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NATIONAL GUIDELINE FOR

TRAUMA

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1. Introduction

Globally, trauma is one of the leading causes of death, along with cardiovascular diseases and cancer. It is responsible for more than six million deaths each year, with 80 and 90% of the fatal injury burden occurring in low- to middle-income countries (LMICs).

Trauma results from motor vehicle crashes, falls, drowning, burns, poisoning, and acts of violence against oneself or others, among other causes. Amongst injuries because of transport, particularly roads and especially motorcycles, outweigh all others. LMICs disproportionately shoulder that burden.

Every year, tens of millions more people sustain non-fatal injuries that require treatment by general practitioners, hospital stays, emergency department (ED) visits, and acute care visits. These injuries frequently result in temporary or permanent disability and the need for ongoing medical care, rehabilitation, and mental and physical health support.

In the Maldives, preventable deaths due to injuries accounted for 6% of all deaths in 2020. Especially with the increasing urbanisation, mechanisation, and utilisation of motor vehicles within the cities contribute to an exponential increase in several high-velocity motor vehicle incidents. Furthermore, the development of newer causeways and highway bridges nationwide contributes to this increasing number.

Violence and injuries are predictable, and there is strong scientific evidence on what can be done to stop violence and injuries as well as address the effects of these things in different contexts. With the introduction of trauma protocols and systems in many developed regions worldwide, the burden of traumatic injuries has been reduced. The goal of the trauma protocol is to return the injured to their pre-injury state while preventing additional injuries through an organised utilisation, multidisciplinary response to trauma. The main objective of this strategy is to enhance the coordinated treatment that trauma victims receive at different levels of healthcare facilities.

The establishment of achievable and affordable standards for trauma care and appropriate utilization of health resources in the country is of utmost importance.

2. Scope

This guideline shall apply to all healthcare facilities and all healthcare professionals involved in emergency trauma care services.

The three-tier health care delivery system of the Maldives includes island-level primary health centres, higher-level health facilities at the atoll/regional level, and tertiary care hospitals. This guideline will highlight the minimum standard of care that should be available and provided at each level of health facility for critically injured patients and how the continuum of care should be carried out.

3. Case definition

3.1 Trauma: any wound or penetrating or non-penetrating injury caused intentionally or unintentionally to the human body by external factors.

3.2 Polytrauma: severely injured patient with two or more major, significant injuries

3.3 Trauma levels: defined as the various levels (Level I, II, III, IV, or V) that correspond to the types of resources that are offered at a trauma centre and the annual admission rate of patients. (Table I)
The national guidelines for trauma care in hospitals are outlined in these categories.
The trauma centre verification should be done and regulated by the Ministry of Health to evaluate and improve trauma care.

Level I: Major trauma centre
Level II: Regional-level trauma centre
Level III: Community-level trauma centers
Level IV: Primary healthcare centres
Level V: Resort medical clinics and other private clinics without inpatient facilities

3.3.1 Level I

A Level I Trauma Centre is a comprehensive regional resource trauma centre and typically functions as a tertiary care facility at the core of the trauma system. It possesses the capability to deliver complete care for all facets of injury, ranging from prevention to rehabilitation, with 24-hour availability of all major specialities.

As the core component of the system, a Level I centre must maintain sufficient resources and expertise.

3.3.2 Level II

A Level II Trauma Centre is equipped to deliver both initial and definitive care for trauma patients of any injury severity. They provide 24-hour medical coverage, including the common specialities.

Based on factors such as location, patient volume and available personnel and resources, a Level II centre may not be able to offer the same level of care as a Level I trauma centre. Patients with complex injuries, requiring more advanced critical care, may need to be transferred to a Level I centre.

Level II trauma centres are often the most common facilities in a community and typically handle the majority of trauma cases.

3.3.3 Level III

A Level III Trauma Centre should cater to providing prompt assessment, resuscitation, basic emergency operations, and stabilisation of injured patients.

They provide 24-hour prompt access to general surgeons and have a well-established early transfer system for patients requiring more comprehensive care at a Level I or Level II trauma centre.

3.3.4 Level IV

A Level IV Trauma Centre should have the capacity to provide basic trauma life support before the transfer of patients to a higher-level trauma centre for definitive care. They provide evaluation, stabilisation, and diagnostic capabilities for injured patients. They should have prompt access to a medical practitioner with expertise to provide basic trauma care with standardised treatment protocols and have a well-established early transfer system for patients requiring more comprehensive care at a Level I or Level II trauma centre.

3.3.5 Level V

A Level V trauma centre should provide initial evaluation and stabilization of the patients with lifesaving interventions and prepare patients for transfer to higher levels of care. They should have prompt access to a healthcare provider with an after-hours activation protocol if the facility is not open 24 hours a day.

They should have a local standard of operation (SOP) for interfacility transfer for patients requiring more comprehensive care at Level I through III trauma centres.

Table 1. Verification criteria for trauma levels

	LEVEL				
	I	II	III	IV	V
A. Hospital organization					
1. Trauma service (trauma care from patient entry)	E	E	D	D	D
2. Designated head of trauma (registered trauma surgeon)	E	D	D		
3. Trauma multidisciplinary team	E	D	D		
4. Hospital departments					
a. EM	E	E	E	D	
b. General surgery	E	E	E	D	
c. Anaesthesia	E	E	E	D	
d. Orthopedic surgery	E	E	E	D	
e. Neurosurgery	E	D	D		
B. Clinical capabilities					
Discipline availability					
1. In-house 24 hours a day (available within 10 minutes)					
a. Emergency medicine	E	E	D		
b. Trauma surgery	E	D	D		
2. On call and available within 20 minutes					
a. General surgery	E	E	D		
b. Anaesthesiology	E	E	D		
3. On call and available within 30 minutes					
a. Anaesthesiology	n/a	n/a	E	D	
b. Cardiothoracic surgery	E	D	D		
c. Cardiology	E	D	D		

d. General surgery	n/a	n/a	E	D	
e. Emergency medicine	n/a	n/a	E	D	
f. Intensive care	E	D	D		
g. Internal medicine	E	E	D	D	
h. Microvascular surgery	E	D	D		
i. Neurosurgery	E	D	D		
j. Obstetric/gynaecology	E	E	D	D	
k. Ophthalmic surgery	E	D	D		
l. Oral/maxillofacial surgery	E	D	D		
m. Orthopedic surgery	E	E	D	D	
n. Pediatric surgery	E	D	D		
o. Pediatrics	E	E	D	D	
p. Plastic surgery	E	E	D		
q. Radiology	E	E	D	D	
r. Respiratory medicine	E	D	D		
s. Urology	E	D	D		
t. Vascular surgery	E	D	D		
C. Facilities and resources					
Emergency centre					
1. Personnel					
a. Designated doctor in charge of the shift	E	E	E	D	
b. Doctor with special competence in care of critically injured who is a member of the trauma team and is physically present in ED 24 hours a day	E	E	D	D	
c. ATLS trained personnel 24 hours a day	E	E	D	D	D
d. ACLS trained personnel 24 hours a day	E	E	D	D	D
e. Nursing personnel with specific training in trauma care who provide continual monitoring of trauma patient	E	E	D	D	
2. Equipment for resuscitation					
a. Airway control and ventilation equipment, including laryngoscopes, ETT of all sizes, Bag valve mask, rescue devices and oxygen	E	E	E	E	E
b. Pulse oximetry	E	E	E	E	E
c. End-tidal CO2 monitoring device	E	E	E	D	D
d. Suction devices (portable or wall mounted)	E	E	E	E	D

