



MANAGEMENT OF LIMB INJURIES

During disasters
and conflicts

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preface

In 2013, the WHO EMT Initiative published the *Classification and Minimum Standards for Foreign Medical Teams in Sudden Onset Disasters* in response to concerns from the humanitarian community that the world had largely failed in its efforts to provide life- and limb-saving care following the Haiti earthquake and Pakistan floods.

Many of the teams arriving on the ground were unable to provide care that truly met the needs of the population they hoped to serve. They were unfamiliar not only with the emergency-response system and standards, but also with the particular challenges of providing care in extremely austere environments.

Nowhere was this more pronounced than in the care of patients with limb injuries. Although data and hard evidence were difficult to obtain, stories abounded of patients who underwent surgical procedures without any follow-up, and most disturbing, patients whose amputations were inappropriate or unnecessary.

Lately, the EMT Initiative has been helping countries and NGOs set up emergency medical teams that will be able to maintain agreed standards of quality and self-sufficiency, resulting in better patient care. As more teams strive to reach these standards, they need clear guidance on best practice, particularly in managing patients with limb injuries, which make up the majority of cases.

This consensus-based field guide is aimed at providing that guidance. It draws on the expertise of the International Committee of the Red Cross, which has a long history of delivering care to patients and protecting them in conflict. It also captures the knowledge of other experts whose experience was forged in disasters and conflicts past.

Ultimately, this guide will help national and international emergency teams improve the care they provide to those we all seek to serve: our patients – the victims of armed conflicts and natural disasters.



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introduction

It has long been conventional wisdom that the lessons of war must be re-learned by each new generation of surgeons. These lessons, particularly regarding care for limb injuries, follow an almost identical approach to what is needed to care for people injured in disasters. Indeed, up to 90% of the surgical workload faced by national and international emergency medical teams in disasters involves limb injury. But as medical science improves and trauma rates decrease in high-income countries, well-intentioned surgical teams can find themselves unprepared for the realities of austere settings. More than ever, they need clear practical guidance on how to adapt what they do on a daily basis to provide safe and effective limb-injury care in conflicts or disasters.

Although randomized controlled trails are not possible in these settings, there are a number of senior surgeons who have decades of experience working under similar circumstances for NGOs, militaries or public hospitals around the world. They don't regularly publish their knowledge – often because they are too busy responding to the next emergency. With this short field guide, we are seeking to bring these experts together and distil their knowledge for the benefit of national and international responders. This work is the result of collaboration between the ICRC and the WHO's EMT Initiative, with support from the AO Foundation. It seeks to respond to controversies and improve trauma teams' practical approaches to the wounds and orthopaedic injuries they will face when responding to the next disaster or conflict.

This text is a free, open-access resource and is intended to serve alongside a growing body of online training material to provide guidance for national and international emergency medical teams caring for patients in disasters and conflicts. It will be updated regularly as new controversies arise and evidence grows. We thank you for your commitment to delivering care to those who need it most under the world's most challenging contexts, and trust that you will find this text fit-for-purpose.



A handwritten signature in black ink, consisting of a large, stylized 'H' and 'V'.

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ICRC ABCD initial assessment	
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ICRC Thromboprophylaxis guideline	
ICRC Triage	
ICRC Femur Fracture and Traction	

abbreviations

Above Knee Amputation	AKA	Milliliters	mL
Activities of Daily Living	ADLs	Millimeters of Mercury	mmHg
Anti-personel Mine.....	APM	Ministry of Health	MoH
Anti-Tank Mine	ATM	Negative Pressure Dressing	NPD
Beats Per Minute	bpm	Noncommunicable Diseases	NCDs
Below Knee Amputation.....	BKA	Non-Steroidal	
Breaths Per Minute	breaths/m	Antiinflammatories	NSAIDs
Deep Vein Thrombosis.....	DVT	Open Reduction and Internal	
Delayed Primary Closure	DPC	Fixation	ORIF
Emergency Medical Team	EMT	Plaster of Paris	POP
Explosive Formed Perforator	EFP	Position of Safe Immobilization	POSI
Full Metal Jacket	FMJ	Semi Jacketed	SJ
Gastrointestinal	GI	Silver Sulfadiazine	SSD
Gunshot wound	GSW	Split Thickness Skin Graft	STSG
Improvised Explosive Device	IED	Standard Operating Procedure.....	SOP
Intensive Care Unit	ICU	Sudden Onset Disaster	SOD
Internally Displaced Person	IDP	Systemic Inflammatory	
International Committee of the		Response Syndrome.....	SIRS
Red Cross	ICRC	Total Body Surface Area	TBSA
Intravenous	IV	Tranexamic Acid	TXA
Level of Consciousness	LOC	Traumatic Brian Injury	TBI
Liters	L	United Nations	UN
Mass Casualty Incident	MCI	Urine Output	UOP
Medical Treatment Facilities	MTFs	Walking Blood Bank.....	WBB
		Weapons of Mass Destruction	WMDs
		World Health Organization	WHO





CONTEXT



- SCENARIO
- TRIAGE
- PHASES OF DISASTERS
- BURDEN OF DISEASE IN SUDDEN ONSET DISASTERS
- EARTHQUAKES, TSUNAMIS, AND FLOODS
- HEALTHCARE IN DANGER
- PATIENT FACTORS

- SUGGESTED RESOURCES
- REFERENCES

SCENARIO

You have recently set up a type 2 EMT in an earthquake zone, when a significant aftershock occurs.

You, your team, and your facility, are unaffected. The district health officer calls to alert your team to expect between 25-50 casualties to be sent to your facility. How should you prepare for the incoming wave of patients?



Figure 1. ICRC staff assist patients in a hospital staging area. (ICRC)



- Type 1 EMTs must be prepared to manage large numbers of patients.
- A recognized system for the assessment of injury severity should be employed to identify those requiring life-saving first aid, urgent and non-urgent surgery, and minor injury care.
- The use of the "expectant" category for patients should be done in consultation with the ministry of health whenever possible.



- Type 2 EMTs should concentrate on surgical triage and identifying those with life threatening medical and obstetric presentations.
- The EMT should be able to triage appropriately 200 cases daily.
- The EMT must have a plan to deal with overwhelming situations by arranging referral to higher levels of care.



- Type 3 EMTs should reserve resources for referral from other facilities.
- Type 3 EMTs must retain their ability to manage patients who self-present as well.
- A method of triage involving available specialists should be available for the triage of complex patients referred to the type 3 facility.

PITFALL

Triage at type 3 facilities is complex and often time consuming. It should be managed by specialists or the facility will quickly be over-run with cases that are inappropriate for type 3 specialty care.

TRIAGE

TERMINOLOGY

Using common language is important for documentation and communication, particularly when arranging patient transfers. The categories below are a widely accepted system for triage.

- » **Category 1:** Immediate medical or surgical management
- » **Category 2:** Patients who are able to wait
- » **Category 3:** Patients awaiting ambulatory care
- » **Category 4:** Patients with little to no hope of survival regardless of care delivered

COMMON TRIAGE MISTAKES

Triage in austere situations, while never an easy task, can be made more difficult by specific challenges that will vary depending on the situation.

- » **Cultural:** Different cultures have different values. For example some cultures will prioritize caring for the dead over caring for the injured.
- » **Ethical:** The idea of deciding not to deliver care to an acutely injured patient can be uncomfortable for many physicians from high income settings who are used to delivering care to all or nearly all patients. Additionally, it should not be forgotten that these situations may be very distressing to the local population as well.
- » **Contextual pressures:** Individuals can face pressure from community leaders, armed groups or other influential individuals when making triage decisions.
- » **Logistics:** Even in well resourced and rehearsed facilities, triage areas are frequently chaotic with little opportunity for human dignity. Triage areas should not be used for initiating treatment.



Figure 2. ICRC staff teach local staff to triage and manage a mass casualty incident. (ICRC)

PHASES OF DISASTERS

TERMINOLOGY

Trying to place the features of a SOD in terms of a chronological sequence is unhelpful as, in reality, it is more a case of overlapping phases. A country with a more developed health system may be able to restore at least some degree of services fairly quickly, while a country with a less well-developed health system may require much more time and assistance to recover from a SOD of a similar scale.

Therefore, it is useful to view the phases of disasters in a conceptual framework that reflects the state of the affected country and society.

» PHASE 1

Pre-Event Status – Assessing the degree of damage that a society incurs following an event is impossible without a baseline for comparison. This phase describes the existing infrastructure, hazards, population profile, culture, economy and security.

» PHASE 2

Event – The event phase captures the immediate event, however long it might last. The event can be as short as an earthquake or as long as a civil war.

» PHASE 3

Structural Damage – This phase comprises the physical damage to structures or human beings. Like phase 2, it can be brief, as with an earthquake, or prolonged, as with flooding. That is why using time to describe these events is so problematic.

» PHASE 4

Functional Damage – This phase encompasses all the changes from an event resulting from the first 3 phases. An increase in burns following an SOD is a prime example, because functional damage to infrastructure leads to an increase in cooking over an open flame.

» PHASE 5

Relief – The phase associated with efforts to minimize the effects of structural and functional damage, primarily through the delivery of security, water, food, shelter, sanitation, and medical care.

» PHASE 6

Recovery – This phase is associated with restoring pre-event levels of functioning for the affected population, and not simply alleviating immediate pain and suffering.

BURDEN OF DISEASE IN SUDDEN ONSET DISASTERS

Depending on the situation the type of casualties expected by EMTs can vary. Understanding the situation on the ground and the burden of disease it creates is crucial to the planning of any intervention. Large waves of patients can be created both by disasters (earthquakes) or by conflicts (short term focused military interventions or terrorist attacks). In contrast some situations such as enduring conflicts (a long running civil war) or disasters (drought leading to famine) can create a steady long term flow of patients. A primary goal of the WHO's EMT Initiative is to aid governments and EMTs in delivering the appropriate type of medical surge capacity that a situation requires. This can best be understood by thinking about burden of disease in waves.

» WAVE 1

Days 1-3 – This wave encompasses many of the head, neck, chest, and abdominal injuries that are rapidly fatal without intervention. International EMTs are unlikely to be able to intervene in this phase. Protecting populations during this wave is primarily achieved by building resilience into national health systems and through the response of local or possibly regional EMTs.

» WAVE 2

Days 4-20 – This wave consists of those injuries that were not immediately life threatening, the majority of which will be to the limbs, and constitutes the largest group of victims. These teams must be prepared to manage not only these cases but other surgical emergencies that arise, particularly abdominal cases and C-sections.

» WAVE 3

This wave actually starts at day 1 but peaks later. It consists of the infectious disease issues faced by internally displaced persons (IDPs), as well as the NCDs and mental health issues faced by a population recovering from a SOD requiring a surge in healthcare capacity. **It is unacceptable for EMTs to come only for surgery and have no plans to address endemic and infectious diseases and their complications.**

» WAVE 4

This wave has variable timing depending on the phase 1 health needs of the affected population. Wave 4 refers to the background surgical, oncological, and NCD needs of the population that have likely gone unaddressed due to the SOD.

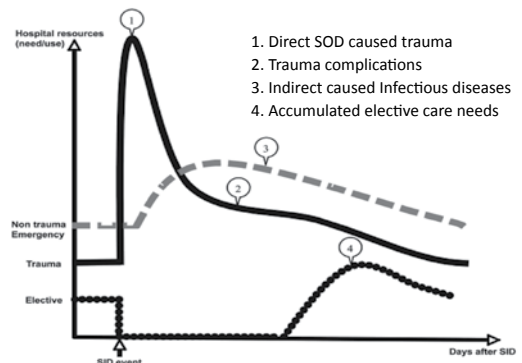


Figure 3. Waves of burden of disease during a disaster graphed as hospital resources required over time. (von Schreeb J, Riddez L, Samnegård H, Rosling H. Foreign field hospitals in the recent sudden-onset disasters in Iran, Haiti, Indonesia, and Pakistan. *Prehospital and disaster medicine* 2008; 23(02): 144-51.)

EARTHQUAKE

Earthquakes are some of the highest profile situations that EMTs can respond to. Their relative unpredictability, combined with the obvious destruction of buildings and infrastructure make these events widely reported and often widely responded to.

It is crucial for EMTs to understand the needs and limitations of earthquakes when deciding whether to respond to these events.

- » The patient load and demand on EMTs can differ widely depending on the degree of preparation of the society prior to the event.
- » Earthquakes carry a low death-to-injury ratio with approximately 1 death for every 3 injuries, meaning that surgical response can result in decreased morbidity and mortality by treating wounds and fractures.
- » Earthquake victims frequently present with crush type injuries that can progress to crush syndrome. This clinical scenario can present some difficult management challenges, particularly for those inexperienced in dealing with these types of injuries. Management may require ICU care or even dialysis.
- » The collapse of structures brought on by earthquakes changes the nature of the demands for EMTs. If healthcare facilities are destroyed then the demand for more advanced, totally self-sufficient type 2 and 3 EMTs becomes greater.



Figure 4. An ICRC and Haitian Red Cross Team survey damage after the Haiti Earthquake. (ICRC)

PITFALL

Deployment of surgical resources outside of the 2 week window following a disaster is unlikely to aid the population and will likely place an increased burden on the local infrastructure, a scenario that could possibly divert needed resources from the local health system or recovery efforts.

TSUNAMIS

- » Tsunamis create a much different context compared to earthquakes. They carry a much higher mortality ratio of approximately 9 deaths for every 1 injury.
- » The relatively small number of injured patients means that fewer surgical teams are needed. However, they may demand other types of EMTs such as medical or public health teams.
- » The surgical need that does exist following a tsunami tends to center around soft tissue injuries and infections sustained during the event or the immediate aftermath. These wounds are made worse by continuous exposure to wet, contaminated conditions.
- » There may be some role for bolstering local surgical capacity by EMTs that can deploy temporary structures while local structures are being rehabilitated, as the aftermath of Tsunamis can involve significant structural damage due to either the tsunami itself or the inciting earthquake. However, this need should not be assumed to be present unless the host government issues a specific request.

FLOODS

- » The need for a surgical response and the factors affecting what types of EMTs would be of greatest value are highly dependent on the cause of the flood, the state of health-care facilities and the rapidity of the flooding.



Figure 5. ICRC volunteers search for Tsunami victims. (ICRC)

ARMED CONFLICT

- » Wounds obtained in armed conflict have their own specific epidemiology and demand principles of management that sometimes differ from civilian practices.
- » Unlike SODs where many or all of the patients are injured simultaneously, conflicts can deliver a steady tide of patients that ebbs and flows based on the situation on the ground.
- » Areas of conflict present hostile difficult environments that can change rapidly. This can place constraints on the locations and scope of care that EMTs are able to deliver.
- » Many surgeons receive training in large institutions, from which there is no higher level to transfer patients to. Surgery in conflict areas is often provided as a series of operations performed in successive echelons of care, according to resources and the principles of damage control surgery.
- » In conflict surgery, as in all types of SODs, the traits of professionalism, sound judgment, common sense, and adaptability are key to successfully delivering care.
- » While the laws and principles governing the delivery of care in armed conflict can be complex, two simple principles should guide the actions of humanitarian actors in these situations:
 - The human dignity of all individuals should be respected at all times without any kind of discrimination.
 - Everything that can be done should be done to alleviate the suffering of those who take no part in the conflict or have been put out of action by sickness, injury, or captivity.

HEALTHCARE IN DANGER

- » The Geneva Conventions protect medical facilities and personnel. However, recent conflicts have seen a drastic increase in attacks on healthcare providers and facilities. This results in the destruction of resources for populations that require care and inhibits future providers from coming to fill these gaps.
- » The minimum standards require EMTs to provide their practitioners with a safe environment in which to operate and to have a security risk management system in place.
- » National EMTs and health providers, sometimes with remote support, may be the only responders in very high risk situations.



Figure 6. The main hospital in Aleppo following a bombing raid. (ICRC)



Figure 1. Soft tissue infection in a diabetic foot. (Norton)

SCENARIO

You are in a type 2 EMT deployed to a country struck by a tsunami four days ago. There are still large amounts of standing water throughout the area in which your hospital is set up.

A 67-year-old man with clear evidence of vascular disease and diabetes presents with an infected wound on his lower leg.

- » What specific concerns do you have for this patient given the context of the disaster?
- » How should your management change, given the likely disruption of the healthcare system in the country to which you are deployed?



Type 1 EMTs must be capable and self-sufficient to manage minor exacerbations of chronic diseases that require emergent care on an outpatient basis.



Type 2 EMTs must be prepared and self-sufficient to manage acute exacerbations of chronic diseases requiring inpatient admission.



Type 3 EMTs must be prepared and self-sufficient to manage acute exacerbations of chronic diseases requiring intensive care management as per the normal standard and context of the country.

PATIENT FACTORS

- » Provision of good patient care requires the ability to communicate. The patient's own language should be used for the discussion of all surgical interventions and clinical management.
- » Identifying individuals from the local population or selecting team members for deployment who speak local languages is important for provision of safe, ethical patient care.
- » In many austere settings, family members will perform many of the functions associated with nursing staff in high income countries.
- » It is important to demonstrate clearly to these family members how care should be provided to the patient. Often pictorial instructions may be useful, particularly when language barriers are present.
- » Tasks such as pressure care, limb elevation, ambulation, toileting, eating, and drinking will likely require the assistance of family members, especially for patients in traction.

PITFALL

- A close family member of the patient may communicate his or her own thoughts rather than those of the patient when translating.
- Using a child to interpret is not advisable given what may be lost in translation, and because it may compromise the child.



Figure 8. Patients on a hospital ward. (ICRC)

NONCOMMUNICABLE DISEASES

A growing proportion of the world's disease burden is noncommunicable diseases (NCDs). SODs or conflicts can lead exacerbate NCDs through destruction of healthcare infrastructure, displacement, loss of housing and trauma from which patients with co-morbid conditions may have a more difficult time recovering. The UN Interagency Task Force splits the management of these issues into two response phases.

» **FIRST 30-90 DAYS**

The focus should be on the treatment of life-threatening or severely symptomatic conditions.

» **AFTER 90 DAYS**

Attempts to expand management to include sub-acute and chronic conditions should begin. This may involve shifting from EMTs with surgical capacities to those designed to supplement the primary healthcare portion of the health system while it rebuilds.

PRINCIPLES OF NCD MANAGEMENT

NCDs should not be forgotten during a disaster. These conditions can result in morbidity and mortality when exacerbated by stress or trauma. Objectives for management of NCDs during the initial response are:

- » **Ensure clinical management via referral or by stabilizing the patient.** EMTs standard operating procedures (SOPs) should include processes for identifying patients in need of palliative care and pain relief.
- » **Ensure identification for NCD patients for whom interruption of treatment could be fatal or critical.** These patients include patients requiring dialysis, type 1 diabetics, patients who are status post organ transplant, or patients with mechanical heart valves..
- » **Avoid sudden discontinuation of care** and prioritize resources.
- » **Primary health clinics should be identified to triage and treat as many symptoms of NCDs as possible.** Restoration of services at type 1 EMTs may allow type 2 and 3 EMTs to manage remaining surgical or complex medial conditions.

SPECIAL CONTEXTS

CHRONIC ARTERIAL OCCLUSIVE DISEASE

- » Always assess and record the vascular status of a foot or lower leg prior to debriding a lower extremity wound. If a patient with chronic ischaemia of the lower leg presents with a wound, debridement should be performed very cautiously. The healing process can be very slow in these patients.

SUGGESTED RESOURCES

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EMT Website: <https://extranet.who.int/emt/page/home>

AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>

2

BALLISTICS

SCENARIO

BALLISTICS & ENERGY TRANSFER

BULLET WOUNDS

BLAST INJURIES

SUGGESTED RESOURCES

REFERENCES

SCENARIO

Your EMT type 2 has recently deployed to a rural area prone to insurgent activity and set up within a small local hospital to augment the local health infrastructure. The local staff inform you that the surrounding areas are frequently targeted with IEDs. Once word spreads of your team's arrival, it is not long before patients with multiple traumatic amputations and large soft tissue injuries start being delivered to your EMT on a regular basis.

- » How should you plan for both the short and long term care of these injuries?
- » What planning with regard to operative schedule and supplies must be undertaken to care for patients with this injury pattern?
- » What do you need to know regarding this particular type of weapon to care for these patients?



Figure 1. Red Cross Society Emergency action teams transfer patients to ambulances. (ICRC)



TYPE 1

- Triage patients and attempt to separate the “walking wounded” from the severely injured in order to transfer and refer appropriately.
- Provide stabilization and effective transfer as well as wound care.



TYPE 2

- Type 2 EMTs should triage specifically for patients requiring surgical treatment of primary blast injuries and open fractures that are unlikely to require prolonged intensive care.
- Provide damage control surgery and resuscitation of severely injured patients and potential transfer to a higher level of care if available.



TYPE 3

- Management of severely injured patients requiring multiple operations or complex intensive care.
- Provision of intensive care or, potentially, renal replacement therapy for patients with crush syndrome secondary to building collapse.

BALLISTICS

BALLISTICS AND ENERGY TRANSFER

Injuries sustained in conflict situations differ from those seen in civilian practice, particularly with regard to the limited resources that may be available. A working knowledge of the different mechanisms of war related injury and their sequelae is therefore important for any surgeon deploying to an area of conflict.

THE PRINCIPLE OF ENERGY TRANSFER - The total kinetic energy of a projectile is the potential to cause damage, the transfer of this kinetic energy from the projectile to the tissues is the capacity to cause damage. The actual degree of tissue damage depends on the efficiency of this energy transfer.

Many weapon types can be classified by the amount of energy available for transfer:

- » Low energy: knife or hand energized missiles
- » Medium energy: handguns
- » High energy: military or hunting rifles with a muzzle velocity of greater than 600 m/s or a large mass projectile

Fragments given off by explosions are a special case. Immediately following the explosion they can form high energy projectiles, but the amount of energy available for transfer dissipates rapidly over distance due to the poor aerodynamic properties of the fragments.

The transfer of energy occurs at the projectile-tissue interaction. This transfer of energy compresses, cuts, or shears the tissue, depending on the characteristics of the projectile and its path as it passes through the tissue.

PAEDIATRIC CONSIDERATIONS

As more conflicts have become urban in nature with loosely defined or changing factions, the exposure of children to conflict induced injury has increased.



Figure 2. A child injured by a landmine is fitted for a prosthesis. (ICRC)

BULLET WOUNDS

Like civilian gunshot wounds (GSWs), military assault style weapon or handgun injuries may have exit wounds that are large, small, or absent. Munitions used during conflict are required by international law to be full metal jacketed (FMJ) rounds.

- » The FMJ rounds have a copper casing that entirely surrounds the bullet's lead core.
- » These munitions have greater penetrating power, but do not easily deform on impact with tissue.

Many civilian variants of ammunition are semi-jacketed (SJ) meaning that the lead core is not fully surrounded by the copper shell.

- » SMJ bullets can easily deform on impact causing greater tissue damage but with less penetrating power.

This distinction is important for the limb surgeon as these different types of munitions have differing effects on bone.

- » A FMJ bullet impacting bone shortly after entry into the tissue will break the bone and continue on into deeper tissues. However, when a FMJ bullet ricochets or tumbles prior to impact it can cause enormous amounts of soft tissue or bony injury.
- » A SJ bullet will shatter the bone completely if the impact is shallow due to the deforming nature of the bullet.
- » From the perspective of the surgeon the difference between the two types of rounds is that with SJ rounds the majority of the energy transfer is made within the first few cm of penetration into the tissue, while with a FMJ round most of the energy transfer occurs deeper in the tissue. When this occurs, a temporary cavity is created that collapses immediately hiding the internal injuries.



Figure 3. The shower of lead effect demonstrated on this plain radiograph is a marker of severe tissue damage. (ICRC)

KEY POINT

If radiography is available, then the patient should be imaged to ensure that the sum of the number visible intact rounds and wounds adds to an even number.

BLAST INJURIES

ANTI-PERSONNEL MINES

Anti-personnel mines are explosive devices meant to be triggered by a person, rather than a vehicle. Because of their lack of precision, they commonly injure both combatants and civilians. They can stay on the battlefield long after a conflict has ended, injuring the civilian population for years afterwards.

Anti-personnel mines (APMs) tend to cause injury in one of three specific patterns.

- » **PATTERN 1:** Pressure plate trigger that results in traumatic amputation of the triggering leg, with severe soft tissue injuries to pelvis, genitals, contralateral limb and contralateral arm.
- » **PATTERN 2:** Tripwire trigger injury causes injuries that stem primarily from fragmentation injuries as opposed to primary blast injuries. The severity of injury is inversely proportional to the distance from the device, as the fragments are not aerodynamic and their energy dissipates quickly in flight.
- » **PATTERN 3:** An individual handles a mine either attempting to clear it or due to a child playing with it. The patient sustains injuries to the eyes, face, hands, and chest.



Figure 4. From top to bottom, patterns 1, 2, and 3 injuries involving injuries from anti-personnel landmines. (ICRC)

ANTI-TANK MINES

These explosive devices are intended to be triggered by a vehicle. These devices frequently cause an injury pattern referred to as “*pied de mine*.” This injury pattern involves comminution of many of the bones of the foot due to sharp upward force of the floor of the vehicle. This commonly occurs in occupants of armored vehicles, but is common in occupants of non-armored vehicles as well.

IMPROVISED EXPLOSIVE DEVICES

Improvised explosive devices (IEDs) are home-made rather than commercially manufactured. They have become synonymous with recent conflicts in Iraq and Afghanistan.

These devices are often manufactured from modified commercial munitions. IEDs can present with injury patterns similar to APMs or ATMs depending on the size of the charge, the location of the device, and the triggering mechanism.

A distinct category of IED is the explosive formed perforator (EFP) variant. These are a shaped charge weapon in which the blast deforms a portion of the container resulting in a penetrating projectile.

These injuries are often caused more via the secondary blast injury due to the fragments as opposed to the primary blast.

These injuries also have a tendency to present in an "all or nothing" pattern, with victims either dying from being struck by the shrapnel or surviving with relatively minor injuries.

SUICIDE BOMBINGS

Suicide bombings often cause devastating physical and emotional damage to a population due to the ability of the bomber to mobilize the explosive into populated areas. Suicide bombings carry nearly double the mortality rate of conventionally deployed explosives.

Patients present with severe injuries, altered LOC, multiple areas of bodily injury, and hypotension on arrival more often than other types of blast injuries.

Suicide bombings can create a sudden enormous demand on EMT resources.

PAEDIATRIC CONSIDERATIONS

Children are more often severely injured compared to adults from blast injuries due to their proximity to the ground, curious nature, inability to effectively flee danger, increased head to body size, and decreased physiologic reserve.

MANAGEMENT

The management of the results of the aforementioned mechanisms of injuries is covered throughout this text, but some general notes, specifically with regard to limb injuries following APM or dismantled IED injuries, bear mentioning here.

- » IED/APM injuries are dirty, contaminated wounds resulting from the propulsion of large amounts of soil, clothing, and other organic matter upward into the wound.
- » These wounds often require a level of amputation higher than what would initially appear necessary due to the blast forcing debris very deep into the tissues and underneath skin flaps that appear healthy.
- » The blast can cause pressure waves within the blood and tissue column leading to venous thrombosis with subsequent compartment syndrome.
- » Small APMs can result in incomplete traumatic amputation with wide and deep soft tissue injuries to the foot. These wounds often result in amputation and require meticulous debridement every 2-3 days if amputation is to be avoided.



Figure 5. The umbrella effect of an antipersonnel landmine or ground mounted IED. Note the way that debris is forced into the wound deeper than may appear possible on initial examination. (A. Kay)

PITFALL

Not all traumatic amputations require placement of a tourniquet. Tourniquets are intended to stop life-threatening haemorrhage when there is a higher level of care that a patient can be transferred to. If the patient is not haemorrhaging, no tourniquet is needed as this can cause tissue ischaemia or impede venous return, resulting in increased haemorrhage or compartment syndrome.

SUGGESTED RESOURCES

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EMT Website: <https://extranet.who.int/emt/page/home>
 AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>



LOGISTICS, FIELD SUPPORT AND TRAINING

SCENARIO

LOGISTICS AND SELF-SUFFICIENCY

LOGISTICS STANDARDS

TRAINING FOR EMTS

CONSIDERATIONS FOR TRAINING

SUGGESTED RESOURCES

REFERENCES

SCENARIO

You are the director of a type 2 EMT that has answered a request for surgical support for a country struck by a large earthquake.

At the request of the MoH you were sent to a remote area several hours outside the capital city, and have been there for approximately one week.

The caseload has been slightly heavier than expected and you are starting to run low on a few key supplies. Unfortunately, recent rains have made the roads essentially impassable for the time being.

- » What responsibilities and options are available regarding your own resupply?
- » What needs might a surgical EMT have that differ from other humanitarian operations?



Figure 1. Transit and transport can become difficult or impassable resulting in increasing logistics challenges. (Norton)



TYPE 1

STERILIZATION – Must be able to provide basic steam autoclave for instruments
LAB AND BLOOD BANK- Type 1 EMTs must be able to provide basic outpatient tests by finger prick including glucose, point of care hemoglobin and white blood cell count, and some form of rapid malaria detection.



TYPE 2

STERILIZATION – Full autoclave function with traceability
LAB AND BLOOD BANK – Type 1 level tests plus urinary electrolytes.
 Must be able to collect blood and microbiology specimens for outside analysis.
 Must be able to provide for safe blood transfusions from volunteers or family with testing for blood type, HIV, Hepatitis B and C, Syphilis and any endemic blood borne diseases.



TYPE 3

Type 3 facilities must be able to perform all of the above functions along with electrolyte, blood gas and microbiology testing.
 They must be able to provide the same services for safe blood transfusions as type 2 EMTs.

LOGISTICS AND SELF-SUFFICIENCY

EMTs must be self-sufficient to arrive at and operate within an SOD. A correct understanding of the term self-sufficient is crucial to an understanding of this core standard.

- » EMTs should bring at least a 2 week supply of food. Identifying a local food supply can be very difficult in the first hours following arrival.
- » EMTs that have robust local supply chains that are pre-planned and with a positive rather than a negative impact on the local economy can be termed self-sufficient.

FACILITIES

- » EMTs must articulate whether they are offering to work inside an existing facility or will provide a field hospital. Field hospitals must be self-sufficient for all supplies but local fuel and water access will be required.
- » Teams embedding into existing facilities require at least some supplies to cover the work required.
- » All facilities must comply with the WHO EMT minimum standards.



