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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>