e. Cardiac monitor and defibrillator	E	E	E	E	E
f. Standard IV fluids and administration devices including large bore IV catheters	E	E	E	E	E
g. Apparatus to establish central venous catheter	E	E	E	D	
h. Sterile surgical sets for :					
- Cricothyroidotomy	E	E	D	D	
- Thoracotomy and tube thoracostomy	E	E	E	D	
- Vascular access (cutdown)	E	D	D		
- Intraosseous access	E	E	D	D	D
- Chest decompression	E	E	D	D	
i. Drugs necessary for emergency care	E	E	E	E	E
j. X-ray availability 24 hours a day	E	E	D	D	
k. Two way communication devices with emergency transport system	E	E	D	D	
l. Skeletal traction devices	E	E	E	D	D
m. arterial catheters and monitoring devices	E	E	D		
n. Thermal control equipment					
- For patient: patient warming blanket	E	E	E	D	
- For blood and fluids: high capacity, fluid warming	E	E	D	D	
o. Bedside ultrasound	E	E	D	D	
Operating theatre					
1. Personnel					
a. Adequately staffed in-house and immediately available 24 hours a day	E	E	D		
2. Equipment					
a. Cardiopulmonary bypass capability	E	D			
b. Operating microscope	E	D			
c. Thermal control equipment					
- For patient: patient warming blanket	E	E	E		
- For blood and fluid: high capacity, fluid warming	E	E	D		
d. X-ray capabilities, including c-arm intensifier	E	E	D		
e. Endoscopes	E	E	D		
f. Craniotomy instruments	E	E	D		
g. Equipment appropriate for fixation of long bone and pelvic fractures	E	E	D		

Post-anaesthetic recovery room					
1. Personnel					
a. Registered nurse	E	E	E		
2. Equipment					
Shall include but not limited to					
a. Equipment for the continuous monitoring of temperature, hemodynamic and gas exchange	E	D	D		
b. Equipment for continuous monitoring of intracranial pressure	E	D	D		
c. Pulse oximetry	E	E	E		
d. End-tidal CO_2 determination	E	E	E		
e. Active patient warming device	E	E	D		
Intensive care unit for trauma patients with trained staff					
1. Personnel					
a. Trauma specialist ultimately responsible for trauma care	E	D			
b. Critical care physician available to ICU 24 hours a day	E	D			
c. 24 hours nursing acuity per patient	E	E	D		
2. Equipment					
Shall include but not limited to					
a. Airway control and ventilation equipment, including laryngoscopes, ETT of all sizes, Bag valve mask, rescue devices and oxygen	E	E	E		
b. Mechanical ventilation equipment	E	E	E		
c. Pulse oximetry	E	E	E		
d. End-tidal CO_2 determination	E	E	E		
e. Suction devices	E	E	E		
f. Monitor defibrillator	E	E	E		
g. Invasive pressure monitoring	E	E	D		
Additional clinical services					
1. Physiotherapy	E	E	D		
2. Psychotherapy	E	E	D		
3. Occupation therapy	E	D	D		
4. Dietetics	E	D	D		

5. Acute hemodialysis capability	E	E	D		
6. Acute burn care capability	E	D			
7. Acute spinal cord/head injury management capability	E	E	D		
8. Access to comprehensive rehabilitation service	E	D	D		
Specialist radiology services					
1. Computed tomography	E	E	D		
2. Interventional radiology	E	D	D		
3. Magnetic resonance imaging	E	E	D		
4. Sonography	E	E	E		
Clinical laboratory service (available 24 hours a day)					
1. Full blood count	E	E	E	D	D
2. Urea and electrolytes	E	E	E	D	D
3. Blood glucose	E	E	E	E	E
4. Urinalysis	E	E	E	D	
5. Blood typing and cross-matching	E	E	E	D	
6. Coagulation studies	E	E	E	D	
7. Thrombo-elastography	E	D			
8. Comprehensive blood bank access to banked blood with adequate storage facilities	E	E	D		
9. Blood gas, lactate and pH determinations	E	E	E	D	
10. Microbiology	E	E	D		
11. Drug and alcohol screening	E	D			
D. Prehospital trauma care system					
1. Personnel					
a. Advanced prehospital care team with trained paramedics or emergency medical technicians to provide trauma care	E	D			
b. Basic prehospital care provider	E	E	D		
2. Transportation					
a. Advanced life support ambulance	E	D			
b. Basic life support ambulance	E	E	D		
E. Quality assurance and quality improvement					
1. Documented evidence of ongoing quality improvement	E	E	E	D	D

2. Outcomes-based trauma registry	E	E	D		
3. Morbidity and mortality review	E	E	E		
4. Published on-call schedule for all essential specialities	E	E	E		
F. Outreach programme					
1. Telephone and/or on-site consultations with physicians and nurses of the community and outlying areas	E	D			
G. Preventive measures and public education					
1. Epidemiology research and collaboration with other relevant organizations in injury prevention education	E	D	D		
H. Trauma research programme	E	D			

Adapted from Guideline for the assessment of trauma centres for South Africa
Abbreviation : E = essential, D = desirable

4. Assessment and Management of Trauma Patients

4.1 Prehospital phase

The treatment of trauma patients starts with pre-hospital care (PHC). Suppose an advanced prehospital team is available once a trauma call is attended. In that case, the PHC providers should emphasise maintaining the patent airway with cervical spine immobilisation, control of external bleeding and shock, immobilisation of any possible fractures of the patient, and immediate transport to the closest appropriate healthcare facility. Ideally, the PHC personnel should notify the receiving healthcare facility before transporting the patient from the scene. The PHC may use the ATMISTER format (Annex 1) to notify the receiving facility. PHC providers should also aim to minimise scene time and facilitate early transport of the patient.

4.1.1 The PHC providers

4.1.1.1 First Responder Care

First responders can be the interested community members who are taught basic first aid techniques.

This first tier of the system should be established in all areas, including areas where no prehospital trauma care system exists, i.e., in areas where only level V and IV trauma centres are situated.

They should be taught to recognise emergencies, call for help, and provide basic first aid until healthcare professionals arrive or the injured person is taken to the nearest trauma centre. In addition to first-aid skills, this group should be taught the principles of safe rescue and transport.

4.1.1.2 Basic prehospital trauma care

This is the second tier of prehospital trauma care and includes those individuals who are trained in basic first aid and basic life support that includes extensive formal training in prehospital care, scene management, rescue, stabilisation, and transport of injured people.

Basic prehospital trauma care providers should be available in all areas where level III and above trauma centres are situated.