Figure 2. The running of complex EMTs such as this, require robust logistics and support operations. (Norton)

PITFALL

- The ability to have a local supply chain requires extensive experience and local connections particularly in the aftermath of a SOD. EMTs that do not have standard operating procedures (SOPs) and experience in developing such supply chains should be self-sufficient by bringing in sufficient supplies to care for the entire team.
- It is unacceptable for EMTs to comply with standards initially but allow their standard of care to deteriorate as they run low on supplies. The minimum standards must be met at all times. If circumstance arise during which teams cannot meet the standards then they should inform the MoH or plan to withdraw.

LOGISTICS STANDARDS

EMTs must provide a safe environment in which to operate and avoid having a negative impact on the community. The below are a summary of the guidelines to reach minimum standards as an EMT.

For complete guidelines, please refer to the *WHO's Classifications and Minimum Standards for Emergency Medical Teams in Sudden Onset Disasters*.

WATER – Access to adequate water for all team members for washing and drinking must be available.

POWER AND LIGHTING – Access to reliable electrical power should not be assumed and teams should be prepared to provide for lighting without interruption in patient areas, operating theatres, and for instruments or patient care devices requiring power.

FOOD – Adequate food supply for staff and patients must be brought and/or purchased without affecting the local food supply.

SHELTER - Staff should be housed in an area away from clinical work and in safe conditions that allow adequate rest between shifts.

MEDICAL WASTE DISPOSAL - The guiding principle remains that **waste disposal should not have a negative impact on the community**.

This is especially important for medical waste. EMTs are responsible for the safe disposal of medical waste from their own facilities. If operating from within a local facility, teams should encourage the safe disposal of waste from that facility.

Contaminated waste and sharps should be separated into adequately designed yellow labeled receptacles and dealt with appropriately.

For more information on adequately dealing with medical waste, see the ICRC or WHO policies on medical waste management cited at the end of this chapter.

KEY POINT

Ensuring an adequate water supply is a crucial part of EMT logistics. The water needs of an EMT will vary based on size and type of clinical activity. Water demands for surgical EMTs can be very high. For example, a type 2 EMT may require as much as 7,000 -10,000 L per day. A rough guide for calculating water needs is below:

- 60-100 L per person per day for staff
- 100 L per surgical case
- 5 L per outpatient visit
- 50 L per inpatient per day



Figure 3. Appropriate staff shelter for a deployed EMT. (Norton)

SANITATION – EMTs must ensure that they have plans for management of the sanitation needs of their own staff, as well as culturally appropriate toileting facilities for patients receiving and awaiting care.

Providing areas for hand washing and scrub areas for surgery is a crucial part of sanitation logistics. Viable options for washing can range from wash basins with reticulating faucets to pre-filled jerry cans. The key is to provide easy and reliable access to clean water for washing.

The SPHERE standards state that ensuring the optimal use of all water supply and sanitation facilities and practicing safe hygiene will result in the greatest impact on public health. The standards provide minimum standards and guidance toward achieving these goals.

TRANSPORT – EMTs should state when and where they will arrive and either arrange for their own transport to their agreed area of work, or arrange for support from the host government or local partners.

COMMUNICATIONS – EMTs must consider robust, redundant communications system to be mandatory. This means prioritizing an ability to communicate and coordinate with the host government coordination center. Additionally, daily reporting of activities to the MoH or designated authorities is an important consideration.



Figure 4. Robust and redundant communications for EMTs are mandatory. Consideration should be given to having means of communications that function independent of the potentially damaged infrastructure of a country. (Norton)



Figure 5. Appropriate facilities must be provided for both staff and patients. The facilities pictured include access for injured or disabled patients. (Jamieson)

TRAINING FOR EMTS

RECOMMENDED 3-STEP LEARNING PROCESS FOR EMT MEMBERS

EMTs must prepare and rehearse for delivery of care as well as for the anticipated context on the ground. The development of both professional skills as well as situational preparedness is important for an effective response to both disasters and conflict.

To ensure appropriate EMT performance all EMT members should go through a learning process encompassing the following steps:

1. Ensure **professional competence and license to practice**
2. Support adaptation of technical and non-technical professional capacities into low-resource and emergency **contexts**
3. Prepare for an effective **team** performance in the field as part of an EMT organization

EXAMPLE:

AN ORTHOPAEDIC SURGEON DEPLOYING WITHIN AN EMT

TECHNICAL TRAINING

- **Validated medical degree and specialization in orthopaedic surgery with license to practice in the country of origin.**

ADAPTIVE TRAINING

- **Course in Global Health and/or Disasters**
- **Workshop about surgery in disaster contexts, with both theoretical and practical sessions**

TEAM ORGANIZATION AND PRE-DEPLOYMENT TRAINING

- **Pre-deployment course provided by the EMT organization, including presentation of SOPs, safety procedures, equipment, preparation for life in the field, and team dynamics**



Figure 6. EMTs deployed to Tacloban (NCCTRC)

CONSIDERATIONS FOR TRAINING

- » Both **individual and team training** are needed. EMT training improves surgical outcomes!
- » Theoretical lessons should always be combined with practical sessions. Role-playing, simulations, and virtual reality formats are options for putting theory into practice. The development of soft skills should be encouraged through team based learning.
- » The teams should be constituted by professionals with different and complementary knowledge and skills, in accordance with the needs identified in the field. Members with different levels of experience should be incorporated (i.e. combine senior and new EMT members).
- » **JUST IN TIME TRAINING** – effective training method to disseminate new concepts or seldom-performed procedures. Just in time training modules will introduce additional skills and knowledge to the staff before deploying into a specific context (i.e. review national guidelines of the disaster affected country).

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4

ANAESTHESIA AND PERIOPERATIVE CARE

SCENARIO

INITIAL ASSESSMENT

PRE-OPERATIVE CARE

POST-OPERATIVE CARE

ANAESTHESIA

PAIN MANAGEMENT AND PATIENT RECORDS

SUGGESTED RESOURCES

REFERENCES

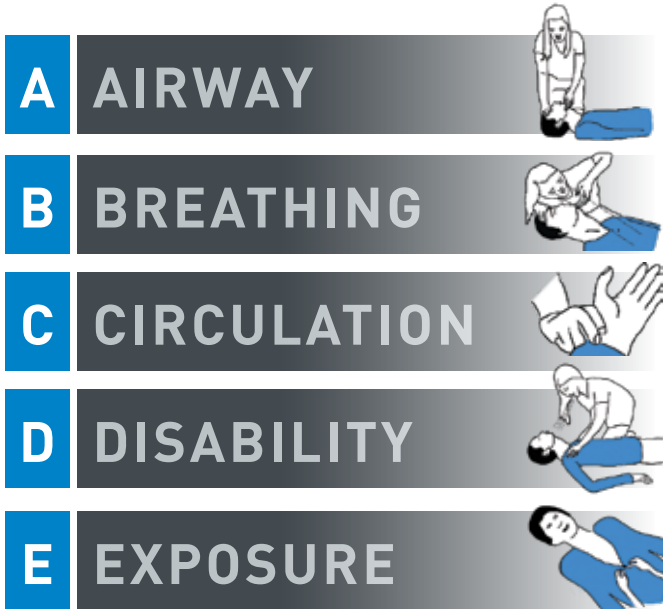


Figure 1. ABCDE steps for Initial Assessment (ICRC)

SCENARIO

A 30-year-old woman arrives in the emergency room after receiving a gunshot wound in the left arm. She is in severe pain and appears pale and sweaty. The arm is bleeding and covered with a dirty cloth. You are the first health provider she encounters since the injury happened. What are the first steps you should take now?

INITIAL ASSESSMENT

- » Assessments of: Airway, Breathing, Circulation, Disability, Exposure (Figure 1).
- » Control **catastrophic haemorrhage** with direct pressure.
- » Complete the adjuncts to the primary survey if they are available, particularly chest X-ray, C-spine or pelvic images, if indicated.
- » Once the primary survey is complete, provided there is no imminent unaddressed threat to life or limb, proceed to the **secondary survey** with adjuncts.

HOW TO ASSESS A PATIENT WITH LIMB INJURY

HISTORY

- » Past medical history, current medications, known allergies, last oral intake, beliefs around medical care
- » Description of the event causing the injury: mechanism, date and time, effects on the patient, interventions to date

SIGNS AND SYMPTOMS

- » Pain
- » Loss of function
- » Reduced mobility
- » Abnormal movement
- » Crepitus

PHYSICAL EXAMINATION

- » **Look:** Change of position pattern, gait pattern, bruising, swelling, joint effusion and limb alignment
- » **Feel:** bony tenderness, joint effusion, distal circulation and sensation
- » **Move:** active before passive movement, do not force patient to move beyond what they can tolerate

INVESTIGATIONS

- » Plain radiological imaging in two planes at 90 degrees to each other
- » Include the joint above and below a suspected fracture
- » Radiological images are not essential to diagnose a fracture
- » Radiological images are not required to initiate treatment

KEY POINT

The clinical assessment of a limb must be adequate to evaluate for the presence of fractures or dislocations (deformity, tenderness, crepitus, active and passive range of movement), as well as joint stability, vascular status, nerve function, and distal status of the extremity.

PITFALL

- If patient is referred to your facility, do not assume the prior care provider fully assessed the patient and the limb and provided appropriate care.
- Absence of active movement does not confirm a fracture.
- Presence of active movement does not exclude a fracture.

PRE-OPERATIVE CONSIDERATIONS

- » Ensure **patient privacy** for all procedures: a mobile screen system is necessary in wards and in operating theatres with more than one table.
- » **Always** explain all procedures to the patient before any intervention, repeat this multiple times and obtain a translator if necessary for understanding.
- » **Surgical stores** should be kept adjacent to the operating room and protected from the environment. If there is not a pharmacist within the team, another health professional should be in charge of managing all medicines and disposables to avoid stock-outs. Laws regarding narcotics vary widely, so teams should be prepared to work with local governments in order to minimize delays at customs.
- » In the case of emergency surgery, ensure a **prepared tray** of sterile instruments is immediately available for emergency laparotomy, caesarean section, neurotrauma, thoracotomy and vascular injuries in limbs.
- » The **planning of the day's operating list** should involve surgeons, anaesthetists and nurses for optimal efficiency and should be communicated on a communal white board.
- » The order of the operating list should reflect a progression throughout the day from clean to contaminated cases with children being done first whenever possible.
- » To optimize patient flow practice ingress and egress of multiple patients through the operating room.
- » Clean and dirty areas within the operating room should be differentiated.
- » Prevention of hypothermia is important in surgical patients, particularly trauma, burn, and paediatric patients. Operating theatre temperatures should be kept between 27-40°C. All fluids, blood products, and blankets should be warmed for surgical patients.



Figure 2. Operating theatre with multiple teams (Baumgartner-Henley)

PRE-OPERATIVE SCRUB PREPARATION FOR LIMB SURGERY

- » Place an impervious layer between the limb and the operating table—ideally an absorbent layer.
- » Scrub the limb to remove skin and wound contamination. A plain brush, soap and water will work, as well as iodine based or chlorhexidine scrub brushes .
- » Copiously irrigate any limb wounds over a large dish with 3-12 L of fluid, depending on the degree of contamination.
- » Dry the limb.
- » Discard the absorbent layer.
- » Apply a tourniquet proximally on the limb, set the inflation pressure but do not inflate until required.
- » A staff member should be identified who is responsible for marking down the time the tourniquet is inflated so that tourniquet time is accurately recorded.
- » Patient pressure points should be checked to ensure adequate padding prior to beginning the case.

EXPERT TIPS

Wound irrigation with low pressure is preferred in most circumstances. Preserve any pulse lavage units for wounds with established infection.

Potable (drinkable) water is adequate for wound washouts; warm it to 38–41 degrees C. This temperature is that of a warm shower. In other words, warm to the touch but tolerable to keep ungloved hands immersed.



Figure 3. Scrub preparation for limb surgery (Kay)

POST-OPERATIVE CARE

An area for post-operatively recovery is mandatory.
It should be located next to theatre, not on the ward.

MAIN TASKS FOR NURSING STAFF IN THE RECOVERY ROOM

- » Assess and record patient's **vital signs** (HR, RR, BP, SpO₂, and temperature).
- » Identify and report abnormal vital signs or evidence of clinical deterioration.
- » Prepare **oxygen** concentrator and masks for oxygen therapy. Patients must be awake enough to protect their own airway before returning to the ward.
- » Prepare to set up and use **suction** to clear vomit/secretions from upper airway.
- » Assess and record level of consciousness using AVPU scale (A=Awake, V=responds to verbal stimuli, P=responds to painful stimuli, U=unresponsive).
- » Assess **pain** using agreed pain score and give prescribed medications. Pain should be under control before returning to the ward.
- » Assess **nausea and vomiting** and give prescribed medications.
- » Set up an **IV infusion** and record urine output if required.
- » Observe and assess **surgical sites and drains** for bleeding. Reinforce dressings as needed and inform surgical team if concerned.
- » Understand and recognize the **criteria for discharge** from recovery, and initiate physiotherapy as soon as possible following surgery.

DEEP VEIN THROMBOSIS (DVT) PROPHYLAXIS

The main options to prevent DVT and pulmonary embolism in adult surgical patients are pharmacological and mechanical prophylaxis:

- » Early mobilization and mechanical prophylaxis will cover most short surgical procedures .
- » Chemoprophylaxis will add a layer of complexity in the treatment but will be required in some cases.

Recommendations for clinical decision making:

- » Follow standard DVT guidelines and allow teams to adapt according to their resources, local protocols and individual patient factors.
- » Example ICRC guidelines for DVT prophylaxis is included in this book as an annex. (*See page 178*)

HEALTH STAFF CONSIDERATIONS

- » **Physician assistants** may face credentialing or licensing issues and if deployed should always be under the supervision of a qualified specialist.
- » **Nurse anesthetists** can face similar issues with credentialing, depending on individual country laws. Nurse anesthetists must work under the supervision of a licensed anesthetist.
- » **Medics and paramedics** are versatile team members in disaster response. Their medical training and understanding makes them ideal for supporting activities in an emergency department or in an operating theatre. In any of these roles, supervision is required.
- » For perioperative nurses the team is often best served by having the most experienced member of the team serve as the circulating nurse.
- » **Military medics or corpsman** working within a military medical team can offer significant military knowledge and expertise that may be a vital part of the team competencies required.



Figure 4. Health staff involved in preoperative procedures (*Baumgartner-Henley*)

ANAESTHESIA & PAIN MANAGEMENT

SAFE PRACTICE OF ANAESTHESIA

Current international standards apply:

World Federation of Societies of Anesthesiologists (WFSA) International Standards for a Safe Practice of Anaesthesia, 2016



TYPE 1

- » No general anaesthesia provided
- » Basic life support capacities
- » Local anaesthesia for minor procedures
- » Analgesia for treatment
- » Analgesia for transfer:
 - Appropriate dressings and fracture splinting
 - Peripheral nerve block for transfer recommended, with clear documentation of block performance and pre-block examination
- » Prevention of hypothermia in transfer



TYPE 2

- » Type 1 capacities plus:
- » At least 1 anesthetist
- » Damage control resuscitation and advanced life support capacities
- » Regional anaesthesia – spinal anaesthesia (mandatory), plexus and peripheral nerve blocks (recommended). Epidural anaesthesia/analgesia not recommended in this setting
- » Intravenous or inhalational general anaesthesia for adult and paediatric patients
- » Analgesia for inpatient treatment



TYPE 3

- » Type 2 capacities plus full ICU facilities

CONSIDERATIONS FOR THE PERFORMANCE OF REGIONAL BLOCKS

- » Clinically examine the patient's limb for **neurovascular status** and record this prior to performing a regional block.
- » Peripheral nerve blocks should be performed with the use of **ultrasound guidance**.
- » Peripheral nerve blocks **mask the symptoms of compartment syndrome**—if you cannot watch the patient closely, consider performing a fasciotomy.

PAIN ASSESSMENT

- » **Pain score charts** are appropriate for adults and children and are mandatory in caring for patients with limb injuries. They must be understandable across cultures – for example charts using faces 😊, may be more useful than numbered scales.
- » Pain must be assessed and recorded **both at rest and with movement**.
- » Monitor patients with regional blocks post-operatively paying particular attention to pain scores.

CONSIDERATIONS FOR ANALGESIA

- » Pain relief is a human right!
- » Distraction therapy is effective, as is splinting soft tissue injuries and fractures.
- » Paracetamol, narcotics and blocks are the preferred post-operative analgesia.
- » A ketamine infusion may be used on an open ward with a syringe pump—50mg in 500ml over 8 hours.
- » Ketamine can be as useful drug in the management of the limb injuries. Team members should be familiar with its side effects, including its propensity to induce dysphoric reactions in adults.

KEY POINT

- **Avoid NSAIDs in the first 48hrs in trauma patients due to risk of renal injury particularly, in patients with severe dehydration, haemorrhage, crush or burns.**
- **Limit NSAIDs to short courses and consider GI ulcer prophylaxis with use.**

PATIENT RECORDS

- » Patients involved in a disaster without local civil unrest may safely wear an identification bracelet.
- » Records of all care provided must be kept.
- » **Patients need to have the original or a copy of their records** to keep and use for subsequent care.
- » EMTs may keep their own records by photographing patient documents (notes, x-rays, images of injuries) Images need to be secured by the authority and removed from personal devices such as phones, tablets, and cameras as quickly as possible.
- » The ministry of health in the country may request a copy of the medical records for the care provided in the facility.
- » Many patients require on-going care post disaster. Being registered by their government as people with disaster related injuries may provide increased access to care in the reconstructive phase.
- » Maintenance of careful, accurate records is of extra importance in patients who will require long term follow up once the situation on the ground has stabilized, such as amputees or patients with spinal cord injury.
- » For more information on patient records please refer to the WHO Classification and Minimum Standards for Emergency Medical Teams in Sudden Onset Disasters and Handicap International's Rehabilitation in Sudden Onset Disasters.

SPECIAL CONTEXTS: CONFLICT

- » Patients in war zones may be safer if they carry a card with a numeric identifier rather than their name. Issuing a card that can be concealed, rather than an ID bracelet, may protect patients in conflict zones.
- » Consider providing de-identified data to protect patients if governments demand a record of the medical care provided.

SUGGESTED MAIN ITEMS IN DATA COLLECTION FORM

- » Date of arrival at the medical facility
- » ID number
- » Surname and first name
- » Gender
- » Age
- » Mobile phone number
- » Sudden onset disaster related incident: yes/no
- » Date of injury
- » Date of admission
- » Nature of first medical care if provided prior to current medical facility
- » Diagnosis
- » Comorbidities
- » Surgical procedures performed inside and outside the operating room.
- » Follow up: nursing/rehab/physician/none required
- » Date of discharge

UPDATES IN DATA COLLECTION AND REPORTING

The WHO has recently developed a standardized form to allow EMTs to accurately and efficiently report to the relevant health authority.

POSSIBLE KEY PERFORMANCE INDICATORS TO USE

- Unplanned return to operating room: yes/no
- Fracture stabilized within 12 hours of admission: yes/no

CONTROVERSY!

Who should keep the medical records in disaster situations? The patient, the government of the affected country or the health provider? How to ensure the data is protected and confidentiality is preserved?

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EMT Website: <https://extranet.who.int/emt/page/home>
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DAMAGE CONTROL SURGERY AND RESUSCITATION

SCENARIO

PRINCIPLES OF DAMAGE CONTROL SURGERY AND RESUSCITATION

RESUSCITATION AND PELVIC FRACTURES

DIAGNOSIS AND MANAGEMENT

PLACEMENT OF ANTERIOR FRAMES FOR PELVIC FRACTURES

SUGGESTED RESOURCES

REFERENCES



Figure 1.
LEFT: Large wound resulting from GSW of the thigh (ICRC)

Figure 2.
FAR LEFT: Displaced femur fracture following GSW to the thigh (ICRC)

SCENARIO

A 25-year-old man presents with a gunshot wound to the medial thigh. There is an obvious open fracture of the shaft of the femur, and no distal pulses. The time of the injury is unclear, but at least two hours and perhaps four hours have passed.

- » Which injury should be addressed first?
- » Should a shunt be placed or definitive vascular repair be attempted?
- » Does the patient require fasciotomies?



TYPE 1

- Avoid hypothermia by removing wet clothing, applying cloth or heat blankets.
- Cover the head or scalp, especially in children
- Gain haemostasis of life threatening bleeding with pressure. Consider a tourniquet **if a transfer to a higher level of care is feasible**



TYPE 2

- All fluids contacting the patient should be warmed to 39-42 °C.
- Any air conditioning should be turned off for trauma patients.
- On table warming should be used if possible to avoid hypothermia.



TYPE 3

- Prepare to accept complex patients from type 1 and type 2 teams
- This will likely include undertaking completion and reconstruction of damage control procedures done to avoid loss of life and limb at type 2 facilities.

KEY POINT

- » **All trauma patients must have a full primary and secondary survey to ensure all injuries are identified. The physiology of the patient as a whole must be managed and not just the anatomical aspects of the injuries.**

PRINCIPLES OF DAMAGE CONTROL SURGERY AND RESUSCITATION

The principles of damage control surgery and resuscitation listed below are of tantamount importance for the care of the patient who is hypothermic, coagulopathic, acidotic, and resistant to fluid resuscitation. The goal is to minimize surgery by performing rapid control of hemorrhage and ongoing contamination. Once these goals are achieved, surgery is stopped to allow for physiologic recovery through resuscitation and intensive care with anatomical correction of injuries to be addressed later.

In its essence, damage control surgery is surgery with the goal of maintaining physiology compatible with life. Successful practice requires constant communication between the surgeon and anesthetist in order to:

- » Minimize time to surgery and time on the operating table
- » Limit the early use of crystalloids for resuscitation and use blood products if available
- » Utilize permissive hypotension, particularly in victims of penetrating trauma
- » Manage coagulopathy using tranexamic acid if necessary and appropriate
- » Prevent and manage hypothermia
- » Reduce contamination
- » Improve oxygenation

KEY POINT

- » Tranexamic acid (TXA) has been shown to reduce all cause mortality in bleeding trauma patients with, or at risk for, life-threatening hemorrhage.
- » The medication should be given only in patients whose injury occurred within 3 hours of evaluation.
- » Type 1 institutions must be aware of these constraints if administering TXA to patients with plans to transfer patients to a type 2 or 3 facility, and should ensure that the receiving facility knows TXA has been administered and when.

SPECIAL CONTEXTS

Damage control principles are applied for two reasons:

1. Individual patient considerations (above)
2. In Mass Casualty Incidents, SODs, conflicts and austere environments, due to triage considerations and unavailability of definitive care.

Sudden Onset Disasters

During disasters patients receive their injuries largely as part of a single event. EMT type 2 and 3 teams do not arrive until days later.

Many patients with severe head, thorax, and abdominal injuries have died or been dealt with by local actors on the ground. However, damage control principles can still apply to preserve limbs and spare patients the life long burdens of an amputation.



Figure 3. Severe open tibial fracture requiring rapid decision making regarding limb salvage. (Bar-On)

PAEDIATRIC CONSIDERATIONS

Prediction of the need for damage control surgery can be difficult but is guided by clinical signs and laboratory values. Paediatric vital signs differ from those of adults, and children must be considered as a distinct patient population when making patient triage decisions.

VITAL SIGN	INFANT		CHILD		TEEN
age	0-6 months	6-12 months	1-5 years	6-11 years	12 years and up
heart rate	100-160 bpm		70-120 bpm		60-100 bpm
respirations	30-60 breaths/m	24-30 breaths/m	20-30 breaths/m	12-20 breaths/m	12-18 breaths/m
blood pressure	65-90/45-65 mmHg	80-100/55-65 mmHg	90-110/55-75 mmHg		110-135/65-85 mmHg
temperature	37°C		37°C		37°C

Table 1. Reference for the assessment of paediatric vital signs.

SPECIAL CONTEXTS

CONFLICT

EMTs caring for patients in situations of conflict are more likely to receive patients soon after injury allowing for intervention in life threatening injuries to the head, neck, thorax, and abdomen.

The limb surgeon must apply damage control principles to remove contaminated tissue, temporarily stabilize bones, and restore circulation to muscular compartments. In these contexts, the two surgeons and the anesthetist must carefully coordinate care in order to act in the best interests of the patient given the available resources.

RESUSCITATION/TRANSFUSION

The use of crystalloids/colloids should be limited. Transfusion capability requires standard pathology services and should be based on the clinical picture rather than hemoglobin level alone. Patients in disaster prone areas may be affected by chronic anemia due to malnutrition, malaria or helminth infection.

Access to blood products will require family blood donation or a "walking blood bank." Blood banking in disasters and conflict requires significant planning in order to acquire, use, and store blood products safely.

SPECIAL CONTEXT

WHOLE BLOOD TRANSFUSION

- » The “walking blood bank (WBB)” has gained popularity during recent conflicts with deployed militaries who transfuse whole blood from healthy or “walking wounded” soldiers to injured soldiers or civilians requiring massive transfusion.
- » EMT standards require all type 2 and type 3 EMTs to be able to safely test and transfuse whole blood in emergencies. (See Page 32)

DIAGNOSIS OF PELVIC FRACTURES

A significant amount of energy is required to fracture a human pelvis, therefore suspicion should be high for additional injuries. All trauma patients must receive a primary survey (Airway, Breathing, Circulation) no matter how impressive or distracting their presenting injuries.

Pelvic fractures of hemodynamic significance can often be clinically diagnosed.

- » Palpate the entire pelvic brim to identify an intact edge, tenderness over the sacroiliac joints or gaps at the pubic symphysis
- » Radiographs, if available, can help. It is important to look at the width of the sacroiliac joints bilaterally
- » Rectal examination is a vital part of the assessment of a pelvic fracture. Blood on the gloves indicates an intestinal injury.
- » Look for bruising over the pelvis and around the scrotum in men
- » Pelvic compression can identify fractures that show no obvious signs of fracture

Figure 4. Picture demonstrating scrotal bruising denoting bleeding from a pelvic fracture. An external fixation frame can be viewed at the top of the image.
(E. de Loos)



PITFALL

Heat sensitive paper for haemoglobin testing will “self-develop” in hot environments

PITFALL

DO NOT test for stability of the pelvis when a pelvic fracture is suspected by palpation.

DIAGNOSIS AND MANAGEMENT

Pelvic fractures can present a diagnostic and management challenge for EMTs in austere environments. Treatment options available may differ significantly based on the resources available. These injuries are frequently associated with life-threatening venous bleeding or injuries to internal viscera.



TYPE 1

- Pelvic binders are the optimal initial management for suspected pelvic ring disruption.
- If a urethral injury is suspected the patient should be immediately transferred to an EMT type 2 available.
 - » If transfer time will be long then **gentle** placement of a urinary catheter should be undertaken.
 - » If passage is difficult do not proceed, a suprapubic catheter may be required.



TYPE 2



TYPE 3

- Type 2 EMTs should evaluate pelvic fractures with plain radiographs of the pelvis.
- Pelvic binders can be maintained as a treatment option when the injury is not life threatening.
- Be aware of pressure sores underneath binders left in place for prolonged periods.
- If the binder cannot be removed without hypotension, then an anterior frame should be placed. This may require transfer.

PITFALL

- While pelvic binders may cause further displacement in central fracture and dislocation of the hip. They are more likely to help than cause harm.
- Pelvic binders must be centered on the greater trochanters, they are commonly applied too high.



Figure 5. Correctly placed pelvic binder. Note the urethral bleeding denoting a urethral injury

(E. de Loos)

PLACEMENT OF ANTERIOR FRAMES FOR PELVIC FRACTURES

- » Anterior frames are generally placed with C-arm imaging control in the operating room. Single supraacetabular pins are preferred but require radiologic control.
- » Pins can be placed in the sub-crystal plane but, in an austere environment this adds little beyond a pelvic binder.
- » If C-arm imaging is not available, iliac crest pins are viable but have a higher rate of infection, and make for a more problematic frame. This type of frame can make sitting difficult and limit abdominal access for concomitant intra-abdominal injury.
- » If C arm imaging is available, bilateral supraacetabular pins are the preferred method of external fixation placement.
- » At the type 3 EMT definitive surgery may be possible if proper expertise becomes available or the situation on the ground improves or stabilizes.

PITFALL

- Plating of the pelvis is not acceptable treatment in a tent or during response to a sudden onset disaster.
- When placing the anterior frame, ensure that space is left between the skin blocks and bars to allow for post-operative abdominal distension and abdominal access.
- Patients with open pelvic fractures carry a mortality rate of 50%.

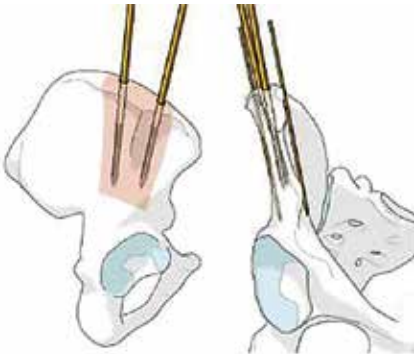


Figure 6. Proper placement of pins in the iliac crest.
(AO Foundation, Switzerland)

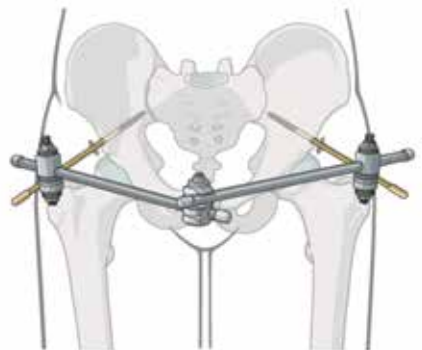


Figure 7. A line diagram denoting the proper placement of Schanz screws for external fixation.
(AO Foundation, Switzerland)

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LIMB WOUNDS

SCENARIO

WOUND MANAGEMENT

WOUND SURGERY

WOUND DEBRIDEMENT BY LAYERS

DRESSINGS

SUGGESTED RESOURCES

REFERENCES

SCENARIO

A 4-year-old boy presents to you with a dilemma. He is conscious and alert with an isolated foot injury.

Perhaps in an effort to control the subcutaneous infection, all the skin from the lower calf and the foot has been excised.

The wound is relatively clean, but at the point of the heel, the calcaneus can be seen.



(ICRC)

KEY POINT

- » All wounds in disaster and conflict situations must be assumed to be contaminated and treated as such. These wounds are at high risk for fatal infections including gas gangrene or tetanus (ACS class 3 and 4).
- » No wound sustained in a disaster or conflict should be sutured primarily. They should be left open and undergo delayed primary closure on day 2-5.



TYPE 1

- Wounds that can be managed at an EMT type 1 facility include:
- Superficial wounds with no nerve, tendon, bone or joint involvement.
- Wounds that can be washed out under local anaesthesia.



TYPE 2

- Wounds requiring debridement require a minimum of type 2 facility to allow for surgical care with anaesthesia.



TYPE 3

- Complex wounds requiring frequent dressing changes may require a type 3 facility to allow for advanced nursing care.

