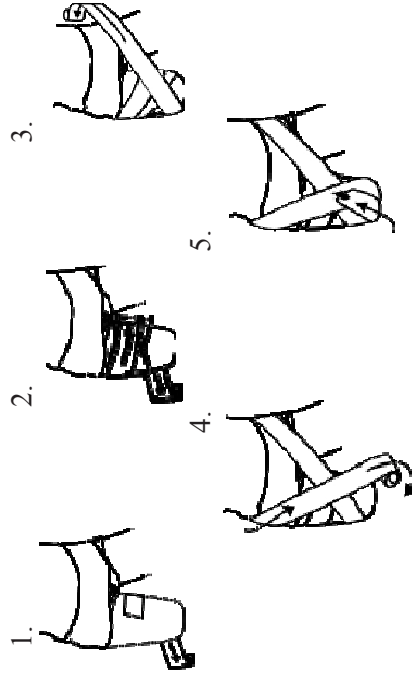
Bandaging for a Below Knee Amputation



Always bandage up to the knee and above

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Bandaging for an Above Knee Amputation



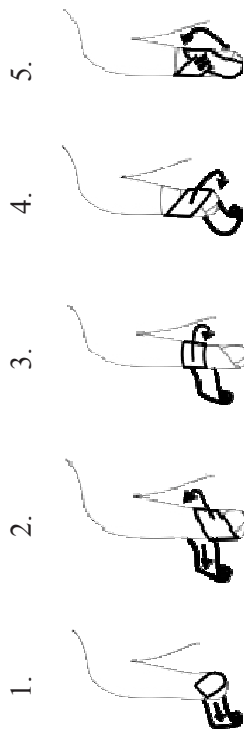
Always bandage up to the groin. Include all of the skin and tissue of the inner thigh and groin.

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## Following Upper Limb Amputation

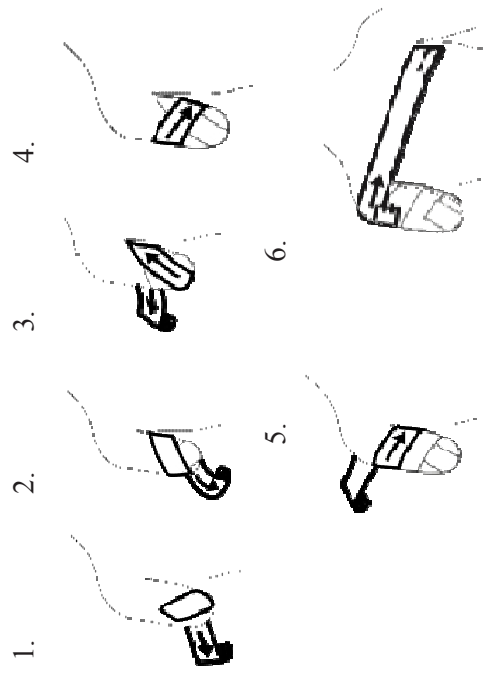
Bandaging for a Below Elbow Amputation



Always bandage above the elbow

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Bandaging for an Above Elbow Amputation



Always bandage above the elbow

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## Autonomic Dysreflexia Alert and Information Card

*Carry this card at all times. Show it to a doctor to explain Autonomic Dysreflexia.*

..... has a spinal cord injury and is susceptible to a condition called Autonomic Dysreflexia (or Autonomic Hyperreflexia). This occurs as a result of painful stimuli in a part of the body in which there is no sensation. Due to an exaggerated response by the autonomic nervous system blood vessels throughout the body constrict and forces a sudden surge of blood pressure causing it to rise. The blood pressure will continue to rise until the painful stimulus is removed. There is a risk of a stroke (a bleed in the brain tissues.) This is unique to spinal cord injury and will affect a person with a lesion above T6 vertebra. An increase of 20 mm/hg in BP **above the baseline** of normal blood pressure may indicate an episode of autonomic dysreflexia.

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### **THIS IS A MEDICAL EMERGENCY. IF NOT TREATED IT WILL LEAD TO DEATH**

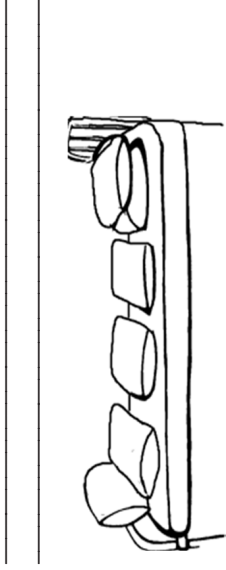
Some signs and symptoms of Autonomic Dysreflexia \_\_\_\_\_

- Pounding headache \_\_\_\_\_
- Light headedness, dizziness or confusion \_\_\_\_\_
- Profuse sweating in areas of sensation \_\_\_\_\_
- Blotches or rashes in areas of sensation \_\_\_\_\_
- Very high blood pressure \_\_\_\_\_
- Irregular or racing heart rate \_\_\_\_\_

If Autonomic Dysreflexia /Autonomic Hyperreflexia is suspected the following steps must be taken:

1. Monitor Blood Pressure
2. Sit up or better still, stand up if possible.
3. Check all possible causes of the painful stimulus such as pressure areas on skin, in-growing toe nails, broken bones, infections? Treat the problem immediately and remove the cause of the problem. Check urinary catheter is flowing freely.
4. Be sure bowels are empty, if bowel care is required administer sub lingual anti-hypertensive medication (e.g. Nifedipine (10mg) or Glycerine Trinitrate - GTN). Only use digital stimulation after giving medication and waiting 15 minutes before performing bowel evacuation.
5. If BP continues to rise and no cause is identified administer the anti-hypertensive medication to manage the symptoms.

You should make sure that when you leave the hospital you have an appropriate mattress and cushion where you are going.



A mattress must offer support to the body. The mattress must not be too soft so that the body touches the base of the bed underneath the mattress. A big wrinkle may cause a pressure ulcer. If the sheets become wet or dirty have them changed. Lying on wet or dirty sheets will cause a pressure ulcer.

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Leaflets created by Handicap International and ACPIN based on materials developed by Motivation Charitable Trust, UK.



## Looking After Your Skin after a Spinal Cord Injury

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When able bodied people sit in the same position, after a short while they will feel uncomfortable. This feeling of discomfort is a warning signal from the body to encourage action to relieve the pressure. For most people this is automatic and happens without the person even noticing what they are doing. When skin sensation and movement are impaired or lost (as in spinal cord injury) these warning signals to move are lost. Without regularly changing position, pressure builds and and skin breakdown, or pressure ulcers, occur. Although these are painless they are very dangerous.

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### **WARNING!**

**A PRESSURE ULCER CAN DEVELOP IN ONLY A FEW HOURS**

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## What is a pressure ulcer?

A pressure ulcer is an area of damaged skin and flesh. A pressure ulcer is **usually** caused by pressure from sitting or lying in the same position for too long without moving. It can however be from friction (rubbing) from sliding, trauma, or moisture.

## Prevention of pressure ulcers

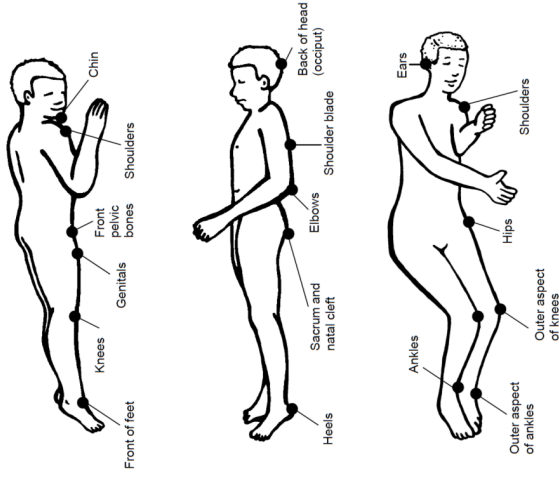
The best way to avoid a pressure ulcer is to move frequently. Do not lie or sit in the same position for too long.

**The only way to prevent pressure ulcers is to AVOID the cause. Prevention is better than treatment.**

The following is a list of extra guidelines that will help avoid pressure ulcers:

- Observe the skin for signs of breakdown
- Using pressure relieving equipment (mattresses, pillows and cushions once off bedrest)
- Using the correct positioning in bed
- Build up skin tolerance by gradually increasing the time spent in each position
- Having an adequate balanced diet and fluid intake
- Keeping the skin clean and dry
- Avoiding trauma and insect bites
- Avoiding infections

Where are pressure ulcers likely to occur?  
Lying



As you can see from these pictures the majority of ulcers occur over bony prominences. That does not mean that pressure ulcers cannot occur on other parts of the body. For example, there can be pressure caused by rubbing from a urinary catheter.

## Observe

While in hospital the nurse should check your skin every time your position is changed (normally every 2 hours)

Before you go home, you and/or your family should be shown how to check your skin

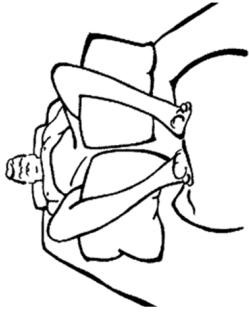
When checking skin check all areas. Start at the head and work down to the toes, looking for:

- Signs of discoloration, red or dark depending on skin colour
- Heat in the discoloured area
- Skin dryness
- Skin moisture
- Blanching (capillary refill / flushing)
- Lumps and hardness
- Skin folds for cleanliness
- Skin rashes, bruising, blistering etc.



Self checking for pressure ulcers

Frog \_\_\_\_\_



Good for:

- people with **stable** thoracic or lumbar or an unstable cervical injuries
- contractures of the hip
- airing the groin if a skin rash is present
- pressure ulcers on the knee
- pressure ulcer on the groin or testicles

Running \_\_\_\_\_



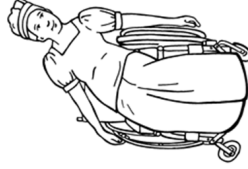
Good for:

- people with **stable** injuries
- pressure ulcer on the sacrum or ischium
- pressure ulcer on the back of the shoulder
- pressure ulcer on the hip (opposite one to the one they are lying on)
- pressure ulcer on the back of the head
- paraplegic practising self turning

When ready to start sitting out or using a wheelchair it is still important to continue to change position.

The longer they sit in one area the greater the risk of pressure ulcers

**Initially pressure relief in sitting should be done for 2 consecutive minutes every hour. See examples below**



Lifting, bending forward, leaning to the side, or lifting up will qualify as a pressure relief. This should become automatic after a while but initially people may need some prompting.

## POSITIONING TO PREVENT PRESSURE PROBLEMS

The positions you should use will depend on your type of injury and any pressure ulcers you may already have. Your team will indicate which positions are best for you here.

### Positioning when you have an unstable spinal cord injury

A suitable position is one that will minimise the amount of pressure going through a weight bearing bone. The use of mattresses, cushions and pillows will assist in positioning.

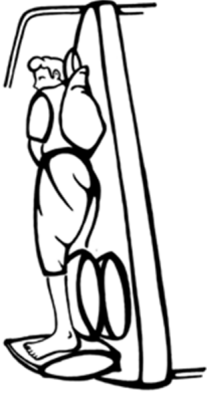
• All position changes must maintain spinal alignment to prevent further damage to the cord.

• Regular position changes from back and side to side will prevent pressure build up.

• Gradually build up skin tolerance (toughening the skin); starting with changing position every three hours (day and night), and if no marks, increase to four.



Full roll



Good for:

- people with **unstable thoracic or lumbar injuries**
- pressure ulcer on the sacrum
- pressure ulcer on the hip (opposite one to the one they are lying on)

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Hip twist



Good for:

- **unstable or stable cervical injuries**
- shoulder contractures
- pressure ulcer on the hip

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### Positioning when you have a stable spinal cord injury

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Consider:

- Skin tolerance
- Position of any pressure ulcers
- Contractures

### Summary of positions to choose from

Once your spine is stable, you can use all of the unstable positions but also lie on your back or tummy using extra pillows for comfort and pressure relief:

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Supine (with pillows)



Good for:

- people with **stable injuries**
- pressure ulcer on the sacrum (if sacrum is between 2 pillows)
- pressure ulcer on the hip
- pressure ulcer on the back of the heels
- pressure ulcer on the knees
- hip contractures

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Prone



Good for:

- people with **stable injuries**
- pressure ulcers (single or multiple) on the back of the body
- pressure ulcer on the hip
- pressure ulcer on the back of the heel
- pressure ulcer on the back of the shoulder
- pressure ulcer on the ischium
- hip contractures
- severe spasms

### If you notice a red mark

If you notice a new mark then you should avoid lying or sitting on that area until the mark clears.