4.1.1.3 Advanced Prehospital Trauma Care

These include trained personnel to provide advanced trauma care in prehospital settings. This service should be established in all areas where level I trauma centres are situated.
The advanced prehospital trauma care team should be able to assess and treat the injured at the scene with interventions such as securing the airway, including the placement of airway adjuncts, intravenous fluids, and other lifesaving interventions like needle decompression.
This team should include a paramedic or an emergency medical technician (EMT), who is also a qualified ambulance driver as well.

4.1.2 The communication system

An integrated radio communication system is highly recommended and can be used for communication between the PHC team and the receiving facility. This allows rapid communication with portable units.
Alternatively, a mobile phone may be used to pass information to a designated number of the receiving hospital.

4.1.3 Pre-hospital care transportation

- Due to the nation's geographic features and the way health care is delivered at different levels, a well-organised and effective system must be in place for prehospital care as well as for patient transfers.
- Although air transfer is provided for critically ill patients and land and sea ambulances are used to transport patients from health centres to larger hospitals, an adequate ambulance services system is necessary to bridge the gap in the delivery of ambulatory care. Transportation requirements in the Greater Male' Region are vastly different than those required for the Atolls due to the obvious aquatic topography of the country.
- An effective ambulance services system is required to bridge the gap in the delivery of ambulatory care, even while critically ill patients are transported by air and patients are transported from health centres to larger hospitals via land and sea ambulances.
- Note that ambulance vehicles are only one part of the equation for the Greater Male' region and the bigger land masses, as most patients in the Atolls have to be transported by air or sea to either regional hospitals or Male-based general hospitals or even to other countries.
- The Maldives National Defence Force (MNDF) is now in charge of overseeing the maritime ambulances, which were previously owned and operated by the Ministry of Health (MOH). The MNDF coordinates with the Aasandha Insurance business, which authorises cost coverage, to fund medical transfers between islands.
- The recommendation of the equipment and facilities of the ambulance depends on the trauma care level provided by the healthcare facility.
- It is recommended for Level I and II trauma facilities to have ambulances compatible to provide advanced life support (ALS).
- Level III and below must have ambulances (including sea/land) which can provide Basic Life Support (BLS)

4.1.3.1. Basic Life Support (BLS) ambulance

- A BLS ambulance is utilised in situations where a patient is not suffering from a life-threatening condition or injury.

- Staff are trained to administer first aid and control minor bleeding while preparing the patient for transport to a hospital. They are also trained to assess the patient's condition and, if necessary, summon an advanced life support ambulance.
- BLS ambulances shall also meet technical specification requirements as ALS ambulances.

4.1.3.2. Advanced life support (ALS) ambulance.

- Advanced life support ambulances are dispatched for critically ill or injured people or those who require specialised medical care during transport.
- ALS ambulances have staff with advanced medical training for treating patients with life-threatening injuries or serious medical conditions.
- ALS equipment and supplies include that of a BLS ambulance and, in addition, have equipment for advanced airway management, manual defibrillators, and transport ventilators.
- ALS ambulances are equipped to treat more complicated and seriously injured patients
- Staff: Ideally, these ambulances must have 2 paramedics to provide the ALS.

Table 2. Equipment and medication available in BLS and ALS ambulances.

	BASIC LIFE SUPPORT AMBULANCE	**ADVANCED LIFE SUPPORT AMBULANCE**
Airway and Breathing		
Oxygen: Oxygen tanks (D or M size), regulator, and flow meter.	E	E
Bag-Valve Mask (BVM): masks in various sizes (adult, child, and infant).	E	E
Airway Management Equipment: laryngoscope, endotracheal tubes, supraglottic airway devices,		E

Suction: Portable and/or wall-mounted suction units with various catheters (rigid and soft)	E	E
Nasal cannulae, face masks and Non-Rebreather Masks	E	E
Pocket Masks:	E	
Oropharyngeal and Nasopharyngeal Airways:	E	E
Pulse Oximeter	E	E
CO2 Monitoring Equipment (or Capnography)		E
Nebulizer: with Salbutamol and Ipratropium respirator solution		E
Transport ventilator	E	E
Cardiovascular		
Automated External Defibrillator (AED) with Defibrillator pads	E	
Blood Pressure Monitor	E	E
Cardiac Monitor		E
Manual Defibrillator:		E
ECG Machine:		E
IV therapy and medications:	E	E
IV Fluids:		E
IV Infusion Pump		E
Syringes and Needles: different sizes		E

Patient Transport and Immobilization:		
Ambulance Stretcher	E	E
Spine Board	E	E
Scoop Stretcher	E	E
Cervical Collar: adult and paediatric sizes	E	E
Head Immobilization Devices	E	E
Traction Splints	E	E
Extremity Splints	E	E
General Equipment:		
Ambulance Cot: For transporting patients.	E	E
Hot and Cold Packs	E	E
Blankets and Sheets	E	E
First Aid Kit: With bandages, dressings, and other supplies.	E	E
Sharps Container	E	E
Biohazard Bags:	E	E
Gloves, Gowns, and Eye Protection:	E	E
Flashlights and Hazard Lights	E	E
Communication Equipment	E	E
Fire Extinguisher	E	E

Wheelchair	E	E
Thermal Blanket:	E	E
Thermometer:	E	E
Glucometer:	E	E
Obstetrical Kit:	E	E
Emesis Basin:	E	E
Bedpan and Urinal:	E	E
Disposable Tissues:	E	E
Paper drinking cups:	E	E
Medication:		
Chewable Aspirin:	E	E
Adrenaline autoinjector	E	E
Inj Adrenaline		E
Inj Atropine		E
Inj Phenergan		E
Inj Tranexamic acid		E
25% Dextrose		E
Inj Diclofenac		E
Inj ketorolac		E
IVF Normal saline		E

IVF DNS		E
Inj. Emeset		E
Inj. Pantoprazole		E
Inj. Paracetamol		E

Abbreviation : E = essential

4.2 Hospital phase

For all trauma patients, standard Advanced Trauma Life Support guidelines should be followed, based on available services.

4.2.1 Trauma Team members and activation

The trauma team is a multi-specialty team uniquely suited to its function. Its members will be drawn from the specialties of emergency medicine, intensive care, surgery, nursing, allied health, and support staff. Each member will be allocated a specific role in the team, which will include pre-arrival and post-arrival duties.

All members should perform the given role unless specifically instructed by the trauma team leader. Any overriding of default allocation should be made solely to ensure optimal outcomes for the patient.

Trauma team activation is expected to be established and coordinated in a Level I and II trauma centre. In addition, trauma facilities Level III and below must develop and implement a local trauma SOP according to the availability of resources in their respective centres.

- **Trauma Codes**

  Two different trauma codes will be created for the activation of the trauma team.