EMT TYPE 1 WOUND MANAGEMENT

Initial care of a wound requires simple washing to minimize contamination and a light dressing for protection of the wound from environmental hazards. Any wound that has been sutured primarily should have the sutures removed if there is any suspicion of infection. Feel for crepitus and fluctuance in the soft tissues. In some patients infection may present with purulence in the absence of swelling or erythema.

- » **If pus is present in the wound, the patient must be transferred to a type 2 EMT for surgical debridement.**
- » Irrigate copiously with between 3 and 12 L of fluid. While isotonic fluid is ideal, drinking water can be used if needed to preserve resources.
- » Wipe the wound surface gently with gauze within the patient's tolerance .
- » Wound cleaning may be facilitated by providing analgesia or local anesthetic, however this should always be within the appropriate scope of care for your level of EMT.
- » **Do not primarily suture any wound.**
(Some exceptions can be made for simple wounds of the face, scalp and perineum).
- » **Antibiotics cannot replace cleaning and surgical debridement of wounds.**
- » Dress the wounds with a bulky absorbent dressing.
- » Following sudden onset disasters, the injured survivors predominately present with wounds sustained during the event, or in the hours or days that follow, as they move around in debris.
- » In hot climates and in the absence of any immediate medical care, contaminated wounds progress quickly to wound infection and tissue necrosis.
- » This is seen clinically as cellulitis, subcutaneous infections, and possibly necrotizing fasciitis with necrotic muscle and gangrene.
- » Wounds from tsunamis typically involve wound infections, while earthquakes tend to create wounds with crush injuries. Both types can result in necrotic tissue that requires debridement.



Figure 2. Initial irrigation and cleaning of a wound prior to any surgical treatment.

Alan Kay

EMT TYPE 2

WHEN TO REFER FROM EMT TYPE 1 TO EMT TYPE 2 FACILITY:

- » Complex wounds that penetrate fascia
- » Contaminated wounds due to requirements for sharp excision and anaesthesia
- » Impaired sensation distal to the wound
- » Bleeding vessel within the wound not controlled by 10 minutes of pressure
- » Infected wounds with obviously necrotic tissue requiring debridement
- » Palpable crepitus in the soft tissues or other signs of deep infection such as increased pain or fever
- » Suspicion of fracture
- » Not possible to administer adequate anesthetic to properly clean the injury

WOUND SURGERY

- » Formal wound surgery (as opposed to wound cleaning) must **not** be performed in an EMT type 1 facility.
- » The goal of wound care surgery is to provide the optimal outcome as early as possible. Surgery will prevent deterioration and allow transfer if available, acknowledging that this may be delayed. **Antibiotics for wounds are an adjunct to surgery and wound cleaning not an alternative.**
- » Wound debridement must be performed in a designated room where safe sedation and anaesthesia can be provided. Surgery must be provided under adequate analgesia and sedation, or anaesthesia as required ensuring that the patient does not suffer pain during the procedure.
- » ***Surgery in disaster and conflicts should still be undertaken with the same precautions as an elective operation in a high resource hospital.***



Alan Kay

Figure 3. Massive lower leg wound following full surgical debridement.

TECHNIQUE FOR INITIAL WOUND EXCISION AND DEBRIDEMENT

- » Remove all dead, contaminated and infected tissue but leave all viable tissue to assist with reconstruction for maximum function.
- » **WOUND EXTENSION:** Every wound must be extended proximally and distally to adequately explore and examine the tissues for necrosis, contamination, and damage of vital structures. Extensions should be in the long axis of the limb, and not transverse, except when crossing a flexion crease. If they are required along the whole length of either the forearm or lower leg, they should be placed to join the lines of election for fasciotomies.
- » Be methodical in excising the wound. Progressively explore and debride in layers from superficial to deep.
- » Sharp dissection using a scalpel or sharp scissors should be used to remove any contaminated tissues. Electrocautery can be used for excision of tissue, but keep in mind that it can leave some dead tissue in the wound.
- » Techniques of excision that minimize bleeding provide an advantage. Carefully consider the use of a surgical tourniquet during debridement; this causes further tissue ischemia and can impair assessment of viable tissues but this must be balanced with the need for a clear view of the wound and prevention of blood loss.



Figure 4.
Recommended
incisions for fasciotomy
and wound extension
(BOA/BAPRAS)

KEY POINT

- » Scraping the surface of damaged muscle with a sharp gynecological ring curette to remove surface necrosis or infection is efficient and effective without stimulating further bleeding.

WOUND DEBRIDEMENT BY LAYERS

Skin is very forgiving and generally has a very good blood supply. Leaving some doubtful skin is not going to result in rapid sepsis, so excise the edges—a maximum of 1–2 mm, or wider where the tissue is contused and ragged. This margin should only be exceeded in the event of **obvious** skin necrosis.

Be very conservative on the face and upper limbs. All viable skin should be left intact at this stage, increasing the subsequent reconstruction options.

Subcutaneous fat that is undamaged and viable should be left, but be generous with the excision of necrotic and contaminated fat.

Fascia that is shiny and clean is left, but excise anything impregnated with dirt or that appears ragged or dull. If the fascia is already grey and thickened with a fur like covering then it needs to be excised as **this is likely necrotizing fasciitis**. Wound extensions are required to excise the affected fascia over the compartment. These extensions may well convert a small puncture wound to a linear wound over the full length of the fascial compartment.

Muscle is unforgiving. All dead and doubtful muscle must be excised. **The timing of second surgery in a disaster or in conflict is never assured; so do not risk leaving doubtful muscle in a wound.** The next wound review is more than likely five days away.

PITFALL

- **Muscle can fail to contract when pinched if the patient is under the influence of a depolarizing paralytic.**
- **Acutely after blast injury, capillary circulation is impaired for several hours, but often returns.**

KEY POINT

VIABLE MUSCLE IS:

COLOUR: is pink

CONTRACTS: when pinched with forceps

CONSISTENCY: is firm

CAPACITY: to bleed when cut

WOUND SURGERY

- » **BONE** – Remove only the contaminated periosteum taking care to preserve as much as possible. This layer is thick in children but thin in adults.
Articular fragments with a soft tissue attachment should be preserved, but loose bone fragments must be removed.
- » **NERVES** – Do not trim or tag the ends of nerves as it risks further damage. Perineural repairs should only be attempted at the time of definitive operation, when the risk of infection is lower.
- » **TENDONS** – Ragged ends may be sharply trimmed.
- » **BLEEDING** – All wound bleeding must be controlled to prevent formation of haematomas that can precipitate infection. Electrocautery is acceptable if available. Alternatives include suture ligation, clip and wait, or clip and twist.
- » **WASHING** – Pulse lavage is not recommended. Low pressure washout with isotonic fluid is preferred. In the absence of isotonic fluids clean water can be used.

WOUND COVERAGE EXCEPTIONS

- » Wounds in the face, head, neck, perineum and possibly hand may be considered for primary closure.
- » Wounds involving nerves, brain/dura, or vessels (picture right) should not be left without soft tissue coverage.

PITFALL

WOUND COVERAGE

Wounds sustained in conflict or disaster should be considered contaminated and almost never closed primarily, and then only if wound debridement is complete.



Figure 5. Exposed vascular repair in an open leg wound.

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DRESSINGS

- » The simplest dressings are **dry** gauze, or absorptive layers of cotton or wool held in place by elastic bandages. Dressings treated with iodoforn, chlorhexidine or sodium hypochlorite are not required and have been reported to damage host cells and inhibit healing.
- » Bandages should be applied in a traditional figure of eight pattern without tension. This avoids a circumferential bandage becoming a tourniquet when the limb swells.
- » Non-adhesive dressing layers such as petroleum jelly impregnated gauze may be laid next to the wound if the next dressing change is planned in a ward area.

SPECIAL TOPIC: NEGATIVE PRESSURE WOUND DRESSINGS

- » Although there is no published evidence that negative pressure dressings improve healing in acute wounds, their use is of practical benefit. Exudate soaking through dressings is eliminated, patient comfort is improved, and dressing change frequency is reduced.
- » Negative pressure dressings should only be placed on wounds that have been adequately debrided.
- » Foam should be of open cell type and placed only in the wound. Gauze can be safely allowed to overlap on to normal skin.
- » Staff should only use negative pressure dressings if they have experience in the technique.
- » For large wounds and stump dressings it may be necessary to hold the gauze in place with circumferentially wrapped adhesive tape. This should be carefully laid on and not tightly wrapped. Adherence can be improved with tincture of benzoin and application of a 2 cm strip of dressing around the wound edges to create a “window.”

NEGATIVE PRESSURE DRESSINGS IN AUSTERE SETTINGS

A negative pressure wound set up can be created with gauze and perforated tubing. (Figure 6)

- Loosely pack the wound with gauze and place a tube with several holes overlying the gauze. This can run through the dressing as shown or simply exit on one side of the dressing.
- Cover the gauze and tubing with more loose gauze.
- Cover with clear adhesive tape and connect to suction. The dressing should shrink down and become hard if the seal is effective. In the absence of a formal proprietary pump, improvised solutions such as wall suction, vacuum bottles or a vacuum created by using a syringe with the plunger held out with sticks, may be effective.



Alan Kay

DELAYED PRIMARY CLOSURE

- » Delayed primary closure, including skin grafting or repeat wound debridement, should be planned. “Look and see” as a planned procedure is a poor approach.
- » The timing of this next intervention is not strictly fixed. Experience suggests that the window for closure is between day 2 and day 5. An early return to the operating room is indicated if there are clinical signs of infection: fever, tachycardia, pain and malodor—the “bad smell”—for re-debridement.

HEALING BY SECONDARY INTENTION

- » If there is no plan to close the wound, in other words to allow the wound to heal by secondary intention, then dressing changes in a treatment area or ward are possible, as long as acceptable analgesia is achieved.
- » ***It is safer to allow a wound to heal by secondary intention if there is any doubt as to the adequacy of debridement or the presence of infection.***
- » Healing by secondary intention may occur in less than two weeks for wounds less than 2.5 cm in diameter. If healing is expected in less than two weeks, equivalent to the time for a graft to take and the donor site to heal, then skin grafting is not indicated.

ANTBIOTICS

- » Antibiotics are an adjunct to surgery and good wound care. See Open Fractures chapter for ICRC antibiotic guidelines. For wounds sustained in conflict and disaster settings then 3 days of broad spectrum antibiotics are advised. ***An open draining wound is more important than antibiotics.***

NUTRITION

- » The nutritional state of the patient pre-disaster may have been suboptimal to begin with and injury and surgery create a high catabolic state. Good nutrition is essential for wound healing. Appropriate foods rich in calories are required. Treatment for parasitic infection may also be appropriate, as well as iron supplements.
- » Comorbidities such as anaemia and diabetes need to be considered and addressed as soon as possible to facilitate healing.

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CLOSED FRACTURES

SCENARIO

CLOSED FRACTURE MANAGEMENT

POP IMMOBILIZATION

POP AFTER-CARE AND FOLLOW UP

REMOVING CASTS

TRACTION

PAEDIATRIC CONSIDERATIONS

TRANSFERS

MANAGEMENT OF CLOSED FRACTURES WITH INTERNAL FIXATION

SUGGESTED RESOURCES

REFERENCES

SCENARIO

It is 5 days post earthquake.

A 25-year-old man with a clinical diagnosis of a closed fracture of the mid-shaft of the left femur is brought to the medical facility.

An elderly woman with a swollen, unstable knee presents. She fell during the earthquake and has been unable to bear weight since her fall.

A 6-year-old girl presents after a fall from a damaged building the night prior. Her left elbow is grossly swollen, deformed, and no radial pulse is palpable.



TYPE 1

- Treat non-displaced clinical fractures with immobilization (back slab, splinting) but NOT circumferential casts.
- Provide analgesia and mobility aids such as crutches or walking frames for the elderly.
- Refer patients to higher levels of care with: limb deformities, neurovascular injury, major trauma (tibial/femoral fractures) or any injury that cannot be managed locally.
- If available, radiography may prevent unnecessary transfers.



TYPE 2

- Plain radiography required
- Treat with immobilization (splints/plaster), traction with pins and external fixation
- Early physical therapy to improve functional outcomes and prevent complications



TYPE 3

- No open reduction and internal fixation (ORIF) in temporary (tent) structures.
- Treat complex fractures that may benefit from internal fixation (periarticular or intraarticular), only if the team is integrated into the local infrastructure.
- Provide higher levels of medical and intensive care.

KEY POINT

The goals of treatment of closed fractures should include:

- » Avoid infection – first do no harm (such as through unsafe internal fixation).
- » Optimize functional outcomes and minimize pain.
- » Promote fracture union with acceptable length, rotation and alignment.
- » In the upper limb, mobility is a priority over stability.
- » In the lower limb, stability is a priority over mobility.

CLOSED FRACTURE MANAGEMENT



TYPE 1

If limb alignment is normal but a fracture is suspected or confirmed on radiology, a splint or cast should be applied to maintain the position and reduce pain.

NON-DISPLACED FRACTURES

- » Application of casts and splints for fractures with acceptable position in the wrist, forearm and humerus may be applied without sedation.
- » Application of casts for non-displaced fractures of the tibia is difficult and should be performed in a designated room where sedation can be provided if necessary.



TYPE 2

All patients who require closed reduction of fractures and application of some form of immobilization should be managed in a designated area where safe anaesthesia or sedation can be provided.

DISPLACED FRACTURES REQUIRING REDUCTION

- » In the immediate post injury period, back slabs rather than full circumferential casts are preferred.
- » A bi-valved plaster cast of this type is easier for family to remove if necessary, but has a higher incidence of loss of fracture reduction.
- » On most occasions this bivalve approach is the safer option if follow up is of concern.
- » Follow up with all patients with limbs immobilized in full casts is essential.
- » If this is not possible, select those patients most likely to have complications during the healing process:
 - Patients with fractures that required reduction
 - All patients with circular casts in order to rule out issues with cast pressure
 - Patients with fractures involving the elbow
 - Patients with fractures treated very close to the time of injury, as these can have an increased risk of problematic swelling.
 - Patients who underwent closed reduction while a significant amount of swelling and oedema were still present.

SPECIALIST SURGICAL TEAMS

- » **If possible, all closed fractures should be initially treated in a closed fashion** to minimize complications, particularly infection, despite the longer treatment times associated with this approach.
- » Articular and periarticular fractures which could benefit from delayed internal fixation should only be performed in facilities with the expertise, sterility and equipment to do this safely.
- » Surgical techniques must be adapted to the local environment. Exceeding the local technical capability in fracture management creates problems for patients and staff alike when complications arise. **Any patient that has a fracture immobilized must have a follow up plan for review.**
- » **Internal fixation uses up limited resources and carries a high risk of infection in disasters and in conflict.**
- » **ORIF should only be performed at appropriate facilities with a safe water supply, sterile of equipment, specialist surgical teams, appropriate nursing support, and physical therapy following surgery.**
- » Non-operative fracture management and avoiding internal fixation methods in the initial three weeks post disaster is not a reflection of the technical capability of the surgeon but of related resources such as:
 - contaminated water supplies
 - co-location of “clean” patients in wards with patients who have wound infections.



TYPE 1

EMT type 1 Facilities should have the equipment and expertise available to apply and manage a range of lower and upper limb immobilization techniques including splints and Plaster of Paris back slabs or casts.

APPLYING CASTS

CASTING MATERIALS

- » **Plaster of Paris (POP) is the casting and splinting material of choice.**
- » It can be removed by soaking and cutting the wet plaster.
- » Medical teams who carry fiberglass as a fracture management solution should only use this material for splints and **never for full casts** in a disaster or in a conflict zone.
- » Power failures, plaster saw breakage, and transfer of the patient to a facility without a plaster saw all place the patient at risk of having a cast that cannot be removed without serious risk to the casted limb.

PATIENT INFORMATION

- » Patients who have splints or casts applied must be provided with a plain language statement, in their first language, regarding care while in the splint or cast. Emphasis should be placed on returning for medical care if pain is not controlled by the analgesics provided.
- » Patients should be encouraged to mobilize even with one extremity splinted or casted.
- » Write the POP calendar on the cast – including date of application of the cast, date of removal and X-ray.

DIFFERENT EXPECTATIONS

Write on tape secured to the cast the suspected diagnosis, name of provider, place, date, and a line drawn where the fracture is. This transcends language barriers and helps patient and family understand the diagnosis.



Figure 1. Plaster of Paris cast with patient info recorded on it. (ICRC)

POP IMMOBILIZATION

FABRICATION PROCEDURE OF POP CASTS AND SLABS

PREPARATION OF THE NECESSARY MATERIALS

- » Prepare a good number of plaster bandages rather than just a few rolls, as the POP should be made all at once to assure the continuity of its structure.

POSITION OF THE PATIENT

- » Adjust position with cushions and pillows if required.
- » More than one person may be required to support the fractured limb.
- » The medical professional should be in a suitable position to work without obstruction or difficulty.

PROTECTION OF SENSITIVE AREAS

- » Clean and dry the skin as well as possible to avoid odour and discomfort inside the cast.
- » Apply the stockinet over the entire area to be covered with POP, plus an extra length for folding back at both extremities.

APPLY ADDITIONAL PADDING (COTTON WOOL OR SOFT BAND) OVER SENSITIVE AREAS

- » Areas that should never be compressed and must be well padded:
 - Fracture site
 - Bony prominences
 - Nerves
 - Vessels
 - Wounds

GENERAL PRINCIPLES

- » Never put plaster directly on unprotected skin.
- » The edges of the POP should be covered and not chafe or puncture the skin.
- » Molding should be done with the palms of the hands and not the fingertips.
- » Application should be continuous to allow the cast to dry as a single, solid piece.
- » Check and document the anatomical and functional position of the limb.
- » For unstable patients immobilization with a POP back slab or skeletal traction is faster and easier than placing an external fixator.

DURATION OF IMMOBILIZATION

- » If properly diagnosed and treated with immobilization, fractures of different bones require varying periods of immobilization to achieve union.

BONE	MOST COMMON IMMOBILIZATION PROTOCOLS WITH NO COMPLICATIONS		AVERAGE HEALING PERIOD WITH NO COMPLICATIONS	
	ADULT	CHILD < 10 YEARS	ADULT	CHILD < 10 YEARS
Metacarpal	4-6 weeks	2-3 weeks	6 weeks	4-6 weeks
Scaphoid	8-12 weeks	8-10 weeks	15-20 weeks	12 weeks
Carpal	4-6 weeks	2-3 weeks	6 weeks	4-6 weeks
Ulna	4-6 weeks	3-4 weeks	6-8 weeks	4-6 weeks
Radius	4-6 weeks	3-4 weeks	6-8 weeks	4-6 weeks
Humerus	4-6 weeks	3-4 weeks	6-8 weeks	4-6 weeks
Clavicle	4 weeks	2-3 weeks	4 weeks	2-3 weeks
Scapula	4 weeks	2-3 weeks	4 weeks	2-3 weeks
Ribs	4-6 weeks	2-4 weeks	4 weeks	2-3 weeks
Vertebral bones	6-8 weeks	4-6 weeks	12 weeks	6-8 weeks
Pelvic bones	6-8 weeks	4-6 weeks	6-8 weeks	4-6 weeks
Femur	6-8 weeks	4-6 weeks	12 weeks	6-8 weeks
Tibia	6-8 weeks	4-6 weeks	12 weeks	6-8 weeks
Talus	6-8 weeks	4-6 weeks	12 weeks	6-8 weeks
Calcaneus	6-8 weeks	4-6 weeks	12 weeks	6-8 weeks
Phalanges	4-6 weeks	2-3 weeks	6 weeks	4-6 weeks

Figure 2. Length of Immobilization times. (ICRC)

KEY POINT

- » When applying POP, the drying time depends on the quantity of water left in the plaster.
- » If there is too much water in the plaster, the POP becomes fragile after drying.
- » Increasing the water temperature shortens the drying time. For long POP, cold water should be used to allow the different layers to dry as one solid cast.
- » The higher the water temperature, the higher the temperature generated inside the cast:
- » If the water temperature is 24°C, the POP temperature increases to 38°C. If the water temperature is 38°C, the POP temperature increases to 57°C.
- » With a water temperature over 50°C, the heat produced inside the POP could burn the skin.

APPLYING BACK SLABS

- » Position the patient appropriately, obtain materials, and prep the skin.
- » Stockinet is applied to the limb to cover all joints surrounding fracture.
- » Padding is applied over the stockinet to pad high risk pressure points.
- » The first wetted plaster slab is applied along the length of the posterior aspect of the injured limb.
- » A second slab is applied in the same fashion as the first using a figure-of-eight or X-crossing of the two slabs to give the lightweight posterior splint its strength.
- » Any excess plaster is trimmed for patient comfort and to prevent any skin irritation.
- » Gauze or elastic bandage is gently but firmly applied to keep the slabs in position.
- » The back slab is held until the plaster has set with the appropriate joint position to facilitate fracture healing.

APPLYING CIRCULAR CASTS

- » The skin should be thoroughly washed and dried before application.
- » Stockinet is applied and the necessary amount of padding for protection of bony prominences is applied.
- » The plaster bandages should be applied by rolling without tension. Each bandage covers one-half of the previous bandage without wrapping circumferentially.
- » The palm of the hand is used, not the fingers, to mold the wet bandages to avoid pressure sores through the cast.
- » The limb is held in the appropriate joint positioning until the cast is set. (Figure 5)
- » When dry, the calendar time, fracture location, and other documentation is written on the cast.



Figure 3. Forearm slab with fingers splinted in the safe position. (ICRC)



Figure 4. Molding a tibial cast by indenting thumbs into both sides of the patellar tendon. (ICRC)



Figure 5. Allowing the plaster to set on a tibial cast. (ICRC)

POP AFTER-CARE AND FOLLOW UP

ADVICE AND INSTRUCTION FOR PATIENTS

Give the following advice to the patient and his or her family.

- » Respect drying time before ambulation.
- » POP should not be covered with cloth, varnish, or a blanket until it is dry.
- » The POP must not come in contact with water or any other liquid.
- » Raise or elevate the leg with POP on a pillow to decrease swelling.
- » Perform isometric contraction under the POP to protect against muscle atrophy and phlebitis.
- » Mobilize free joints.
- » Never walk on the cast without a rocker or tip.

CAST VITAL SIGNS

- » Pain
- » Odour
- » Cleanliness
- » Strength
- » Colour, heat, sensation and mobility of extremities
- » General fever and heart rate

DANGER SIGNS IN CASTED FRACTURES

- » Increasing pain
- » Motor or sensory changes
- » Increasing swelling
- » Seepage through or around the cast

FOLLOW UP AND SUPERVISION

- » Ideally have one follow up after 24 hours
- » Provide basic physical therapy exercises if needed
- » Tell the patient (and family) to return if there are any concerns
- » All POP not tolerated by the patient should be removed
- » Ensure patients have plans that allow for clinical review and cast removal
- » Ensure mobility aids are provided if needed

POSSIBLE COMPLICATIONS

- » Skin (pain, burns, sores due to pressure)
- » Bones (secondary displacement, osteomyelitis)
- » Joints (stiffness, osteoporosis)
- » Muscles atrophy (amyotrophy)
- » Neurovascular complications (complex regional pain syndrome, local compressions, compartment syndrome, thromboembolism).



Figure 6. Skin reaction to POP. (ICRC)

REMOVING CASTS

IMMEDIATE REMOVAL OF THE POP

- » If swelling, diffuse pain or lack of sensation occurs, immediately split the POP along its length.
- » Should local pain occur, open a window and check the skin. Close the window with an elastic bandage or POP if there is no wound. The incident should be recorded in writing on the cast.

REMOVING CAST TECHNIQUES

- » The cast may be removed by an electric cutting device or plaster shears.
- » For children, or if electricity is not available, plaster shears are necessary.
- » Prior to removal, gather all materials needed. These include scissors, removal tools (Figure 7), materials to wash the limb after, and supportive material.
- » Position and drape the patient. For upper extremity casts the patient can be in the sitting or supine position. For the lower extremity the patient should be in the supine position.
- » Determine cutting lines, and do not cut over bony prominences.
- » When using plaster shears, ensure correct blade alignment with each cut, and after 4-6 cuts clear the blades, utilize the benders, and continue. Never cut around corners, remove the blade and cut from the opposite direction.
- » When using an electric cutter, ensure the patient is comfortable and understands the blade will not cut their skin.
- » After the cast is removed, assess the skin for any damage from removal and assess the form of the limb following immobilization.
- » Wash and dry the area, and apply oil or lotion to assist in restoration of normal skin nutrition.
- » The patient needs to be educated about care of the skin and of the injured limb as the muscle tone returns.
- » A referral for rehabilitation is strongly advised.

PITFALL

If a window is cut to assess the skin under a cast, or for treatment of a small (type 1) open fracture, the plaster should be reapplied and fixed in place with elastic bandage to prevent the formation of "window edema".



Figure 7. Tools needed for removal and manipulation of POP. From top to bottom, oscillating saw, cast spreader, plaster shears, cast breaker. (ICRC)

TRACTION



TYPE 2

Surgical teams providing care in disaster response and in conflict zones **must be familiar with the principles of managing patients with fractures in traction**, which may be used as a temporary method to manage a fracture or as a definitive technique (See ICRC manual on POP and Traction for additional information).

SKIN TRACTION

- » Skin traction can be used temporarily in adults with femur fractures (for no more than 48–72 hours).
- » It can serve as a method to allow for placement of traction for transfer to a higher level of care.
- » Skin traction can serve as a definitive method of treatment for many femoral fractures in the paediatric group.

SKELETAL TRACTION

- » Skeletal traction can be used as definitive management for adults with open long bone fractures, although external fixation provides better stabilization and optimizes management of the soft tissue injury (see chapter on open fractures).
- » Skeletal traction for children with hip fractures is effective and commonly used.
- » Although definitive treatment with traction is not as effective in adults, it may be the only locally available treatment for adults who sustain fractures of the proximal femur, and is more effective than skin traction.

PLACEMENT OF TRACTION PINS

- » Traction pins should have a centrally threaded section, as this will prevent slipping in the bone.
- » This can be inserted under local anesthesia with a hand drill (for safe pin insertion see the section on open fractures).
- » Traction should not be applied across an unstable joint.

KEY POINT

- » When placing a Denham pin for skeletal traction in a deployment scenario, place a piece of tape on the pin and write “threaded.” This is important as you cannot guarantee that you will be the one to remove the pin.
- » Always check the stability of the knee joint prior to placing a traction pin for a femoral shaft fracture.

TECHNICAL ASPECTS

- » Traction pins should not pass through a synovial joint space or an open physal plate.
- » Beware the proximal extent of the knee joint and the proximal tibial physis in children.
- » Check stability of the knee prior to inserting a traction pin for a femoral shaft fracture.
- » If the knee is unstable, insert the pin in the distal femoral metaphysis.
- » During insertion, start from the safe side—where the vessels and nerves at risk can be localized and avoided by careful selection of the insertion point.
- » Distal femoral traction pins should be inserted from medial to lateral to avoid the adductor canal and femoral artery.
- » Proximal tibial pins should be inserted from lateral to medial to avoid the common peroneal nerve as it passes around the neck of the fibula.
- » Calcaneal pins should be inserted medial to lateral to avoid the posterior tibial neurovascular bundle.
- » A Thomas splint or variant can be used for temporary stabilization, or for definitive care for a patient with a femoral shaft fracture.
 - These are commonly used for temporary treatment, either until femoral nailing can be safely performed, or to transport a patient to another surgical centre.
- » If using a Thomas splint as a treatment option (more common in children), the ring must fit the patient, and attention must be paid to correctly padding and adjusting the traction equipment to prevent pressure areas in the groin.



Figure 8. Thomas splint. (ICRC)



Figure 9. Traction pin placed in the femoral metaphysis and an empty vial used as a pin guard. (ICRC)

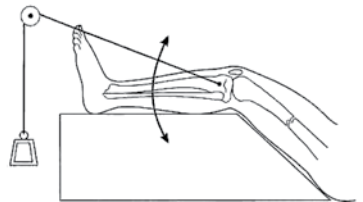


Figure 10. The larger force applied in skeletal traction is transmitted along the axis of the limb via a pin, pulley and a weight. (ICRC)

- » Adults with femoral shaft fractures being managed in skeletal traction are often on a Böhler-Braun frame.
- » This allows elevation of the lower limb, and knee flexion during traction. The frame must fit the patient and be suitably lined.
- » In the absence of a Böhler-Braun frame, a split Hamilton Russell or a Thomas splint can be used for traction.



Figure 11. Construction of a traction frame in the field. (J. von Schreeb)



Figure 12. Alternative method to a Böhler-Braun frame for a proximal femur fracture. (ICRC)



Figure 13. Preparation of a Böhler-Braun Frame. (ICRC)

KEY POINT

- » Patients in traction often develop an equinus deformity of the foot.
- » This can be prevented with active and passive physiotherapy using bands and/or foot slings.
- » Pressure sores of the heel and sacrum should be prevented, and DVT prophylaxis, if available, is indicated.

PAEDIATRIC CONSIDERATIONS

TRACTION AS DEFINITIVE CARE

- » Children who have femoral shaft fractures are commonly treated in traction with union occurring in approximately the patient's age in years plus one week.
- » Patients less than 8 should be treated with early Spica casting under sedation 1-3 days after fracture.
- » Fixed traction using adhesive skin or skeletal traction in a Thomas splint is possible. Hamilton Russell Traction is possible as well and does not require a Thomas splint.
- » Some surgeons view the Thomas splint as primarily useful for transport as the device can lead to pressure sores in the groin.
- » Children under the age of 2 years with a femoral shaft fracture can be managed in Gallows traction.
- » Children under the age of 6 months can be managed in a "Soft Spica" built with padding and bandages or by using a Pavlik harness if available.
- » Weights required are minimal (1-2 kg) and should be over a pulley on an overhead bar, not tied off to the bar.

SKELETAL TRACTION

- » Skeletal traction for children with hip fractures is effective and commonly used.
- » Skeletal traction is the best choice for:
 - Initial immobilization of most femoral and some tibial and humeral fractures
 - Definitive immobilization of fractures of the femur
 - Definitive immobilization of particularly difficult fractures of the tibia near the knee and of the humerus near the elbow
 - Traction pins in children should not be placed near the tibial tuberosity as they may cause an anterior growth arrest and subsequent recurvatum deformity. They should be placed in the distal femur 1 cm proximal to the growth plate.



Figure 14.
Gallows
traction from a
beam. (ICRC)



Figure 15. Patient in skeletal traction. (ICRC)

DISADVANTAGES OF SKELETAL TRACTION AND CONSIDERATIONS

- » The principal disadvantage of skeletal traction is prolonged bed rest, along with increased demands on both nursing and physiotherapy care.