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Once the mark has cleared gradually build up skin tolerance again, starting with 15 minutes on that side.

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For example, for a mark on your right hip, avoid lying on that side and lie on your back and left side instead until the mark clears.

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## What you need to do \_\_\_\_\_

- **PROTECT YOUR SKIN FROM INJURY** \_\_\_\_\_

- **CHECK YOUR SKIN EVERYDAY**

For signs of burns, wounds, blisters or infection \_\_\_\_\_

- **MASSAGE ANY SCARS FROM INJURY OR SURGERY**

Try to do this 4 times during the day for 5 minutes at least \_\_\_\_\_

- **DO YOUR EXERCISES** \_\_\_\_\_

- **WEAR YOUR SPLINT/CAST** \_\_\_\_\_

- **DO NOT SMOKE** \_\_\_\_\_

**Remember** it may take up to 2 years for your nerve to recover. you can make a real difference by continuing with these exercises and advice even when it feels like nothing is changing. \_\_\_\_\_



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## Understanding your Peripheral Nerve Injury

**Nerves have three functions:** \_\_\_\_\_

1. What you can feel \_\_\_\_\_
2. Telling your muscles to work and creating movement \_\_\_\_\_
3. Control how your skin sweats, help temperature control and provide texture to your skin \_\_\_\_\_

**Following injury** any one of these functions may be affected or all three. This depends on which nerve has been injured and where it has been injured in your body as each nerve looks after different areas of muscle and skin. \_\_\_\_\_

**This may mean** you have difficulty moving certain parts of your body and/or feeling different areas. \_\_\_\_\_

**You may also notice** the area affected does not sweat as much and the skin becomes quite dry. \_\_\_\_\_



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## About recovery

Nerves are able to recover following injury but this can be a slow process and may not be a one hundred percent recovery. It may be **2 years** before the final result is achieved.

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**Nerves re-grow slowly** from the point where they have been injured and move down towards your hand or foot. Feeling and movement will gradually recover as the nerve re-grows.

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While this happens you feel nothing in the areas affected or sensations like:

- Tingling (pins and needles) \_\_\_\_\_
- The area feels normal on and off but doesn't last \_\_\_\_\_
- Normal sensations can feel more sensitive. \_\_\_\_\_



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## What you need to do

### AVOID RISKS

- **Further Injury**

- Be aware when using hot/cold objects; for example when cooking, using fire/flames, using hot water
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- Until your nerve has recovered remember **you cannot feel anything** including flames or boiling water which will still injure your skin
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- **Stiff Joints**

- Because some of your muscles are not working at the moment your joints can become stiff and difficult to stretch
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- If you let your joints become stiff you will not be able to move them well again even if your nerve recovers fully
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The aim of the external fixator is to make it easier to be independent. If you use a walking frame or crutches, you can wear loose clothing over the frame. It is important to be as active as possible in your recovery and as independent as possible. It can be tiring but try to make a daily routine to keep yourself busy and involved in daily life, and avoid spending your time lying down if at all possible.

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Follow these guidelines below to make sure you take the good care of your frame and pin sites.

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**Before you are discharged, make sure you know**

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The number of weeks you are expected to be in an external fixator or plaster

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If there are any restrictions on what you can do

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And if so, how long these last for

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If you should attend somewhere for rehabilitation

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If there are any exercises you should be doing

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The date and location of your next follow up appointment

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Possible signs and symptoms of complications related to your injury and what to do about them \_\_\_\_\_

Make sure you have a summary of your medical notes, xrays or discharge plan before you leave the hospital \_\_\_\_\_

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**It is important to make routine checks to identify any infection or complications, and tell your doctor if you notice any signs of infection.**

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**New or increasing pain**

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**Very oozy pus or a bad smell from your wound**

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**New swelling around the pin sites or in the area**

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**Redness spreading across skin**

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**If you start to feel unwell or have a fever**

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What do you need to do once you are discharged?

Check the fixator for any loose parts each day

Check for signs of infection each day

Clean the pin sites and the limb as you have been shown

Look after your nails and skin – cut nails as needed, and put moisturising cream on any dry skin or closed scars

Do any exercises you have been given each day to stay strong and help with swelling and circulation

Try to eat healthily and avoid smoking to encourage healing

***If you find any signs of infection see a doctor for advice. You may need to take some tablets or have the frame looked at by an expert***

Follow the advice of the doctor and if you are given any tablets take them as instructed

When cleaning the infected area, be aware to not spread the infection. Clean each pin site separately with new materials and destroy used materials.

Remember that an infection can be very dangerous. See a doctor as soon as you can!

## Looking After Your External Fixator

It is important to have some basic information and know-how for you to care for your frame and pin sites - here are some key points. It is useful to make sure that your caregiver also knows this information.

The frame is the external device to correct, lengthen or shorten your limb to allow healing to occur. Pins and wires go through the skin, muscle and bone to hold the limb in the best position for healing.

You need to check daily that the wires and pins are not loose and the joints, nuts and bolts are tight and the check that the frame is clean and free from dirt and old dressings to be sure that it is doing its job.

Taking care of the frame and pins will reduce the risk of infection into the frame and pin. Infection will delay tissue and bone healing and recovery of both wound and fracture sites.

## If you have a skin graft

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A skin graft is where skin is taken from one part of your body to cover a wound in another area. It will have been needed to help you heal properly.

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The place it came from should heal normally with 1-2 weeks. It might be painful for the first few days but improves quickly. The skin may look slightly lighter than normal once it is healed.

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The place it has been put will heal in the same way as a wound.

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Your doctor will tell you how quickly you can start moving the area where the graft has been placed.

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## Your Discharge

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Before you go home, make sure you know:

- If you need to come back
  - When your dressing should be changed
  - How often to take your medication
  - What exercises you need to do and how to do them
- 
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## Looking after your wound or skin graft

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Having a large wound can be scary for you, but there are lots of tips that can help you care for it that will help your recovery. The most important thing is to follow the advice of your doctor.

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If you have problems with any of these you should tell your doctor immediately:

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- Fever
- Being sick or having diarrhea
- If pain increases

Or if your dressing becomes:

- Wet, dirty or smelly
  - If it falls off or is loose
  - If the wound oozes through the dressing
- 

If the wound is:

- More Red or swollen
- Oozing green or yellow fluid
- Smelly
- Getting more painful
- Bleeding a lot

## Bandages\_\_\_\_\_

Every injury is different so it is important that you know when your bandages need to be changed. It's possible that someone will teach you how to change the bandages yourself \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Try to keep your bandages clean and dry, this will help the wound to heal and avoid any risk of infection. If there is a lot of bleeding or oozing through the dressings, let your doctor know.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Exercises\_\_\_\_\_

You might be seen by a physiotherapist or occupational therapist who will give you exercises and maybe a splint (something to keep your body in one position). These are very important to ensure that you don't lose movement. Follow their advice carefully  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Pain\_\_\_\_\_

Tell the doctor if you have pain. We can give you medicine that will make a huge difference to any pain you might have. Take this as instructed, as it is important to reduce your pain so you can move as normally as possible.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Try to take pain relief to help with dressing changes or exercises  
\_\_\_\_\_  
\_\_\_\_\_

## Scarring\_\_\_\_\_

After a large burn or wound, you will get some scarring. This will improve slowly over time and can continue to change for 2 years. It might get itchy, and can get very dry. There might be areas where there is no feeling.  
\_\_\_\_\_  
\_\_\_\_\_

If over time your scar becomes very red and itchy and grows bigger then tell someone in your team or visit a doctor for advice \_\_\_\_\_  
\_\_\_\_\_

## Once the wound is closed and dry, there are some

things you can do to help reduce the scarring and the itchiness:

- Apply a moisturising cream 2-3 times a day. The hospital might be able to give you some \_\_\_\_\_
- If your team say it is ok, you can start massaging the area using the cream \_\_\_\_\_
- You might need to protect your scar using sun cream – your doctor will tell you this \_\_\_\_\_

## Helping you heal \_\_\_\_\_

There are some things you can do to help yourself to heal well: \_\_\_\_\_

- Don't smoke \_\_\_\_\_
- Try to eat healthily \_\_\_\_\_
- Keep moving as much as possible \_\_\_\_\_
- Follow your exercises \_\_\_\_\_
- Take your pain medication as told \_\_\_\_\_
- Use cream regularly once healed \_\_\_\_\_
- Massage the area as you have been shown \_\_\_\_\_



## Advice for patients following mild to moderate brain injury

Effects of brain injury aren't always obvious to others, but can significantly affect people's lives and the lives of their family/caregivers. Effects can include:

### Physical \_\_\_\_\_

Weakness on one side of the body, including the face \_\_\_\_\_

Dizziness and balance problems \_\_\_\_\_

Fatigue \_\_\_\_\_

Nausea/Vomiting \_\_\_\_\_

Sensitivity to light \_\_\_\_\_

Visual disturbance (double vision, blurred vision) \_\_\_\_\_

Seizures or absences \_\_\_\_\_

Headaches \_\_\_\_\_

Sleep disturbance \_\_\_\_\_

### Cognitive \_\_\_\_\_

Attention and concentration problems \_\_\_\_\_

Decision making problems \_\_\_\_\_

Memory problems \_\_\_\_\_

Problem-solving difficulties \_\_\_\_\_

Communication difficulties \_\_\_\_\_

Information processing difficulties \_\_\_\_\_

Planning and organisation difficulties \_\_\_\_\_

### Emotional and Behaviour \_\_\_\_\_

Anger \_\_\_\_\_

Apathy/loss of motivation \_\_\_\_\_

Impulsivity and self-control problems \_\_\_\_\_

Mood swings \_\_\_\_\_

Restlessness \_\_\_\_\_

Anxiety \_\_\_\_\_

Depression \_\_\_\_\_

Irritability \_\_\_\_\_

Personality changes \_\_\_\_\_



**Social and personal problems** \_\_\_\_\_

Domestic activities like making a drink or getting dressed

Difficulty with driving, making it unsafe to operate a vehicle

Employment problems, e.g. inability to carry out previous duties effectively, finding work more tiring \_\_\_\_\_

Independence loss \_\_\_\_\_

Personal and sexual relationship problems \_\_\_\_\_

Self-esteem problems \_\_\_\_\_

Social interaction problems \_\_\_\_\_

**If you notice any symptoms in addition to the ones known by the medical team, please inform the team!**

**What is involved in rehabilitation?** \_\_\_\_\_

When the brain is damaged, it is unable to regenerate itself. However, it is possible for other areas of the brain to take over functions. It is important that people who experience any of the above symptoms are seen by an appropriately skilled healthcare professional who will try to help the brain to find the most efficient ways of working in order to minimise the long-term effect of the brain injury. These can include (delete as appropriate):

Physiotherapist \_\_\_\_\_

Occupational Therapist \_\_\_\_\_

Psychologist \_\_\_\_\_

Counsellor/peer support worker \_\_\_\_\_

Speech and Language Therapist \_\_\_\_\_

Social Worker \_\_\_\_\_

The exact type of rehabilitation that each patient receives will depend on what symptoms they present with and local service availability. For example, someone who has a weakness will normally receive therapy that will work towards strengthening the weak parts of the body. This may involve specifically training the arm or leg, as well as practicing sitting, standing and walking if appropriate.



Someone who has memory problems will work with the therapist to try and improve their memory and also develop strategies that compensate for the memory impairment.

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**How long will the symptoms last?** \_\_\_\_\_

It is not possible to say how long the symptoms will last, as this will be different for everybody. Some people have no remaining symptoms after a few days, other people have symptoms for several weeks, months or longer. Not everybody will make a full recovery and some people will need help carrying out everyday tasks for the rest of their life. However, the appropriate healthcare professionals will work with the patient and their family either in hospital or at home until the patient has achieved their maximum level of function and independence. If the patient stops making progress in their rehabilitation programme but still has deficits following their brain injury, the therapists will work with the family so that they are able to cope with any remaining disabilities and support the patient as needed.

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Sometimes the patient will be provided with specialist equipment in order to be able to function independently, such as an ankle splint, or the family will be given equipment, such as a wheelchair, in order to be able to safely assist the patient in moving around.

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When all the rehabilitation goals have been achieved, or there is no longer any improvement in function, the patient will be discharged from rehabilitation with details of who to contact if they need further help or advice in the future.