  1. **Code 1**: Signifies major to moderate injury, which entails the following:
     a. Life-threatening injuries with or without unstable vital signs.
     b. Potentially life-threatening injuries with unstable vital signs

  2. **Code 2**: Signifies injuries, which entails the following:

a. Significant mechanism of injury with potentially life-threatening injury and stable vital signs

Table 3. Criteria for trauma code I

DOMAIN	**PARAMETER**
	Trauma Code 1
PHYSIOLOGICAL	RR <10 OR >29 **or** SpO2 <92% ***On Air***
	SBP < 90 mmHg
	PR < 60 or > 110
	GCS < 12 **or** GCS Motor component <4
ANATOMICAL	Penetrating injury to chest, abdomen, head, neck or groin
	Burns ***with a history of*** trauma
	Flail chest, tension pneumothorax or massive hemothorax
	Crushed/degloved/mangled/amputated limb(s)
	>1 fractured long bone
	Suspected major pelvic injury
OTHER CONSIDERATIONS	Need for emergency airway**
	Fall > 6 meters (or 20 feet or 2 stories)
	High-velocity impact (ejection, death of a vehicle occupant, pedestrian struck at > 50 km)
	For age group > 65 years • SBP < 110 • HR > 100 • Fall with GCS < 12 • Currently taking anticoagulant • Comorbid CLD, CKD, COPD, HF

Adapted from University of South Hampton Adult Major Trauma Guidelines 2020
**Laryngeal injuries, maxillofacial injuries, foreign body in airway, inhalational injuries.

- **The trauma team roles and their specific duties are as follows:**

Table 4. Trauma team members and required response time

Team member	**Preferred specialty**	**Response time requirement Code 1**	**Response time requirement Code 2**
Trauma team leader (TTL)*	Emergency medicine specialist or ED medical officer	Immediate	<15 minutes
Airway doctor*	Anesthetist/Intensivist Emergency medicine	<10 minutes	-
Assessment doctor*	ED medical officer	<10 minutes	<10 minutes
Procedure doctor*	Surgical medical officer/Surgeon AND Orthopedic medical officer/orthopaedician	<15 minutes	-
Specialty support	As requested	<60 minutes	<60 minutes
Nurse team leader*	Nursing	<10 minutes	-
Procedure nurse*	Nursing	<10 minutes	On arrival
Circulation nurse*	Nursing	<10 minutes	<10 minutes
Drug nurse*	Nursing	On arrival	-
Runner*	Nursing	On arrival	On arrival
Scribe*	ED medical officer ED house officer Nursing	On arrival	-
Radiographer*	Radiology	<15 minutes	As needed

*Required members of the trauma team. The trauma team leader is responsible for all decisions on invasive procedures until a speciality consult is obtained.

- **Trauma team leader (TTL)**

Default speciality: Emergency medicine specialist

Alternate allocation: Emergency department Medical officer (MO)

The trauma team leader is responsible for the functioning of the trauma team. Hence, the clinician filling this role must be experienced in emergency medical care and also possess the required communication and team management skills to effectively optimize team performance.

- **Role of TTL Pre-arrival**
    - Inform all trauma team members following activation of a trauma code and ensure the assembly of the required team before arrival.
    - Perform pre-arrival briefings for team members.
    - Utilize the trauma checklist (if available in the institution) during each trauma presentation.
    - Allocate pre-designated roles to trauma team members OR override roles when needed based on member skills and experience.
    - Arrange replacement members if needed in case a trauma team member is unable to attend the activation call.
    - Maintain consistent and effective communication with team members at all times. The trauma team roles and their specific duties are as follows:
- **Role of TTL Post arrival**
    - Receive the handover from the pre-hospital team.
    - Ensure streamlined and thorough assessment of trauma patients.
    - Request assistance and organise patient disposition with relevant speciality departments when required.
    - Perform formal handover to appropriate management team members at appropriate times.
    - Perform the documentation of the primary survey, secondary survey, and ongoing management plan; this duty can be designated to another suitable team member at the team leader's discretion.
- **Role of Trauma team member**
    - Once in the resuscitation bay, all members must don the required PPE and attach name tags (names must be written in clearly legible handwriting).
    - Each team member must check all equipment required for their role.
    - Team members must stand at their allocated positions once the patient arrives.
    - All members must maintain consistent and effective communication with each other and TTL via clear, concise language and closed-loop communication.

- All members must alert the TTL of any new developments as they prepare for their role and request clarification and assistance promptly if required.
- On arrival of the patient to the resuscitation bay, the EMS staff accompanying the patient will hand it over to TTL using the IMIST-AMBO9 format to ensure rapid and comprehensive transfer of information.

4.2.2. Trauma Bay Preparation

Trauma Bay is the area in which emergency assessment and treatment begin. From this area, patients may be transported to the radiology department for a CT scan, the operating room, or an inpatient unit for admission.

All trauma centres should have a specific bed or beds allocated for trauma patients depending on the capacity of the facility. The bed should be easy to access, have necessary resuscitation equipment in the vicinity, and have enough surrounding space for the resuscitation and for the trauma team to easily move around as necessary.

The following should be ensured as soon as a call is received from prehospital care (PHC): there is an incoming trauma patient.

- The resuscitation bed should be plugged in, flat, and set at the appropriate height with rails down and a fresh sheet laid down.
- Name band and patient identification number (national ID for locals, hospital number for foreigners if available).
- Trauma documentation is an essential part of the treatment.
- Airway and ventilation equipment:
    - Check the availability of wall/cylinder oxygen supply
    - BVM with valves and bag checked, a variety of mask sizes
    - O2 humidifier filled with water to the appropriate level.
    - Intubation equipment, including laryngoscopes, different sizes of endotracheal tubes, OPA/NPA
    - Rapid Sequence Induction drugs
    - Difficult airway trolley, including equipment for Front-of-neck approach/surgical airway

- Circulation equipment:
    - The defibrillator is turned on and in monitoring mode, and paddles and pads are plugged in.
    - 2 sets of cardiac leads plugged in (1 set to defibrillator and 1 set to vitals monitor).
    - Blood pressure cuff, SpO_2 probe, and $EtCO_2$ probe plugged in.
    - Large bore cannulas and warm normal saline must be readily available
    - Limb immobilization devices and cervical collars
    - Splints, pneumatic immobilizers, bandages, arm slings
- Semi-rigid adjustable cervical collars
- Patient gown, warm cloth blanket, hugger sheet, and patient warmer machine if available.
- If available, a point-of-care USG machine was plugged in and turned on, and a new gel bottle was available.

Once a trauma patient is brought to a health facility, the patient is assessed, and treatment priorities are established based on the injuries, vital signs, and injury mechanisms. Logical and sequential treatment priorities are established based on the overall assessment of the patient. The patient's vital functions must be assessed quickly and efficiently. Management consists of a rapid primary survey with simultaneous resuscitation of vital functions, a more detailed secondary survey, and the initiation of definitive care.

5. Approach to Polytrauma: Initial assessment and simultaneous resuscitation

When managing a severe trauma patient, resuscitation and assessment must be done simultaneously. This initial assessment aims to identify and treat the life-threatening conditions promptly because if these conditions are left untreated promptly, this could lead to death or severe morbidity. This is referred to as the primary survey.