TRANSFERS

- » An injured patient may have the opportunity for evacuation from the first hospital to a higher level of care.
- » The patient needs to be consulted about a transfer and the transfer should be discussed with their family or support system.

SKIN TRACTION AND TRANSFERS

- » Transport of a patient with a long bone fracture can be facilitated by using skin traction for a limited amount of time during the transport. Skin traction for transport should be adhesive in children and non-adhesive in the adult.
- » Femoral shaft fractures in adults can be managed during a short distance transfer by continuing traction with a weight on a traction pin, but this should be avoided if possible.
- » An alternative is the application of a Donway, Hare or Thomas splint. ***These splints cannot be used in the presence of ipsilateral pelvic fracture.***
- » Another option is bandaging the fractured limb to the intact limb with slings or strips of fabric.

AIR TRANSPORT

- » Consider a prophylactic fasciotomy of the calf prior to transfer due to pressure changes.

TRANSFERS IN CASTS

- » Any patient in a full cast should have the cast split to skin for transfer.
 - This is done due to swelling and to minimize the risk of a tight cast/compartament syndrome during the transfer.
- » Elevate the patient's hand or foot as appropriate to prevent distal limb swelling.
- » Avoid hanging an arm in fabric on a pole beside the bed.
 - The edge of that fabric will cause an ulnar nerve neuropathy if it is allowed to compress the postero-medial aspect of the elbow.
 - Simply elevate the hand on the abdomen, or prop it to be well above the elbow at rest.

MANAGEMENT OF CLOSED FRACTURES WITH INTERNAL FIXATION

H

TYPE 3

BEWARE THE RISKS OF INTERNAL FIXATION

LIMITED INDICATIONS IN DISASTER AND EMERGENCY SITUATIONS

- » Only indicated if the situation has stabilized and a type 3 team is integrated into a local facility with prior history of performing internal fixation.
- » Incidence of 50-80% of infection has occurred when internal fixation was used as a primary means of treatment.
- » Consider transferring the patient to a more advanced facility if internal fixation is necessary.
- » Evaluation of patient's normal environment, safety, risk of complications, and available resources must be considered before closed fracture internal fixation is performed.
- » The principal methods of Plaster-Of-Paris, skeletal traction, and external fixation are viable options for many fractures and should be the first choice in disaster and conflicts.

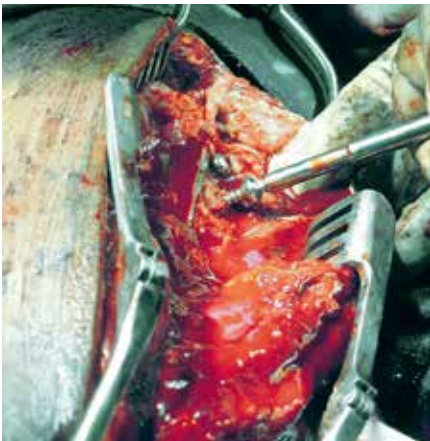


Figure 16. Pus pours from a wound treated with internal fixation. The plates and screws must now be removed. (ICRC)

SUGGESTED RESOURCES

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EMT Website: <https://extranet.who.int/emt/page/home>
 AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>

8

OPEN FRACTURES

SCENARIO
WOUND DEBRIDEMENT
FRACTURE STABILIZATION
EXTERNAL FIXATION FOR OPEN FRACTURES
MANAGEMENT OF OPEN FRACTURES

SUGGESTED RESOURCES

REFERENCES



(ICRC)



(Bar-On)

SCENARIO

Your team arrived three days ago, 48 hours after the earthquake struck, and by now the hundreds of patients in the parking lot of the partly destroyed hospital have been managed, but new patients keep trickling in regularly.

A mobile surgical facility 25 kilometers away is now operational. One of the new patients is a 23-year-old female with a wound over the distal leg and exposed fracture of the tibia. There is pus in the wound but no crepitus, and the patient is febrile at 38.5° C.

Where should this patient be managed, at a EMT type 1? EMT type 2? type 3?



TYPE 1

- Lavage, dress, align and splint wounds
- Administer antibiotics and tetanus prophylaxis
- DO NOT CLOSE THESE WOUNDS PRIMARILY



TYPE 2

- Formal wound debridement
- Apply cast with window or external fixation for continuation of management of open wound management



TYPE 3

- Receive dressed and splinted wound from type 1 or 2 EMT.
- Provide definitive treatment with plan for long term follow up

KEY POINT

- » Assess every patient and every injury that presents to your facility.
- » This includes removing bandages, changing dressings, and adjusting splints.
- » Every injury gets a priority and a plan!

TRiage MATTERS...HAVE A PLAN

The rate at which patients present can influence the surgical plan by requiring abbreviated options. Know your situation. Patients from a SOD tend to present all at once, while the tide of patients presenting from conflicts ebbs and flows.

DIFFERENT EXPECTATIONS

Open fractures managed in civilian practice outside of conflict zones are often caused when the bone penetrates the skin—or ‘from within.’ Limb surgeons in high-resource settings are familiar with dealing with these injuries with little contamination and a lower risk of infection than in disasters and conflict. A soft tissue injury with a break in the skin removes the biological protection of the soft tissue and of bone, opening the patient to infection of the soft tissue, the bone or both.

Open fractures in conflict are usually from the outside to in and therefore at increased risk of contamination. This is exacerbated by the contaminated surroundings and the delay in treatment initiation. Therefore, all open fractures should be assumed to be infected upon arrival.

SPECIAL CONTEXTS

EARTHQUAKES

Earthquakes can result in crush type injuries. These mechanisms of injury cause not only fractures but significant soft tissue injuries, which can often go unrecognized at the initial evaluation. Crush injuries should be expected in all patients with injuries caused by falling debris or entrapment under building or landslide rubble.

FLOODS AND TSUNAMIS

Floods and tsunamis more frequently produce lacerations in large numbers, but the proportion related to fractures is reduced compared to earthquakes or conflict. Tibial fractures in floods and tsunamis are often open. Femoral fractures from tsunamis and floods are often closed.

ARMED CONFLICT

Injuries sustained in conflict may include soft tissue injuries or open fractures. The type of injury depends on the type of weaponry used. Injuries from GSWs, blast injuries, shrapnel injuries, and landmine injuries should be expected.

KEY POINT

- » Patients with open fractures should be considered to have a soft-tissue wound with an underlying bone injury.
- » Treatment of soft tissue injury is as important as treatment of the fracture.
- » The outcome for the patient will depend on the degree of injury of the soft tissues around the fracture.

WOUND DEBRIDEMENT



TYPE 2

Debridement of all wounds, including open fractures should be performed by a surgeon at an EMT type 2 or 3 facility.

Paediatric Considerations

Preserve all periosteum when possible, even if only an empty sleeve is present. Children can undergo remarkable regeneration of bone over several centimeters within a periosteal sleeve.

WOUND DEBRIDEMENT FOR PATIENTS WITH OPEN FRACTURES

- » Washing of bone ends with a syringe of water or saline is most effective when done with a syringe with a small outlet or through a needle, rather than through a large bore outlet.
- » Each bone end must be visually inspected for contamination and cleansing.
- » Bone debridement: remove all detached, devitalized, non-articular bone fragments.
- » Leave articular fragments unless they are grossly contaminated.
- » **Avoid damaging the remaining soft tissue attachments of bone fragments.**
- » A gauze square can be used to abrade the bone ends and remove visible contaminants.
- » A dental pick is equally effective in removing material on the bone ends.
- » Use a bone nibbler or rongeur to remove the remaining contaminated ends of the fracture fragments.
- » In cases with significant bone loss, acute shortening can be performed. This will also assist in bone coverage by soft tissues.
- » Volume is more important than pressure for washout, a minimum of 3-12 L per wound is required.
- » Bones and joints should be covered by soft tissue when possible. Soft tissues should not be sutured under tension.
- » Skin should never be closed primarily.

DIFFERENT EXPECTATIONS

While sterile isotonic solutions are used in hospitals, they are often impractical for use in a disaster setting. Clean drinking water from a tap or bottle is suitable for use washouts.



FIGURE 3 Low pressure irrigation during debridement. (ICRC)

FRACTURE STABILIZATION

**DO NOT INTERNALLY FIX OPEN FRACTURES
PRIMARILY IN CONFLICT RELATED WOUNDS OR
DISASTER ENVIRONMENTS.**

EXTERNAL FIXATION



Casting and external fixation can both provide management strategies for open fractures. In austere environments the simplest technique should always be considered first. For example, a cast with a “window” cut in the POP for wound care may be a safe and acceptable option.

External fixation of open fractures can be useful for **wound management**. However, the ease of access to wounds provided by **external fixation is not a replacement for good wound management with debridement, appropriate DPC, or other safe wound coverage**. External fixation of an open long bone fracture provides stability of the soft tissues, alignment of the fracture, protects neurovascular structures, maintains limb length, and can reduce the infection risk in comparison to longitudinal traction when used as a definitive treatment.

The goal of care of the open fracture is to provide alignment of the fracture in a stable environment for wound management and wound healing or early wound closure, in the simplest and safest way possible.

KEY POINT

- » External fixators applied initially as “temporary” may become definitive, so they should be constructed for that circumstance.
- » When applying external fixation to a femur fracture with a small distal femoral segment, the external fixation construct should span across the knee joint to the proximal tibia.

 TYPE 2	Application of external fixation is beyond the scope of a type 1 EMT and should be performed at a type 2 or 3 facility
 TYPE 3	

FEMUR

If external fixation is required for fractures of the femoral shaft, fixation should include 2–3 pins above and below a fracture. The pins can be either anterior or lateral.

Anterior is preferred if internal fixation may follow as it avoids the surgical incision sites for internal fixation. Two pins are adequate for temporary fixation. A lateral position and three pins are preferred if it is possibly the definitive management. Do not place pins within 2 fingerbreadths of the proximal border of the patella. This will avoid placing them through the suprapatellar pouch. If needed, place the more distal pins laterally.



Figure 4. Insertion site for calcaneal pin.
(AO Foundation Switzerland)

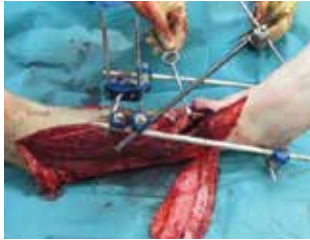


Figure 5. A Delta frame over an open fracture. The lateral fasciocutaneous flap has been raised to provide temporary loose immediate cover for the underlying vascular repair.(A.Kay)

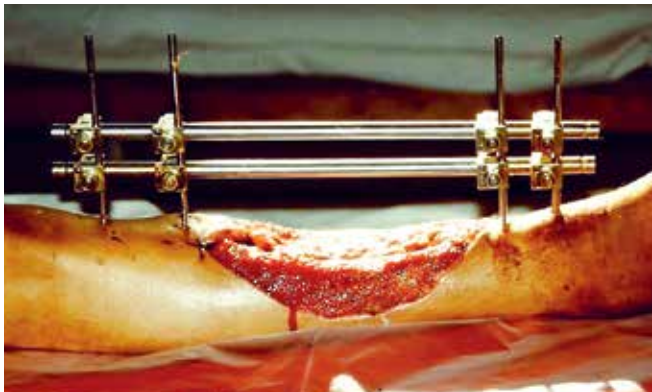


Figure 6. Mono-axial side-tube method: the four Schanz screws are well-aligned in a row. (ICRC)

TIBIA

A standard construct for a tibial shaft fracture should include 2–3 pins above and below a fracture on the anteromedial surface by preference, and a single bar.

More stability is provided by a second bar bridging the fracture site. This may be desirable for the management of pain related to movement at the fracture site.

DISTAL TIBIA

Fixation should span from the proximal tibia across the ankle joint to the foot when the distal tibial segment is small, or a distal leg wound prevents pin insertion in the distal tibia.

Construct a delta frame between the tibial shaft above the fracture and the foot.

A calcaneal pin is required as well as one or more pins in the metatarsals to triangulate the frame and prevent the distal tibia and foot slipping forward or backward off the plane of the proximal tibia.

KEY POINT

- » It is important to avoid bars that are too long, impeding joint motion or extending beyond the plantar surface and impeding weight bearing.

BIPLANAR

The pins above the fracture are connected by a short bar to create a 'handle' and the same technique used below the fracture. The fracture is reduced and the handles are then connected by a third rod.

This rod may connect the bar above to the bar below, a pin above to a pin below, or a bar one side of the fracture to a pin on the opposite side of the fracture.

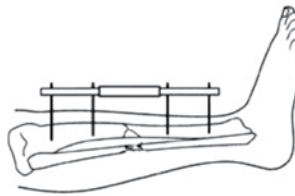


Figure 7. Modular technique: the two modules are manoeuvred into position, aligning the bone, both axially and rotationally, and the two short tubes joined together with a cross-tube. A second tube may then be applied to make the device more rigid. (ICRC)

UNIPLANAR

A single pin is inserted proximally and another distally, loosely connected by a single bar.

The fracture is then reduced and the frame locked. A second pin above and another below the fracture are inserted freehand with the drill or pin resting on the bar as a guide to line up the bar and the bone.

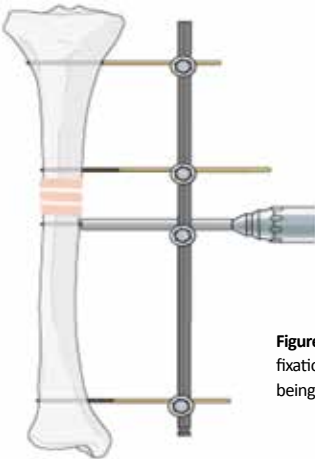


Figure 8. Standard uniplanar external fixation of the tibia showing the last pin being placed distal to the fracture site.

(AO Foundation, Switzerland)

KEY POINT

- » The further apart the pins on each side of the fracture, and the closer to the fracture the bar is, the more stable the construct. Leave room to allow for soft tissue swelling, wound care and dressing.
- » Constructs may also be attached only to the fractured bone, or span a joint.

EXTERNAL FIXATION FOR OPEN FRACTURES

PIN SELECTION

- » Do not use conical pins—if inserted too far, they cannot be backed off without losing their fixation in bone. The re-use of threaded half pins or Shanz-type pins is not recommended due to the difficulty in cleaning, sterilizing and tracking the pins.
- » Choose threaded half pins appropriate to the size of the bone and the patient (around 1/3 of the bone diameter). **Adult lower limb: 5mm pins for almost all circumstances, and 3–4 mm in the hand and arm.**
- » Pins may be self-drilling and self-tapping, or not—check the pins. If pointed and fluted, they are self-drilling self-tapping, if round without flutes they are not.

PAEDIATRIC CONSIDERATIONS

Children can have the same sized pins as adults from age 5. Under age 5, use 4 mm pins in the lower limb and 3 mm in the upper limb, if available.

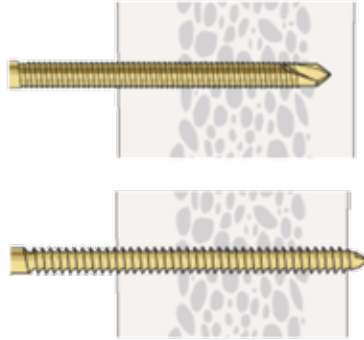


Figure 9.

A: Self Tapping Schanz screw

B: Conventional threaded pin

(AO Foundation, Switzerland)

PIN PLACEMENT

Power drills, if available should only be used by experienced surgeons. For surgeons with less orthopaedic experience, it is preferable to insert pins by hand using a Hudson brace system or a hand drill. Pre-drilling will facilitate the insertion of pins in fit, healthy people. A size 3.2 or 3.5 drill is adequate for the purpose. Self-drilling, self-tapping pins should be used when available.

If pins are not self-drilling, self-tapping, pre-drilling before pin insertion is required. Use only sharp drills. Blunt drills used on high speed produce significant heat and the heat will kill the bone in a ring around the pin.



Figure 10. Hand Chuck (ICRC)

Figure 11. Placement of a pin with a hand drill (ICRC)

PIN SELECTION

Pin length needs to be long enough to attach the connectors and allow the wearing of loose clothing but not so long that they interfere with joint movement.

The thicker the soft tissues, the longer the pin required to clear these before the blocks are added—femoral fractures need longer pins than tibial fractures.

A pin that is too short needs to be changed. A pin that is too long can be cut with bolt cutters, but this leaves a sharp end that causes the patient difficulty with protecting themselves, their clothing and bedding from injury.

Pins can be inserted under local anaesthesia, 5mL of lidocaine 1% on each side, from the skin down to the bone, as the periosteum is richly innervated.

Wait 5 minutes for the local to take effect, and make generous longitudinal skin incisions (at least 1 cm, not just a knife stab) so there will be no tension on the skin from the pin after the construct is secured. When inserting the pin, “walk” it on the bone to feel the anterior and posterior cortices, and triangulate to feel the mid-portion of the bone, where the pin should be inserted.

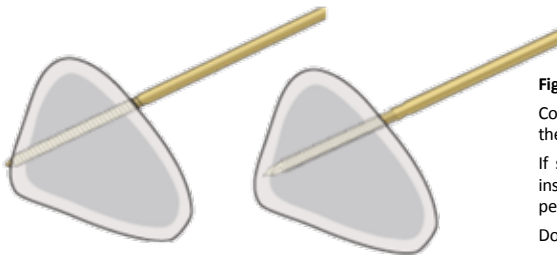


Figure 12.

Correct depth insertion may be achieved by feeling the opposite cortex.

If self-drilling screws are used (far left), they are inserted through the near cortex until they just penetrate the far cortex.

Do not break through the far cortex.

(AO Foundation, Switzerland)

KEY POINT

- » **Ring Sequestra:** Drilling by hand limits the drill speed, and therefore heat generation. It will quickly be recognized if a blunt drill is in use. If using a power drill, ensure every drill bit is sharp to reduce heat generation and the risk of ring sequestra. These ring sequestra harbor infection when a pin site becomes infected and can become the source of osteomyelitis and continuous discharge of pus.
- » **Pin Length:** Check the two pins for each bone segment before you insert the first. The second pin will give you a guide as to how much of the pin is engaged in the bone—or projecting beyond the far side of the bone.

SELECTION OF PIN ENTRY POINT

Pins should preferably be inserted separate from the wound, rather than through the wound. Pins placed through the wound may cause further soft tissue damage and interfere with wound care and coverage.

All pin sites are considered contaminated and some become frankly infected.

Consider the surgical approach for any future internal fixation or soft tissue reconstruction and avoid placing pins in this line. Internal fixation is an unlikely option following an open fracture and would only be considered after the wound has healed.

Consider also what structures are at risk on entry and at the exit point on the far side of the bone. Safe zones are described to assist in pin placement in the tibia.

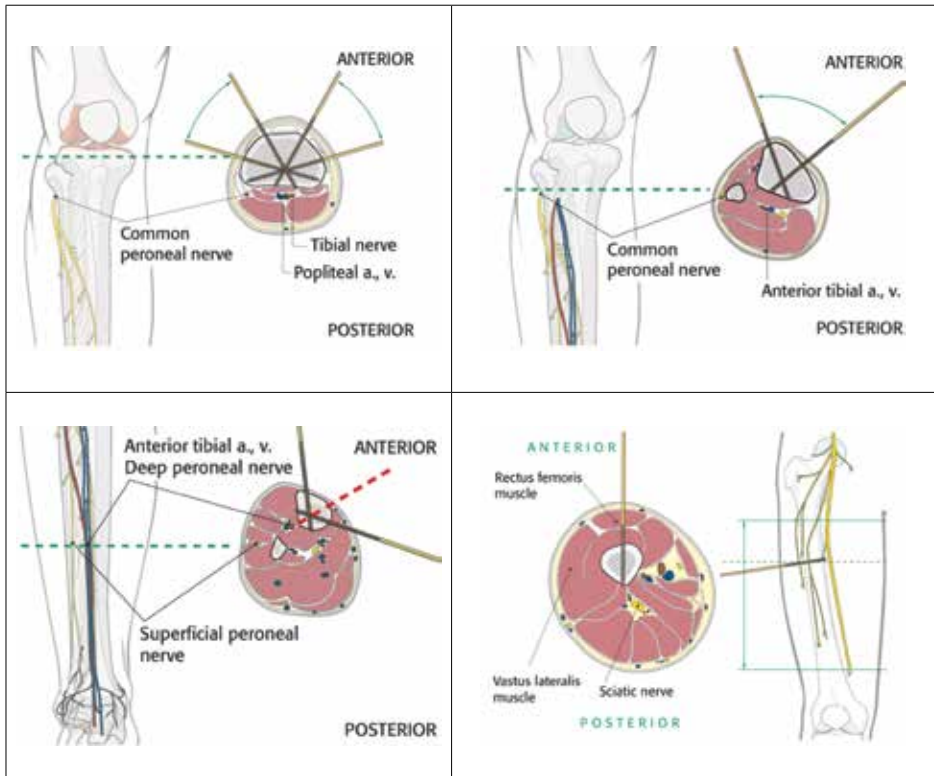


Figure 13. Safe zones for access to the proximal tibia
(AO Foundation, Switzerland)

PIN DEPTH

Pins are often inserted in disaster response and conflict environments without the benefit of radiological control.

Depth of pin insertion is important as a pin inserted too deeply can damage structures on the far side of the bone. Correction of an overly deep pin requires anaesthesia. Correct depth at the time of first insertion is desirable. It is far easier to judge pin depth when the pin is inserted **by hand**.

Tibial pin depth can be estimated from the breadth of the subcutaneous border of the tibia. The tibia is roughly triangular.

The depth of insertion should approximate the palpable bone breadth. With one pin on the bone, a second pin of equal length put on the skin will give you an idea of how much further you need to go.

As the pin engages the far cortex, it becomes more difficult to turn.

Three and a half full turns from this point should have the pin fully engaged in the far cortex, but not projecting beyond it by more than a few millimetres.

If using a power tool drill to insert pins, imaging would ideally be obtained to check depth whilst the patient is anaesthetized.

PITFALL

FAILING TO CHECK THE NEUROVASCULAR STATUS AFTER PIN INSERTION

Always check the neurovascular status of the limb after the patient has recovered from the anesthetic and record this in the clinical notes.

Ensure that there has been no deterioration compared to the patient's pre-operative exam.

KEYS TO PLACEMENT OF EXTERNAL FIXATION

- » The closer pins are to a fracture, the more stable the construct.
- » The further apart pins are on each side of the fracture, the more stable the construct.
- » Two pins a set distance apart have a higher pull out strength the more distant they are from the fracture.
- » The closer the frame is to the bone, the more stable the construct. Keep the frame as low as possible within the limits of needing to tend to the wound.
- » Inserting pins through a block provided in some external fixation systems requires that the pins be perfectly parallel and a set distance apart. Use the block and any tissue protectors as the guide to perfect pin placement.
- » If inserting pins as individual pins, they do not need to be at right angles to the bone. Angling them apart may better suit the construction of a handle, and avoid insertion of the tip of the pin into a joint or the fracture site.

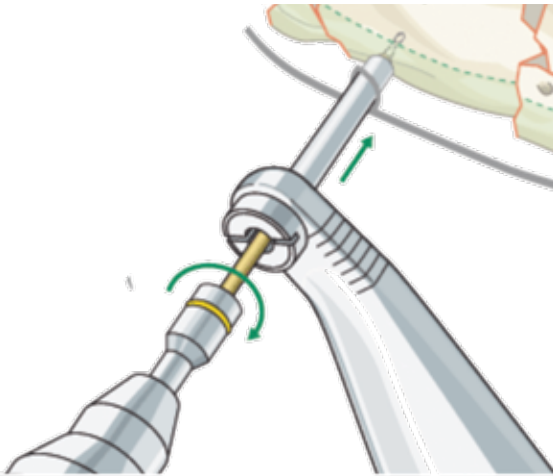


Figure 14. Image demonstrating the use of a soft tissue protection guide for the protection of soft tissue superficial to pin placement site
(AO Foundation, Switzerland)

KEY POINT

- » Always use a soft tissue protection guide when drilling or inserting pins. This prevents winding up neurovascular tissues on the drill or pin.

SAFE ZONES OF THE FEMUR

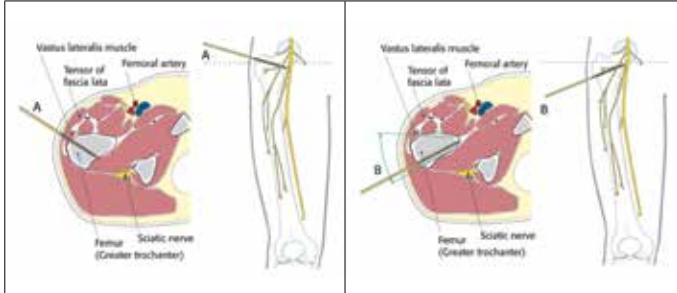


Figure 15A

Figure 15B

(AO Foundation, Switzerland)

Proximal 1/3

With the patient supine, the greater trochanter is palpated and, depending on the fracture configuration, the pin is directed through the vastus lateralis, either aiming towards the lesser trochanter (15A) or the femoral neck (15B).

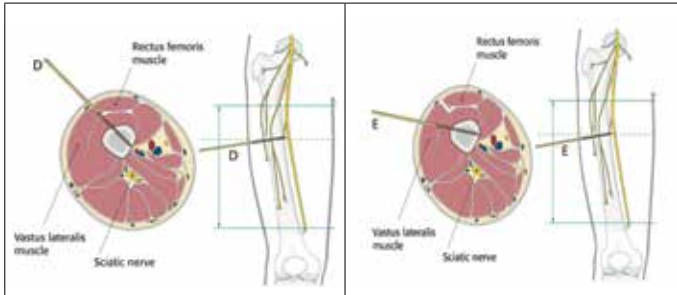


Figure 16D

Figure 16E

(AO Foundation, Switzerland)

Midshaft

Anterolateral Approach (Figure 16D) Vastus lateralis and rectus femoris are palpated with the patient in supine position. The direction of the pin should be in the plane between these two muscles. The *Direct Lateral Approach (16E)*.

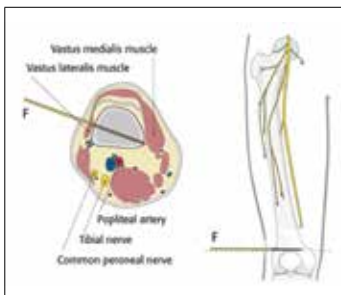


Figure 17F

(AO Foundation, Switzerland)

Distal 1/3

Direct lateral approach (17F) The lateral area of the distal part of the femur is easily accessible for pin insertion. The distal part of vastus lateralis is the only structure of the soft-tissue envelope to consider. The direction of the pin should follow path (F).

KEY POINT

- » Posterolateral pin insertion is possible but should be avoided as it places the sciatic nerve at risk and so that the external fixator frame does not interfere with sitting or lying supine.

Proximal

Neurovascular structures (NVS)

In the depth of the popliteal fossa we find the neurovascular structures in close proximity to the bone. The exact distance of the neurovascular structures to the bone and to the middle of the tibia is variable.

Knee joint capsule

Pin placement should respect the knee joint capsule and therefore be below 2 cm of the tibial plateau. If a more proximal pin fixation is necessary for very high fractures, pin placement should be as anterior as possible due to the shorter extent of the knee joint capsule in this area. (Figure 18)

Tibiofibular joint

Transfixation

At the level of the fibular head the only safe zones for transfixation of the tibia are the medial and lateral zones.

Unilateral fixation

At the level of the fibular head both sides of the patellar ligament are a safe zone for unilateral frame fixation. Therefore, one can construct a T-frame with good stability with only a minor risk of intra-articular pin placement. (Figure 19)

Distal to tibial tuberosity

To minimize the risk of infection, it is best to insert the pins where soft-tissue coverage is minimal. Therefore, distal to the tibial tubercle the safe zones for pin insertion are the tibial crest and the medial face of the tibia. One must be careful and avoid deep penetration beyond the far cortex. (Figure 20)

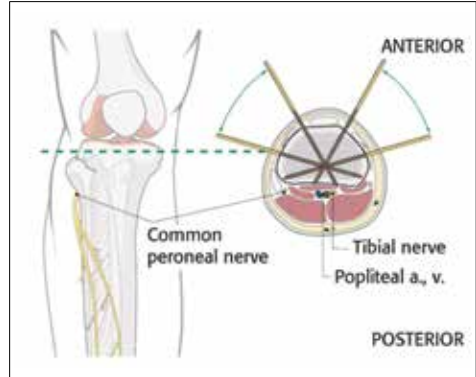


Figure 18

(AO Foundation, Switzerland)

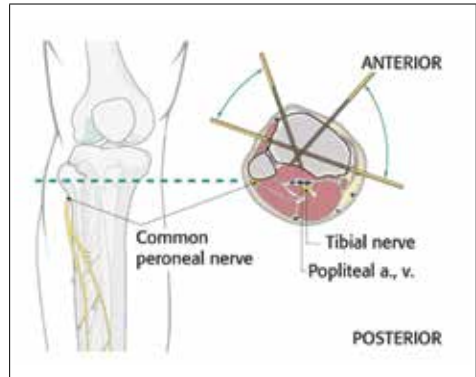


Figure 19

(AO Foundation, Switzerland)

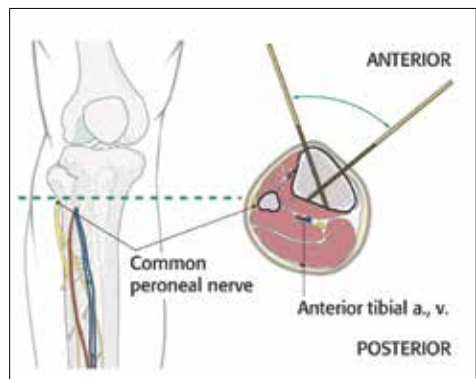


Figure 20

(AO Foundation, Switzerland)

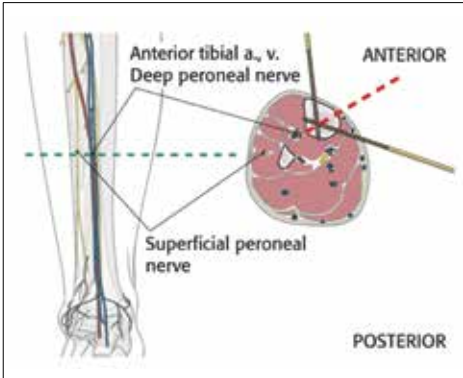


Figure 21 (AO Foundation, Switzerland)

Tibial shaft

The neurovascular bundle (the anterior tibial artery and vein together with the deep peroneal nerve) run anterior to the interosseous membrane close to the posterolateral border of the tibia.