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## Advice for patients following concussion

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Common symptoms of concussion that do not require medical attention include:

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Headache \_\_\_\_\_

Sleep disturbance \_\_\_\_\_

Disorientation \_\_\_\_\_

Dizzy/nauseous \_\_\_\_\_

Fatigue \_\_\_\_\_

Irritability \_\_\_\_\_

Difficulty concentrating \_\_\_\_\_

Difficulty remembering \_\_\_\_\_

However, if the above symptoms are getting worse you do need to seek medical attention. \_\_\_\_\_

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**DO NOT** stay at home alone for the first 24 hours after leaving hospital

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**For the next week or until your symptoms resolve:**

DO make sure you stay within easy reach of a telephone and medical help

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DO have plenty of rest and avoid stressful situations

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DO NOT take any alcohol or drugs

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DO NOT take sleeping pills, sedatives or tranquilisers unless they are given by a doctor.





If you or your family notice any of the **below** symptoms, you need to **seek medical help immediately**:

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Unconsciousness, or lack of full consciousness (for example, problems keeping eyes open) \_\_\_\_\_

Drowsiness (feeling sleepy) that goes on for longer than 1 hour when you would normally be wide awake \_\_\_\_\_

Problems understanding or speaking \_\_\_\_\_

Loss of balance or problems walking \_\_\_\_\_

Weakness in one or more arms or legs \_\_\_\_\_

Problems with your eyesight \_\_\_\_\_

Painful headache that won't go away \_\_\_\_\_

Vomiting (being sick) \_\_\_\_\_

Seizures (also known as convulsions or fits) \_\_\_\_\_

Clear fluid coming out of your ear or nose \_\_\_\_\_

Bleeding from one or both ears \_\_\_\_\_

# Self-Rated Confidences





## Self-Assessed Confidence

As therapy staff on the register may be required to work alone without direct supervision, it is essential that they are able to carry out their work safely and effectively with the required skill, knowledge and experience. This form allows you to assess your own confidence to see if further training is required before you are ready to deploy. We will also use this data to tailor our training to meet the needs of register members.

Confidence	YES/NO	Recommended Action
Have you ever worked with this patient group as a qualified therapist?		If No must arrange for workplace experience/external training in the UK before being ready to deploy
Have you worked with acute patients with this condition in the past 2 years?		If No - recommend attend top up training
Have you worked with non-acute patients with this condition in the past 2 years?		If No - recommend attend top up training
Do you feel confident to assess a patient post amputation including multi limb loss and poly trauma?		If No - recommend attend top up training
Are you confident to be able to identify indicators for suitability of a prosthetic limb?		If No - recommend attend top up training
Do you feel confident in your ability to physically prepare someone for amputation?		If No - recommend attend top up training
Do you feel confident in your ability to measure and fit a compression sock or compression bandaging?		If No - recommend attend top up training
Do you feel confident in your ability to teach specific transfers for amputees including multi limb loss or poly trauma?		If No - recommend attend top up training
Do you feel confident in your ability to assess and manage post op oedema?		If No - recommend attend top up training
Do you feel confident in your ability to give advice on falls and strategies to get up from the floor?		If No - recommend attend top up training
Do you feel confident in your ability competent to assess and manage pain (stump and phantom)?		If No - recommend attend top up training
Do you feel confident in your ability to problem solve functional activities?		If No - recommend attend top up training

### Outcome:

- Self assessed as confident
- Top up Training Required
- Top up Training Required and additional clinical experience/training.

Signed \_\_\_\_\_ Therapist Name \_\_\_\_\_



## Amputation - Personal Action Plan

**Current Situation:**

**Ideal Situation:**

*Within the next .... I would like to ....*

**Steps to success:**

**SWOT Analysis:**

***Strengths***

***Weaknesses***

***Opportunities***

***Threats***

**Name** \_\_\_\_\_

**Date:** \_\_\_\_\_



### Self-Assessed Confidence

As therapy staff on the register may be required to work alone without direct supervision, it is essential that they are able to carry out their work safely and effectively with the required skill, knowledge and experience. This form allows you to assess your own confidence to see if further training or experience is required before you are ready to deploy. We will also use this data to tailor our training to meet the needs of register members.

Skill or Experience	YES/NO	Recommended Action
Have you ever worked with this patient group as a qualified therapist?		Arrange for workplace experience/external training in the UK before being ready to deploy
Have you worked with acute patients with this condition in the past 2 years?		If no – recommend attend top up training
Have you worked with non-acute patients with this condition in the past 2 years?		If no – recommend attend top up training
Can you safely handle a patient with an acute spinal injury		If no – recommend attend top up training
Can you identify symptoms of autonomic dysreflexia and respond appropriately?		If no – recommend attend top up training
Are you aware of key bladder and bowel concerns for SCI patients and their treatments		If no – recommend attend top up training
Would you feel confident to assess an acute SCI patient		If no – recommend attend top up training
Would you feel confident developing a treatment plan for an SCI patient?		If no – recommend attend top up training
Could you teach a patient and their carers a plan to prevent or treat pressure sores?		If no – recommend attend top up training
Could you safely provide respiratory PT, included assisted cough, for a non-ventilated patient with an acute SCI?		If no – recommend attend top up training
Can you identify the likely functional outcome of different levels of injury?		If no – recommend attend top up training
Could you fit an emergency motivation wheelchair for an SCI patient?		In no must attend further motivation training.
Are there any other areas you do not feel confident in? Please specify		

**Outcome:**

- Self assessed as confident
- Top up Training Required
- Top up Training Required and additional clinical experience/training.

Signed \_\_\_\_\_ Therapist Name \_\_\_\_\_



## Spinal Cord Injury - Personal Action Plan

**Current Situation:**

**Ideal Situation:**

*Within the next .... I would like to ....*

**Steps to success:**

**SWOT Analysis:**

***Strengths***

***Weaknesses***

***Opportunities***

***Threats***

**Name** \_\_\_\_\_

**Date:** \_\_\_\_\_



## Self-Assessed Confidence

As therapy staff on the register may be required to work alone without direct supervision, it is essential that they are able to carry out their work safely and effectively with the required skill, knowledge and experience. This form allows you to rate your own confidence to see if further training is required before you are ready to deploy. Training places will in part be allocated based on the results of this assessment.

ACTION	YES/NO	ACTION
Have you ever worked with this patient group as a qualified therapist?		If No recommend workplace experience/external training in the UK before being ready to deploy
Have you worked with acute patients with this condition in the past 2 years?		If No recommend attend top up training
Have you worked with non-acute patients with this condition in the past 2 years?		If No recommend attend top up training
Can you identify signs & symptoms of peripheral nerve injury, specific to each nerve?		If No must review anatomy and landmarks
Would you feel confident in fabrication of POP casts to protect an acute peripheral nerve injury specific to each nerve?		If No recommend attend top up training
Would you feel confident in fabrication of POP casts to prevent secondary contracture following peripheral nerve injury, specific to each nerve?		If No recommend attend top up training
Would you feel confident developing a treatment plan for peripheral nerve injury patients?		If No - recommend work based experience
Could you teach a patient and their carers a plan to re-educate motor and sensory function?		If No - recommend work based experience
Can you identify the likely functional outcome & timescale of different levels of peripheral nerve injury?		If No recommend further reading
Are there any other areas you do not feel confident in? Please specify		

### Outcome:

- Self-Assessed as Confident
- Top up Training Required
- Top up Training Required and additional clinical experience/training.

Signed \_\_\_\_\_ Therapist Name \_\_\_\_\_



## Peripheral Nerve Injury - Personal Action Plan

**Current Situation:**

**Ideal Situation:**

*Within the next .... I would like to ....*

**Steps to success:**

**SWOT Analysis:**

***Strengths***

***Weaknesses***

***Opportunities***

***Threats***

**Name** \_\_\_\_\_

**Date:** \_\_\_\_\_



## Self-Assessed Confidence

As therapy staff on the register may be required to work alone without direct supervision, it is essential that they are able to carry out their work safely and effectively with the required skill, knowledge and experience. This form allows you to assess your own competency to see if further training is required before you are ready to deploy. Training places will in part be allocated based on the results of this assessment.

ACTION	YES/NO	ACTION
Have you ever worked with this patient group as a qualified therapist?		If No - recommend arrange for workplace experience/external training in the UK before being ready to deploy
Have you worked with acute patients with this condition in the past 2 years?		If No - recommend work based experience
Have you worked with non-acute patients with this condition in the past 2 years?		If No - recommend work based experience
Can you confidently recall the main types of trauma fractures and their restrictions?		If No - recommend further reading
Could you identify signs of complications of orthopaedic trauma and advise on solutions?		If No - recommend further reading
Could you assess an adult patient's post orthopaedic injury including poly trauma and make a treatment plan?		If No - recommend work based experience
Would you rate yourself as confident to progress early rehab and measure the progression for an adult (in bed)?		If No - recommend work based experience
Could you assess a child's post orthopaedic injury including poly trauma and make a treatment plan?		If No - recommend work based experience
Could you assess the anatomical impact of an external fixator and make a treatment plan accordingly?		If No - recommend work based experience
Are you confident to assess a patient for suitability to mobilise safely post operatively?		If No - recommend work based experience
Could you provide general fitness, balance and fine motor activities to adults and children?		If No - recommend work based experience
Could you prepare protocols for specific injuries for patients to use when in their home-based setting?		If No - recommend work based experience
Are you confident in your ability to teach patients and carers sets of exercises and functional activities?		If No - recommend work based experience
Are you confident in your ability to problem solve functional activities?		If No - recommend work based experience
Are there any other areas you do not feel confident in? Please specify		

### Outcome:

- Self assessed as confident
- Top up Training Required
- Top up Training Required and additional clinical experience/training.

Signed \_\_\_\_\_ Therapist Name \_\_\_\_\_

## Fracture – Personal Action Plan

**Current Situation:**

**Ideal Situation:**

*Within the next .... I would like to ....*

**Steps to success:**

**SWOT Analysis:**

***Strengths***

***Weaknesses***

***Opportunities***

***Threats***

**Name** \_\_\_\_\_

**Date:** \_\_\_\_\_

## Self-Assessed Confidence

As therapy staff on the register may be required to work alone without direct supervision, it is essential that they are able to carry out their work safely and effectively with the required skill, knowledge and experience. This form allows you to assess your own confidence to see if further training is required before you are ready to deploy. Training places will in part be allocated based on the results of this assessment.

ACTION	YES/NO	ACTION
Have you ever worked with this patient group as a qualified therapist?		If No - recommend arrange for workplace experience/external training in the UK before being ready to deploy
Have you worked with acute patients with this condition in the past 2 years?		If No - recommend work based experience
Have you worked with non-acute patients with this condition in the past 2 years?		If No - recommend work based experience
Do you understand the relevance of healing times and appropriate treatment intervention based on burn depth and general medical/surgical condition of the burns patient		If No - recommend work based experience
Are you confident in your ability to recognise the depth of a burn?		If No - recommend work based experience
Do you understand how and when not to over-treat or under-treat a burn patient with regard to rehabilitation / scar management provision?		If No - recommend work based experience
Are you confident to be able to advise on correct positioning for a burn or significant soft tissue injury?		If No - recommend work based experience
Would you be able to provide basic splinting?		If No - recommend attend top up training
Would you be confident to prescribe exercise and stretching for the burn patient?		If No - recommend work based experience
Could you provide basic respiratory care for a burn patient post inhalation injury?		If No – recommend seek training within own workplace/external
Could you provide basic scar management?		If No - recommend work based experience
Could you provide post op therapy for patients post skin graft or reconstructive surgery?		If No - recommend work based experience
Are there any other areas you do not feel confident in? Please specify		

### Outcome:

- Self-Assessed as Confident**
- Top up Training Recommended**
- Top up Training Recommended and additional clinical experience/training.**

Signed \_\_\_\_\_ Therapist Name \_\_\_\_\_

## Burns & Soft Tissue – Personal Action Plan

**Current Situation:**

**Ideal Situation:**

*Within the next .... I would like to ....*

**Steps to success:**

**SWOT Analysis:**

***Strengths***

***Weaknesses***

***Opportunities***

***Threats***

**Name** \_\_\_\_\_

**Date:** \_\_\_\_\_



### Self-Assessed Confidence

As therapy staff on the register may be required to work alone without direct supervision, it is essential that they are able to carry out their work safely and effectively with the required skill, knowledge and experience. This form allows you to assess your own confidence to see if further training or experience is required before you are ready to deploy. We will also use this data to tailor our training to meet the needs of register members.