Life-threatening conditions to look for during the primary survey:

- Airway obstruction or disruption
- Tension pneumothorax

- Open pneumothorax
- Massive haemothorax
- Tracheobronchial injury
- Traumatic cardiac arrest
- Cardiac tamponade

5.1. Primary survey

The primary survey includes 5 components, which should always be followed in strict order. In addition to this, immediate haemorrhage control must be the priority when a patient presents with catastrophic bleeding.

A. Airway maintenance with restriction of cervical spine motion
B: Breathing and ventilation
C: Circulation with haemorrhage control
D: Disability/neurological status
E: Exposure/Environment Control

After the 5 main components of the primary survey, continue with adjuncts to the primary survey, F, G, and H:

F: Foley's catheter insertion if no contraindications
G. Gastric tube
H. Hertz-Trauma Ultrasound (eFAST)

A. Airway maintenance with restriction of cervical spine motion

Cervical Spine Protection

- A high index of suspicion depends on the history of the accident (traffic accidents, falls, certain sports).
- Avoid rough manipulation of the head and neck. Use hard collars to immobilise the neck.
- Immobilise the whole body on a long spinal board with a head immobiliser during transport.
- Obtain an appropriate radiological evaluation.

- Symptomatic or unevaluable patients with suspicious mechanisms of injury should be evaluated with a CT scan of the cervical spine. Radiological evaluation should be done only after the patient has been stabilised, if necessary, after an emergency operation. Clearance of the cervical spine is NOT an emergency!

Airway management

Securing the airway, protecting it, and adequate ventilation are critical to preventing hypoxaemia, and supplemental oxygen must be administered to all severely injured trauma patients.

- Ensure the airway is patent by clearing the oropharynx of blood, mucus, and foreign bodies.
- Perform jaw thrust by lifting the angle of the jaw to prevent the tongue from falling back and obstructing the airway. (Don't perform other manoeuvres to open the airway, such as a chin lift and head tilt, as this may overextend the neck; the patient might have a spinal injury!).
- The use of oropharyngeal airways (OPA) in patients with gag reflexes may induce vomiting and aspiration. Choose the correct length OPA. The distance between the angle of the mouth and the earlobe is an easy way to choose the right size tube. Nasopharyngeal airways (NPA) are contraindicated if features of basal skull fractures are suspected.
- If the above measures are not sufficient or if the patient is unconscious (GCS=<8), endotracheal intubation is the next step.
- If endotracheal intubation is impossible (e.g., in severe facial trauma), the next step is a cricothyroidotomy. In emergencies, there is no place for tracheostomy

B-Breathing and ventilation

- To assess the neck veins and breathing, completely expose the patient's chest and neck. This may require temporarily releasing the front of the cervical collar; in this case, to ensure restrictive cervical spine movement, manual-in-line immobilisation of the cervical spine must be performed while the collar is loosened.
- Follow the basic principles of physical examination, such as inspection, palpation, percussion, and auscultation. Inspect the chest wall to assess movement to determine whether it is symmetrical. Assess the adequacy of respirations. Palpate to determine if

there are areas of tenderness, crepitus, or defects. Auscultate the chest to evaluate for equal breath sounds and identify any extra sounds that may indicate effusion or contusion.

- Increased respiratory rate and alterations in the patient's breathing pattern, which are frequently characterised by more shallow respirations, are important but often subtle indicators of chest injury and/or hypoxia. Keep in mind that cyanosis is a late indicator of hypoxia in trauma patients and can be hard to elicit in those with darkly pigmented skin; its absence does not always mean that the airway or tissue oxygenation is adequate. It is important to check the SPO_2 reading on vital monitors.
- Tension pneumothorax, open pneumothorax, and massive haemothorax recognition are the major thoracic injuries that affect breathing. Clinicians must recognise and manage these injuries during the primary survey. (Details will be discussed under Specific injuries and approaches.) When suspicious of these injuries, eFAST can aid in confirming the diagnosis during the primary survey itself.

C-Circulation and haemorrhage control

- Assess blood pressure (BP), heart rate (HR), and evidence of bleeding.
- Control any external bleeding by direct pressure or apply a tourniquet.
- In penetrating injuries of the neck, where venous injuries are suspected, put the patient in the Trendelenburg position (head down) to prevent air embolism.
- Insert one or two large intravenous (IV) lines and start fluid resuscitation accordingly. In case of difficult IV access, obtain intraosseous access (IO) and begin resuscitation.
- If suspecting long bone fractures, reduce and immobilise as soon as possible.
- If pelvic fracture is suspected, apply a pelvic binder (may use the commercially available brands; that or a simple bed sheet can be used)

Following a trauma, there are 4 conditions that can result in shock:

1. Hypovolemic shock

This is the most common cause of post-traumatic hypotension and could be due to external or internal blood loss.

- Vascular access with two or more large bore intravenous lines. Access to central veins can be achieved using subclavian, jugular, or femoral vein catheterization. In

patients with neck or arm injuries, the intravenous line should be inserted on the opposite side to avoid extravasation of the infused fluid from a proximal venous injury.

- In children younger than 6 years, consider intraosseous infusion if a peripheral vein is not available.
- Give a fluid challenge of up to 1 litre of warm crystalloid (or 20 ml/kg for children). If more fluids are needed, consider blood transfusion and perhaps an operation. However, if the patient has a clear indication for surgery, no time should be wasted for fluid resuscitation!
- Principles of damage-control resuscitation (DCR) should be applied when managing a critically ill polytrauma patient. This aims to limit blood loss and prevent trauma-induced coagulopathy.
    - Permissive hypotension: maintain a hypotensive resuscitation high enough to maintain perfusion and mentation. Allow SBP 80-90 mmHg for better haemorrhage control.
    - Haemostatic resuscitation:
        - Apply direct pressure on the bleeding wounds; apply a tourniquet on the limbs whenever appropriate.
        - IV tranexamic acid 1g over 10 minutes within 3 hours of the onset of injury and continue 1g over 8 hours.
        - Early use of blood products:
        - Safe O (rhesus negative) transfusion does not require typing or crossmatching and must be available for immediate transfusion.
        - Type-specific blood products (not cross-matched) must be available within 10 minutes.
        - Fully typed and crossmatched. Ready in about 30 minutes.
        - If further blood products are needed, activate massive transfusion protocols (MTP). i.e. PRBC: FFP: Platelet transfuse at a 1:1:1 ratio
            - Level I and II trauma facilities should have a local SOP established with their blood banks and follow the universal standards to activate the MTP.
        - Always use blood warmers, as hypothermia may aggravate acidosis, induce arrhythmias, and impair platelet function, resulting in trauma-

induced coagulopathy, which subsequently worsens the haemorrhage control.

- Hypocalcaemia prevention and correction, especially when/if blood products need to be transfused.

- Damage control surgery: rapid termination of an operation after control of life-threatening bleeding and contamination followed by correction of physiologic abnormalities and definitive management.

2. Cardiogenic shock

In a trauma patient with hypotension and distended neck and peripheral veins with no obvious external bleeding or other blood losses, cardiogenic shock must be suspected and excluded.

The following conditions may be associated with cardiogenic shock: myocardial contusion, air embolism, and myocardial infarction.