They are at risk if the pin is inserted in the direction as indicated by the red dotted line approximately half way between the anterior crest and the medial edge of the tibia. (Figure 21)

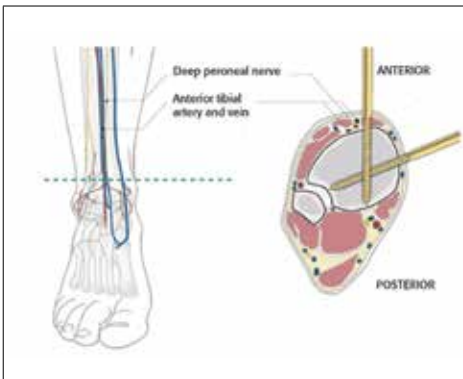


Figure 22 (AO Foundation, Switzerland)

Tibiofibular joint

When inserting Schanz screws in the distal zone take into account the position of the anterior tibial artery and vein.

Percutaneous insertion of Schanz screws in this area is dangerous. A minimal incision will allow preparation and safe insertion. (Figure 22)

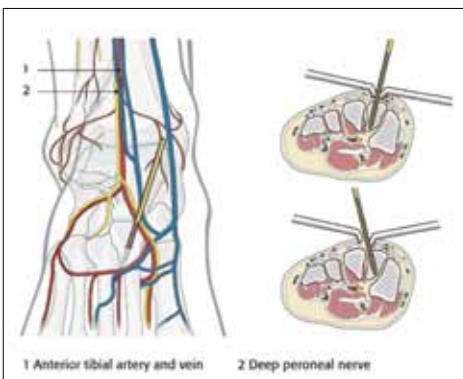


Figure 23 (AO Foundation, Switzerland)

Metatarsal placement

A small Schanz screw (4 mm) can be placed in the second metatarsal.

However, remember that the dorsalis pedis artery and veins and deep peroneal nerve lie on the medial side of the second metatarsal base.

A pin inserted here requires blunt dissection to the bone and careful retraction.

PLACEMENT OF CALCANEAL PINS

Use a full length Denham pin. This looks like a Steinman pin but has a central threaded section to prevent slippage in the bone.

A Steinman pin can be used, but will have a reduced period of effectiveness until it starts to slip in the bone. Place this pin 2/3 of the way along a line between the tip of the medial malleolus and the tip of the heel. The neurovascular bundle is 1/3 of the way down this line. The neurovascular bundle is nearer the medial malleolus. Insert the calcaneal pin from the medial side to reduce the risk of inadvertently impaling the neurovascular bundle. Ensure that the pin is inserted in plane 90 degrees to the long axis of the tibia.

PAEDIATRIC CONSIDERATIONS

- » External fixation pins in children with open growth plates should be inserted in the metaphysis, 1 cm from the growth plate. The growth plate and epiphysis should be avoided in order to prevent iatrogenic growth disturbances.
- » Remember that the anterior proximal tibial growth plate extends into the tibial tuberosity.
- » **As a rough guide, the long bones in boys cease growth around 16 years of age and girls around 14 years of age. However, delayed onset of menarche due to being underweight or having poor nutrition will prolong the years of growth in girls.**

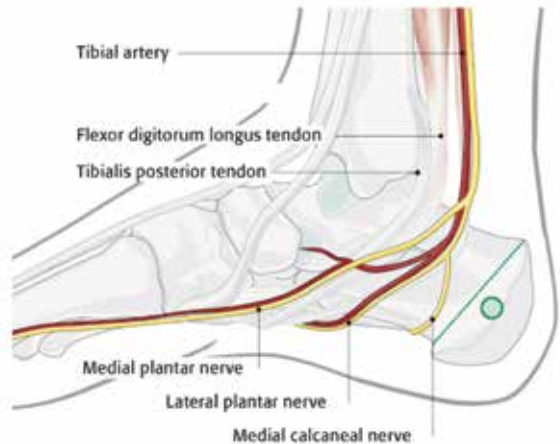


Figure 24. Calcaneal pin placement site. (AO Foundation, Switzerland)

TECHNIQUE FOR BRIDGING THE WRIST

- » Forearm pins—4 mm pins x 2 in the radius, placed under direct vision, avoiding the dorsal branch of the radial nerve
- » 3 mm pins in the 2nd or 3rd metacarpal dorsally, ensuring the extensor tendons are not impaled or wound up on the pins.
- » Construct a handle on the forearm, and a second handle on the metacarpal and connect the 2 handles with a 3rd bar. (Figure 25A)
- » Alternatively the technique using a single pin proximally and distally can be implemented, and the additional 2 pins can be added after reduction. (Figure 25B)

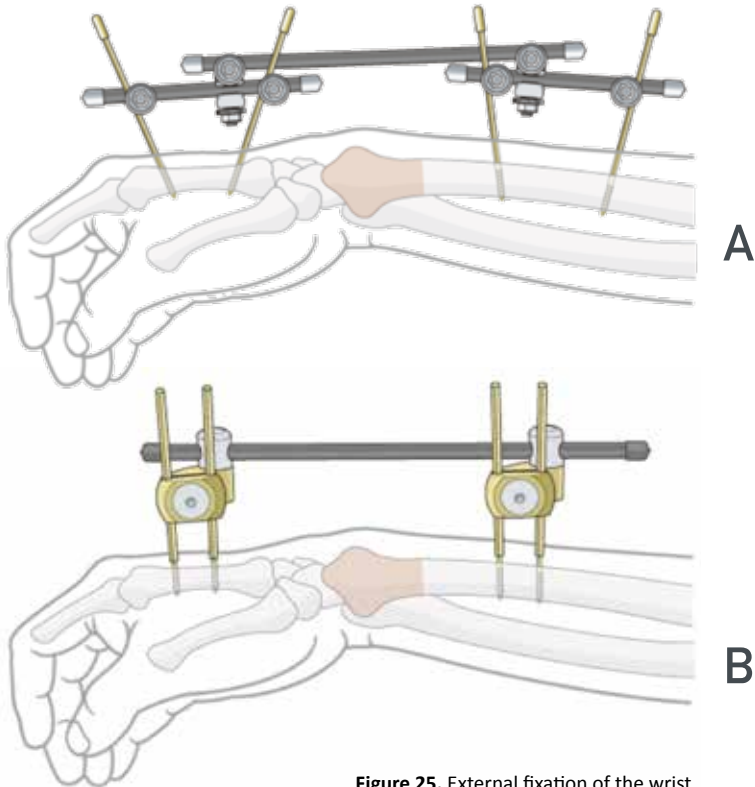


Figure 25. External fixation of the wrist
(AO Foundation, Switzerland)

PIN CARE

- » All management techniques are intended to prevent the bone or tissues around the pins from becoming infected.
- » Absorbent dressings to soak up early oozing of blood are usually applied in the operating room at the time of insertion. This discharge usually stops at 24–48 hours.
- » A dry square of sponge with a small ‘L’ cut into it fits neatly around the pin, soaks up tissue fluid and is easily removed at 48 hours. No additional support to keep it in place is needed, but dressings for the limb wounds can be easily applied over top of the L-cut sponges.
- » Dressing pin sites, with gels, ointments, or occlusive dressings should be avoided as they will prevent drainage from around the pin sites. Erring on the side of a slightly larger incisions during pin placement can aid with drainage.
- » After 48 hours, the absorbent pin dressing can be removed. Care from this may be dictated by the local infrastructure and accessibility of available medical care.
- » Daily routines of pin washing and removing of crusts by the patient are often advised, and the patient may be permitted to shower or bathe and dry the pin sites afterwards. The washing of pin sites should be done using a safe water supply.
- » The skin around the pin should be mobilized daily to prevent the skin from "closing" on the pin.
- » Pin site infections if caught early can be managed by a short course of antibiotics. However, persistent infection should be treated by IV antibiotics, local debridement or pin change in order to prevent deep infection and chronic osteomyelitis.
- » Established infection results in pin loosening. If the fracture is not united this may necessitate re-siting the pin and reconstructing a frame.
- » Once the wound over an open tibial fracture is healed and stable, the external fixator can be replaced by a cast (usually around 6 weeks following the fracture).
- » In remote and rural areas, where clean water is a finite resource and preserved for drinking, external fixation pins are often covered in swathes of bandages in an effort to prevent dust getting into the tissues alongside the pins.

MANAGEMENT OF OPEN FRACTURES

H

TYPE 3

Treatment of long segment defects requires long term follow up and should be sent to a type 3 if possible.

SEGMENTAL DEFECTS IN LONG BONES

- » In the event of loss of a segment of a long bone shaft of <5cm, consider an acute shortening to allow the bone ends to contact and facilitate primary union.
- » Later lengthening may be an option.
- » An alternative if swelling is already a problem is to apply an external fixator with the bone segment at the normal length to rest the soft tissues and make a plan to acutely shorten the segment when the swelling resolves and the risk of compartment syndrome has been minimized.
- » Segmental loss of greater than 5 cm, particularly if associated with significant soft tissue damage and nerve injury (mangled extremity) often results in poor functional outcomes. Early amputation could be considered based on the soft tissue injury.



Figure 26. Open tibial fracture with non-viable bone and soft tissue loss. (Bar-On)



Figure 27. Fracture from Fig. 26 following extensive bone and soft tissue debridement, shortening and external fixation. (Bar-On)

CONTROVERSY!

In the event of open fracture with interruption of vascular supply vascular shunting (see next page) should be a standard skill. However, the duration of shunting remains an open question without consensus.

OPEN FRACTURES WITH VASCULAR INJURY

- » The return of circulation to distal tissues is time critical. Warm ischaemic time should not exceed 4 hours.
- » Some bone stabilization is required if any vascular reconstruction or repair is performed. External fixation would be the most likely preferred option.
- » If time permits, then external fixation prior to vascular repair prevents bone movement during pin insertion and fracture reduction from stressing the vascular repair.
- » For this approach to be effective, patients must be able to be evacuated promptly to a higher level of care.
- » If the limb is viable, shunt with a longer than required shunt, then apply an external fixator and perform a distal fasciotomy.
- » Convert the shunt to vascular repair at a suitable time. If formal vascular shunts are not available, any tube of appropriate size will do (IV or paediatric nasogastric tubing).

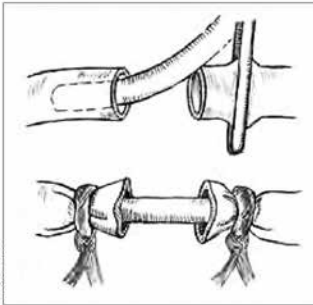


Figure 28. Line drawing of placement of tubing for temporary vascular shunt (ICRC)



Figure 29. Temporary vascular shunt secured with suture (ICRC)

KEYS TO VASCULAR SHUNTS

- » The criteria to install a temporary shunt as a bridge to definitive repair will depend on the clinical evaluation of hard and soft signs of vascular injury, but ***the most important factors to consider are the presence of ischemia or hemorrhage.***
- » Many patients with vascular injuries can have a "contained lesion" with no ischemia or active hemorrhage, and they should be moved to the proper facility with no procedures beyond immobilization of fractures.
- » **DURATION OF THE SHUNT:** The shunt should be in place until the second stage of damage control can be safely completed in unstable patients, and for stable patients, until external fixation can be obtained.
- » **HEPARINIZATION:** Distal shunts such as those below the knee tend to obstruct more easily than larger caliber, more proximal shunts. Therefore, the decision for heparinization should be taken based on the presence or absence of other major injuries and the expected time to definitive repair.

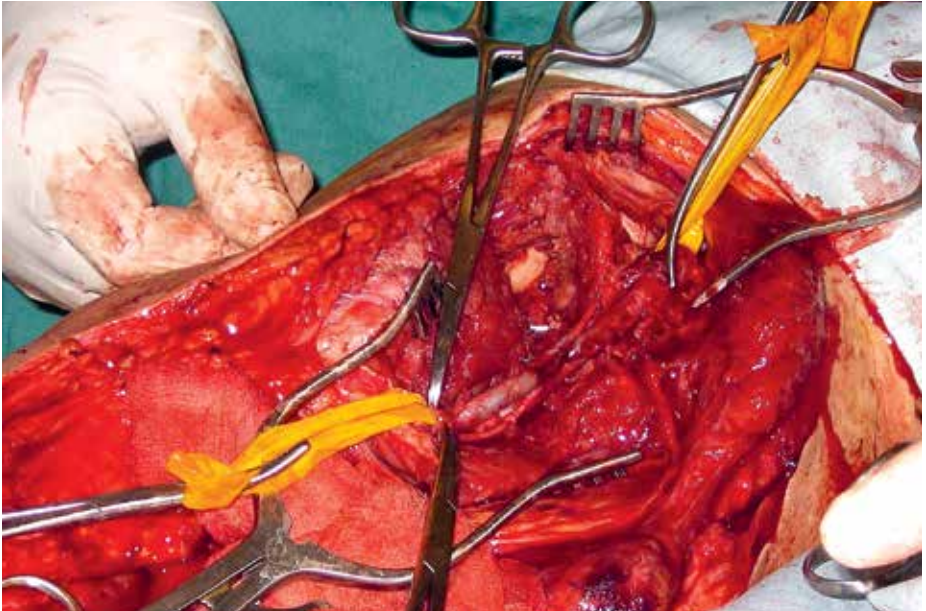


Figure 30. Effective control and exposure is crucial for successful control or repair of vascular injuries. (ICRC)

OPEN REDUCTION AND KIRSCHNER WIRE (K-WIRE) FIXATION

Use only single ended K-wires for safety of the operating room staff. Double ended wires have a high risk of injury to staff that outweighs any perceived benefit. Sizes needed are 1.6 and 1.1 mm, and *cerclage wire 16 and 18 Gauge*.

K-wire fixation may be considered early in open fractures of the hands, and less often with open fractures of the feet.

Hand injuries often appear worse than they are and every attempt should be made to keep as many digits as possible, especially the thumb.

Using k-wires may mean that badly injured fingers are salvaged that would otherwise have been lost through instability and further injury to their vascular supply. They should not be used in open long bone fractures.

The insertion of k-wires under power is more accurate and faster than using a hand drill. They are difficult to insert with a hand drill as one hand is necessary to stabilize the segment to be pinned.

Early use of K-wires in open fractures raises the risk of colonization of the wires and subsequent infection. Consider timing of K-wire fixation to minimize infection risk in fractures of the olecranon, patella and to secure large articular fragments.

The olecranon and patella fractures may be amenable to waiting until wounds have healed before proceeding to internal fixation with wires.

However, early use may be advisable in securing articular fragments where the loss of those fragments is a worse outcome than if the wires become infected.

PITFALL

NO INTERNAL FIXATION OF FRACTURES OTHER THAN K-WIRE FIXATION IN HANDS AND FEET SHOULD EVER OCCUR IN A TENT.

Refer local patients needing ORIF (i.e. for intra-articular fracture) to local services. The local teams will be providing follow up and should be involved in the care from the early stages.

ANTIBIOTICS IN OPEN FRACTURES

- » Antibiotics are an adjunct to wound surgery and not an alternative. The use of antibiotics for open contaminated fractures is limited to 24-72 hours, unless clinical evidence of infection is present.
- » Tetanus prone wounds and uncertainty regarding past immunization should prompt treatment with Immunoglobulin 500 units and administration of the tetanus vaccine

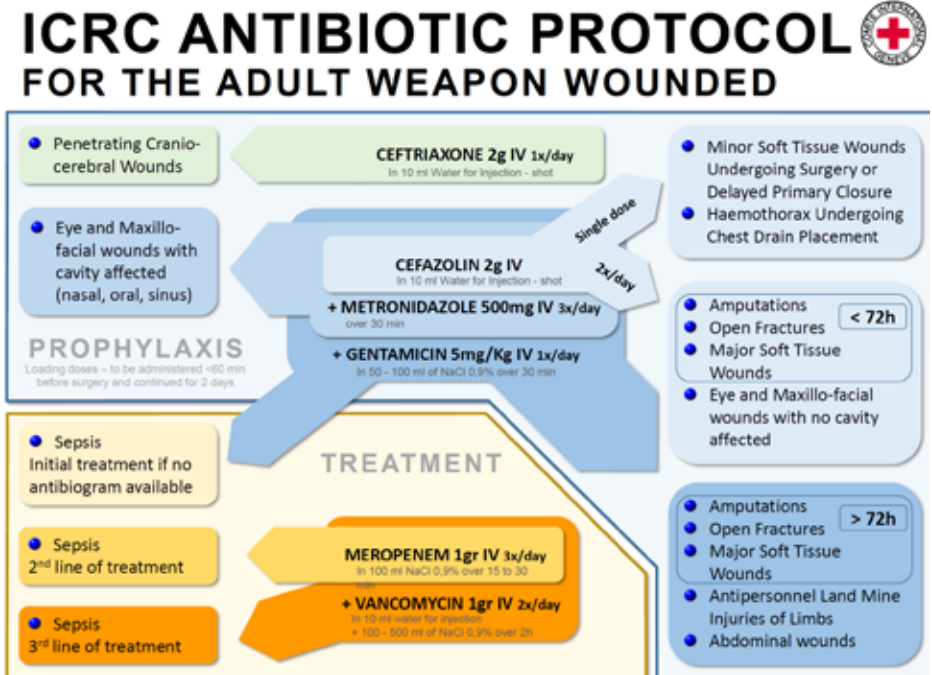


Figure 31. Antibiotic Protocol for Adults with conflict injuries (ICRC)

SUGGESTED RESOURCES

1. Gosselin RA. War injuries, trauma, and disaster relief. *Techniques in Orthopaedics* 2005; 20(2): 97-108.
2. Herard P, Boillot F. Amputation in emergency situations: indications, techniques and Médecins Sans Frontières France's experience in Haiti. *International Orthopaedics* 2012: 1-3..

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EMT Website: <https://extranet.who.int/emt/page/home>
 AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>



9

COMPARTMENT SYNDROME AND CRUSH SYNDROME

SCENARIO

COMPARTMENT SYNDROME DIAGNOSIS

COMPARTMENT SYNDROME TREATMENT

CRUSH SYNDROME

CRUSH SYNDROME MANAGEMENT IN SODS

SUGGESTED RESOURCES

REFERENCES

SCENARIO

Your EMT type 2 just set up 48 hours after an earthquake has struck. There are five patients on stretchers with closed lower limb fractures requiring your care.

The first patient, a 24-year-old girl, has a mid-tibia and possibly fibula fracture.



(Bar-On)

The leg is swollen and tender and the distal status is difficult to fully assess, although there seems to be a faintly palpable posterior tibial pulse. She can, with pain, slightly move her toes and has sensation, but the translation regarding her sensation is not exact.

The remaining four patients have similar status; they have all had extremities crushed under the rubble with varying degrees of functional distal status. You suspect that they all have compartment syndrome, but what to do? At home, all the patients would get an acute fasciotomy. But here, in this context, and more than 2 days after the injury?

CASE CONTROVERSIES:

- » Will fasciotomy benefit the patient and save the limb or create more suffering?
- » What is your surgical strategy?
- » How accurate is the clinical examination in diagnosing compartment syndrome?
- » Is there any role at all for compartment pressure testing in SOD's?



TYPE 1

- Analgesia & Splinting.
- Record the neurovascular status of the limb.
- Elevate on maximum 1 pillow.
- Urgent transfer to surgical facility.



TYPE 2

- Fasciotomy if indicated and less than 24 hours since time of injury.
- Minimal limb elevation to reduce compartment blood flow.



TYPE 3

- Delayed closure or coverage of fasciotomy incisions.

DIAGNOSIS

Early diagnosis of compartment syndrome must be made based on the clinical picture and the suspicion that acute compartment syndrome may be present.

Early symptoms include:

- » Pain out of proportion to exam (i.e. excessive pain)
- » Less than expected response to analgesia
- » Pain with passive stretching
- » Tense swelling over the compartment
- » Distal paraesthesia in peripheral nerve distribution

SPECIAL CONTEXTS

Compartment Pressure Checks in Disasters and Conflicts

- » Measuring compartment pressures cannot exclude compartment syndrome.
- » Measurement and interpretation requires experience and equipment that is not always present.
- » The value of implementing these checks in an austere setting has never truly been evaluated.
- » **Conclusion:** unless in very experienced hands, in specific situations, compartment pressure measurements are not recommended in the disasters and conflicts.

PATHOPHYSIOLOGY

- » Increased muscle compartment pressures result in impaired cellular oxygenation.
- » Any movement that increases the volume of the compartment or stretches the ischaemic fibers results in pain.
- » Subsequent fluid extravasation results in increased pressure on sensory nerves yielding distal paraesthesia. Further pressure increases overcome the protective barrier of the motor neuron's myelin sheath yielding loss of motor function.
- » Further pressure increases can overcome arterial pressures resulting in limb ischaemia and loss.

There are 2 treatment options following the diagnosis of acute compartment syndrome: fasciotomy and immobilization.

These need to be guided by the context with regard to resources as well as the overall clinical picture.

SPECIAL CONTEXTS AND COMPARTMENT SYNDROME TREATMENT

In a SOD, patients may present with compartment syndrome in a very delayed fashion. Fasciotomy will create wounds requiring care and make a closed fracture into an open fracture.

Thus, fasciotomy should not be a “knee-jerk response” to any suspected compartment syndrome. The factor of time since injury **must be included in the decision on type of treatment**.

- » **0–8h:** An injury with clinical signs of compartment syndrome should receive an urgent fasciotomy.
- » **8–24h:** It remains controversial whether fasciotomy will benefit the patient. Careful assessment should be done for signs of extremity viability (e.g. pain on passive stretching of compartment, some sensation, capillary refill) and how the patient has progressed before a decision is made regarding fasciotomy.
- » **>24h:** injuries at this time point are treated by observation and splinting in a functional position, with slight elevation (i.e. one pillow).

MISSED OR VERY LATE PRESENTING COMPARTMENT SYNDROME:

For patients with clinical evidence of muscle necrosis and possible clinical evidence of crush syndrome, urgent and massive debridement of muscle tissue may be required.

Additionally, these patients may require **intensive care and renal protective strategies**. In these cases an amputation and EMT type 3 level care may be the only option to spare the patient’s life.

H

TYPE 3

KEY POINT

- » Late sequelae of “missed” compartment syndrome may cause fibrosis and contracture of muscles.
- » In the forearm this may result in “Volkmann’s contracture.”

LOWER LIMB FASCIOTOMY

Perform a two incision, four compartment fasciotomy by:

- » **A:** Make an incision through the skin 2 cms medial to the subcutaneous posteromedial edge of the tibia from the tibial flare to just behind the medial malleolus. Without undermining the skin, deepen this incision through the fascia.

This will open the superficial posterior compartment. Identify the posterior tibial neurovascular bundle and incise the thinner fascia over it. Extend this along the whole length of the fasciotomy wound to open the deep posterior compartment. In the more proximal part this will involve incising through the tibial origin of the soleus muscle.

- » **B:** Make the second incision through the skin 2 cms anterolaterally to the subcutaneous anterior edge of the tibia from the tibial flare to just above the lateral malleolus. Without undermining the skin, deepen this incision through the fascia. This will open the anterior compartment. Sweep the muscle bellies anteromedially to identify the intramuscular septum. Incise this along the whole length of the wound. This will open the lateral compartment .

This technique preserves the vascularity of fasciocutaneous flaps that can be used for later reconstruction.

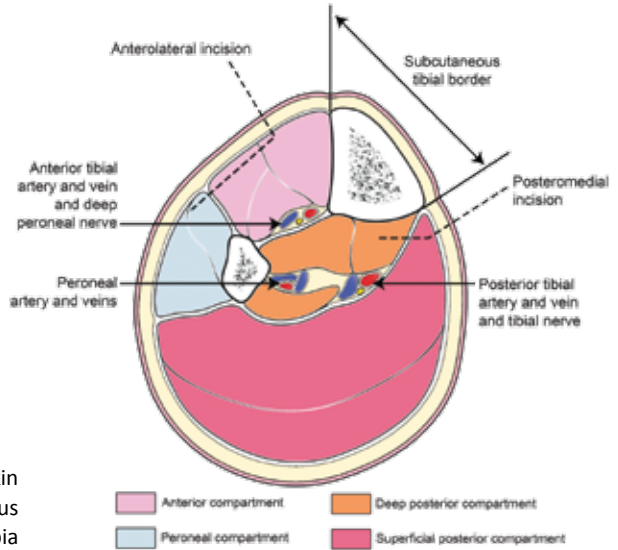


Figure 2. Illustration of the compartments of the lower leg, as well as the incisions required for performance of a 2 incision, four compartment fasciotomy. (BOA/BAPRAS)

FOREARM FASCIOTOMY

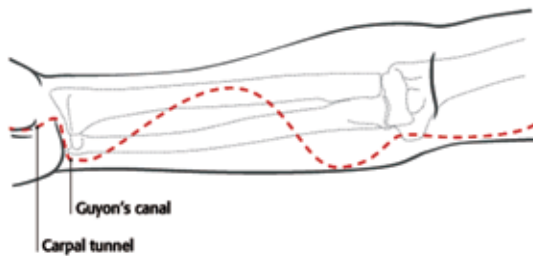


Figure 3. The standard anterior fasciotomy incision extends over the carpal tunnel and Guyon's canal distally (in order to decompress the median and ulnar nerves), continues with a curved incision towards the radial side of the mid-forearm and back to the ulnar side of the proximal forearm. It may be extended proximally across the elbow if wider access is required.

(AO Foundation, Switzerland)

POST OPERATIVE MANAGEMENT OF FASCIOTOMY INCISIONS

- » Dressing care is similar to other open wounds. Dry gauze dressings with or without a non-stick dressing on the muscle bed are reasonable.
- » Negative pressure wound therapy is also appropriate if resources are available.
- » Most fasciotomy wounds can be closed with delayed primary closure. This can be assisted by utilizing a variety of techniques designed to gradually close the wound.
- » If delayed primary closure is not possible then split thickness skin grafting (STSG) may be required.

PITFALL

FASCIOTOMY

- There is no role for subcutaneous fasciotomies in a disaster or in conflict, nor in acute trauma.
- Do not be tempted to close the wounds in the absence of early swelling—reperfusion after the fasciotomy will result in more swelling than observed at the time of fasciotomy.

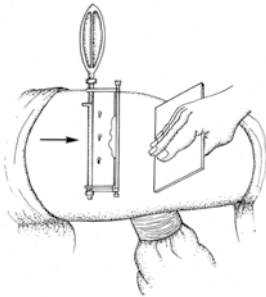


Figure 4. Dermotome being used to harvest skin from the medial thigh. Note the assistants hand applying upward pressure to flatten the donor surface. (ICRC)



Figure 5. Scalpel being used to mesh a split thickness skin graft. (ICRC)

SPLIT THICKNESS SKIN GRAFTING

- » Take small split thickness grafts with a razor blade held with forceps, for larger grafts use a skin graft knife (pictured). Apply traction using the grafting board and have an assistant apply counter traction. The graft knife is used with a back and forth sawing motion.
- » Exposed fat indicates full thickness graft, the area should have a homogenous bleeding surface if the depth is appropriate for a split thickness graft.
- » The graft can be perforated in order to prevent hematoma formation under the graft.
- » After cleaning the recipient area, lay the graft in and suture it at a few points for alignment then suture all graft edges. The sutures can be removed in 7-10 days.
- » It is preferable to leave skin graft donor site dressings in place until the area has healed, even for several weeks.

CRUSH SYNDROME

- » Crush syndrome is the severe systemic manifestation of trauma and ischemia involving soft tissues, principally skeletal muscle, due to prolonged crushing of tissues.
- » The prolonged muscle ischaemia increases cell membrane permeability and leads to the release of potassium, enzymes and myoglobin from cells.
- » This, combined with systemic hypotension, results in renal dysfunction with acute tubular necrosis and uremia.



Figure 6. Woman crushed and entrapped by rubble. This patient required a field amputation of the upper right arm in order to extricate her. (Bar-On)

SPECIAL CONTEXT: EARTHQUAKE

- » Crush syndrome can be a common presentation following an earthquake and can present in advanced stages due to the length of time required to locate and extricate victims.
- » Late presentations of crush syndrome include:
 - hypovolaemic shock
 - hyperkalaemia
 - metabolic acidosis
 - disseminated intravascular coagulation (DIC) in very late cases



Figure 7. A swollen leg with sloughing skin, concerning for underlying muscle necrosis (Bar-On)

CRUSH SYNDROME

Management of crush syndrome can require high level resources including intensive care and renal replacement therapy.

Thus, the progression of care for these patients is often dependent on appropriate management at each EMT level of classification and proper transfer between the levels depending on available resources.



TYPE 1

The type 1 EMT receiving crush patients is often a search and rescue team (SAR). These units should be prepared to:

- Secure the airway.
- Secure vascular access and commence resuscitation with normal saline 1000-1500 mL/h modified by weight.
- Monitor urine output. If no output for 3 hours following initiation of fluids then give furosemide 40 mg or 1 mg/kg IV. Repeat the dose if no output one hour after administration.
- Monitor pulse and BP. If there are signs of congestion or anuria then slow the infusion to 500-1000 mL/24hr, beyond the patient's calculated losses.
- Placement of a urinary catheter is not recommended at this level.
- Provide basic wound care and splinting if necessary.

CONTROVERSY!

When transfer to a higher level of care is available, tourniquet application to the crushed limb may prevent loss of life from hemorrhage or electrolyte abnormalities secondary to crush syndrome.



TYPE 2

- Continue fluid replacement with crystalloid and sodium bicarbonate
- Electrolyte management to control hyperkalaemia and hypercalcaemia
- Continue to force diuresis with furosemide, mannitol, or acetazolamide.
- Monitor urine output and urine myoglobin.
- Assess injury for need for possible fasciotomy, debridement, or amputation.



TYPE 3

- Continue all medical and surgical management as at levels 1 and 2.
- Consider peritoneal dialysis
- Consider transfer to a center where haemodialysis is available.
- Assess and plan for reconstruction or completion of advanced wound care for injured limb.

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EMT Website: <https://extranet.who.int/emt/page/home>

AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>



10

AMPUTATIONS

SCENARIO

LOWER EXTREMITY AMPUTATIONS

SPECIFIC TECHNICAL CONSIDERATIONS

UPPER EXTREMITY AMPUTATIONS

SPECIAL CONSIDERATIONS

COMPLICATIONS OF AMPUTATION

KEY MESSAGES REGARDING AMPUTATION

SUGGESTED RESOURCES

REFERENCES



Figure 1. Traumatic Amputation of the left leg (Bar-On)

SCENARIO

A 20-year-old female was a victim of blast injury to her right lower leg four hours prior to presentation at an EMT type 1.

There is soft tissue loss over the anterior aspect of the ankle with loss of the tibial pilon and exposed fragments of bone from the distal tibia. In the foot there are no palpable pulses, with very slow capillary refill. There is no sensation over the plantar aspect of the foot.