Skill or Experience	YES/NO	Recommended Action
Have you ever worked with this patient group as a qualified therapist?		Arrange for workplace experience/external training in the UK before being ready to deploy
Have you worked with acute patients with this condition in the past 2 years?		If no try to arrange further clinical experience
Have you worked with non-acute patients with this condition in the past 2 years?		If no try to arrange further clinical experience
Do you feel confident to recognise the symptoms suggestive of a deteriorating brain injury?		If no try to arrange further training or self directed learning
Would you feel confident to know what to do if you suspected a patient had a brain injury and was deteriorating?		If no try to arrange further training or self directed learning
Do you feel confident in understanding and giving advice on mild brain injury?		If no try to arrange further training or self directed learning
Would you feel confident to assess a patient with an acquired brain injury?		If no try to arrange further clinical experience
Would you feel confident developing a treatment plan for a patient with an acquired brain injury?		If no try to arrange further clinical experience
Could you teach a patient and their carers a plan to prevent or treat contractures due to spasticity?		If no try to arrange further clinical experience
Could you safely provide respiratory PT for a patient with an acute acquired brain injury?		If no try to arrange further clinical experience
Would you feel confident to discuss other impacts of acquired brain injury other than the physical deficits?		If no try to arrange further clinical experience
Could you identify when a swallow assessment would be needed?		If no try to arrange further clinical experience
Do you feel confident to give advice to carers of or people who may lack capacity to make certain decisions or who are vulnerable to exploitation?		If no try to arrange further experience.
Are there any other areas you do not feel confident in? Please specify		

**Outcome:**

- Self assessed as confident**
- Further Training Required and additional clinical experience/training.**

Signed \_\_\_\_\_ Therapist Name \_\_\_\_\_



## Acquired Brain Injury - Personal Action Plan

<p><b>Current Situation:</b></p>
<p><b>Ideal Situation:</b></p> <p><i>Within the next .... I would like to ....</i></p>
<p><b>Steps to success:</b></p>
<p><b>SWOT Analysis:</b></p> <p><i>Strengths</i></p> <p><i>Weaknesses</i></p> <p><i>Opportunities</i></p> <p><i>Threats</i></p>

Name \_\_\_\_\_

Date: \_\_\_\_\_

# Cheat Sheets

## Amputation Rehabilitation

Guidance for therapy staff in a field hospital environment, on the immediate treatment of patients with amputation of upper or lower limbs, assuming delayed primary closure (DPC) of wound. For more detail & specific treatment options refer to the Amputation Rehabilitation in Humanitarian Emergencies Manual.

### Communication

Liaise with

- HI
- Surgical team (hospital team)
- On-going/later stage rehab team (e.g Prosthetist re; availability of prostheses, OT)
- Resources for basic needs (water, sanitation, food, shelter)
- Family (cultural/religious considerations, survivors, others injured)

Initiate longer term planning for individual patients and development of rehabilitation service

- Local resources post UKIETR involvement – HI, local or other? Training needs?
- Local health services for provision and maintenance of prostheses
- Local DPOs
- Incoming international staff

### Pre-amp preparation (if possible). Refer to Manual sections for Upper & Lower limb, including multiple limb loss.

- Assessment of patient; including use of WHODAS as outcome measure
- Discussion of amputation level with surgical team & Prosthetist, dependent on type of prosthesis available
- Liaise with surgical team re management plan, particularly pain management
- Education of patient & family, cultural & religious considerations, survivors, others injured
- Discuss rehab process with patient, establish patient's priorities and demonstrate prosthesis
- Collection of equipment for post-op (wheelchair/crutches/stump board)

### Post-amputation early rehab. Refer to relevant Manual sections

- Assessment (continuing from pre-amp or initial)
- Liaise with surgical team re management of DPC, pain relief, discharge planning
- Pain management
- Oedema management; stump elevation, compression socks when indicated (see patient advice leaflets)
- Positioning to prevent contractures, pressure sores and reduce oedema
- Education and psychological support/manage expectations, set goals related to patients' environment
- Start active exercises (see patient advice leaflet) for residuum and whole body as soon as possible
- Handling residuum/massage/desensitisation/adjusting to body image
- Transfers/Bed mobility/ Mobilise with wheelchair/crutches
- Encourage ADL/independence/functional ability
- Treat concurrent injuries



**Check daily for**

- Signs of infection
- DVT
- Delayed healing
- Concurrent injuries
- Mental state
- Chest complications
- Pressure sores
- Pain
- Compartment syndrome
- Heterotrophic ossification

**Pain management**

- Modalities available
  - Drug therapy
  - Physio interventions
  - Self help
  - Education
- Liaise with surgical team
- Accurately assess pain; PLP, sensation, stump pain
- Appropriate analgesia prior to physio treatment

**Promote healing**

- Liaise re dressing changes
- Oedema control
- Nutrition
- Check for infection, additional tissue damage
- Scar management, including harvest sites for skin grafts
- Psychological wellbeing of patient

**Pre-Prosthetic management. Refer to relevant Manual sections.**

- Oedema management/compression
- Pain management
- Prevention of contractures
- Promotion of healing
- Treat concurrent injuries as necessary
- Increase range of movement and muscle strength (see patient advice sheets)
- Improve posture/balance/mobility/function
- Promote ADL & independence, including on/off floor
- Education of patient & family; psychological support
- Issue of equipment & teaching safe use
- Preparation for discharge to rehab unit or community
- Assessment for suitability of prosthetic limb, refer as early as possible, as appropriate
- Preparation for prosthetic fitting and use
- Outcome measures

**Exercises**

- To prevent contractures
- Maintain & improve
  - joint ROM
  - muscle strength
  - core strength
  - Cardiovascular fitness
- Improve mobility & function

**Oedema management**

- Elevation/Positioning
- Active exercise
- compression

See patient advice leaflets

**Patient education**

- Safe use of aids & equipment
- Information on prosthetic process
- Psychological support
- Family involvement
- Discharge plan

See patient advice leaflets

**Factors to consider when assessing for prosthetic use (consider use of predictive Outcome Measures)**

- Patient's goals & priorities and Motivation
- Physical ability, Achievement of agreed rehab goals
- Concurrent injuries/co-morbidities
- Home & cultural circumstances
- Availability of prosthetics

**Consider alternatives if a prosthesis is not appropriate/suitable**



## Spinal Cord Injury Management

Guidance for therapy staff in a field hospital environment on the immediate management of patients with Spinal Cord Injury, including cauda equina lesions. For more detail & specific treatment options refer to the SCI section in the Humanitarian Emergencies Manual.

### Initial Assessment

<b>Database</b>	<ul style="list-style-type: none"> <li>• Spinal fractures</li> <li>• Spinal level of spinal cord lesion Neurological level of injury</li> <li>• Spinal stability, liaise with surgical team Turning guidelines</li> <li>• Associated injuries</li> <li>• Respiratory status</li> <li>• Neurogenic and Spinal shock- absent reflexes</li> </ul>
<b>Subjective</b>	<ul style="list-style-type: none"> <li>• Pre morbid musculo-skeletal problems</li> <li>• PMH: relevant respiratory factors, BMI,</li> <li>• Social History (smoker, family, work, cultural beliefs, language)</li> </ul>
<b>Objective</b>	<ul style="list-style-type: none"> <li>• Respiratory status (including FVC and cough) (Hough 2001).</li> <li>• Passive range of movement of all joints(with precautions)</li> <li>• Active movement (with precautions)</li> <li>• Muscle strength: standard muscle chart (MRC,1978) Oxford grading scale and ISNCSCI Chart (2011) establish ASIA Impairment classification</li> <li>• Tone: Modified Ashworth Scale (Bohannon &amp; Smith, 1987)</li> <li>• Sensory especially pin prick sensation (ASIA 2002).</li> <li>• Joint range</li> <li>• Other injuries/ tissue viability issues.</li> </ul>

### Communication

Liaise with

- HI or other local rehabilitation coordinators
- Surgical team (hospital team) and Nursing team to establish stability and management.
- Resources for basic needs (water, sanitation, food, shelter)
- Family/friends (cultural/religious considerations, survivors, others injured)
- Interpreters
- ASAP consider on-going/later stage rehab team (e.g wheelchair provision, mattress, positioning and seating)

Initiate longer term planning for individual patients and development of rehabilitation service

- Local resources post acute involvement – HI, local or other? Training needs? Is there specialist SCI centre?
- Link to local health services for ongoing rehabilitation or care, provision and maintenance of aids
- Local DPOs and psycho-social support coordinators
- Incoming international staff

*Written records*

*Outcome measures*

*Data collection*



### Pre-operative spinal fixation

- Assessment of patient; identify single neurological level. (USB ISNCSCI/ASIA)
- Establish expected respiratory management for post op.(USB Resp parameters)
- Liaise with surgical team re management plan, particularly pain management.
- Establish positioning management for 24 hour plan. (USB NICE Guidelines 2014)
- Education of patient & family, cultural & religious considerations, survivors, others injured
- Discuss rehab process with patient, establish patient's priorities.
- Collection of equipment for post-op (corset/wheelchair/crutches/transfer board, splints)

### Post-operative spinal fixation - early rehab (Refer to relevant manual sections)

- Assessment (continuing from pre-op or initial)
- Liaise with surgical team re management of spinal stability/precautions, (USB ATLS Guidelines)
- Discharge planning
- Pain management
- Respiratory assessment post operatively and establish treatment plan (FVC/PCF/MAC)
- Skin management coordinate positioning with respiratory management and BP
- Prevent contractures, pressure sores and reduce oedema
- Liaise regarding bladder and bowel management (USB MASCIP bowel guidelines)
- Education and psychological support/manage expectations, set goals related to patients' environment
- Initiate strengthening exercises to facilitate active movement, minimise muscle imbalance and maintain joint ROM.
- Spasticity management.
- Transfers/Bed mobility/ Mobilise with wheelchair/crutches
- Assess PADL/independence/functional ability
- Treat concurrent injuries

### Check daily for

- Respiratory compromise
- Changes in neurological status.
- Pressure sores
- Loss of joint range of movement
- Concurrent injuries
- Mental state
- Pain
- Neurogenic shock
- Autonomic Dysreflexia
- Heterotrophic ossification

### Pain management

- Modalities available
  - Drug therapy
  - Physio interventions
  - Self help
  - Education
  - Relaxation/visualisation
- Liaise with surgical team
- Accurately assess pain; PLP, sensation, neuropathic pain
- Appropriate analgesia prior to physio treatment

### Facilitation of potential long term recovery

- Spasticity management
- Splinting
- FES (if locally available)
- Psychological wellbeing of patient (consider peer to peer or group support)
- Mental imagery of movement pattern
- Sensory stimulation (hands)



### Rehabilitation (Refer to relevant manual sections)

- Liaise with team re: diagnosis and prognosis
- Liaise with surgeons re: stability / bracing
- Pain management
- Facilitate positioning for pressure relief
- Treat concurrent injuries as necessary
- Facilitation of active movement and manage muscle imbalance
- Maintain painfree range of movement and prevention of contractures
- Improve muscle strength
- Spasticity management
- Improve posture/balance/mobility/function/ transfers
- Promote ADL & independence, including on/off floor
- Education of patient & family; psychological support
- Issue of wheelchair/ equipment & teaching safe use
- Preparation for discharge to rehab unit or community
- Assessment for potential standing programme
- Outcome measures (consider SCIM for an injury specific measure)

### Posture management

- Seating
- Skin management
- Limb positioning
- See patient advice leaflets

### Exercises

- To prevent contractures
- Minimise pain and muscle imbalance
- Maintain & improve:
  - joint ROM
  - Muscle strength
  - Cardiovascular fitness
- Improve mobility & function

### Patient education

- Safe use of aids & equipment
- Information on skin, bladder, bowels
- AD
- Spasticity/Joint ROM management
- Signs of heterotrophic ossification
- Psychological support
- Family involvement
- Discharge plan



## Rehabilitation in hand/forearm tendon repair

Guidance for therapy staff in a field hospital or humanitarian rehabilitation environment, on the treatment of patients who have undergone tendon repair in the hand or forearm. This information sheet is intended as a general guide only, and can be used in conjunction with training materials from the UKIETR splinting workshop.