- Blunt chest trauma can cause cardiac contusion and myocardial dysfunction. Continuous ECG monitoring is required.
- Air embolism may follow injuries to major veins, lungs, or the low-pressure cardiac chambers. Occasionally, it may be iatrogenic during central venous line insertion. Sudden deterioration of a patient in the presence of one of the above injuries should alert the doctor to the possibility of air embolism. Sometimes "sloshing" sounds may be heard over the heart. The treatment consists of positioning the patient in the Trendelenburg position, thoracotomy, and direct aspiration of the air from the heart. In lung injuries, cross-clamp the hilum to control the source of air embolism.
- Myocardial infarction should be suspected in elderly patients presenting with cardiogenic shock. ECG and troponin levels should be performed routinely.

3. Obstructive shock

In a trauma patient, obstructive shock can occur in two conditions, i.e., tension pneumothorax and cardiac tamponade.

- Tension pneumothorax will be discussed under Specific injuries and approaches.
- Cardiac tamponade: More common in **penetrating thoracic trauma** than blunt trauma. Clinical manifestations include tachycardia, hypotension, cool peripheries,

Beck's triad (muffled heart sounds, hypotension, distended neck veins), and pulsus paradoxus (drop in SBP > 10 mmHg on inspiration). An inadequate response to fluid resuscitation suggests cardiac tamponade. FAST performed in the ED can identify pericardial fluid, which suggests cardiac tamponade as the cause of shock (also useful for finding the source of bleeding).

- Management includes: HFM to maintain SpO_2 targets; may transiently respond to fluid challenge; needle pericardiocentesis; and pericardiotomy is the definitive treatment. Emergency thoracotomy in the event of cardiac arrest.

4. Neurogenic Shock

- This is the result of loss of vascular tone following cervical cord or upper thoracic spinal cord injury (above T6 level). Isolated intracranial injuries do not cause shock unless the brainstem is involved.
- Patients presenting with hypotension and bradycardia must be examined properly, and appropriate investigations must be conducted to look for spinal cord injuries.

D: Disability (Neurologic evaluation)

- Assess GCS, pupils (size, reactivity), and motor and sensory function in all limbs before sedation or intubation.
- The suspect critically raised ICP if Cushing's response (bradycardia, hypertension, apnoea), fixed and dilated pupils, and hemiparesis.
- Check capillary blood glucose level.
- Patients with evidence of brain injury should be treated at a facility that has the personnel and resources to anticipate and manage the needs of these patients. When resources to care for these patients are not available, arrangements for transfer should begin as soon as this condition is recognised.

E: Exposure/Environment Control

- Undress the patient completely for a thorough examination.
- Prevent hypothermia by keeping the patient warm with blankets and warm IV fluids. Severe blood loss, elderly patients, and paediatric trauma patients are at

high risk for hypothermia. Hypothermia contributes to trauma-induced coagulopathy and intensifies the bleeding.

- Physiologic parameters such as pulse rate, blood pressure, pulse pressure, ventilatory rate, ABG levels, body temperature, and urinary output are assessable measures that reflect the adequacy of resuscitation. Values for these parameters should be obtained as soon as is practical during or after completing the primary survey and re-evaluated periodically.

5.2. Secondary survey

- Should begin after the primary survey is completed, resuscitative efforts are ongoing, and the patient has started showing vital improvements.
- During the secondary survey, a complete, focused history and physical examination, including reassessment of vital signs, should be obtained.
- A complete head-to-toe examination should be performed to look for any other life-threatening conditions.
-

Life-threatening conditions to look for during the secondary survey

- Aortic injury
- Thorax injuries (non-massive haemothorax, simple pneumothorax)
- Esophageal perforation
- Muscular diaphragmatic injury
- Fistula (bronchopleural) and tracheobronchial
- Contusion to the heart or lungs

History: AMPLE history

A: Allergies

M: Medications currently used

P: Past illnesses/pregnancy

L: Last meal

E: Events/Environment related to the injury

Physical examination

Head

Maxillofacial structures

Cervical spine and neck

Chest

Abdomen and pelvis

Perineum, rectum, and vagina

Musculoskeletal system

Neurological system

Adjuncts to the secondary survey

Specialized diagnostic tests to identify specific injuries based on findings, including but not limited to,

- Additional x-ray examinations of the spine and extremities,
- CT scan of head, chest, abdomen, spine
- Contrast urography and angiography
- Transesophageal ultrasound
- Bronchoscopy, esophagoscopy

Investigations

- A preset trauma panel should be utilized to ensure all required investigations are ordered. CBC, RFT, LFT, Na^{+}, K^{+}, Ca^{2+}+, RBS, Coagulogram, Blood grouping & type, Crossmatch, Antibody screening, UFR
- In cases of unknown identity, a local (hospital/institute) identification number should be assigned upon the patient's arrival and should be utilized to process all required investigations without delay. Example: use of "ER seal"
- If available, necessary point-of-care testing such as VBG, Chem-8 (biochemistry panel), and capillary blood glucose should be promptly obtained from all trauma patients once IV access has been established.
- ABG should be obtained instead of VBG if the patient is ventilated.
- ECG should be performed for all patients over 35 years if indicated.
- All results of investigations, including ECGs, must be recorded in the trauma documentation provided and reviewed by the TTL.

5.3. Specific injuries and approaches

5.3.1. Thoracic injuries:

Table 5. Thoracic injuries, clinical manifestations and management

	Pathophysiology	Clinical manifestations	Management
Open pneumothorax	Air-suckling chest wound. With immediate air equilibration between intrathoracic pressure and atmospheric pressure, when the opening in the chest wall is approximately two-thirds the diameter of the trachea or greater, air passes preferentially through the chest wall defect with each inspiration. Effective ventilation is thereby impaired, leading to hypoxia and hypercarbia.	**Breath sounds:** decreased/absent ipsilaterally. **Percussion:**hyperresonant ipsilaterally. **Tracheal position:** midline, but may deviate away if large. **Chest movement:** Expanded immobile	1. High-flow mask (HFM) to maintain spO2 targets 2. Cover with occlusive 3-sided dressing to form a flutter valve that allows the egress of air through the wound but prevents sucking-in 3. Place formal catheter in separate intercostal space 4. Needs formal exploration prior to closing
Tension pneumothorax	Tension pneumothorax develops when a "one-way valve" air leak occurs from the lung or through the chest wall. Air is forced into the pleural space with no means of escape, eventually collapsing the affected lung. The mediastinum is displaced to the opposite side, decreasing venous return and compressing the opposite lung. Shock (often classified as obstructive) results from a significant drop in venous	**Breath sounds:** decreased ipsilaterally. **Percussion: hyper-resonant** ipsilaterally. **Tracheal position:** Deviate away **Neck veins:** Distended **Chest movement:** Expanded immobile **Others:** Chest pain, Air hunger, Tachypnea, Respiratory discomfort, hypotension,	1. HFM 15L/min via non-rebreather mask 2. Immediate needle thoracocentesis or finger thoracostomy (decompression) 3. Formal intercostal catheter after needle decompression 4. Do not delay treatment to obtain radiologic confirmation.