After washout, dressing, and splinting the patient arrives at an EMT type 2, twelve hours later. No tourniquet was applied but the patient's toes are now cyanotic and there is no longer capillary refill. An amputation is recommended but the patient's husband categorically refuses to consent.



TYPE 1

- Management of injuries that may require amputation at type 1 facilities primarily consists of wound care, analgesia, possible tourniquet placement to stop life threatening hemorrhage and transfer to a higher level facility. Patients with vascular compromise should have a high priority for transfer.



TYPE 2

- Amputation is a surgical and reconstructive procedure that is a last resort. Evaluation by experts at type 2 and 3 facilities to assess for possible options for limb salvage should be obtained whenever possible.



TYPE 3

SPECIAL CONTEXTS

- » The case scenario discussed at the opening of this chapter is, unfortunately, not uncommon. Amputation is not just a surgical procedure, it is a process through which the patient, the patient's family, and the entire social circle must navigate for the remainder of the patient's life.
- » The decision to amputate must take into account socio-cultural, religious, economic and ethical dimensions.
- » In many places an insensate and useless, even painful, limb is preferred to an amputation. Young male amputees may never work, young female amputees may never marry.
- » The humanitarian community has been criticized recently for having too low a threshold to amputate, particularly following the 2010 earthquake in Haiti.
- » The various scoring systems used to predict the need for amputation may not be applicable in disaster and austere settings.
- » The availability of reconstructive surgery should be taken into account when planning the treatment.

GENERAL CONSIDERATIONS

- » The amputation stump should be painless, well padded, balanced, and easy to fit with a prosthesis.
- » Prosthetics should be comfortable, light, durable and built from locally available materials by local prosthetists.
- » Upper extremity amputees always lose some degree of function, and social reintegration may be compromised where much of the work is manual in nature.
- » Loss of function in lower extremity amputees depends largely on the prosthetics and rehabilitation capacity of the local system.
- » In the absence of an appropriate prosthesis, lower extremity amputees can move only with assistive devices that occupy both upper extremities.

KEY POINT

- » **Amputations should never be performed without the written and witnessed consent of the patient and/or guardian, and when possible, additional family members should be included in the decision process.**
- » **Photographic evidence and a second opinion should be obtained when possible in order to strengthen the documentation.**



Figure 2. Severe soft tissue damage and open fracture of the lower limb that required amputation (*Bar-On*)

CONTROVERSY!

There is disagreement among surgeons as to whether the local prosthetics and rehabilitation capacity should dictate the level and type of an amputation. Some advocate always taking these factors into account, while others feel that in conflicts and SODs it is often impossible to know what services may be present in the months and years ahead.

KEY POINT

Principles of Amputation in conflict and disasters

- » Guillotine amputation is almost never indicated except as a last resort to extricate an entrapped patient.
- » Preserve limb length
- » Use flaps of convenience

GENERAL PRINCIPLES

- » The definitive indications for amputation are:
 - Avascular limb in the absence of vascular reconstruction capabilities
 - Uncontrollable infection
 - Mangled extremity in the absence of reconstructive capabilities
- » Even in disaster management settings, amputations can generally be delayed except in the case of severe wounds that are complex, infected, contaminated, or have no viable distal tissues.

- » The principles of wound debridement apply when performing an amputation: remove all devitalized tissues, leave as much skin as possible for flaps, and create as long a stump as possible.
- » A pneumatic tourniquet should be used if available. Care should be taken to deflate tourniquet prior to flap closure to ensure adequate haemostasis of the lower limb.
- » Named vessels should be ligated individually with transfixing sutures.
- » Nerves should be sharply transected under gentle traction, allowing the tip of the nerve to retract or be buried in the muscle belly.
- » When selecting the level, remember that a short stump that preserves a joint is preferable to a more proximal amputation.
- » A disarticulation is preferable to a more proximal through the bone amputation, as the stump end is already a weight bearing surface and prosthetic fitting has improved with more modern techniques and materials.

DELAYED CLOSURE

- » The amputation stump should be treated as any other wound and never closed primarily.
- » Delayed primary closure of the amputation stump should be attempted when the wound is clean, usually 2-5 days following the initial operation.
- » If needed, stumps can be partially closed and allowed to heal by secondary intention. Additional options include skin grafts or flaps.
- » Efforts to preserve maximum limb length are not always successful. However, bone ends should always have adequate soft tissue coverage. Bone shortening is preferable to inadequate soft tissue padding of the stump end.

PITFALL

NEVER put a pillow directly under the knee joint of a BKA patient.

NURSING, REHABILITATION AND PHYSIOTHERAPY

- » Prevention of joint contractures is of paramount importance.
- » For above-knee-amputations (AKA) flexion and abduction contractures can be prevented through proper surgical technique and early active and passive physiotherapy.
- » The AKA patient should lie prone for several hours each day.
- » For below-knee-amputations (BKA), knee flexion contracture is a major concern. It can be prevented by splinting the joint in extension until the time of DPC or having the closed stump rest on a pillow

KEY POINT

CULTURAL CONTEXT

- » Ensure that proper arrangements are made for the disposal of an amputated limb. These practices will vary between cultures and religions.

SPECIFIC TECHNICAL CONSIDERATIONS

FOOT AMPUTATIONS – When feasible, toe, ray, and trans-metatarsal amputations result in a sensate and weight bearing stump and should be employed when possible.

- » More proximal amputations rely on the preservation of the high quality heel pad and balancing the opposing dorsal and plantar flexors.
- » Mid-tarsal amputations are not recommended.
- » If the heel pad is intact a calcaneo-talo-tibial fusion can provide a stable weight bearing stump.



Figure 3. Severe injury with no chance of re-implantation is an indication for amputation. (Bar-On)

KEY POINT

- » If the heel pad is lost, severely damaged or missing then a distal BKA should be undertaken.

ANKLE DISARTICULATION – Syme amputation often provides the best result if an ankle disarticulation is required. The procedure provides an end bearing stump.

- » The procedure requires an intact heel pad which is secured to the distal tibia anteriorly with trans-osseous sutures.

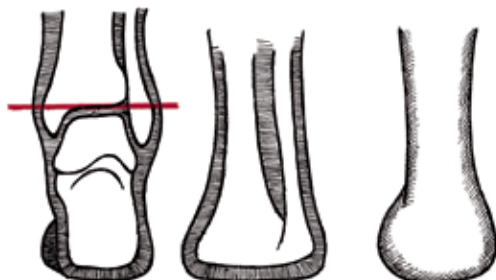


Figure 4. Line diagram of a Syme amputation. This technique utilizes an intact heel pad to provide patients with a stable weight bearing stump. The operation preserves the physal plate and can be fitted with a prosthesis for aesthetic reasons. (ICRC)

CONTROVERSY!

Many surgeons prefer excising the talus and doing a tibio-calcaneal fusion to a tibio-talo-calcaneal fusion. However, other surgeons feel that in austere conditions fusions should be avoided due to risks of infection and non-union and a Syme amputation may be preferable.

TRANS-TIBIAL AMPUTATIONS – BKA is the most common amputation performed in most disaster settings. The classic Burgess step cut is often not possible, however less orthodox stumps can still provide excellent results.

- » The distal $\frac{1}{3}$ of the tibia is not useful in weight bearing, but the stump should be left as long as possible up to this point.
- » Proximally, amputation less than 6 cm below the tibial tubercle will often require conversion to a knee disarticulation.
- » The anterior tibial crest should be beveled at a 45 degree angle and the edges smoothed with a rasp.
- » The fibula should be 1.5 - 2 centimetres shorter than the tibia, and the deep posterior fascia sutured to the anterior aspect of the tibia.
- » Skin should be closed over a drain in an interrupted fashion, with care taken to avoid “dog-eared” skin edges.
- » The stump should be splinted in extension and rehabilitation begun as soon as possible.

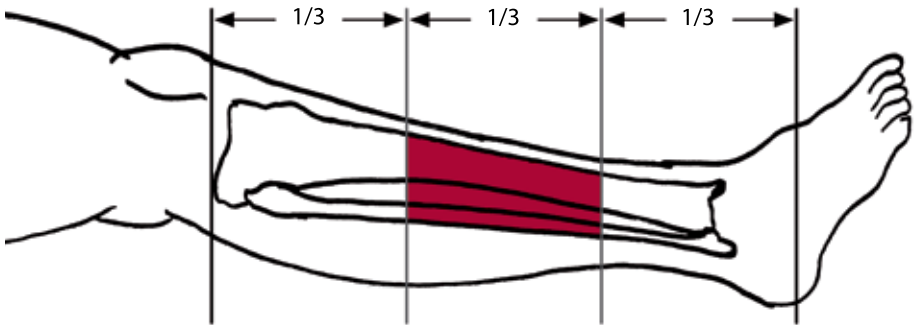


Figure 5. ICRC illustration of the ideal stump length for BKA, emphasizing the fact that the middle third of the tibia makes for the ideal stump. (ICRC)

KNEE DISARTICULATION – This procedure produces a sturdy end-bearing stump. In the past technical problems with the prosthetic knee joint have discouraged its use. However, recent technical advances in materials and prosthetics can allow prosthetists to address this issue, even in austere environments.

- » Closure of knee-disarticulation incisions utilizes a standard fish mouth incision with patellar tendon sutured to the posterior cruciate ligament posteriorly.

TRANS-FEMORAL AMPUTATIONS – Trans-Femoral or above knee amputations (AKA) are the second most common amputation that requires cutting a long bone. These stumps, like BKAs are not end bearing and must be contact fitted.

- » The femur is usually cut at or near the distal metaphyso-diaphyseal junction in a transverse fashion.
- » The key to successful AKA requires appropriate balancing of agonistic and antagonistic forces, as amputations at the mid or distal femoral shaft are at risk of developing an abduction contracture of the hip from an unopposed gluteus medius.
- » The belly of the adductor magnus is cut at or near Hunter’s canal and fixed on the lateral side of the femur, preferably with trans-osseous sutures. This maneuver serves to counteract the abductor forces. The quadriceps is attached posteriorly in a similar fashion.
- » The suturing of the quadriceps directly to the hamstring should be avoided as it can create a “slinging” effect over the bone end that is painful.
- » Amputations through the proximal 1/3 of the femur are at risk of developing a flexion contracture from unopposed actions of the psoas muscle. To prevent this every effort should be made to keep or reattach the gluteus muscle to the linea aspera posteriorly.
- » Hip disarticulation and pubo-sacro-iliac disarticulation are rare procedures and should be reserved for instances in which no other procedure is possible.

Figure 6. Image demonstrating the importance of good soft tissue covering. The left stump is well covered, the right is lacking. (ICRC)



UPPER EXTREMITY AMPUTATIONS

HAND INJURY

- » Hand function is precious and every millimeter of movement and length is of high value. Therefore, debridement should be as conservative as possible and every effort made to preserve the maximum number of digits, particularly the thumb.
- » A small phalangeal stump provides better function than a metacarpal phalangeal disarticulation.
- » K wires can be used to stabilize fractures, and second look operations should be utilized whenever possible in order to allow dead tissue to declare itself.
- » Dressings should consist of absorbent, fluffy, dry dressings that allow for visualization of the finger tips.
- » If a wrist disarticulation is required the thicker palmar skin should be used to cover the stump.
- » There are a multitude of coverage techniques that can prove to be digit-saving (V-Y advancement flaps, finger to finger flaps, hand in belly technique).

ARM INJURY

- » **Forearm Amputations** – the longer the stump of forearm preserved, the higher degree of pronation and supination function will be preserved.
- » The radius and ulna should be amputated at the same level. There are no indications for the Krukenberg or “lobster claw” technique.
- » An elbow disarticulation is preferable to a through the humerus amputation.
- » **Upper Arm Amputations** – amputations through the distal half of humerus allow for pinching between the arm and chest.
- » Proximal amputations often result in an abduction contracture that limits functionality.
- » Shoulder disarticulation and scapula-thoracic disarticulation should not be considered except in instances of life-saving emergency surgery.
- » All upper extremity amputees must start rehabilitation as soon as possible.
- » In resource poor environments basic prostheses are normally available.
- » Patients often require only a cosmetic hand or no prosthesis at all.



Figure 7. Upper extremity amputation in a young patient . (Bar-On)

PAEDIATRIC CONSIDERATIONS

- » If the physal plate is intact, the limb will continue to grow. Therefore, bone resection in children should be very conservative.
- » In children, disarticulations do better than through the bone amputations, due to the fact that exostosis and overgrowth are common with AKA and BKA.
- » If possible, a long periosteal sleeve should be preserved and sutured to itself over the bone end.
- » The open bone end should be “capped” by plugging the open medullary cavity with a piece of bone harvested from the amputated segment.



Figure 8. Amputations in children require special attention due to the fact that the bones are often still capable of growth. (Bar-On)

KEY POINT

Mangled Extremity

- » In the event of mangled extremities, the distal extremity should be amputated as if it were an isolated problem and proximal fractures treated as if they were an isolated problem (i.e. fix with sling, external fixation, or traction).
- » **DO NOT** amputate through the fracture.



Figure 9. In the event of mangled extremities (or beyond classification trauma), proximal and distal injuries should be dealt with separately whenever possible (Bar-On)

WOUND ISSUES COMPLICATIONS

- » Acute wound dehiscence and necrosis occur if the wound is sutured under excess tension. This can be prevented by leaving the wound open, wrapping the stump and revisiting the wound when swelling has decreased.
- » Negative pressure dressings are a very effective means of shaping a stump and reducing swelling.
- » Purulent drainage means that necrotic material has been left behind and the wound requires re- debridement. Unless the infection is very superficial, antibiotics alone will prove inadequate.
- » Chronic wounds over bony prominences occur due to poorly shaped or padded stumps, due to excessive pressure in the prosthesis. Prosthetic modification may circumvent the problem, but stump revision is often necessary.

CONTRACTURES

- » Contractures develop when surgical balance of agonistic and antagonistic forces is not achieved or when appropriate rehabilitation capacity is not present. They can be prevented by physiotherapy, splinting, or casting.
- » Equinus contracture of the ankle or flexion contracture of the knee can be particularly crippling and are more easily prevented than treated. They require surgical release when they are rigid.

NEUROMAS

- » Neuromas occur on transected nerves as part of the physiologic process of repair. Painful neuromas are often transient but some never disappear. They can prove difficult to differentiate from phantom limb pain.
- » Pain due to neuromas occurs in the stump rather than the amputated limb, and can worsen with prosthetic use. Diagnostic blocks can be helpful in making the diagnosis.
- » If socket modification does not resolve the issue, surgical revision is indicated. The neuro- ma is resected and the neural stump allowed to retract proximally or buried in a muscle belly.



Figure 10. An infection of an amputation stump. (ICRC)

PHANTOM LIMB PAIN

- » Phantom pain is a common complication of limb amputation, occurring in nearly half of all amputees.
- » The pain is felt to be coming from the amputated segment rather than the stump itself.
- » It is commonly present at rest, but often worsens with the use of a prosthesis.
- » It can be difficult to fully differentiate from phantom sensation, a general sense by the amputee that the limb is still present. Phantom sensation generally disappears between 6 and 12 months post operatively.
- » Many techniques have been attempted to treat phantom pain, but tricyclic antidepressants and gabapentin have generally proven to be an effective regimen.

OVERGROWTH/EXOCYTOSIS

- » Overgrowth and osteophytes appear mainly in children, but can occur in adult patients when periosteal stripping has been overzealous. The pressure points generated by this condition often require surgical treatment of the overgrowth area.

MENTAL HEALTH

- » All patients in disasters and conflict sustain psychological as well as physical trauma. The additional trauma of undergoing an amputation can precipitate mental health problems such as depression, aggressiveness or substance abuse. The entire treatment team should be vigilant regarding these issues.



Figure 11. Osteophyte formation on the tibia, and overly long fibula causing pain and stump erosion in a BKA patient. (ICRC)

PROSTHESIS ISSUES

- » The amputee becomes a life long patient. A 20-year-old male with a 50 year life expectancy may require 20 different prostheses over the course of a lifetime. Maintenance, repair, replacement, and provision of soft goods all need to be provided for in a sustainable and durable manner.

KEY MESSAGES

- » Primary amputations are indicated if:
 - The extremity is not viable and revascularization is either not available or not indicated.
 - It is a life-saving procedure for treatment of an infection such as gas gangrene or decompensated systemic sepsis.
- » Amputations for indications other than those covered above can be performed in a delayed fashion.
- » No amputation should be performed at an EMT type 1 facility.
- » When discussing amputation with the patient and his or her family or support system, it is important to be very clear about the options and alternatives surrounding the operation. Give your best surgical advice and avoid giving unrealistic or false hope.
- » If possible obtain a second documented opinion and photographic documentation.
- » Never amputate without signed consent from the patient or guardian.
- » The viability of distal tissues should determine the indication for amputation, not the distal sensory or motor function or the presence of bone loss.
- » The amputation should always be as distal as is safely possible.
- » Do not primarily close the stump in disaster and conflict situations, plan for delayed primary closure at 2-5 days.
- » Never close the stump under tension, partial closure and repeat attempt at DPC is preferable to a high tension wound closure.
- » Be aware of the psychological repercussions for the patient and provide support as soon as possible.
- » Start physiotherapy and rehab as soon as possible.
- » Ensure that proper arrangements are made for the disposal of the amputated segment. The “proper arrangements” will vary across cultures.

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 AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>

11

BURNS

SCENARIO
CLINICAL MANAGEMENT OF BURNS
SURGICAL MANAGEMENT OF BURNS
SKIN GRAFTING FOR BURNS
SPECIAL CASES
CHEMICAL & ELECTRICAL

SUGGESTED RESOURCES

REFERENCES



Figure 1. Full thickness burns with eschar (ICRC)



Figure 2. A typical ward setting, without ventilator support (Baumgartne - Henley)

SCENARIO

You are in a type 2 facility in an area of internal conflict where the normal health service has collapsed. Six children arrive with burn injuries from a house fire sustained six hours ago. No first aid has been administered. A 10 year old has 75% TBSA deep burns with evidence of inhalation injury and is in extremis, a 10 year old has 50% TBSA mixed depth burns and is hypovolemic, an 8 year old has 30% TBSA superficial burns, a 5 year old with 10% TBSA superficial burns and two very young children present with erythematous faces and hands. There is a facility in the country that has critical care beds but it is uncertain if there is burn surgery expertise. Travel to that facility is unreliable and risky.

What are your priorities in allocating your limited resources to these patients?



TYPE 1

- Superficial burns up to 5% can be treated at these outpatient facilities, as these burns can heal without surgery.
- Burns that heal spontaneously in less than 2 weeks are unlikely to scar **nor** require surgery



TYPE 2

- Burns up to 20% TBSA as they can often be managed without ICU capabilities.
- If some degree of ICU care is present at type 2 then straightforward burns up to 40% can be managed at the type 2



TYPE 3

- All burns greater than 40% TBSA
- Burns to the face, hands, perineum, genitals and soles of feet
- If possible to integrate the type 3 with local services then most burn patients requiring lengthy admissions will benefit from transfer to a type 3.

The best results surrounding burn survival have been achieved in high resource centres of excellence able to deliver an accurate early assessment and aggressive initial treatment. This centralization of care, while useful for patients at these centres, and the specialized staff at burn centres, has reduced the burn care experience of the medical community at large.

- » In underdeveloped health systems, the expected outcome from burn injuries is poor and expertise is not available.
- » It can be anticipated that the management of burn injury related to disasters and conflict will present significant challenges.
- » Assets to manage large burn injuries will be scarce in conflicts and SODs and must be allocated to the patient who will benefit most from them.
- » Simple burns should be managed in an out patient setting and not referred, and patients with extensive burns and a low likelihood of survival should receive their comfort care outside of specialist centers.

DIFFICULTIES OF BURN CARE IN CONFLICTS AND DISASTERS

- » Burn injuries are unpleasant and apart from the simplest cases require expertise and experience to manage.
- » Burns can place significant burdens on staff, time and resources.
- » Survivability is, in part, related to the availability of care and resources that can be allocated to an individual patient.
- » Inhalation injury and even moderate size burns can stimulate significant physiological derangement making management difficult without ICU capabilities.
- » The full clinical manifestation of a burn injury may take hours to develop and patients with burn injury so severe that survival is not expected may stay alive for many hours.

DEPLOYED TEAMS

It is a general principle of EMTs deployed in response to SODs and conflict that they match their care delivery to the pre-event capabilities of the country to which they are deployed.

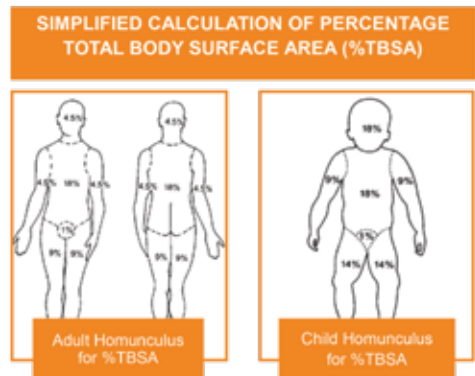


Figure 3. Adult and Paediatric diagrams for calculating Total Body Surface Area (TBSA). Discussions and decisions regarding survivability and required level of care for burns are often made based on TBSA, therefore an accurate estimate of the extent of a burn is important. (ICRC)

SODS

- » Burn injuries are commonly encountered in natural disasters but are not often related to the primary incident.
- » Often burn incidents are a result of alterations to human behaviour secondary to the social shock of the disaster.
- » Much of the protection from burn injury in normal society comes from public health and safety practices, both legislative and practical. All of this can be lost following a SOD.
- » New activities of daily living (ADLs), such as cooking over an open flame, can be made necessary by disasters and can increase the risk of burn injury.

MASS BURN CASUALTY EVENTS

- » Mass burn casualty events are usually the result of human activity and can themselves be the main feature of man-made disasters.
- » Examples include the regular occurrence of multiple burn injuries due to pipeline fuel incidents.

CONFLICT

- » The incidence of burn injury in conflicts varies with the type of military activity, with experience suggesting that between 2-10% of casualties arriving alive at medical treatment facilities (MTFs) can be expected to have a burn injury.
- » Dismounted infantry fighters in open areas sustain few burns but the incidence rises with the use of protective vehicles or ships.
- » Non-combatants may be caught up in the fighting and sustain burns due to direct military action.
- » The use of specific incendiary weapons is still encountered, however it is the impact on normal patterns of life that most change the incidence of civilian burn injury.

KEY POINT

- » Apart from mass casualty events, populations in SODs and conflict will have a sustained higher incidence of burns compared to normal for that society.

SPECIAL CONTEXTS: WEAPONS OF MASS EFFECT

NUCLEAR DETONATION

- » A nuclear blast is not totally beyond the realm of possibility and very large numbers of burn injuries could be generated very quickly.
- » The poor outcomes from burn injuries following Hiroshima and Nagasaki were most likely due to the disruption of health services rather than any specific consequences of a combined thermal and radiation insult.

CHEMICAL WEAPONS

- » Vesicant chemical warfare agents such as Sulfur Mustard are easy to manufacture and have been utilized in recent conflicts.
- » It is possible that both SODs and conflicts may increase the risk of exposure to toxic industrial chemicals and corrosive domestic products.
- » It should be anticipated that chemical burns may be encountered in unstable environments.

ELECTRICAL BURNS

- » Similarly to burns in general, changes to normal society may increase the risk of electrical burns to both children and adults.

ELEMENTS AND PRIORITIES OF BURN INJURY AND CARE

THERE ARE 3 ELEMENTS OF BURN INJURY

1. Cutaneous burn wounds
2. Systemic effects
3. Inhalation Injury

THERE ARE 4 PRIORITIES OF BURN TREATMENT

1. Protect the upper airways from obstruction due to swelling
2. Ensure adequate tissue perfusion through fluid administration and monitoring of response to the fluid
3. Provide optimal conditions to ensure burn wound healing
4. Provide general supportive measures such as analgesia, feeding and physiotherapy

PITFALL

Early assessment of burn depth and extent of burns may not be accurate. Often an overestimation of depth and extent is made when inexperienced practitioners make the assessment.

The danger lies in overestimating the extent of the burns on first look without formal cleansing in an operating theatre. This can result in deliberately limiting the care in a patient with survivable burns.

ASSESSMENT

The treatment of burn injuries will be driven by 3 key assessments:

WHAT IS THE EXTENT OF THE BURN?

- » This measure drives the initial requirements for fluid resuscitation.
- » The size of the burn is expressed as the percentage of the body's total surface body area (%TBSA) that is burnt.
- » This can be calculated using the Rule of Nines or a Lund and Browder Chart
- » The patient's palm and fingers together represent 1% TBSA
- » Burns over 20% TBSA will result in clinically significant alterations in physiology
- » Burns over 30% TBSA may trigger a Systemic Inflammatory Response.

WHAT IS THE DEPTH OF BURN ?

- » The depth of the burn dictates the wound care regimen.
- » Burns must be scrubbed clean prior to any assessment being made.
- » Accurate estimation of burn depth in the first 24-48 hours can be difficult, particularly for practitioners inexperienced in burn care.
- » Differing areas of depth can be seen on a single wound.
- » Simple skin erythema with blistering is not a clinically relevant burn.
- » Wet appearing, blistered areas with marked erythema and brisk capillary refill are often superficial partial thickness burns.
- » Dry appearing areas with non blanching redness (fixed staining) usually represent deeper burns, while full thickness burns can be white.
- » Pain is not a good indicator of burn depth.
- » Superficial partial thickness burns should heal without surgery if managed correctly.
- » Burns that heal spontaneously in less than 2 weeks do not normally result in scarring.

IS AN INHALATION INJURY PRESENT?

- » A history of receiving the burn in an enclosed space with flame or smoke, a hoarse voice, cough, stridor, peri or intra-oral burns, soot in the sputum and an otherwise unexplained or reduced level of consciousness all indicate the possibility of an inhalation injury.
- » Inhalation injuries are generally a fatal injury in an environment without an ICU.
- » An upper airway inhalation injury is a true thermal burn with a risk of subsequent airway obstruction causing obstruction.
- » Lower airway injury is effectively a chemical insult from the noxious products of combustion and can lead to progressive pulmonary failure.
- » Absorption of the products of combustion in the circulation leads to systemic intoxication.

ASSESSMENT

FIRST AID FOR BURNS

- » Stop the burning process: Remove the source of the injury, cool the affected area to prevent on-going burning, remove clothes and other articles that may still be hot, remove any constricting items such as belts, boots, watches, or rings.
- » Continue to cool the affected area with normal domestic temperature water (this can be clean tap water, it does not need to be sterile) for about 30 minutes after the injury. This reduces the inflammation and pain and is appropriate for chemical burns as it dilutes the damaging agent.
- » Give analgesia and cover the wound until medical care is reached.

EMT TYPE 1

- » Burns that appear to be superficial partial thickness at less than 5% TBSA (up to 10% in adults) can be treated in the outpatient setting.
- » Adequate analgesia should be administered and the burn washed with antiseptic solution.
- » Blisters should be burst and blister roofs removed and a clean dressing applied.
- » Prophylactic antibiotics are not routinely used for simple burn care, but it may be prudent to administer a three-dose course of a broad-spectrum antibiotic such as amoxicillin/clavulanic acid, if good wound hygiene cannot be ensured.
- » The burn will be painful for several days so adequate analgesia should be given, e.g. a mixture of paracetamol and codeine.
- » Patients should be advised to return to a medical facility if they become unwell or develops obvious signs of infection (fever, spreading erythema, increasing pain).
- » The burn should be assessed at a medical facility 2 days following the initial visit in order to assess the depth and size and assess for signs of infection. The burn should be cleaned and have a fresh dressing applied as well, and families given wound care instructions at this time.
- » Patients should be advised to seek medical care if the burn has not healed within two weeks. If at the 2 week point, there are confluent areas adding to 1% TBSA then the patient should be referred for surgical evaluation.
- » Healed burns should have a moisturizing agent applied for two weeks after injury or longer if the skin remains dry. Sun protection is important to avoid permanent changes in skin pigmentation for one year following injury.
- » When transferring a burned patient, if there is minimal concern for delays in transport then the wound does not require a formal dressing. Laying clear plastic food wrap over the burn will suffice for 12 -24 hours as long as the wound was thoroughly washed. The limb should not be circumferentially wrapped.

EMT TYPE 1

CRITERIA FOR TRANSFER

- » Burns greater than 10% TBSA irrespective of depth, deep partial thickness or full thickness burns greater than 1% TBSA, any evidence of inhalation injury, evidence of infection or concomitant significant injuries need to be transferred to a type 2 facility.
- » Ideally, patients being transferred to a more capable facility should be moved without delay.
- » Patients should have adequate analgesia for transport and must be kept warm.
- » If there is any concern about the adequacy of fluid input and for all burns over 20% TBSA, IV fluids should be administered at 10 mL per hour for every 10% TBSA.

EMT TYPE 2

BURN CARE AT THE EMT TYPE 2

The care of simple burns at the type 2 does not differ from the management at type 1 facilities.

RE-ASSESSMENT

- » A history should be taken and a clinical examination performed with particular attention paid to excluding other injuries and illnesses. A detailed assessment of size and depth for larger burns requires the wound to be scrubbed down under adequate analgesia and preferably a general anaesthetic in an operating theatre.
- » There are some smartphone based applications available to help in burn size mapping with some limited evidence that they are easier to use and more accurate than a Lund & Browder chart.
- » Upper airway assessment can be made by direct laryngoscopy at the time of induction for anaesthesia. There is no way to definitively assess the lower airways without the aid of bronchoscopy. Therefore, much of the diagnosis of inhalation injury relies on clinical examination supplemented by radiology and blood gas analysis if available.

KEY POINT

- » For burns over 20% TBSA secure IV access, a nasogastric tube and a urinary catheter for monitoring of urine output (UOP) should all be placed.

ESCHAROTOMY

- » Circumferential deep burns around the torso and limbs must be identified.
- » As swelling increases the unyielding burn eschar can lead to a rise in tissue pressure with associated reduction in perfusion, and respiratory excursion can be compromised in the torso.
- » In this instance escharotomies must be performed to relieve the pressure (Figure 4)
- » This should be performed in an operating theatre as a formal surgical procedure under general anaesthetic.
- » If performed correctly there is often significant bleeding and meticulous attention must be paid to haemostasis.
- » It is important that the escharotomies extend along the whole length of the burnt area and into normal tissue.
- » The horizontal torso incision should be, at least in part, below the costal margin to allow abdominal expansion.
- » Burns of any depth over 10% will most likely need significant analgesia for the first couple of days and, therefore, admission.