### General Tendon Repair Information

The anatomy of the tendons/muscles of the hand and forearm are sectioned into zones which is particularly relevant when clinicians are discussing/describing exactly what has been repaired. If you do get to see an operation note you may find the following information on it:

- Specific tendons injured and which have been repaired (repair is not always possible so bare that in mind). Almost always the full anatomical name will not be written so I've added a cheat sheet at the end to help.
- Specific nerves injured and repaired. In the hand/forearm this could be main peripheral nerve, digital nerve or written as neurovascular bundle (the digital nerve and digital artery combined)
- The zone of tendon/muscle repair – see below for more detail
- Percentage of tendon divided and repaired – not all tendons/nerves are 100% lacerations
- The type of suture material and it's size; e.g. 4.0 vicryl, 6.0 prolene, 9.0 ethibond etc
- Type of suture technique. There will often be details of the core suture and an epitendinous suture
- Any difficulties encountered which could include details of contaminated wound, weak repair, tight repair etc

The really key bits of info for you in this context will be what has been repaired, where in the hand/forearm and are there any other structures involved (skin coverage, fracture or combined flexor and extensor tendon injury).

Skin sutures ideally need to be removed at 10-14 days post surgery so if you are seeing anyone after this stage and the skin sutures are still present they can be removed.

As soon as sutures removed and wound healed scar massage can be completed and is really important to have any chance at regaining good range of movement. It will also aide in desensitisation.



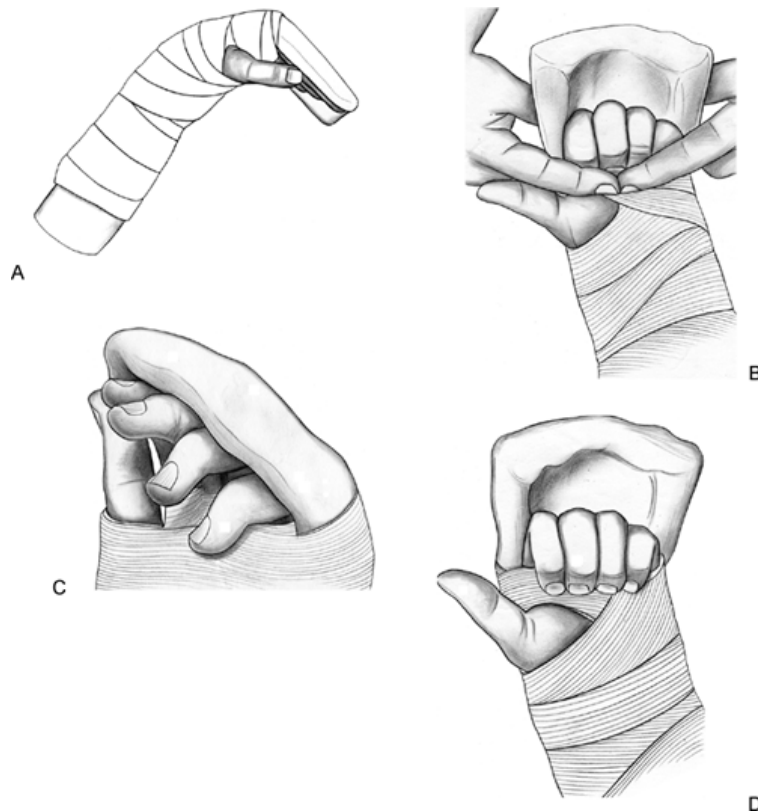
## Flexor Tendon

For acute rehab the zone of injury (level of injury) for a flexor tendon does not make a massive difference other than indicating what other structures you need to bear in mind; e.g. wrist and proximal you may have to think about a main peripheral nerve injury in relation to sensory and motor supply.

This is an extremely basic/key point over view of what you can/can't do at key stages in recovery.

### First 4 weeks post-op

- Splint/cast stays on at all times (see image A for safe position above)



- Full passive flexion is safe for wrist and all digits; image B (complete x5 per day x5 reps)
- Full active flexion is safe for wrist and all digits; image D (complete x5 per day x5 reps)
- Active extension of wrist and digits to protection of splint is safe; image C where the fingers can be as extended as patient able within splint (complete x5 per day x5 reps)
- DO NOT passively extend wrist or digits
- DO NOT use for function
- DO NOT remove splint/cast



#### 4 weeks post-op

- Remove splint/cast in day (if possible need to continue night use for further 2 weeks)
- Full active movement is now safe if patient capable of achieving this
- No passive extension until 8 weeks following surgery
- OK to begin functional use but try to avoid clenching fist tightly or heavy lifting (heavy lifting is OK at 12 weeks post-op ideally)

#### Extensor Tendon

The zone of injury **does** make a difference in the rehab of extensor tendon repair. For ease I have split these into 2 more simple versions and provided you with what is completely safe rather than some of the more technical rehab techniques that you could do:

#### *Injuries from forearm through to base of proximal phalanx level (zone IV-VIII)*

#### First 4 weeks post-op



- Splint/cast stays on at all times
- The wrist and digits can be passively and actively moved into full extension away from the splint/cast (complete x5 per day x5 reps)
- If able passively extend the wrist and actively flex the PIP and DIP joints only – 4<sup>th</sup> image in row above
- If able passively extend the wrist and actively flex the MCP joints only - 3<sup>rd</sup> image in row above
- DO NOT make a full fist - flexing all joints of the fingers at the same time
- DO NOT remove the splint/cast
- DO NOT use for function

If it is just the wrist extensors that have been repaired the patient can wear a wrist cast with the digits free for 4 weeks and do not worry about teaching them any specific exercises until the splint/cast comes off.



If the thumb extensor tendons are injured leave the patient in the splint for 4 weeks with no specific exercises until the cast is removed. Thumb extensor rehab is a bit more involved and in this circumstance leaving the patient in the cast will be safer to do.

#### **4 weeks post-op**

- Remove splint/cast in day (if possible need to continue night use for further 2 weeks)
- Full active movement is now safe if patient is capable of achieving this
- No passive flexion until 6 weeks post-op
- OK to begin functional use but try to avoid clenching fist tightly or heavy lifting (heavy lifting is OK at 12 weeks post-op ideally)

#### ***Injuries from head of mid-proximal phalanx to end of finger (zones I-III inclusive)***

The anatomy in this area is significantly more complex and there are various ways of treating these injuries dependent on level of injury within the finger. This is the safest way to treat these injuries with limited or no hand therapy experience

#### **First 6 weeks post-op**

- Wear a splint that keeps the small joints of the finger in full extension (or as close as you can get to full extension) at all times. The patient can remove it to clean the finger and complete scar massage but must support the joints in extension.
- If the injury is over the PIP joint removal of splint for maximum 45 degrees flexion will be safe and may gain better movement outcome but if you are at all unsure keep the patient still in the splint.

#### **6 weeks post-op**

- Remove splint/cast in day (if possible need to continue night use for further 2 weeks)
- Full active movement is now safe if patient is capable of achieving this
- No full passive flexion until 8 weeks post-op but if the patient is very stiff can start passive flexion up to mid range
- OK to involve injured digit in function but no tight fist clenching until 12 weeks post-op

#### **COMBINED INJURY (Including Crush Or Replantation)**

These are too variable for me to give you a guide but here are some key points:

Maintaining vascular integrity, stable skeleton and adequate skin coverage are the most important features with tendon and nerve integrity coming in second as these are easier to reconstruct at a later date and will not affect survival of the limb/hand. In this setting I would recommend not doing any movement until 7-10 days following surgery. This movement will be dictated by what orthopaedic stabilisation has been carried out e.g. obviously fusion or k-wires crossing joints prevents movement. If you are able to move a joint go for active movement and mid-range.





## Useful Terms

FDP	Flexor Digitorum Profundus
FDS	Flexor Digitorum Superficialis
FPL	Flexor Pollicis Longus
FPB	Flexor Pollicis Brevis
FDM	Flexor Digiti Minimi
ODM	Opponens Digiti Minimi
ADM	Abductor Digiti Minimi
OP	Opponens Pollicis
APB	Abductor Pollicis Brevis
APL	Abductor Pollicis Longus
EPB	Extensor Pollicis Brevis
EPL	Extensor Pollicis Longus
ECRL	Extensor Carpi Radialis Longus
ECRB	Extensor Carpi Radialis Brevis
EPL	Extensor Pollicis Longus
EI	Extensor Indicis (also known as EIP – Extensor Indicis Proprius)
ED	Extensor Digitorum (also known as EDC – Extensor Digitorum Communis)
ECU	Extensor Carpi Ulnaris
CDN	Common Digital Nerve
UDN	Ulna Digital Nerve
RDN	Radial Digital Nerve
NVB	NeuroVascular Bundle



## Lower Limb Peripheral Nerve Injury Quick Guide

Guidance for therapy staff in a field hospital or humanitarian rehabilitation environment, on the motor and sensory supply of key peripheral nerves. This information sheet is intended as a quick reference tool only, and should be used in conjunction with training materials from the UKIETR core training.

### General Peripheral Nerve Injury Information

It is important to remember that level of injury will affect the presentation of a peripheral nerve injury therefore the motor supplies detailed below go from most proximal to most distal. This will help you establish level of injury and/or establish any recovery. Anatomy may vary from person to person but the detail in this document is the most common presentation.

### Sciatic Nerve Supply

Commonly injured by direct trauma or compression with the more distal divisions being significantly affected by external fixator fixation of tibia fractures. Most common observation will be foot drop.

#### Motor supply (before division):

- Hamstrings

#### Tibial nerve motor supply:

- Gastrocnemius
- Popliteus
- Soleus
- Tibialis posterior
- Flexor digitorum longus
- Flexor hallucis longus
- Abductor hallucis
- Flexor digitorum brevis
- Flexor hallucis brevis
- Foot lumbricals
- Quadratus plantae
- Flexor digit minimi
- Adductor hallucis
- Foot interossei
- Abductor digiti minimi

#### Common peroneal motor supply:

- Short head biceps femoris

#### Deep peroneal motor supply:

- Tibialis anterior
- Extensor digitorum longus
- Peroneus tertius
- Extensor hallucis longus
- Extensor digitorum brevis (lateral terminal branch)
- Extensor hallucis brevis (lateral terminal branch)

#### Superficial peroneal motor supply:

- Peroneus longus
- Peroneus brevis



## General Femoral Nerve Supply

Commonly secondary injury following femoral or pelvic fractures, which includes crush injury and bleeding within the pelvis. Key point to observe will be wasting of quads.

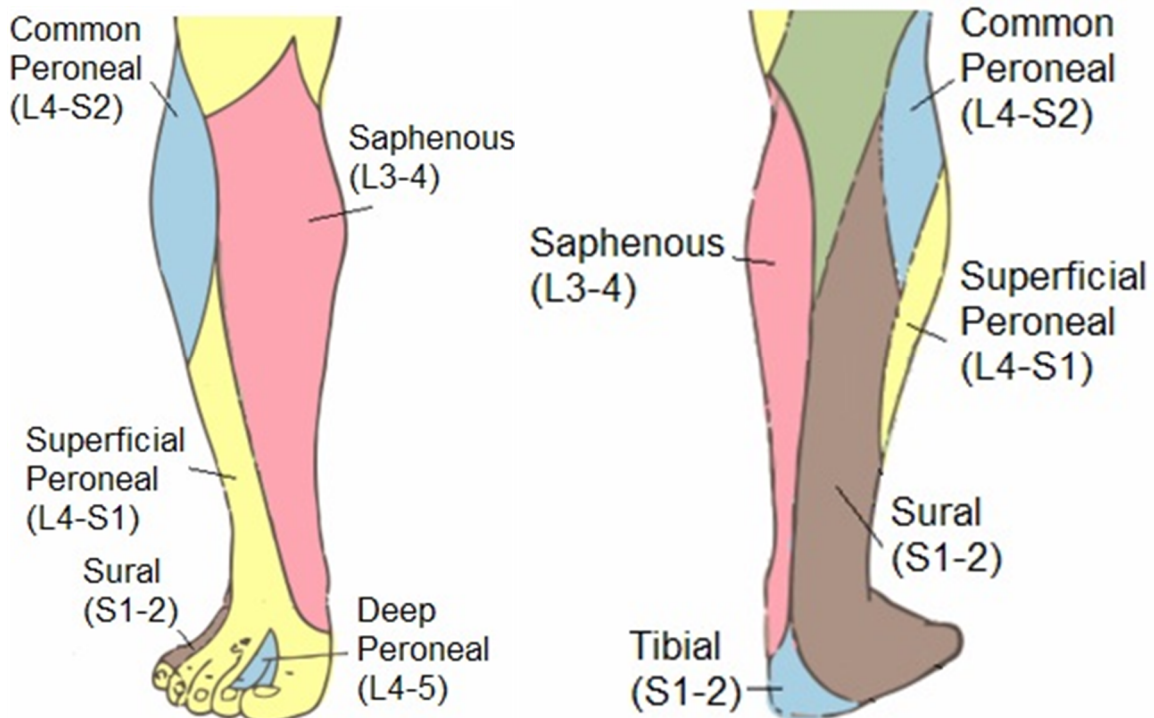
### Motor supply:

- Sartorius
- Pectineus
- Quadriceps

### Sensory supply:

- Anteromedial aspect of lower leg
- Anterior patella region

## Sensory Supply - Lower Leg and Foot





## Upper Limb Peripheral Nerve Injury Quick Guide

Guidance for therapy staff in a field hospital or humanitarian rehabilitation environment, on the motor and sensory supply of key peripheral nerves. This information sheet is intended as a quick reference tool only, and should be used in conjunction with training materials from the UKIETR core training.