	return, which lowers cardiac output.	tachycardia, and cystanosis (late manifestations)	
Massive haemothorax	Definition: blood loss > 1500 mL or 1/3rd of blood volume or blood loss > 200 mL/hour for 2 to 4 hours.	**Breath sounds:** decreased ipsilaterally. **Percussion:** Dull **Tracheal position:** Midline **Chest movement:** Expanded immobile	1. HFM 15L/min via non-rebreather mask 2. Treat with rapid restoration of blood volume combined with concurrent drainage of thorax 3. Immediate intercostal catheter insertion (re-expanding lung may tamponade the bleeding vessels) 4. Haemostatic resuscitation (activate MTP, auto-transfuser) 5. Emergency Thoracotomy
Tracheobronchial injury	Occurs close to the carina associated with severe blunt trauma	**Breath sounds:** decreased ipsilaterally. **Percussion:** Hyper-resonant ipsilaterally **Tracheal position:** Midline **Chest movement:** Expanded immobile	1. HFM 15L/min via non-rebreather mask 2. Multiple intercostal catheters maybe required 3. Urgent bronchoscopy and operative intervention

		Other: Haemoptysis, cough, respiratory distress, subcutaneous emphysema, and pneumothorax with persistent air leak after correct placement of an intercostal catheter (continues to bubble vigorously with little resolution of pneumothorax)	

5.3.2. Abdominal and pelvic injuries

Considering the mechanism of injury makes it easier to anticipate possible injuries promptly, helps determine which diagnostic tests could be required for assessment, and helps determine whether a patient transfer is required. This guideline outlines common injuries from penetrating and blunt trauma.

Blunt trauma may result from the following mechanisms:

- **Shearing forces:** rapid deceleration causing tearing at fixed points
- **Crushing forces:** intra-abdominal contents to be crushed between the anterior abdominal wall and posterior ribs and vertebra
- **External compression:** sudden and rapid rise in intra-abdominal pressure leading to rupture of viscous organs
- **Direct blows** from bike or motorcycle handlebars, the lower rim of a steering wheel, or an intruded door in a car accident are examples of *direct blows* that can compress and crush the pelvic bones and abdominopelvic viscera. In addition to causing rupture with consequent haemorrhage and contamination by visceral contents, these forces can deform both solid and hollow organs, which can result in peritonitis.

  Penetrating trauma: Stab wounds and low-energy gunshot wounds cause tissue damage by lacerating and tearing. High-energy gunshot wounds transfer more kinetic energy, causing increased damage surrounding the track of the missile due to temporary cavitation. Stab wounds typically affect the liver (40%), small bowel (30%), diaphragm (20%), and colon (15%), and they can pass through surrounding abdominal tissues.

Table 6. Approach to abdominal and pelvic injury

History:	1. Following a motor vehicle accident, pertinent information from the history includes: ● the vehicle speed, ● type of collision (e.g., frontal impact, lateral impact, sideswipe, rear impact, or rollover), ● any intrusion into the passenger compartment, ● types of restraints, ● deployment of airbags, ● patient position in the vehicle, ● status of other occupants. 2. Following a fall from height, the height of the fall is important historical information due to the increased potential for deceleration injury at greater heights. 3. When assessing a patient who has sustained penetrating trauma, pertinent historical information includes: ● the time of injury ● type of weapon (e.g., knife, handgun, rifle, or shotgun), ● distance from the assailant (especially for gunshot wounds) ● number of stab wounds or gunshots sustained, and the amount of external bleeding noted at the scene ● magnitude and location of abdominal pain.
Assessment: Abdominal examination is followed by examinations of the pelvis and buttocks, as well as urethral, perineal, and, if indicated, rectal and vaginal exams. The abdomen and pelvic region must be exposed for a better assessment and covered rapidly after examination.	● Inspection: ○ Examine the anterior and posterior abdomen, as well as the lower chest and perineum, for abrasions and contusions from restraint devices, lacerations, penetrating wounds, impaled foreign bodies, and evisceration of the omentum or bowel, and the pregnant state. ○ Inspect the flank, scrotum, urethral meatus, and perianal area for blood, swelling, and bruising. ○ Laceration of the perineum, vagina, rectum, or buttocks may be associated with an open pelvic fracture in blunt trauma patients. ○ Skin folds in obese patients can mask penetrating injuries and increase the difficulty of assessing the abdomen and pelvis.

	● Auscultation: ○ The presence or absence of bowel sounds does not necessarily correlate with injury, and the ability to hear bowel sounds may be compromised in a noisy emergency department. ● Percussion: ○ Causes slight movement of the peritoneum and may elicit signs of peritoneal irritation. ● Palpation: ○ When rebound tenderness is present, do not seek additional evidence of irritation, as it may cause the patient further unnecessary pain. Voluntary guarding by the patient may make the abdominal examination unreliable. ○ In contrast, involuntary muscle guarding is a reliable sign of peritoneal irritation. Palpation may elicit and distinguish superficial (i.e., abdominal wall) and deep tenderness. ○ Determine whether a pregnant uterus is present and, if so, estimate the fetal age.
Pelvic injury assessment: Major pelvic hemorrhages can occur rapidly, which needs to be identified promptly for a timely intervention. Unexplained hypotension may be the only initial indication of major pelvic disruption. Placement of a pelvic binder is a priority and may be lifesaving in this circumstance.	● Physical exams include: ○ evidence of ruptured urethra (scrotal hematoma or blood at the urethral meatus) ○ discrepancy in limb length, ○ rotational deformity of a leg without obvious fracture. ● In these patients, avoid manually manipulating the pelvis, as doing so may dislodge an existing blood clot and cause further hemorrhage. ● Gentle palpation of the bony pelvis for tenderness may provide useful information about the presence of a pelvic fracture. (avoid performing “pelvic spring” on suspected pelvic injuries.) ● An anteroposterior (AP) x-ray of the pelvis is a useful adjunct to identify a pelvic fracture, given the limitations of clinical examination.