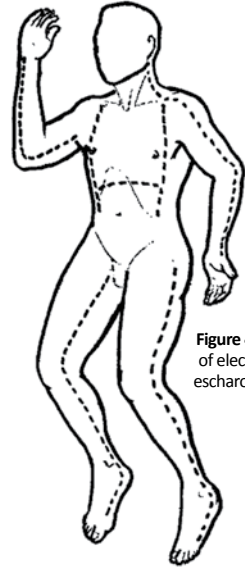


Figure 4. Lines of election for escharotomies (Kay)

DIFFICULT DECISION MAKING IN CONFLICTS AND DISASTERS

Burn management is a resource intensive process and decisions must be made quickly where or if continued care of a patient should occur.

- » Attempts should be made to establish what expert burn care facilities are available (or likely to become available soon) and consider referral.
- » Outside of centers of excellence definite severe inhalation injury and deep burns greater than 60% TBSA are unlikely to survive.
- » Such patients should be discussed to avoid transferring cases when on-going care is deemed futile.

FLUID MANAGEMENT AND RESUSCITATION

- » Burns up to 20% can be managed with oral rehydration.
- » It is important to still make an assessment of hydration status and provide IV fluids if it is apparent that oral rehydration alone is not providing adequate input.
- » Burns over 20% TBSA should be given intravenous crystalloid in the first 24 hours as prophylactic fluids to reduce the chances of developing burn shock.
- » Hartmann's / Lactated Ringers is preferable to Normal Saline. The formula of $2\text{ mL} \times \%TBSA$ burned \times body weight in kilograms should be used as a starting point. This calculation gives a volume of crystalloid in mL that is likely to be required in the first 24 hours from the time of injury.
- » The first half of the total fluid calculated should be administered over the first 8 hours from the time of injury and the second half of the fluid given over the subsequent 16 hours.
- » Urine output is the best guide to adequacy of input with a target of 0.5 ml/Kg/hr (1ml/Kg/hr in children). The urine output should be measured hourly.
- » Two consecutive hours of either too much or too little urine compared to the target output should initiate a change of intravenous input either down or up by 20%.

FLUID REQUIREMENTS IN FIRST 48 HOURS		
HOURS SINCE BURN	FLUID REQUIREMENTS	
0-24 HOURS	2 ml/kg \times % TBSA of Ringers Lactate (1/2 in first 8 hours, 1/2 in following 16 hours)	Target Urine Output = 0.5 ml/kg/hr
24-48 HOURS	To be guided by urine output	
SPECIAL CONSIDERATIONS: <ul style="list-style-type: none"> • Burns > 50% TBSA: Use 50% TBSA in calculations above • Inhalation injury/electric burns: Have increased fluid requirements, use $3\text{ml/kg} \times \%TBSA$ 		

Figure 6. Resuscitation for ICRC burn protocol (ICRC)

PAEDIATRIC CONSIDERATIONS

- » Historically, children with >20% TBSA have been resuscitated with $3\text{ mL/kg} \times \%TBSA$, this frequently leads to fluid overload. The $2\text{ mL/kg} \times \%TBSA$ guideline should be used in children as well as adults.

PITFALL

Thirst alone is a poor indicator of hydration status

Administration of excessive fluids can be just as detrimental to the patient as under-resuscitation with fluid.

KEY POINT

- » If there has been a significant delay in presentation, avoid catching up on fluid as a bolus, spread the volume out over several hours.

SUPPORTIVE MEASURES FOR BURNS

- » Patients with large burns are particularly susceptible to hypothermia and all efforts should be made to prevent this.
- » Burns are painful and psychologically distressing. It is essential to maintain adequate levels of analgesia including opiates if necessary.
- » A protocol of continuous background levels of analgesics should be established with top ups administered as needed for stimulating activities such as physiotherapy or attention to dressings.
- » NSAIDs should be avoided for at least 48 hours post injury because of the risk of renal injury.
- » It is beneficial to maintain gut function and adequate nutrition from as early on as possible. This is best achieved by establishing early feeding and in larger burns this will only be achieved via a nasogastric tube.
- » Prophylaxis against peptic ulceration should be administered in addition to feeding.
- » Initially the patient with a large burn will have a coagulopathy. The risk from venous thromboembolism soon rises and prophylaxis is indicated from day 2 unless there are other contraindications.
- » Antibiotic prophylaxis beyond three doses is not advocated. Further administration of antibiotics should be limited to treatment doses for clinically suspected infection. It should be noted that a tachycardia and pyrexia can be part of the normal response to systemic inflammation and do not necessarily indicate infection.
- » Keeping a patient sitting up with limbs elevated will help reduce swelling.

NUTRITION

- » Nutrition in burn patients is extremely important, however enteric or tube feeds may not be available.
- » It is possible to improvise liquid tube feeds by crushing biscuits into milk or beaten eggs if proprietary formulas are unavailable.



Figure 5. Patient with escharotomy incision of the right arm. The head of the bed should be elevated and the arm elevated to protect against further swelling (ICRC)

WOUND MANAGEMENT

- » Deep burns of more than 1% will do better with surgery. In ideal circumstances this is best performed early, but **when resources and clinical capability are limited it can be preferable to wait for at least two weeks before embarking on surgery.**
- » The delay will allow more superficial burns to heal with dressings alone and provides confirmation of the initial assessment of depth.
- » This approach helps reduce the total area that requires surgical excision and skin grafting.
- » Burn wounds require dressings. Treatment of burns by “exposure” is not advocated.

SELECTION OF BURN DRESSINGS

There are numerous methods of dressing a burn wound and there is no universally agreed dressing regime. Policy in disaster and conflict situations should be dictated by the following principles:

- » Dressings must be applicable for all burn depths.
- » Dressings should have antiseptic properties and minimize the drive of the Systemic Inflammatory Response.
- » Dressings should be easy to apply and comfortable for the patient.
- » Dressings should not require frequent changes or laborious nursing care.

SELECTION OF BURN DRESSINGS

- » In general ointments, such as **Silver Sulfadiazine (SSD)**, are easier to apply than sheets.
- » Preparations of SSD that contain Cerium Nitrate are thought to reduce the systemic effects of a burn wound and also generate a dry eschar that is easier to manage.
- » These ointments should be applied in a thick layer then covered with fluffy gauze.
- » Silver based sheet dressings, can be left on wounds for a longer time and provide ease of management, but are generally expensive.
- » The most basic dressings can be made of paraffin gauze stained with an antiseptic such as povidone-iodine.
- » Dressings must be inspected daily for slippage, comfort and excessive strike-through.
- » Any suspicion of sepsis must prompt an inspection of wounds and exchange of dressings.

PITFALL

Wounds must be thoroughly scrubbed and cleaned prior to the application of any dressing.

HAND BURNS

- » Elevation of hand burns is very important to minimize swelling
- » The use of bags to dress hand burns is not used frequently now. The advantage of hand bag dressings was that the awake patient could assist in their own nursing care, particularly in mass casualty situations or long evacuation journeys when the availability of professional staff may be limited.
- » Unconscious or heavily sedated patients should have hands fully dressed as according to the principles described in this text and splinted in the Position of Safe Immobilization (POSI).
- » Circumferential hand burns require careful monitoring for potential escharotomy. **Warning signs** include the hand becoming pale, cool, and assuming a claw like position.
- » If available, a Doppler monitor can be used to assess for a lack of digital flow, if flow becomes absent a digital escharotomy may be required.



Figure 7. Safe position for splinting of the hand (ICRC)

FACE BURNS

- » Facial burns should be scrubbed as described previously and a petroleum based ointment applied regularly to prevent desiccation.
- » There is no evidence that an antiseptic preparation is superior to plain petroleum jelly for the face.
- » Ears should be covered with an antiseptic agent to prevent chondritis.
- » It is difficult to assess and care for scalp burns unless the head is shaved.

HYPOTHERMIA

- » Burn patients are at very high risk of hypothermia. This is especially true of children.
- » This may be particularly true in disaster situations where permanent structures may be severely damaged or lacking heat.

SURGICAL MANAGEMENT OF BURNS

- » If embarking on surgery in constrained situations it is beneficial to perform excision and skin grafting in small stages rather than trying to deal with a large burn wound in a single session.
- » **10% TBSA of burn wound for each theatre session is a good target with 10 – 14 days in between surgeries.**
- » This helps reduce blood loss, minimizes the further physiological insult, and generates more manageable dressings which reduces the nursing workload.
- » It is important to make sure there will be sufficient skin graft available to cover areas planned for excision. It is preferable to have an unexcised burn wound with appropriate dressing rather than an un-grafted excised wound.
- » Excision of burns on the face and hands should be performed by those with specific experience in burn surgery.

EXPERT TIP

- » Perioperative blood loss can also be reduced by liberal use of 1:1,000,000 adrenalin (epinephrine) solution injected beneath both the burn wound to be excised and skin graft donor areas.
- » This is made by mixing 1mg of adrenalin (1ml of 1:1,000) in 1 L of normal saline.

SKIN GRAFTING FOR BURNS

- » Skin graft should be routinely **meshed 1.5:1** as this reduces the amount required to be harvested, thereby reducing the size of the secondary wound but also improves the chance of the graft taking.
- » If there is a shortage of donor areas, then a 3:1 mesh can be used.
- » Mesh ratios above this are technically difficult and should be reserved for specialist centres.
- » Donor sites can be re-harvested once re-epithelialized but it is recommended to wait for at least two weeks if the surgeon is not familiar with this.
- » The number of times a given area can be re-harvested is dictated by how much dermis is removed each time.



Figure 8. Meshed STSG in place. The graft can be seen on the left side of the picture. The meshing process not only allows for grafting of more TBSA but reduces the chances of hematoma formation under the graft which can lead to graft failure. (ICRC)

- » It is preferable to leave skin graft **donor site dressings** in place until the area has healed, even for several weeks.
- » The routine change of dressings earlier than one week simply causes more pain, bleeding, and damage to the new epithelium.
- » **Skin grafted areas** should have a first change of dressing at five days unless there is a clinical indication to do so earlier, e.g. signs of new systemic infection.

CHEMICAL BURNS

- » Solid particles or powder can be brushed off first.
- » The injuring agent should then be removed as soon as possible with copious irrigation by water.
- » Irrigation should be prolonged but beware of inducing hypothermia.
- » Once decontamination is complete, the burn wound is treated the same as a thermal burn.
- » Chemical burns can cause a differing inflammatory response from thermal burns so close monitoring of fluid requirements is essential.
- » Sulfur Mustard burns take many weeks to heal and skin grafting is prone to failure. All vesicant burns should be referred for specialist care.

PITFALL

If more than 40% TBSA requires excision and skin grafting, complex surgical strategies are required.

Patients with over 40% full thickness burns in low resource situations have a very poor chance of survival, particularly in a field hospital environment.

ELECTRICAL BURNS

- » In the case of electrocution, if an initial ECG is normal there is no evidence to suggest continued cardiac monitoring is necessary in a resource limited environment.
- » Electrical burns can cause much more extensive tissue damage than the skin signs might suggest.
- » Deep necrosis is not uncommon and there should be a very low threshold for performing fasciotomies. It is common to encounter progressive necrosis and full debridement may require a staged approach.

EMT TYPE 3

- » The majority of burns that require surgery will need long periods of inpatient admission with significant input from nursing and physiotherapy.
- » It will be appropriate to transfer cases to type 3 facilities as soon as such capabilities become available. If possible, type 3 EMTs should integrate with pre-disaster/conflict services.
- » Delivery of specialist multidisciplinary care will be required for burns to the face, hands, perineum/genitals and soles of feet in addition to those with large % TBSA.
- » The organization of such specialist services will need careful planning and control to ensure it does not deliver care that is incongruous with the host nation's capabilities and norms.

SPECIAL CONSIDERATIONS

- » Burn patients can create difficult decisions regarding end of life care. It is important that an open dialogue occur between, patients, families, and EMT teams in severely burned patients.
- » It may be helpful to have respected members of the local community on the decision making team.
- » These lines of communication are important during transfer as well. Burn care for severe burns often takes months and is very resource intensive. An EMT receiving burn patients should strive to identify a local or regional centre with the experience and resources to treat burn patients.
- » However, patients should not be transferred without discussion with the family and the consent of the patient and family.

REHABILITATION

- » Rehabilitation of burn patients is a crucial part of the treatment process and should begin as soon as possible.
- » Adequate pain management is compulsory for successful rehabilitation.
- » Wound compression and mobilization should be utilized when recommended by the surgeon.
- » Late stage rehabilitation is not terribly complex, but like all of burn surgery, professionals trained in burn care are necessary to obtain the optimal aesthetic and functional outcome.

PITFALL

Burn injury is distracting and other injuries must be identified and treated along with the burn injury. Primary and secondary surveys for trauma are required in burn patients as in all trauma patients.

SUGGESTED RESOURCES

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3. Norton I, Von Schreeb J, Aitken P, Herard P, Lajolo C. Classification and minimum standards for foreign medical teams in sudden onset disasters. Geneva: *World Health Organization* 2013
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EMT Website: <https://extranet.who.int/emt/page/home>
 AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>



12

ETHICS OF HEALTHCARE IN DISASTERS AND CONFLICT

SCENARIO

MAIN ETHICAL THEORIES

TOOLS TO DEAL WITH ETHICAL DILEMMAS

EMT GUIDING PRINCIPLES

RESEARCH ETHICS IN DISASTERS

SUGGESTED RESOURCES

REFERENCES

SCENARIO

A 23-year-old woman is admitted at your healthcare facility with a fracture for which a surgical intervention is indicated. According to the cultural values in her tribe she cannot give consent for the surgery before her husband is present and agrees with the procedure.

So far, it has not been possible to locate the patient's husband. Her exam indicates that the blood supply to her distal extremity is tenuous, and it is clear that surgery should occur as soon as possible.

What ethical issues does this situation raise?

How should the team reach a final decision?

COMMON ETHICAL DILEMMAS IN DISASTER AND CONFLICT

✓ LACK OF RESOURCES

Acceptance of higher risks
 Unqualified healthcare workers
 Difficulty maintaining continuity of care
 Frustration with policy or aid agency
 Early discharge to suboptimal conditions

✓ TRIAGE

Different criteria
 No senior/trained staff involvement
 Short-term vs long-term outcomes
 Premature, low birth weight babies

✓ CULTURAL ISSUES

Strong religious beliefs
 Gender roles
 Perceptions of health and quality of life
 Pain tolerance

✓ INFORMED CONSENT

Difficult issues with gender or combatants
 Children without parents
 Unconscious patients

✓ LOCAL CAREGIVERS

Reputation
 Financial, livelihood differences
 Positioning in conflicts

HEALTHCARE WORKERS FACING ETHICAL DILEMMAS CAN EXPERIENCE:

- » **Moral distress** – when one knows the ethically correct action but feels powerless to take that action.
- » **Vicarious traumatization** - results from empathic engagement with patient's suffering.
- » **Compassion fatigue** - secondary traumatic stress, gradual lessening of compassion over time.
- » **Burnout** – exhaustion and difficulty coping due to severe stress.

MAIN ETHICAL THEORIES FOR HEALTHCARE IN DISASTERS AND CONFLICT

UTILITARIANISM

- » The right thing to do is to try to **generate the greatest overall good for a group or population**.
- » Focus on the **consequences** of actions, not on good intentions. Decision making in humanitarian healthcare should be informed by measuring and calculating the benefits and burdens resulting from an action.
- » Limitations: uncertain and unpredictable nature of context in disasters, difficulties in collecting data and conducting research to aid informed decisions.

DEONTOLOGY

- » **Duties and rules** are the basis for ethical action. A duty is an obligation to always react in a specified manner, regardless of consequence, because to act in the determined way is the right thing to do.
- » Limitations: difficult to know what to do when two responsibilities are conflict. Deontology does not consider the consequences resulting from an action to evaluate whether the choice was correct.

IDEAL MORAL THEORY

- » Does not consider the specificities of a situation or issue, instead identifies **general ethical principles** and emphasizes rational approaches.
- » It is understood that **moral goodness is always possible**.
- » Limitations: reality is complex, especially in conflict or disaster settings. Sometimes to do the ideal 'right' is not possible under certain conditions.

NON-IDEAL MORAL THEORY

- » Understands that the **world is complex**, and includes rational, emotional and relational factors in all decisions and situations.
- » Assumes sometimes **unfavorable conditions will not allow us to reach a 'right' solution**, so when choosing between undesirable alternatives we should decide for the least detrimental option.
- » Limitations: no definitive answers regarding on clinical decision making.

VIRTUE ETHICS

- » Virtue ethics is less focused on what we should do, and more concerned with the kind of people we should be. Virtue is a type of practical wisdom in which good character traits (virtues) and the right outcome (action) come together.
- » Limitations: can be more subjective (more focused on case discussion than balancing ethical principles or rules). Emphasizes the development of individual moral character (like honesty or courage), but does not often provide clear answers to concrete dilemmas.

TOOLS TO DEAL WITH ETHICAL DILEMMAS

EMTs should consider how to approach ethically challenging cases, especially amputations and end of life decisions. Some teams use an "ethics committee" approach. The committee often consists of the team leader, the treating clinician, a local clinician, and another senior clinician not involved in direct patient care. The committee should agree on the best approach for the patient in consultation with relevant family members.

- » Follow agreed upon codes of behaviour and guidelines covering humanitarian ethics
- » Communicate with local people, organizations, and healthcare colleagues to understand local customs and standard operating procedures
- » Consult with the ethics committee in your organization if present
- » Consult with senior colleagues when feasible
- » Engage in open discussions with colleagues and seek a second opinion

HUMANITARIAN ETHICS ANALYSIS TOOL

Available from: <http://www.humanitarianhealthethics.net/>

1. Identify/clarify ethical issue	Is this truly an ethical issue? What is at stake and for whom? How is the issue perceived from different perspectives? When must a decision be made? Who is responsible for making it? What has been done so far?
2. Gather Information	What information is needed to deliberate well about this issue and enable us to make a well-considered decision? What constraints to information gathering exist? Consider: - Participation, perspectives and power - Community, project and policies - Resources, clinical features & obstacles
3. Review Ethical Issue	Does the process reveal new aspects of the ethical issue or suggest the need to reformulate or redefine the issue? Have our biases/interests affected how we see the issue?
4. Explore ethics resources	What can assist us to evaluate the ethical aspects of this issue? What values and norms ought to inform our decision making? Consider: Codes of ethics (NGO, interagency, professional bodies); local & international law; statements of values/principles; agency policies
5. Evaluate and select the best option	What options are possible in this situation and what ethical values support each option? What consequences might result from each option? Can consequences, values and obligations be reconciled?
6. Follow up	What can we learn from this situation? What support do those involved require?

EMT GUIDING PRINCIPLES

All EMTs should comply with the guiding principles stated in the WHO 'Classification and minimum standards for EMTs in SODs.

- » The EMT provides safe timely, effective, efficient, equitable and patient centered care.
- » The EMT offers a “needs based” response according the context and type of SOD in the affected nation.
- » The EMT adopts a human rights based approach to their response and ensure they are accessible to all sections of the population affected by the SOD, particularly the most vulnerable.
- » EMTs undertake to treat patients in a medically ethical manner consistent with the World Medical Association’s Medical Ethics Manual. In particular, EMTs undertake to maintain doctor-patient confidentiality and, unless obviously impossible, to communicate with patients in a culturally appropriate fashion and in an language that the patient understands when informing patients about their medical condition and prognosis, discussing their treatment options and obtaining their informed consent for medical procedures.
- » All EMTs are accountable to the patients and communities they assist, the host government and MoH, as well as their own organization and donors.
- » EMTs commit to be integrated into a coordinated response under the national health emergency management authorities, and to collaborate with the national health system and MoH.
- » EMTs commit to collaborate with their fellow EMTs as well as the rest of the international humanitarian community.

ETHICS TRAINING FOR HEALTH CARE PROVIDERS

- » Must be provided in pre-deployment training for EMTs.
- » **Purpose:** to prepare providers for the ethical dilemmas they will inevitably face, to build resilience to moral distress and provide tools for clinical decision making when ethical issues are encountered.

ETHICAL DEBRIEFING

- » Debriefing must be available for all health care workers. It should include the discussion of ethical dilemmas faced and address any moral guilt or stress felt by the health professional.
- » It will have similarities to psychological debriefing.
- » Real cases must be discussed afterwards in groups to help future ethical decisions.

KEY POINT

Ethical training and debriefing are especially relevant for type 3 EMT staff.

While challenging ethical situations regarding withdrawal of care can occur in all levels of EMT, these scenarios often occur at the type 3 level. Type 3 EMTs should have protocols in place regarding end of life decisions and amputations.

CONTROVERSY!

Analyzing an ethical dilemma from different points of views may lead to different conclusions, for example

- **Clinical ethics focus on the individual**
- **Public health ethics focus on the common good**

LIMITS OF CARE

- » EMTs should only provide **care appropriate for their level and capacities** (infrastructure, equipment and trained personnel), adhering to WHO Classification and minimum standards for EMTs in SOD.
- » As a general rule only start treatment that can be maintained by the local health care system after EMT departure.
- » The limits of care provided by a team must be clarified by the coordinator **beginning patient care**. This will avoid discussions once patients have already been admitted and personnel are confronted by situations beyond their capacity.

RESEARCH ETHICS IN DISASTERS

- » Research in disasters is required to improve preparation and response. It is an ethical requirement to collect data and gather evidence to guide future responses to similar events.
- » Any plans for research and data collection beyond patient care and mandatory reporting should be anticipated prior to deployment.
- » There is an ethical imperative to protect patient confidentiality and provide timely and effective treatment. Data collection processes must always place patient dignity before research purposes.
- » Documentation of interventions should be recorded, as it is an ethical imperative to audit practice wherever an ethical issue occurs.
- » While it is ethical to conduct research in disasters and conflict, patient needs must be prioritized.
- » Local communities should be engaged with to the maximum extent possible in all stages of research.
- » All research should receive research ethics approval prior to commencing, and ideally should receive ethical approval from a local research ethics committee or authority.

SUGGESTED RESOURCES

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6. British Medical Association. Ethical decision-making for doctors in the armed forces: A tool kit. BMA 2012.
7. Schwartz L, Hunt M, Redwood-Campbell L, de Laat S. Ethics and Emergency Disaster Response. Normative Approaches and Training Needs for Humanitarian Health Care Providers. *Disaster bioethics: Normative issues when nothing is normal*: Springer; 2014: 33-48.
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EMT Website: <https://extranet.who.int/emt/page/home>

AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>



13

PHYSIOTHERAPY

SCENARIO

ACUTE CARE TREATMENT/CONSIDERATIONS

SUB ACUTE TREATMENT

CHRONIC-LONG TERM MANAGEMENT

FAMILY INVOLVEMENT AND EQUIPMENT

SUGGESTED RESOURCES

REFERENCES



Figure 1. Physiotherapy for a patient in traction. (ICRC)

SCENARIO

A 25-year-old man presents to a type 2 facility following a gunshot wound resulting in a left femur fracture without vascular damage.

He subsequently undergoes wound debridement and is placed in traction. The team has only recently become operational and is still in the process of finding referral pathways to a higher level of care.



TYPE 1

Type 1 EMTs should be able to provide basic rehabilitation care or refer patients to an appropriate EMT or existing local facility.



TYPE 2

Must have at least one rehabilitation professional per 20 beds



TYPE 3

Must have at least one rehabilitation professional per 20 beds

KEY POINT

- » EMTs offering rehab services need to be self-sufficient for 2 weeks
- » Supply list should include 6 wheelchairs and 20 crutches per 20 beds.
- » Rehab decisions must take into account the likely logistical constraints of regard the deployment.



TYPE 2

DELIVERY OF PHYSIOTHERAPY TYPE 2 AND 3 FACILITIES:

- Physical therapy benefits bed bound patients with long bone fractures by preventing complications such as pneumonia and muscle contractures.
- The early mobilization of patients on crutches, or simply transferring bed to chair enhances the patient's perception of recovery and helps set the patient up for a safer discharge.



TYPE 3

NURSING AND RESPIRATORY CARE

- » Patients need to be nursed in an upright position as much as possible to optimize respiratory effort.

CONSIDERATIONS FOR AUSTERE ENVIRONMENTS

- » Water bottles can be used as spacers to deliver aerosolized medications to individuals.
- » In bed-bound patients, it is important to encourage re-expansion of the lungs, preventing post operative pneumonia.
- » A bubble positive expiratory pressure (PEP) set up can be easily constructed by partially filling a container water and submerging a tube or straw.
- » When a patient exhales through the tube the bubbles provide a stimulus to encourage good air movement.



Figure 2. Chest physiotherapy can be an important tool to prevent post operative complications (ICRC)

ACUTE REHABILITATION NEEDS

TREATMENT 1-2 TIMES A DAY FOR 30-60 MINUTES

ESTABLISH EARLY MOBILIZATION

- » Depending on the injury and patient's stability, there is evidence of improved systemic function and faster functional recovery with early mobilization.
- » Establish early with medical team the weight bearing status of the patient of all extremities

DEVELOP A PROGRAM TO ENCOURAGE MOBILITY ACCORDING TO WEIGHT BEARING STATUS

- » Work within the weight bearing status to begin sitting up unsupported and mechanisms for transfers out of bed as tolerated.

DEVELOP A PROGRAM FOR ACTIVITY BOTH IN AND OUT OF BED

- » Out of bed activity improves respiratory status, early weight bearing reduces strength loss and improves recovery, and increases patient well being
- » In bed positioning, to prevent contracture, prevention of pressure ulcers, and pain management is imperative.



Figure 3. ICRC patients receive information in preparation for rehabilitation from injury (ICRC)

PREVENTION OF COMMON CONTRACTURES

EQUINUS CONTRACTURE

- » All patients who plan to weight bear in the future need to have a plantigrade foot position.
- » Equinus contractures, which are common in bed-bound, patients will limit rehabilitation potential.
- » These contractures can be prevented by actively dorsiflexing the ankles.
- » If the patient cannot actively dorsiflex, they should passively dorsiflex the foot by wrapping bandage or fabric around the toe of the foot and pulling the free end to provide dorsiflexion.
- » Patients who have no active movement should be splinted into a neutral position unless the calf muscles are being passively stretched.



Figure 4. Strengthening the upper body is essential in patients with lower extremity injuries (V. Hasselman/ICRC)

KEY POINT

- » In any patient who cannot easily dorsiflex the foot past the neutral position, the foot should be splinted into a neutral position when not actively engaged in dorsiflexion exercises, in order to prevent the formation of Equinus contracture.

PITFALL

A well placed pillow has many advantages. It can protect the heels from developing decubitus ulcers and relieve back pain. However, A pillow to flex the knees must be avoided in patients with periarticular knee injuries, femoral shaft fractures, tibial shaft fractures, and below knee amputations. A pillow causing persistent flexion of the knee can result in a contracture that limits the patients future ambulation.

SUB ACUTE REHABILITATION NEEDS

DAILY TREATMENT 30-60 MINUTES 1-2 TIMES PER DAY

KEY TENANTS OF SUB-ACUTE REHABILITATION OF THE LOWER EXTREMITY

- » Initiate the patient's activities of daily living as able and create a schedule for getting out of bed.
- » Emphasize range of motion work, progressing from passive to active range of motion activities.
- » Increase weight bearing as appropriate depending on patient tolerance.
- » Exercise uninvolved limbs and gradually increase the exercise of the involved limb as appropriate.
- » Continued positioning and stretching of patient when in bed.
- » Introduce stump wrapping for amputees, to encourage stump shaping and prepare the limb for eventual prosthetic training.

KEY TENANTS OF SUB-ACUTE REHABILITATION OF THE UPPER EXTREMITY

- » Joints not involved in the injury should be mobilized early and often, i.e. a patient with external fixation of a forearm fracture should receive routine mobilization of the shoulder and scapula.
- » Mobility of the upper extremity is crucial. Patients must have assistance with, and learn to position distal and proximal joints when at rest to prevent soft tissue contractures.
- » The extremities contralateral to the injury should routinely undergo full active range of motion, even while the patient requires assisted range of motion for the injured limb.
- » Introduce stump wrapping for amputees and continue training for performance of activities of daily living following upper extremity amputation.

CHRONIC LONG REHABILITATION NEEDS DAILY TREATMENT 30-60 MIN BY REHABILITATION PROFESSIONAL WITH PERFORMANCE OF HOME REGIMEN BY PATIENT

AMPUTATIONS

- » Discharge planning must be established early to prepare the patient and family for successful transition to home care.
- » Following earlier rehabilitation phases the continued rehabilitation needs for patients following amputation include: Continued gait training, teaching for activities of daily living, strength training, and prosthesis and limb preservation training.
- » All activities should involve the patient's support system as much as possible.

PROSTHETIC PLANNING AND TRAINING

- » It is important to consider the length of deployment and prosthetic and rehabilitation resources within an EMT when planning for amputee rehabilitation and prosthetic training.
- » Patients will require resources for long term maintenance prostheses. The rehabilitation professional should engage with local resources to make these connections to enable the patient to continue with his/her management in the community.

OTHER CONSIDERATIONS

- » The greater the comorbidities or other injuries of a patient, the longer the amputee requires for positioning and the longer time the patient should spend in earlier phases of rehabilitation.
- » Other adaptive equipment must be required or adjusted for complications such as multiple amputations, traumatic brain injury, or spinal cord injury.

CHRONIC LONG REHABILITATION NEEDS TREATMENT DAILY 30-60 MIN BY REHABILITATION PROFESSIONAL AND HOME PROGRAM BY PATIENT

ORTHOTICS

- » Orthotics are important but often overlooked devices that facilitate improvements in function after peripheral nerve injury in the limbs.
- » Orthotics are utilized both during healing as well as during the return to mobility.
- » Orthotics assist in positioning during healing as well as compensates for the loss or weakness of muscle action to improve functional capacity.
- » Orthotics can be easily fabricated with moldable materials and soft bandages for positioning, comfort, and prevention of skin breakdown.
- » Orthotics are an inexpensive assistive devices that can make large improvements in functional status following limb injury.
- » Patients with nerve damage following injury, require orthotics just as amputees require prosthetics.

COMMUNITY CARE

- » Continued long term treatment and follow up by a medical professional and rehabilitation specialist is appropriate for up to one year following a limb injury.
- » The EMT rehabilitation specialist will need to gather and provide information for their patients regarding how to engage local care resources following the disaster or conflict.



Figure 5. A patient receives adjustments to her prosthetic leg. She was 14 years old when injured by a landmine. (ICRC)

FAMILY INVOLVEMENT AND EQUIPMENT

FAMILY INVOLVEMENT

- » Families need to be involved in patient treatment.
- » Families are an important member of the discharge planning.
- » For carry over and consistency and to combat complications, families must be trained in their loved ones care.
- » Teaching family positioning, mobility, and pain management practices improved patient outcomes and compliance.