### General Peripheral Nerve Injury Information

It is important to remember that level of injury will affect the presentation of a peripheral nerve injury therefore the motor supplies detailed below go from most proximal to most distal. This will help you establish level of injury and/or establish any recovery. Anatomy may vary from person to person but the detail in this document is the most common presentation.

### Median Nerve Supply

Injury to this nerve may cause significant functional impairment due to the affect on sensation to the thumb and the motor supply in relation to opposition of the thumb to the other digits. Key observation point will be wasting of the thenar eminence.

#### Motor supply:

- Pronator teres
- Flexor carpi radialis (FCR)
- Flexor digitorum superficialis (FDS)
- Palmaris longus
- Anconeus
- Flexor pollicis longus (FPL)
- Flexor digitorum profundus to index and middle (FDP)
- Pronator quadratus
- Abductor pollicis brevis (APB)
- Flexor pollicis brevis (FPB)
- Opponens pollicis
- 1<sup>st</sup> & 2<sup>nd</sup> lumbricals

### Ulnar Nerve Supply

Key observation points will be wasting of the hypothenar eminence. Be aware that clawing of the little and ring fingers will only be present in ulna nerve injuries distal to the FDP motor supply. High level injuries will not demonstrate clawing until the motor supply has regenerated to the FDP muscle bellies.

#### Motor supply:

- Flexor carpi ulnaris (FCU)
- Flexor digitorum profundus to ring and little (FDP)
- Abductor digit minimi (ADM)
- Flexor digit minimi (FDM)
- Opponens digit minimi (ODM)
- 3<sup>rd</sup> & 4<sup>th</sup> lumbricals
- Palmar interossei
- Dorsal interossei
- Adductor pollicis
- Flexor pollicis brevis – deep head only (FPB)



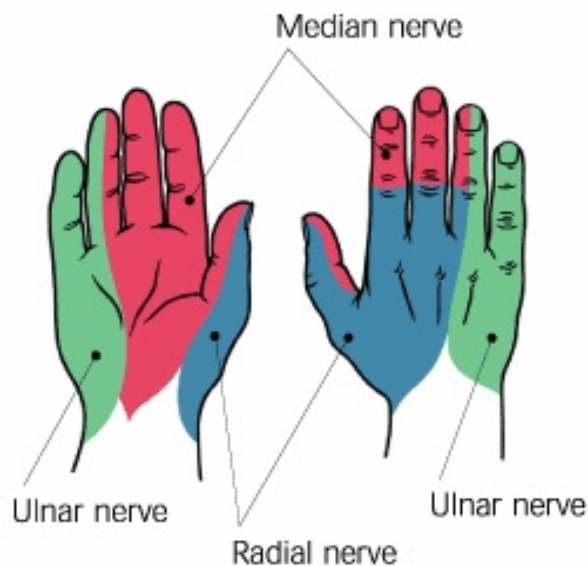
## Radial Nerve Supply

Key observation point will be wrist drop for injuries at the level of the extensor muscle bellies or higher. Remember the main radial nerve branches at the proximal forearm into the posterior interosseus nerve (motor only) and the superficial branch (sensory only).

### Motor supply:

- Brachialis – contribution
- Triceps
- Brachioradialis
- Extensor carpi radialis longus (ECRL)
- Extensor carpi radialis brevis (ECRB)
- Supinator
- Extensor carpi ulnaris (ECU)
- Extensor digitorum communis (EDC)
- Extensor digiti minimi (EDM)
- Abductor pollicis longus (APL)
- Extensor pollicis brevis (EPB)
- Extensor indicis proprius (EIP)
- Extensor pollicis longus (EPL)

## Sensory Supply



### Fracture Complications

Guidance for therapy staff in a field hospital environment on the recognition of and action for various fracture complications typically seen in emergency settings. For further details on fracture management please see relevant section of the rehabilitation manual.

Complication	Pathophysiology	Signs and Symptoms	Therapist Actions
Deep Vein Thrombosis	Multiple causes – in fractures it can be caused by inactivity due to a fracture and/or blood vessel damage, both of which slow the flow of blood which increases risk of clotting. The formation of a clot within the vessel causes obstruction to blood flow.	Heat Swelling Redness Localised pain and tenderness increased by dorsiflexion of the ankle. Commonly in the calf but can occur elsewhere.	Inform the doctors urgently – it can result in a pulmonary embolus.  Treatment – anticoagulation.
Fat Embolism	Following a fracture, bone marrow may be exposed which allows fat droplets to enter the blood supply. These droplets can then travel around the body and occlude blood vessels – most notably the lungs or brain.  More common in long bone or pelvis fractures. Also seen with significant soft tissue injury and major burns.	Symptoms normally present 24-72 hours post injury.  Altered mental state/GCS. For example – irritability, agitation, confusion, headaches, seizures, coma.  Increased respiratory rate, hypoxia, shortness of breath or difficulty breathing.	Prevention – early stabilisation and fixation of fractures.  Inform medical team. Management depends on severity and nature of symptoms. If respiratory symptoms ensure adequate oxygenation. If severe, they may require ventilation if available.  No direct treatment for the embolus intervention is supportive while the body naturally absorbs it.

Complication	Pathophysiology	Signs and Symptoms	Therapist Actions
Pulmonary Embolism	Caused by occlusion of the pulmonary artery usually by a clot. This prevents the flow of blood to the lungs.	Shortness of breath – sudden or gradual onset. Chest pain – usually worse on inspiration.	Inform doctors urgently – can be life threatening. Symptoms may vary in severity depending on the size of the clot.  Treatment – anticoagulation.
Compartment Syndrome	Following an injury, swelling and bleeding may occur within a compartment, commonly a limb or the abdomen.  The fascia surrounding a compartment is formed of tough connective tissue and is therefore unable to stretch to accommodate the increased volume within the compartment. As a result pressure rises and blood flow to the tissues within the compartment is restricted.  In acute compartment syndrome, if the pressure is not relieved immediately it can result in severe tissue damage or necrosis.  Compartment syndrome is associated with fractures, significant soft tissue injury and crush syndrome.	Intense pain, disproportionate to the injury itself. Pain increases with use or stretch of the muscle involved.  Skin paraesthesia – tingling or burning.  Numbness or paralysis – late signs indicating permanent damage.  Palpation – the area feels tight and perhaps warm.	Inform doctors/surgeons.  This is a surgical emergency and requires a fasciotomy to release the pressure within the compartment.  There may be a delay in wound closure if swelling is severe. Skin grafts may be required.

Complication	Pathophysiology	Signs and Symptoms	Therapist Actions
Crush Syndrome	<p>Occurs when the mechanism of trauma results in someone being trapped or crushed for a period of time.</p> <p>Muscle injury and muscle necrosis are caused by the initial trauma, subsequent ischaemia from sustained pressure on the muscle, and compromise blood flow to the muscle by obstruction of major vessels. Muscles can tolerate 2 hours of ischemia, after 4-6 hours necrosis develops.</p> <p>When pressure is removed from the area re-perfusions results in toxins being released into the blood stream. The toxins cause metabolic imbalance and organ failure. The most immediate concern is cardiac dysrhythmia due to hyperkalaemia. Renal complications are however the more serious concern. Acute kidney injury following crush injuries is commonly a leading cause of death.</p>	<p>Suspicion of crush syndrome is raised based upon the mechanism of injury and the length entrapment time.</p> <p>They may appear stable and alert prior to being extricated.</p> <p>Medical intervention should ideally begin prior to extrication.</p>	<p>Unlikely to be involved acutely.</p> <p>Post-extrication be aware of the signs of crush injury. Monitoring of physiological observations, blood results and vascular supply of the affected limb should be done.</p>
Peripheral Nerve Injury	Nerve injury due to direct insult during trauma, by the displaced fractured bones, following surgical procedures or due to vascular compromise.	Altered neurological assessment – sensation and power.	See peripheral nerve injury resources for further information.



Complication	Pathophysiology	Signs and Symptoms	Therapist Actions
Blood loss	<p>Particularly common with femoral and pelvic fractures as they are well vascularised bones. Increased risk with complex or multiple injuries that also involve soft tissue/vascular structure.</p> <p>With significant blood loss (&gt;20%) they may go into hypovolemic shock. The body will compensate by peripheral vasoconstriction and reducing blood flow to the gut.</p>	<p>Reduced capillary re-fill</p> <p>Rapid heart rate, potentially weak and thread</p> <p>Low blood pressure</p> <p>Low temperature</p> <p>Reduced or no urine output</p> <p>Pallor</p> <p>Increased respiratory rate</p> <p>General weakness and malaise</p> <p>Cool, clammy skin</p>	<p>Liaise with doctors – may require transfusion or fluids to increase blood volume and medication to support blood pressure.</p> <p>Source of bleeding should be identified and managed.</p>
Growth Plate (Physis) Fracture	<p>More common in fingers, ulna, radius, tibia and fibula. Fracture occurs at the physis as it is the weakest area in the bone structure of a child. They are classified by the Salter-Harris Classification system.</p> <p>Children heal faster than adults and therefore require orthopaedic review as soon as possible. This is particularly important if the fracture is not aligned.</p> <p>The long-term complications include:</p> <ul style="list-style-type: none"> <li>• A bony bridge may form within the growth plate, preventing growth and causing curvature of the bone.</li> <li>• The fracture can stimulate growth, resulting in the injured bone being longer than the uninjured side.</li> </ul> <p>Both require surgery to correct.</p>	<p>Normal fracture signs and symptoms perhaps with pain and swelling localised to the ends of the involved bone.</p>	<p>Management depends on the classification of the fracture. The aims are to: restore alignment, protect and immobilise while to bone heals. In the UK they often have internal fixations or for more simple cases a plaster cast.</p> <p>Follow up is recommended in the year (and potentially longer) following fracture to monitor growth.</p> <p>Physiotherapy – standard post fracture management. Education for patient and family regarding abnormalities to look out for.</p>

Complication	Pathophysiology	Signs and Symptoms	Therapist Actions
<p>Delayed/Non-union</p>	<p>Delayed union caused by compromised blood supply, infection and poor immobilisation.</p> <p>Non-union caused by loss of bone tissue, soft tissue interposition, a pathological process, poor blood supply, infection, fracture traction, inadequate immobilisation.</p> <p>Risk factors:</p> <ul style="list-style-type: none"> <li>• Smoking</li> <li>• Older age</li> <li>• Anaemia</li> <li>• Diabetes</li> <li>• Poor nutrition</li> <li>• Anti-inflammatory medication</li> <li>• Infection</li> <li>• Complex fracture pattern</li> </ul>	<p>Tenderness or pain at the fracture site beyond the time of expected healing</p> <p>Movement on the bone fragments at the fracture site</p> <p>Visible fracture line on x-ray.</p>	<p>Problems with initial management should be corrected – e.g. fracture alignment and immobilisation. Risk factors should be minimised as possible.</p> <p>They patient may require surgical fixation or bone grafting if available.</p> <p>Physiotherapy should aim to promote healing and educate the patient.</p>
<p>Avascular necrosis</p>	<p>Caused by compromise of blood supply to a bone following trauma. This results in cell death and change in bone structure which can lead to collapse of the bone.</p> <p>Risk is increased by smoking, pregnancy, bone marrow and blood disorders, diabetes and vascular disease.</p>	<p>The condition is painless until it influences a joint. In a weight bearing joint the patient may complain of pain on weight bearing and have a limb.</p> <p>Changes on x-ray indicated progressed disease and are a late sign. Early changes are seen on MRI.</p>	<p>Treatment aims are to preserve the affected joint. E.g. reduce weight bearing, address contributing factors such as smoking, manage underlying disease well.</p> <p>Further intervention requires surgery.</p>

Complication	Pathophysiology	Signs and Symptoms	Therapist Actions
Infection	<p>Caused by bacteria entering the body due to an open fracture or, less commonly, as a result of surgery.</p> <p>Risk of infection is increased in the presence of chronic disease such as diabetes and HIV. It is also increased by smoking, obesity, poor nutrition and poor hygiene.</p>	<p>Signs and symptoms include the following being seen above what is normal post fracture:</p> <ul style="list-style-type: none"> <li>• Warmth</li> <li>• Redness</li> <li>• Increased pain</li> <li>• Swelling</li> <li>• Stiffness if the infection is within the joint</li> <li>• Pus</li> <li>• Systemic signs e.g. increase temperature</li> </ul>	<p>Antibiotics are required as well as cleaning of the wound and potential debridement.</p> <p>Physiotherapy – inform doctors/nurse if signs of infection are noted, educate patient and family of what to look out for.</p>
Complex Regional Pain Syndrome	Chronic pain presentation associated with peripheral and central nervous system changes.	<p>Symptoms include:</p> <ul style="list-style-type: none"> <li>• Hyperalgesia</li> <li>• Allodynia</li> <li>• Parasthesia</li> <li>• Altered skin colour and texture e.g. shiny skin, mottled etc</li> <li>• Altered sweating response</li> <li>• Hair and nail changes</li> <li>• Swelling and inflammation</li> </ul>	<p>Management should ideally take an MDT approach. It should include:</p> <ul style="list-style-type: none"> <li>• Education, aiming for self-management</li> <li>• Desensitization of affected limb.</li> <li>• Mirror therapy</li> <li>• Exercise</li> <li>• Psychological support</li> </ul>

Complication	Pathophysiology	Signs and Symptoms	Therapist Actions
Bed sores	More common in disaster setting secondary to prolonged bed rest and lack of pressure relieving knowledge/care.	<p>Grade 1 – superficial ulcer, red in Caucasian people, purple/blue in people of darker skin, may be itchy or sore.</p> <p>Grade 2 – appears like an open wound or blister, damage to the epidermis and dermis.</p> <p>Grade 3 – deep cavity-like wound, full thickness damage to the skin but no damage to underlying muscle or bone.</p> <p>Grade 4 – skin is severely damaged with necrosis of surrounding tissue, underlying muscle or bone may also be affected. Risk of life threatening infection is high.</p>	<p>Management – prevention is the best policy! Education for staff, patients and family. Positioning regime to minimise risk, especially for immobile patients or those on bed rest.</p> <p>Nursing wound care for those with skin break down.</p>

## Physical Rehabilitation of Burns Injuries

Guidance for therapy staff in a field hospital environment on the immediate treatment and early physical rehabilitation of patients with burns and soft tissue injuries. For more detail & specific treatment options refer to the Burns and Soft Tissue Rehabilitation Section in the manual and to the info in the resource file..

### Prevention of Burns: Prevention is our first responsibility and better than cure

**Primary Prevention** – Prevent the injury. Identify common local causes of burns - educate and increase awareness.

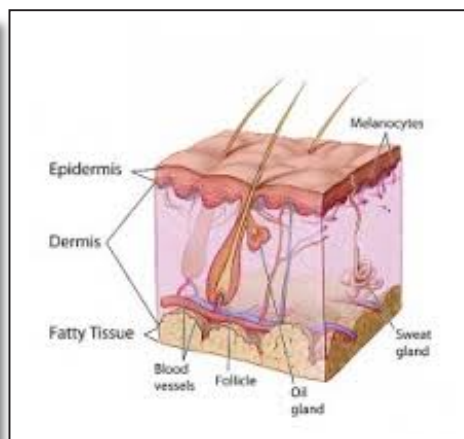
**Secondary Prevention** – First Aid. Flush area with clean water for 20 minutes. Keep the patient warm; do not put ointment on the wound, cover burn with a clean sheet or similar. Transport to the relevant health care facility ASAP. Encourage the patient to take fluids.

**Tertiary Prevention** – Prevent morbidity and mortality post injury. Therapists have greatest influence here. Aim to completely prevent loss of range of movement and contractures for your patient

#### Cause of Burn

Refer to manual for characteristics of each cause:

- **Flame** - ? Inhalation injury
- **Electrical** - ? Cardiac
- **Scald**
- **Chemical** –? Eye damage



#### Area of Burn (Measured by Total Body Surface Area burned = TBSA %)

See manual for charts - Rule of Nines / Lund and Browder Chart  
TBSA % is used to calculate fluid requirements and with depth of burn is the biggest predictor of survival and final outcome

**Minor burn** = children under 10%, adults under 15% TBSA,  
**Moderate burn** up to 30% TBSA  
**Major burn** over 30% TBSA

### Burn Depth (Note: Wounds can deepen e.g. due to infection, lack of nutrition, poor handling)

Thickness	Depth	Characteristics	Healing	Scarring
Superficial	Epidermis	Moist, red, blanches and refills on pressure, blisters	<14 days	Not expected
Superficial Partial (SPT)	Epidermis & more superficial dermis	Difficult to differentiate Pink/White/Mottled/cherry red if deeper	3-5 Weeks DPT may need <i>grafting</i>	Burns that heal in less than 3 weeks without grafting are unlikely to cause any problematic scar
Deep Partial(DPT)	Epidermis & deep into dermis			Healing >3 weeks likely to visibly scar - contracture risk
Full Thickness (FTB)	Epidermis and dermis destroyed, structures under	Tight, white & charred If circumferential – can have tourniquet effect & escharotomy needed	Should be excised and <i>grafted</i>	Very severe, Contracture risk

## Emergency Care of Burns

- Assess A, B, C, D, E, F = airway, breathing, circulation, disability (no associated trauma e.g. head injury), exposure (assess area and depth of burn injury), fluids (calculate and administer fluid requirements)
- Any signs of inhalation injury may require prophylactic intubation, followed by chest physio
- Fluid resuscitation to prevent hypovolemic shock is urgently required for all burns over 10% in a child and 15% in an adult
- Emergency escharotomy may be necessary with circumferential full thickness burns to limbs and thorax

## PTs/OTs role in the emergency phase (admission and 48-72 hours following):

1. **Assist** where instructed if appropriate
2. **Positioning** (see manual for specific instruction/diagrams)
  - Oedema prevention / reduction (elevate)
  - Good positioning for prevention of contractures / pressure sores and comfort
  - To maximise ventilation and secretion clearance
  - Fabricate splints if necessary to maintain correct positioning
3. **Respiratory care**
  - Required if inhalation injury – patient may be ventilated – maximise lung ventilation and clear excessive secretions
4. **Once the patient is stable and if priority tasks for the patient are not being interrupted**
  - Commence with active / passive ROM and mobilise as appropriate.

## PTs/OTs role after 72 hours:

Ongoing **respiratory** management

**Position correctly** when at rest

**Splint** as necessary

**Oedema** management

**Active and passive FROM** exercises all affected and surrounding joints as appropriate

Encourage all **functional tasks and mobility** as able

**Educate** and focus on increasing independence

**Scar Management** (see separate sheet)

**Appropriate and adequate pain control is vital – background control and procedural / breakthrough cover (e.g. prior to dressings / physio).**

## Splinting

Splint post surgery as required or to increase lost ROM or to prevent loss of ROM

- Splint over dressings initially
- Ensure good fit and no pressure points
- Clinically reason splint wearing times – e.g. all night, at rest, continually
- For common splints see manual

**Infection control significantly reduced mortality and morbidity in burns care: Hand washing and all measures to prevent cross infection are vital for therapists to implement**

## Active and Passive Exercises

- Active mobilisation and passive exercises should start immediately (whenever possible/appropriate).
- Aim is to prevent or treat loss of ROM, gain strength and endurance,, re-establish function
- Skin grafting and surgical reconstructive procedures require immobilisation initially – see separate sheet.
- Pain, infection and small scale bleeding do not have to limit mobilisation.
- Be gentle but firm, patient and educate your patient

## Rehabilitation following burns and reconstructive surgery

A guide for therapy staff in a field hospital environment, on the immediate treatment and management of patients with skin grafts, traumatic wounds and scar management needs. For more detail & specific treatment options refer to the Burns and Soft Tissue Rehabilitation Section in the manual.

### Split Skin Grafts (SSG)

- If a burn is either full thickness or deeper and has expected prolonged healing time the burn is excised and grafted (SSG) to save life and improve outcomes.
- A skin graft relies on the underlying blood supply – the area is excised down to healthy bleeding bed, in poor resource environments SSG is often delayed and limited, this often results in sub-optimum outcomes (incl. more scarring)
- Immobilise the body part if SSG is over a joint or very near a joint. If the part is not immobilized with bulky or tie over dressings in theatre then make a splint – discuss with the surgeon. Ensure the splint will not cause damage to the area.
- The first change of dressing (COD) of the grafted area is at 48 hours – 5 days.
- Do not mobilise the part before day 5 – unless instructed by the surgeon. Try and attend the first COD so you can see how the SSG responds to movement with dressings down. Unless specified by the surgeon there is normally no restrictions to movement post 5 days. Hydration of the area can start as soon as healed, scar massage when the area is stable.
- For lower limb grafts early mobilisation (immediate or at 48 hours) may be preferred by some surgeons.
  - ✓ Ensure patient has a lower limb supportive dressing e.g. coban / elastic bandage before mobilisation.
- Donor site (commonly the thigh) takes 2 weeks to heal and can be very painful, once healed the areas can be re-used to take more skin.
- SSG's are often fenestrated or meshed to expand the skin available and allow escape of exudate.
- In addition to movement in the 1<sup>st</sup> 5 days avoid any shear force as this can cause graft failure. Graft failure can also result from lack of sufficient excision of the underlying area and infection.
- SSG takes a slice of some of the dermis, full thickness grafts (FTG) are not used in acute burn care (apart from eyelids) and take the whole dermis – the donor site therefore needs to be directly closed if small or grafted.

### Flaps

- If a defect is not appropriate for direct closure or a skin graft e.g. avascular structures are exposed then various flaps can be used to fill the defect. Unlike with SSG a flap brings it's own blood supply with it.
- A flap is a vascularised section of tissue (could be skin, fascia, muscle, bone, subcutaneous tissue, viscera) mobilised from it's donor site and transferred to an adjacent or remote location.
- Flaps are generally classified by location e.g local or regional flap, composition of tissue used e.g. osteocutaneous or muscle flap, blood supply e.g axial or random flap.
- Causes of flap failure are: tension, kinking, compression, infection and vascular thrombosis.
- Flaps are uncommonly used in acute burns surgery but are common in reconstruction of burn sequale, they are more commonly used in acute soft tissue injury.

#### Post-operatively:

- Always discuss post op care with the surgeon.
- Generally the key issue is not to kink, stretch, compress or disturb the pedicle (blood supply) in anyway by movement or positioning or handling.
- The pedicle is the lifeline for the newly placed flap and needs to be protected until the local blood supply or the pedicle blood supply is established – usually a 3-week period.

### Gunshot / blast soft tissue injuries

- All war / blast wounds are heavily contaminated
  - Unlike in burns care wound closure is delayed to ensure all necrotic tissue has been debrided
- The patient may go back to theatre multiple times and any source of infection removed prior to definitive wound closure.
  - During this period the wound will be loosely dressed and left open until clean, then closed by primary closure at around day 5 – elevate the limb.
- Shrapnel is normally not removed as risks of removal are often greater than risks of leaving it in situ – movement is normally not contraindicated.
- Blast injuries can cause damage at multiple layers and scarring in soft tissue injury caused by weapons/blast can be very diffuse and at multiple levels (unlike burn scarring which is usually limited to the dermis).

### Scar Management

**A burn scar replaces normal healthy skin with a more fibrous dermis** of inferior quality and a fragile epidermis; essentially scar consists of too much collagen, and initially high vascularity. Scar maturation (a process of the scar becoming flatter and less vascular) occurs over 18 months to 2 years.