SUGGESTED ALTERNATIVES

- » If certain equipment is unavailable in areas of disaster and conflict:
 - » Wheel chair alternative
 - Chair with something to elevate lower extremities
 - » Walker alternative- crutches
 - » Crutches alternative-Walking sticks
 - » Slide board alternative-Board with a sheet
 - » Platform walker alternative-Pushing a tray table or wheelchair
 - » Cane alternative-Walking stick
 - » Gait belt alternative-Sheet, belt
 - » AFO/ Orthotics- Wood or plastic uprights with bandaged wrap.



Figure 6. Fitting a wheelchair bound patient with walking splints (ICRC)

SUGGESTED RESOURCES

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6. Walsh L, Subbarao I, Gebbie K, et al. Core competencies for disaster medicine and public health. *Disaster medicine and public health preparedness* 2012; **6**(01): 44-52.
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 AO/ICRC/WHO Training Resources: <http://www.aofoundation.org/icrc>

Annexes

EQUIPMENT LIST FOR THE LIMB INJURY MANAGEMENT

ICRC ABCDE INITIAL ASSESSMENT

ICRC BURNS OVERVIEW

ICRC THROMBOPROPHYLAXIS GUIDELINE

ICRC TRIAGE

QUANTITY	DESCRIPTION
	PLASTER CASTING MATERIAL (1 kit for 25 wounded patients)
24	BANDAGE, PLASTER OF PARIS, 10cm x 3 cm
60	BANDAGE, PLASTER OF PARIS, 15cm x 3 cm
1	BANDAGE, TUBULAR, co:on, eached, 08cm x 25 cm for POP
100	GLOVE, EXAMINATION, NITRILE, non-sterile, medium (7-8)
1	BANDAGE, TUBULAR, co:on, eached, 06cm x 25 cm for POP
12	BANDAGE PADDING, for POP, 10cmx2.7m, viscose 100%
36	BANDAGE PADDING, for POP, 15cmx2.7m, viscose 100%
	SPLINTS (for 15-20 cases)
20	BANDAGE, GAUZE, 08cmx4m, elasVc, non-sterile
5	SPLINT, KRAMER, 08 cm x 80 cm
10	SPLINT, KRAMER, 12 cm x 100 cm
5	SPLINT, KRAMER, 15 cm x 100 cm
10	BAG, PE plasVc, for garbage, 100L, black, 0.07 mm
4	COTTON, UNBLEACHED, 1 kg for padding
2	CARTON BOX int.200x160x1100mm, double corrugaVon
	PLASTER CASTS REMOVAL (1 kit for 50 Patients)
1	SCISSORS, PLASTER SHEARS, BRUNS, 24 cm
1	SCISSORS, PLASTER SHEARS, STILLE, 37 cm, reinforced blade
1	KNIFE, PLASTER, ESMACH, 18 cm
1	SPREADER, PLASTER, HENNIG, 27cm
1	BREAKER, PLASTER CAST, WOLFF-BOEHLER, 18 cm
1	SCISSORS, PLASTER SHEARS, STILLE-mini, 20 cm for small POP
	TRACTION (1 kit for 50 patients)
1	BIT, DRILL, 3.2 mm. Jacobs chuck, 180/165 mm
1	CHUCK, UNIVERSAL (3-jaw) with T-Handle + locking device
2	ROPE, TRACTION, 3mm x 15m, bow, extension, Boehler
2	BOW, EXTENSION, BOEHLER, 9 x 16 cm
7	NAIL, EXTENSION, STEINMANN, 210 x 4 mm, trocar point
8	BOW, EXTENSION, BOEHLER, 15x21 cm
3	PIN, STEINMANN, 4.0 mm x 150 mm
5	SPLINT, ICRC tracVon frame, ICRC

QUANTITY	DESCRIPTION
	SET, DPC, instruments (2 kit for 50 patients)
1	SCALPEL, HANDLE, No 3 (for blades 10/11/15)
1	SCISSORS, MAYO, 17 cm, curved
1	NEEDLE HOLDER, MAYO-HEGAR, 15 cm, standard
4	FORCEPS, HEMOSTATIC, CRILE, 14 cm, curved
2	FORCEPS, HEMOSTATIC, KOCHER, 14 cm /1x2 teeth, straight
5	FORCEPS, TOWEL CLAMP, BACKAUS, 13 cm
2	FORCEPS, SPONGE, FOERSTER, 24cm, serrated jaws, straight
1	BOWL, ROUND, 100 ml, 80 x 35 mm, stainless steel
1	KIDNEY DISH, large, 275x150x45mm, stainless steel
1	FORCEPS, DRESSING, BLANK, 14.5 cm, atraumaVc serraVon
1	FORCEPS, TISSUE, LANE, 14cm, 1x2 teeth
1	CURETTE, BONE, VOLKMANN, 22 cm, double ended
	AMPUTATION SET (2 kits for 50 patients)
1	SCALPEL, HANDLE, No 4 (for 20 blades)
1	SCISSORS, MAYO, 17 cm, curved
1	SCISSORS, METZENBAUM, 18 cm, curved
1	NEEDLE HOLDER, MAYO-HEGAR, 15 cm
6	FORCEPS, HEMOSTATIC, CRILE, 14 cm curved
4	FORCEPS, HEMOSTATIC, R-OCHSNER,
5	FORCEPS, TOWEL CLAMP, BACKAUS, 13 cm
2	FORCEPS, SPONGE, FOERSTER, 24cm serrated jaws, straight
1	RETRACTOR, VOLKMANN, 22 cm, 3 sharp prongs 10 mm curve
1	RETRACTOR, VOLKMANN, 22 cm, 1 sharp prong, 20 mm curve
1	FILE, BONE, 22 cm x 20 mm, flat
1	RASPATORY, FARABEU, 150x13mm, light curve, sharp
1	CURETTE, BONE, VOLKMANN, 22 cm, double ended
1	RONGEUR, BONE, LUER, 18 cm x 10 mm heavy
1	FORCEPS, BONE CUT., LISTON, 17 cm, standard , straight

QUANTITY	DESCRIPTION
	AMPUTATION SET (2 kits for 50 patients) <i>continued</i>
1	FORCEPS, BONE CUT., LISTON-STILLE, 27 cm, double acVon, straight
1	BOWL, ROUND, 100 ml, 80 x 35 mm stainless steel
1	SAW GIGLI, HANDLE, inpairs
10	SAW GIGLI, WIRE, 50 cm
1	BIT, DRILL, 3.2 mm. Jacobs chuck, 180/165 mm
1	BASKET, STERILIZING
1	SCISSORS, MAYO, 15.5 cm, straight
1	FORCEPS, DRESSING, BLANK, 14.5cm atraumaVc serraVon
1	FORCEPS, TISSUE, LANE, 14cm, 1x2 teeth
1	KIDNEY DISH, medium, 250x140x40mm stainless steel
2	FORCEPS, TISSUE, ALLIS, 15 cm/4x5 teeth, standard
1	PHOTOMACROGRAPHIC AUTOCLAVABLE SCALE, right angle
	BASIC BONE SURGERY, complementary (2 kit for 50 patients)
1	RETRACTOR, VOLKMANN, 22 cm, 1sharp prong 20 mm curve
1	FILE, BONE, 22 cm x 20 mm, flat
1	RASPATORY, FARABEUF, 150x13mm, light curved, sharp
1	MALLET, 23 cm x 28 mm, 490 g, solid
1	OSTEOTOME, STILLE, 20 cm x 15, mm straight
1	OSTEOTOME, STILLE, 20 cm x 20, mm straight
1	GOUGE, STILLE, 20 cm x 15 mm, straight
1	GOUGE, STILLE, 20 cm x 20 mm, straight
1	CURETTE, BONE, VOLKMANN, 22 cm, double-ended
1	RONGEUR, BONE, LUER, 15 cm x 5mm strong curve
1	RONGEUR, BONE, BANE, 18 cm x 5mm curved
1	RONGEUR, BONE, LUER, 18 cm x 10 mm, heavy pa:ern
1	RONGEUR, BONE, STILLE- LUER, 23 cm x 10 mm, double acVon
1	FORCEPS, BONE CUT., LISTON, 17 cm, standard, straight

QUANTITY	DESCRIPTION
	BASIC BONE SURGERY, complementary (2 kit for 50 patients) continued
1	FORCEPS, BONE CUT., LISTON-STILLE, 27 cm, double acVon, angled
2	FORCEPS, BONE HOLD., VERBRUGGE, 27 cm x 12 mm, dismountable
2	RETRACTOR, BONE, HOHMANN, 29 cm x 34 mm
	BONE WIRING & KIRSHNER, (1 kit for 50 patients)
10	WIRE, KIRSCHNER, Ø 1.60mm x 15cm, trocared + round end
10	WIRE, KIRSCHNER, Ø 2.00mm x 15cm, trocared + round end
10	WIRE, KIRSCHNER, Ø 2.50mm x 15cm, trocard + round end
10	WIRE, KIRSCHNER, Ø 1.00mm x 15cm, trocard + round end
1	WIRE, CERCLAGE, 1.00 mm x 10 m, stainless steel, coil
1	WIRE, CERCLAGE, 1.25 mm x 10 m, stainless steel, coil
1	WIRE PASSER, DEMEL, diam. 45 mm x 28 cm, blunt
1	WIRE PASSER, diam 45mm x 23cm, curved to the lei, blunt
1	PLIERS, FLAT NOSE, 16 cm, serrated jaws, heavy pattern
1	VICE GRIP, 18 cm, self locking
1	PLIERS, FLAT NOSE, 14cm, serrated jaws
1	CASE, STERILIZING, 300x140x40mm, perforated with texVle filter
1	BASKET, STERILIZING
1	PLIERS, WIRE CUTTING, 26cm, hard wire up to 3.2 mm diameter
	PLASTER CASTS REMOVAL (1 kit for 50 Patients)
1	SCISSORS, PLASTER SHEARS, BRUNS, 24 cm
1	SCISSORS, PLASTER SHEARS, STILLE, 37 cm, reinforced blade
1	KNIFE, PLASTER, ESMACH, 18 cm
1	SPREADER, PLASTER, HENNIG, 27cm
1	BREAKER, PLASTER CAST, WOLFF-BOEHLER, 18 cm
1	SCISSORS, PLASTER SHEARS, STILLE-mini, 20 cm for small POP

QUANTITY	DESCRIPTION
	TRACTION (1 kit for 50 patients)
1	BIT, DRILL, 3.2 mm. Jacobs chuck, 180/165 mm
1	CHUCK, UNIVERSAL (3-jaw) with T-Handle + locking device
2	ROPE, TRACTION, 3mm x 15m, bow, extension, Boehler
2	BOW, EXTENSION, BOEHLER, 9 x 16 cm
7	NAIL, EXTENSION, STEINMANN, 210 x 4 mm, trocar point
8	BOW, EXTENSION, BOEHLER, 15x21 cm
3	PIN, STEINMANN, 4.0 mm x 150 mm
5	SPLINT, ICRC tracVon frame, ICRC
	SKIN GRAFT (2 kit for 50 patients)
5	(dermatome Humby), BLADE
1	SCISSORS, METZENBAUM, 14 cm, curved
5	FORCEPS, TOWEL CLAMP, BACKAUS, 13 cm
1	DERMATOME, HUMBY
2	(dermatome Schink) PLATE, for skin holding
1	CASE, STERILIZING, 300x200x50mm perforated with texVle filter
1	BASKET, STERILIZING
1	BOWL, ROUND, 200ml, 9.5 x 5 cm, stainless steel
1	FORCEPS, DRESSING, BLANK, 14.5 cm atraumaVc serraVon
	SET, DEBRIDEMENT, instruments
1	SCALPEL, HANDLE, No 4 (for blades 20)
1	SCISSORS, MAYO, 17 cm, curved
1	SCISSORS, METZENBAUM, 14 cm, curved
1	SCISSORS, METZENBAUM, 18 cm, curved
1	NEEDLE HOLDER, MAYO-HEGAR, 15cm, standard
1	NEEDLE HOLDER, MAYO-HEGAR, 18cm, standard
8	FORCEPS, HEMOSTATIC, CRILE, 14cm, curved
3	FORCEPS, HEMOSTATIC, R-OCHSNER, 16 cm 1x2 cm teeth, straight

QUANTITY	DESCRIPTION
	SET, DEBRIDEMENT, instruments <i>continued</i>
5	FORCEPS, TOWEL CLAMP, BACKAUS, 13 cm
2	FORCEPS, SPONGE, FOERSTER, 24cm, serrated jaws, straight
2	RETRACTOR, LANGENBECK, 21 cm, 13x42 mm
1	RETRACTOR, SELF-RET., WEITLANER, 16 cm, 3x4 cm, blunt prongs
1	CURETTE, BONE, VOLKMANN, 22 cm, double ended
1	RONGEUR, BONE, LUER, 18 cm x 10 mm, heavy pattern
1	BOWL, ROUND, 100 ml, 80 x 35 mm, stainless steel
2	FORCEPS, TISSUE, ALLIS, 15 cm/4x5 teeth, standard
1	KIDNEY DISH, large, 275x150x45mm stainless steel
1	FORCEPS, DRESSING, BLANK, 14.5cm, atraumaVc secVon
1	FORCEPS, TISSUE, LANE, 14cm, 1x2 teeth
2	RETRACTOR, VOLKMANN, 22 cm, 3 sharp prongs, 10 mm curve
	SET, LOWER EXTREMITY EXTERNAL FIXATION (1 kit for ~16 patients, depending on injury patterns)
30	LARGE CLAMP
4	ROD D 12 mm L 150 mm
4	ROD D 12 mm L 200 mm
4	ROD D 12 mm L 250 mm
4	ROD D 12 mm L 300 mm
15	SELF-DRILLING, SELF-TAPPING BONE SCREW L 150/40 mm Thread D 6.0-5.6mm
4	SELF-DRILLING SELF-TAPPING L 260/50 mm Thread D 6.0-5.6mm
8	SELF-DRILLING CORTICAL SCREW 120/40 mm Shai D 6 mm Thread D 4.5-3mm
2	SELF-DRILLING PIN 80 mm Thread length 80mm, Thread Ø7 mm, Shai Ø6mm
1	BONE SCREW HAND DRILL
1	ALLEN WRENCH 6 mm
1	SCREW GUIDE, Length 80 mm

QUANTITY	DESCRIPTION
	SET, LOWER EXTREMITY EXTERNAL FIXATION <i>continued</i>
1	SCREW GUIDE, Length 60 mm
1	UNIVERSAL T-WRENCH
1	DRILL BIT D 48 mm X 240 mm Quick Connect
1	STERILIZATION TRAY
	SET, UPPER EXTREMITY EXTERNAL FIXATION (1 kit for ~ 11 patients, depending on injury patterns)
30	Small Clamp
3	Rod D 6 mm L 200 mm
5	Rod D 6 mm L 180 mm
5	Rod D 6 mm L 160 mm
5	Rod D 6 mm L 120 mm
20	Self-Drilling, Self-Tapping Cylindrical Screw Shai D.4mm THREAD 3mm L 100/200 QC
6	Self-Drilling, Self-Tapping Cylindrical Screw Shai D.4mm THREAD 3mm L 120/25 QC
1	T Wrench AO QC Quick Connect
1	Allen Wrench 5 mm
1	Wrist Guide Template With Handle
1	Drill Bit D 2.7 mm L 127 mm Tin Coated - Quick Connect
1	Drill Guide Diameter 2.7 mm
1	SterilizaVon Tray
	SET, DRESSING MATERIALS (SINGLE USE)
2	Bag PE, plasVc for garbage 35 L, grey, 0.06 mm, 58x60cm
2	Iodine Povidone, 10% SoluVon 1L bottle
60	Bandage, ElasVc, 10 cm x 5 cm, constraining
60	BANDAGE, GAUZE, 08cmx4m, elasVc, non sterile
10	BANDAGE, TRIANGULAR, 136 x 96x 96 cm
250	COMPRESS, GAUZE, 10 x 10 cm, 8 plys, 17 thr., ster., 2 pcs

QUANTITY	DESCRIPTION
	SET, DRESSING MATERIALS (SINGLE USE) <i>continued</i>
300	COMPRESS, GAUZE, 10 x 20 cm, 12 plys, 17 threads, non-ster.
2	COTTON WOOL, 1kg, 100% cotton, hydrophilic
1	DRESSING, ADHESIVE BANDAGE, wound plaster, 6cm x 5m, roll
6	TAPE, ADHESIVE PAPER, 2.5 cm x 10 m, roll
3	TAPE, ADHESIVE PAPER, 5 cm x 10 m, roll
200	GLOVE, EXAMINATION, NITRILE, non sterile, medium (7-8)
1	FORCEPS, DRESSING, BLANK, 14.5cm, atraumaVc serraVon
1	SCISSORS, DRESSING, LISTER, 18 cm
1	BOWL, ROUND, 100 ml, 80 x 35 mm, stainless steel






INITIAL ASSESSMENT OF LIFE THREATENING CONDITIONS FOR HOSPITAL STAFF



ICRC

CATASTROPHIC BLEEDING: <g>ABCDE

Direct pressure/tourniquet

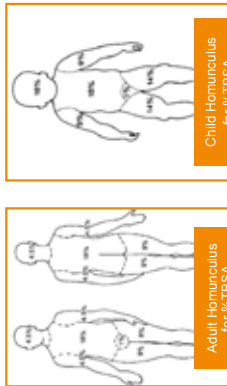
	A	B	C	D	E	ASSESSMENT	EXCLUDE	INTERVENTIONS TO CONSIDER
	AIRWAY	BREATHING	CIRCULATION	DISABILITY	EXPOSURE	<ul style="list-style-type: none"> Is the patient talking? Look and listen for signs of airway obstruction: stridor/gurgling/snoring Expose the chest. Look, feel, percuss, auscultate for signs of respiratory distress Position of trachea, RR, sats, AEG Level of consciousness Skin colour, temp, pulse (radial, femoral), BP, ECG Capillary refill time, heart sounds Consciousness (AVPU/GCS) Pupils, motor function, blood glucose Patient medications Completely undress: examine front to back X-Rays 	<ul style="list-style-type: none"> Airway obstruction 	<ul style="list-style-type: none"> Airway opening manoeuvres/ adjuncts/definitive airway control High flow oxygen and suction C-spine protection
							<ul style="list-style-type: none"> Pneumothorax Haemothorax 	<ul style="list-style-type: none"> Oxygen Bag-Valve-Mask ventilation Needle decompression Chest tube insertion
							<ul style="list-style-type: none"> Haemorrhage 	<ul style="list-style-type: none"> Stop bleeding IV access + take blood Restore volume: IV fluids + blood Target systolic BP ~80 (except in case of head injury)
							<ul style="list-style-type: none"> Hypoglycaemia Alcohol abuse Drug reactions 	<ul style="list-style-type: none"> Antidotes Glucose Avoid hypotension
							<ul style="list-style-type: none"> Hypothermia 	<ul style="list-style-type: none"> Warm the room Warm IV fluids/blood Cover patient Consider analgesia

Then move onto secondary survey...

BURNS OVERVIEW
FOR HOSPITAL STAFF



SIMPLIFIED CALCULATION OF PERCENTAGE TOTAL BODY SURFACE AREA (%TBSA)



Adult Homunculus for %TBSA

Child Homunculus for %TBSA

OR USE PATIENT'S PALM TO CALCULATE %TBSA
1 PALM (WITHOUT FINGERS) = 1%TBSA

FLUID REQUIREMENTS IN FIRST 48 HOURS

HOURS SINCE BURN	FLUID REQUIREMENTS
0-24 HOURS	$2 \text{ ml/kg} \times \% \text{TBSA of Pains to date}$ (1/2 in first 8 hours, 1/2 in following 16 hours)
24-48 HOURS	Target Urine Output = 0.5 ml/kg/hr To be guided by urine output

SPECIAL CONSIDERATIONS:

- Burns > 50%TBSA: Use 50%TBSA in calculation above
- Inhalation injury/electric burns: Have increased fluid requirements, use 3 ml/kg x %TBSA

SKIN DEPTH	SUPERFICIAL	SUPERFICIAL PARTIAL THICKNESS	DEEP PARTIAL THICKNESS	FULL THICKNESS
	Superficial epidermis	Complete epidermis, superficial (capillary) dermis	Complete epidermis, deep dermis	Complete epidermis and dermis extend beyond the dermis
APPEARANCE				
	Erythema, no blisters, dry	Erythema, moist, blisters, rapid capillary refill	Blotchy red/pale, extensive blisters, sluggish capillary return, dryer than superficial partial thickness burns	White, charred, leathery, eschar, dry
TREATMENT	First aid	First aid Consider clean up under anaesthesia Dressing	First aid Clean up under anaesthesia Dressing May require skin grafting	First aid Clean up under anaesthesia Debridement Split skin grafting
HEALING TIME	<5 days	5-21 days	Variable	Months-years
OUTCOME	No residual scarring	Minimal scarring	Scarring	If untreated: severe disfigurement, permanent impairment
SPECIAL COMMENTS	Superficial epidermal burns are NOT included in the assessment of % TBSA burnt.			



ADULT VENOUS THROMBOEMBOLISM PROPHYLAXIS

FOR HOSPITAL STAFF

ICRC

ASSESS DVT RISK FOR ALL ADULT PATIENTS ON ADMISSION AND ON CHANGE IN CLINICAL CONDITION

PATIENT DVT RISK ASSESSMENT	Score
• Major abdominal or thoracic surgery OR	2
• Surgery involves pelvis or lower limb and total anaesthetic and surgical time >60 minutes OR	
• Total anaesthetic and surgical time >90 minutes	
Acute multiple trauma/spinal cord injury/hip, pelvis or leg fracture	2
Acute surgical admission with inflammatory condition	2
Burns >20% BSA	2
Reduced mobility >3 days	1
Age >40 years	1
Dehydration	1
1/+ Significant medical comorbidity (i.e. cardiac/metabolic/ endocrine/respiratory/inflammatory conditions)	1
Personal/family history of DVT/PE	1
Obese (BMI >30kg/m ²)	1
Active cancer/treatment	1
Hormone therapy (CoC/HRT)	1
Varicose veins with phlebitis	1
Pregnancy or <6 weeks post partum	1

Regardless of patient risk, encourage early mobilization and ensure adequate hydration

SCORE = 0 or 1 → **PATIENT LOW RISK FOR DVT**

- Keep patient well hydrated, encourage early mobilization
- Re-assess if clinical situation changes

SCORE = ≥ 2 → **PATIENT AT INCREASED RISK OF DVT**

ASSESS BLEEDING RISK FACTORS

- Active bleeding
- Uncontrolled systolic hypertension (≥230/120mmHg)
- Acute stroke
- Acquired bleeding disorders (acute liver failure, liver failure with coagulopathy, be aware LFT monitoring will not always be available)
- Untreated inherited bleeding disorders (haemophilia, von Willebrand's disease)
- Concurrent use of anticoagulants
- Unacceptable consequences of potential bleeding into vital sites i.e. brain/spinal cord/eye
- Acute thrombocytopenia (platelets <75x10⁹/L, be aware platelet monitoring will not always be available)

CONSIDERATIONS FOR SURGERY

- Last dose of Enoxaparin to be given 12 hours before lumbar puncture/epidural/spinal anaesthesia
- For all surgeries listed in 'Patient DVT Risk Assessment', graduated compression stockings are to be used during surgery (unless surgery is on lower limbs)
- Enoxaparin to re-commence 12 hours post surgery

YES TO ANY RISK FACTOR?

NO

PHARMACOLOGICAL DVT PROPHYLAXIS

ENOXAPARIN 40mg SC/OD
(Unless contraindicated i.e. allergy, GI ulcer)
(20mg SC/OD in case of severe liver/kidney impairment/patient <45kg)
If possible: check platelets prior to starting Enoxaparin

YES

MECHANICAL DVT PROPHYLAXIS

- Provide patient with graduated compression stockings
- Only consider pharmacological DVT prophylaxis if risk of DVT outweighs the risk of bleeding.

MAJOR RECONSTRUCTIVE ORTHOPAEDIC SURGERY PERFORMED?

YES

CONTINUE PHARMACOLOGICAL PROPHYLAXIS FOR 14 DAYS (OR UNTIL MOBILIZED IF > 14 DAYS)

BEWARE!

***HEPARIN INDUCED THROMBOCYTOPENIA**
Signs: External bleeding, purpura, petechia

DVT
Signs: Pain, swelling, erythema and tenderness of affected limb

PE
Signs: Breathlessness, chest pain, sudden collapse

NO

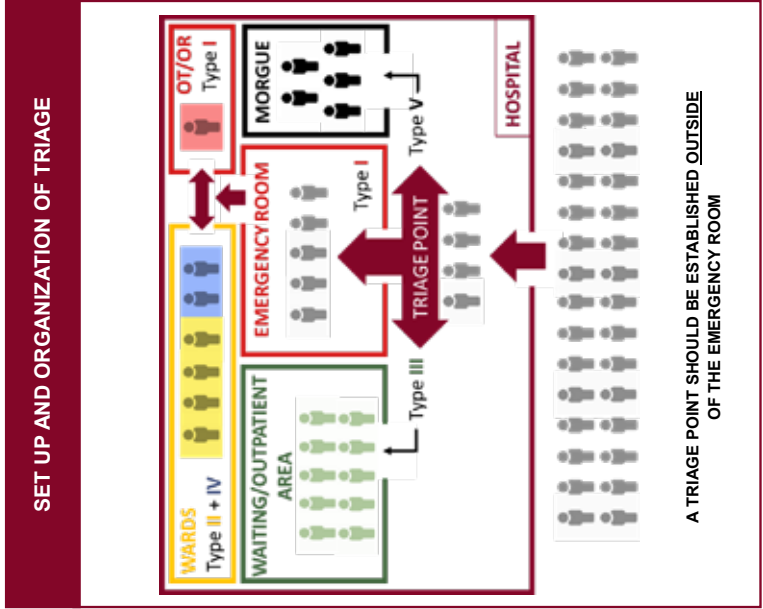
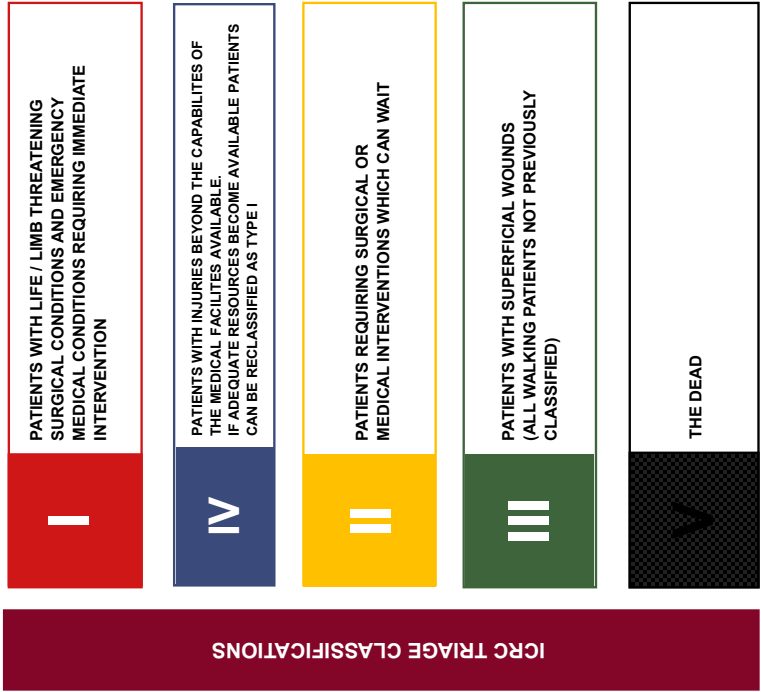
CONTINUE PHARMACOLOGICAL PROPHYLAXIS FOR 7 DAYS

DISCHARGE

- Do not delay discharge due to DVT prophylaxis
- Do not continue DVT prophylaxis on discharge
- Counsel patient on signs and symptoms of DVT/PE

MONITOR PATIENT FOR CLINICAL SIGNS OF HEPARIN INDUCED THROMBOCYTOPENIA*

If platelet monitoring available: check platelets twice a week from day 4-14





MANAGEMENT OF FEMUR FRACTURES

FOR HOSPITAL STAFF

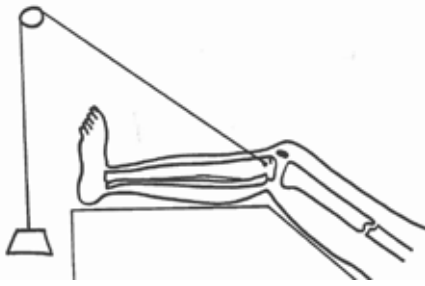
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MEMBER OF MULTIDISCIPLINARY TEAM MANAGING PATIENT WITH A FEMUR FRACTURE

	SURGEON	NURSE	PHYSIOTHERAPIST
WEEK 1 AFTER INJURY DAY 1 DAY 3 DAY 5 DAY 7	Debridement Reduction Skeletal Traction* Decrease traction weight to 7% body weight Delayed Primary Closure X-ray and if required, adjust traction position +/- weight	DAILY	DAILY
WEEK 2 WEEKS AFTER INJURY WEEK 3 WEEK 6	X-RAYS: Weekly for week 1-3, then monthly until consolidation DAILY: Review patient's clinical condition. Perform re-debridement if necessary CONSIDER REMOVAL OF TRACTION: Based on clinical and X-Ray evidence of consolidation	DAILY	DAILY
		WOUND: No dressing changes. Inspect dressing, if signs of infection inform the surgeon PIN SITE: Clean with saline solution and dress daily. Inform surgeon if signs of infection GENERAL: Check leg position 2x/day. Beware of pressure sores	NON-AFFECTED BODY PARTS: Active mobilizing and strengthening as well as functional care to prevent bedrest complications AFFECTED LEG: After discussion with surgeon and considering pain level, mobilise affected leg: aim for passive → assisted knee flexion/extension
		Consider patient's mental health status	AFFECTED LEG: Aim for assisted → active knee maximum range of movement AFFECTED LEG: Aim for active knee maximum range of movement According to guidelines, provide walking aids and start gait training with gradual increase of weight-bearing

NOTE: In some situations, portable X-Rays are not available. In this case patients should not be removed from traction in order to perform an X-ray, reassessment of consolidation should then be clinical

***BROUN-BÖHLER FRAME**



TRACTION IS APPLIED THROUGH A TIBIAL PIN

- 2.5cm distal to and 2.5cm posterior to the tibial tubercle

WEIGHT CALCULATION

- Weight depends on fracture type
- Guide: 1kg per 10kg/body weight to start

CORRECT LEG POSITION

- Hip: Slight abduction, flexion and 30° external rotation
- Knee: On angle of frame