**The longer a burn wound takes to heal the more scarring there will be – as a general rule if healing takes more than 3 weeks the area is likely to have a visible scar. A SSG will leave a visible scar.**

**Hypertrophic Scars (HTS)** can be most common in areas of high tension and most movement

- Cannot be removed via scar management but they can potentially be made to look and feel better
- 3 R's – HTS are usually red, raised and rigid
- Usually develop 1-3 months after an injury post epithelisation
- Can be at their worst (most rigid, red and raised) at 3-6 months and then start to improve thereafter
- Affect the person by their look and feel. Look – e.g. hypo or hyperpigmented (too little or too much pigment compared to the surrounding normal skin), poor texture, thickened. Feel – tight, itchy, painful.
- Even small and scars covered by clothing can have a huge psychosocial impact on the person
- Scars lose moisture far more than normal skin and therefore creaming (moisturisation) of the area is important, this can reduce the occurrence of HTS
- In burns loss of range, function and disfigurement is usually the result of scar restricting movement or pulling on structures. Scar contractures usually develop most commonly on flexor surfaces.

**Regular follow up on discharge is vital as scar is often very active post discharge**

### Basic scar management:

**Hydrate** with an appropriate cream (non-irritative, not full of chemicals) 4 x day or as needed

**Massage** – no rubbing on the fragile new epidermis but firm circular motion or finger rolling – 3-4 times a day, especially on adhered or unpliant areas. Do not massage over open wounds or if skin is very fragile. Over vigorous scar massage on immature (vascular) scars can exacerbate HTS.

**Sun protection** (high factor) for exposed scars


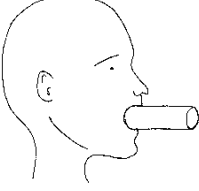

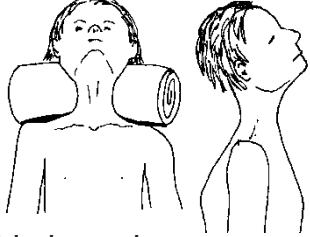

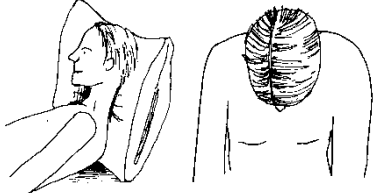
**Stretch** – scars respond best to low load, long and sustained stretch (Splint/ROM exs)

**Pressure garments** +/- silicone gel if available – apply once healed and the newly healed skin is robust enough to tolerate the contact

**Surgery may be required to release scar tissue if conservative treatment is not sufficient**


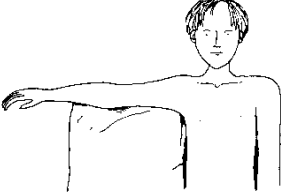

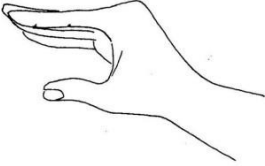

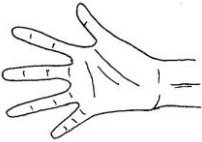


**Skill Station Splinting Anti-deformity Positions**

Burn Site	Contracture	How does this look?	Anti-contracture position
Face	The face can be affected in various different ways including inability to open or closer mouth fully and inability to close eyes fully		<p>Regular change of facial expression and stretching regimen required. A well-padded tube can be inserted into the mouth to combat mouth contracture</p> 
Front of neck	Neck flexion. The chin is pulled towards the chest reducing neck movement. Contours of the neck are lost.		<p>Neck in extension. No pillow behind head, roll behind neck. Head tilted back in sitting.</p> 
Posterior neck	Neck extension and other neck movements.		<p>Sitting with head in flexion. Lying with pillows behind the head.</p> 


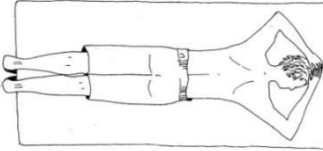




**Skill Station Splinting Anti-deformity Positions**

**AXILLA AND ARM**

Burn Site	Contracture	How does this look?	Anti-contracture position
Axilla or anterior and posterior axillary fold	Limited abduction		Lying and sitting - arms abducted to 90° supported by pillows between chest and arms. Figure of eight bandaging or strapping to provide stretch across chest. 
Back of hands	Metacarpophalangeal (MCP) hyperextension; inter-phalangeal (IP) flexion; adduction of thumb, flexed wrist.		Wrist - 30-40 degrees extended, MCP's 60-70° flexion, IP joints in extension, Thumb mid-palmar radial abduction. 
Palm of hand	Fingers adducted and flexed; palm pulled inwards.		Wrist hyper-extended, minimal MCP flexion, fingers extended and abducted. 

**Skill Station Splinting Anti-deformity Positions**

**LEG**

Burn Site	Contracture	How does this look?	Anti-contracture position
Groin (hip)	Hip flexion; hip adduction.		<p>Lie in prone with legs extended. Limit sitting and side lying. Supine lying with legs extended; no pillow under knees.</p> 
Back of Knee	Knee flexion.		<p>Legs extended in lying and sitting</p> 
Feet	Feet are complex structures and can be pulled in different directions by healing tissues preventing normal mobility		<p>Ankles at 90°, use pillows to maintain position. Encourage sitting with feet flat on floor as long as no oedema present.</p> 



### Acquired Brain Injury Management – Things to be aware of

Guidance for therapy staff in a field hospital environment, on the non-physical aspects of patients with Acquired Brain Injury including differential diagnoses. For more detail & specific treatment options refer to the ABI section in the Humanitarian Emergencies Manual.

#### Differential Diagnoses

- Cerebral malaria
- Meningitis – (TB meningitis)
- Encephalitis – (Japanese B)
- Brain abscess
- SSPE (subacute sclerosing pan encephalitis)
- GBS type syndromes/peripheral neuropathies
- Hydrocephalus
- Spina Bifida
- Nutritional related central and peripheral neuropathies
- Cerebral Palsy
- Polio and post-polio
- Mental Health conditions
- Parkinson's Disease/Multiple Sclerosis/MND/previous acquired brain injury
- All the other rare and amazing neurological conditions

When working in tropical/austere environments you need to be aware that patients may present with symptoms of brain injury but the diagnosis may be different and importantly easily treatable. Please refer to the manual for further details of these conditions.

#### Complications

These can occur at any time post ABI (even years later although most likely in the first few months):

- Seizures
- Spasticity
- Pain
- Hydrocephalus

#### Patient education

- Safe use of aids & equipment
- Ongoing exercises
- Information on complications
- Psychological support
- Family involvement
- Discharge plan

See patient advice leaflets:

- Advice for patients following concussion
- Advice for patients following mild to moderate brain injury

#### Communication

In order to address some of the difficulties that can arise after ABI you may need to liaise with some or all of the following if they are available:

- Physiotherapy
- Ophthalmologists/orthoptists
- Orthotics
- Wheelchair services/Motivation
- Speech and language therapists
- Psychologists
- Occupational therapists
- Local rehabilitation services (e.g wheelchair provision, positioning and seating, spasticity)
- Family/friends (cultural/religious considerations, survivors, others injured)
- Interpreters

Initiate longer term planning for individual patients and development of rehabilitation services:

- Local resources post UKIETR involvement – HI, local or other? Training needs?
- Local health services for spasticity management and management of complications
- Local DPOs
- Incoming international staff



## Other Aspects of ABI

These difficulties may arise post ABI (refer to manual for further details of assessment and management):

- **Vision**
  - Diplopia (double vision)
  - Acuity
  - Hemianopia
  - Inattention/neglect
  - Eye movement
  - Orientation of head and eyes
- **Speech**
  - Dysarthria
  - Expressive dysphasia
  - Receptive dysphasia
- **Swallow**
  - Dysphagia
- **Breathing**
  - Retained secretions
  - Increased work of breathing
  - Reduced lung volume
  - Respiratory muscle weakness
- **Mood/Behaviour**
  - Anxiety
  - Depression
  - Change in personality
  - Disinhibition
  - Apathy
  - Agitation
- **Cognition**
  - Attention, concentration and information processing
  - Memory
  - Self awareness/insight
  - Executive Dysfunction
- **Fatigue**
- **Spasticity**
  - Hypertonia
  - Spasms
- **Posture**
  - Spinal deformities
  - Seating and wheelchairs
  - 24 hour postural management
- **Sensory impairment**
  - Reduced sensation
  - Hypersensitivity
- **Capacity and vulnerability**
  - Ability to make informed decisions (take in information, retain information, weigh up information, communicate a decision)
  - Exploitation by others
- **Continence**
  - Faecal
  - Urinary
- **Sexual dysfunction**
- **Low awareness states**
- **Vocational rehabilitation**
  - Income and finances



## Acquired Brain Injury Management

Guidance for therapy staff in a field hospital environment, on the immediate treatment of patients with An Acquired Brain Injury. For more detail & specific treatment options refer to the ABI section in the Humanitarian Emergencies Manual.

### Initial Assessment

<b>Subjective</b>	<ul style="list-style-type: none"> <li>• Mechanism of Injury, any other traumatic injuries (consider Cx spine)</li> <li>• Length of LOC</li> <li>• Change in behaviour/cognitive function, may need to consult with family</li> <li>• Any surgical management thus far</li> <li>• PMH; predisposition to alternative diagnosis eg. CVA</li> <li>• Social History (smoker, family, work, cultural beliefs, language)</li> </ul>
<b>Objective</b>	<ul style="list-style-type: none"> <li>• GCS; has this been and does it continue to be stable? Should be repeated every 1-4hrs depending upon patients stability.</li> <li>• Respiratory &amp; swallow status</li> <li>• Motor assessment; sensation, power, proprioception, co-ordination.</li> <li>• Tone</li> <li>• Communication; expressive or receptive difficulties</li> <li>• Cognitive assessment; orientation, memory, attention, insight, neglect, executive function.</li> <li>• Visual assessment</li> <li>• Functional assessment; transfers, gait, balance, ADL tasks</li> <li>• Change in mood/behaviour.</li> <li>• Other injuries, associated pain, restrictions to mobility or certain positions</li> </ul>

### Acute management of ABI

- Assessment of patient; establish neurological limb deficits or cognitive changes.
- Liaise with surgical team regarding management plan, restrictions/precautions to positioning or mobility.

***Any deterioration in GCS should trigger urgent review by medical team***

- Education of patient & family with psychological support/manage expectations, set goals related to patients' environment
- Initiate strengthening exercises to facilitate active movement, minimise muscle imbalance and maintain joint ROM.
- Rehab of bed mobility, transfer, gait and balance.
- Assess PADL/independence/functional ability/cognitive function.
- Treat concurrent injuries
- Discuss rehab process with patient, establish patient's priorities, cultural & religious considerations, survivors, others injured.



### Signs to be vigilant of in a patient with an ABI

- Sustained drop in GCS
- Drop of GCS of 3 points or more
- Unremitting headaches
- Change in neurological deficit or behaviour
- CSF leak, blood leaking from ears or change in hearing
- Vomiting
- Seizures
- Onset of photophobia

Glasgow coma scale		Score
Eye opening	spontaneously	4
	to speech	3
	to pain	2
	none	1
Verbal response	orientated	5
	confused	4
	inappropriate	3
	incomprehensible	2
Motor response	none	1
	obeys commands	6
	localises to pain	5
	withdraws from pain	4
	flexion to pain	3
	extension to pain	2
	none	1
Maximum score		15

### Check daily for

- Respiratory compromise
- Changes in GCS
- Tonal changes
- Development of abnormal movement patterns
- Cognitive function/orientation
- Concurrent injuries
- Pain
- Effect of your treatment on ICP (if monitored)
- Signs of neglect

### Cognitive Function

- Consider use of daily orientation log
- Use of appropriate OMs or assessments eg. Westmead PTA, MOCA etc.
- Capacity assessment to ensure safety for discharge
- Self help, compensatory strategies.
- Education for patient and caregiver.

### Facilitation of recovery

- Early functional rehab
- Goal setting
- Spasticity management; Positioning, medical management.
- Sensory Stimulation
- Cognitive Intervention
- Patient and carer education
- Monitor alertness/ over stimulation levels
- Refer to patient advice leaflets

### Factors to consider when planning for Discharge

- Safe methods of transfer, including teaching caregivers
- Provision of any equipment needed and available
- Suitability of discharge destination
- Independence in ADLs
- Advice leaflets for post concussion advice, mild/moderate ABI
- Demographic information recorded for follow up
- Link with external agencies for any ongoing needs









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This Education Resource is designed to complement the UK Emergency Medical Team Rehabilitation in Austere Environments training, but it can also be used as a standalone resource in its own right.

The contents are directly linked to modules taught on the UK training course. In addition there are a number of accompanying resources at the back of the manual which are designed to be used in the field.

Each chapter has been developed by a team of highly specialised rehabilitation professionals, using current evidence or based on best practice consensus, whilst highlighting specific clinical issues which professionals may encounter in an emergency setting.

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