Management approach to abdominal and pelvic injuries:

- Early consultation with a surgeon is necessary for a patient with possible intra-abdominal injuries. Patients who require transfer to a higher level of care should be recognized early and stabilised without performing nonessential diagnostic tests.
- Once the patient is hemodynamically stable, evaluation and management vary depending on the mechanism of injury.
- Hemodynamically abnormal patients with multiple blunt injuries should be rapidly assessed for intra-abdominal bleeding by performing a focused assessment of sonography in trauma (FAST).
- Indications for a CT scan in haemodynamically stable patients include the inability to reliably evaluate the abdomen with physical examination, as well as the presence of abdominal pain, abdominal tenderness, or both. The decision to operate is based on the specific organ(s) involved and injury severity.
- All patients with penetrating wounds of the abdomen and associated hypotension, peritonitis, or evisceration require an emergent laparotomy. Patients with gunshot wounds that, by physical examination or routine radiographic results, obviously traverse the peritoneal cavity or visceral/vascular area of the retroperitoneum also usually require laparotomy. Asymptomatic patients with anterior abdominal stab wounds that penetrate the fascia or peritoneum on local wound exploration require further evaluation; there are several acceptable alternatives.
- Asymptomatic patients with flank or backstab wounds that are not superficial are evaluated by serial physical examinations or contrast-enhanced CT.
- Management of blunt and penetrating trauma to the abdomen and pelvis includes:
    - Delineating the injury mechanism
    - Re-establishing haemodynamic stability and optimizing oxygenation and tissue perfusion
    - Prompt recognition of sources of haemorrhage with efforts at haemorrhage control
    - Meticulous initial physical examination, repeated at regular intervals
    - Pelvic stabilization
    - Laparotomy
    - Angiographic embolization and pre-peritoneal packing
    - Selecting special diagnostic manoeuvres as needed, performed with a minimal loss of time

- Maintaining a high index of suspicion related to occult vascular and retroperitoneal injuries

5.3.3. Traumatic brain injury:

Primary goals of treatment

- Maintain cerebral perfusion and oxygenation by optimising intravascular volume and ventilation.
- Prevent secondary injury by correcting hypoxia, hypercapnia, hyperglycaemia, hyperthermia, anaemia, and hypoperfusion.
- SBP < 90 mmHg and hypoxaemia (PaO2 < 60 mmHg) are associated with a 150% increased risk of mortality.

Table 7. Management aspects of a patient with a traumatic brain injury

Airway and breathing:	● Patients with severe injury (GCS ≤ 8) require intubation. ● Patients with severe injury (GCS ≤ 8) require intubation ● Use short-acting induction agents that have limited effect on BP or ICP. ● Maintain oxygenation and use capnometry to control PaCO2 and avoid hyperventilation. ● Prolonged hypocapnia (> 6 hours) causes cerebral vasoconstriction and worsens cerebral ischemia
Circulation:	● Normal saline is recommended for volume resuscitation. ● Maintain SBP at ≥ 100 mmHg for patients 50 to 69 years old or at ≥ 110mmHg for patients 15 to 49 years old or > 70 years old ● **Permissive hypotension worsens outcomes in patients with brain injury** ● If fluid and blood resuscitation is not effective, use vasopressors to preserve cerebral perfusion ● Anaemia Hb < 8 is associated with worsened outcomes after brain injury. ● Pain and increased ICP can cause hypertension ● Ensure the patient's blood pressure is maintained above the minimum recommended level (MAP 80 mmHg)

Positioning	● Elevating the head of the bed to 30 degrees ● Elevation drops mean pressure within the brain by up to 10-15 mmHg and improves CPP. ● **CPP = MAP – ICP** (lowering ICP improves CPP, but lowering MAP in the setting of hypotension is counterproductive and lowers CPP)
Glucose control:	● Hypoglycaemia is associated with worse outcomes.
Temperature control:	● ICP is raised by elevated temperatures linked to increased metabolic demand and excessive glutamate release.
Seizure treatment and prophylaxis:	● Prophylactic phenytoin if GCS $\leq$ 10 if the patient has an abnormal head CT scan or acute seizure after the injury. ● Prophylactic anticonvulsants reduce the occurrence of post-traumatic seizures within the first week. ● Steroids have no role in the treatment of TBI.
Cerebral herniation	● Signs of trans tentorial herniation = unilateral or bilateral pupillary dilation, hemiparesis, motor posturing, and/or progressive neurologic deterioration. ● Mannitol can lower ICP (an osmotic agent that can reduce ICP and improve CBF, CP, and brain metabolism)—contraindicated in haemorrhage and hypotension. ● Hypertonic saline is used as an alternative to mannitol in patients who are not adequately fluid resuscitated or hypotensive (250 mL over 30 minutes).

Table 8. Demonstration of goal directed therapy of traumatic brain injury, including the vitals and laboratory parameters with respective target values

Goal-directed therapy of TBI	
Pulse oximetry- (SPO2)	>90%
SBP	>90mmHg
MAP	>80mmHg
$PaCO_2$	35-45 mmHg
Temperature	36-38.3 C
CPP	>60mmHg
ICP	<20mmHg
Haemoglobin	>8g/dL
PbtO2 (brain tissue oxygen tension monitoring)	>15mmHg
pH	7.35-7.45
INR	<1.4
Glucose	80-180mg/dL
Sodium	135-140mmol/L
Platelets	>75,000

5.3.4. Musculoskeletal injury

Recognising and controlling haemorrhage from musculoskeletal injuries is essential during the primary survey. Potentially life-threatening extremity injuries include *major arterial haemorrhage, bilateral femoral fractures,* and *crush syndrome.*

Deep soft-tissue lacerations may involve major vessels and lead to exsanguinating haemorrhage. Haemorrhage from long-bone fractures can be significant, and femoral fractures often result in significant blood loss into the thigh.

- **Assessment:**
    - Knowledge of the mechanism of injury and the history of the injury-producing event can guide clinicians to suspect potential associated injuries.
    - Most extremity injuries are appropriately diagnosed and managed during the secondary survey. A thorough history and careful physical examination, including completely undressing the patient, is essential to identify musculoskeletal injuries.
    - Assess injured extremities for external bleeding, loss of a previously palpable pulse, and changes in pulse quality, doppler tone, and

ankle/brachial index. The ankle/brachial index is determined by taking the systolic blood pressure value at the ankle of the injured leg and dividing it by the systolic blood pressure of the uninjured arm.

- A cold, pale, pulseless extremity indicates an interruption in arterial blood supply.
- A rapidly expanding haematoma suggests a significant cardiovascular injury.

- **Management:**
    - The management approach to musculoskeletal injuries mainly focuses on haemorrhage control, fracture immobilisation, and dislocated joint reduction while maintaining haemodynamic stability.
    - **Haemorrhage control:**
        - A stepwise approach to controlling arterial bleeding begins with manual pressure on the wound. Haemorrhage control is best achieved with direct pressure. A pressure dressing is then applied, using a stack of gauze held in place by a circumferential elastic bandage to concentrate pressure on the injury.
        - If bleeding persists, apply manual pressure to the artery proximal to the injury.
        - If bleeding continues, consider applying a manual tourniquet (such as a windlass device) or a pneumatic tourniquet applied directly to the skin proximal to the wound.

    - **Fracture immobilization**

        - Early splinting of fractures and dislocations can prevent serious complications and late sequelae. A careful neurovascular examination must be performed both before and after the application of a splint or traction device.

        - The goal of initial fracture immobilisation is to realign the injured extremity as close to the anatomic position as possible and prevent excessive motion at the fracture site. This is accomplished by applying inline traction to realign the extremity and maintaining traction with an immobilisation

device. Proper application of a splint helps control blood loss, reduces pain, and prevents further neurovascular compromise and soft tissue injury.

- If an open fracture is present, pull the exposed bone back into the wound, because open fractures require surgical debridement. Remove gross contamination and particulate matter from the wound and administer weight-based dosing of antibiotics as early as possible in patients with open fractures.
- Qualified clinicians may attempt the reduction of joint dislocations. If a closed reduction successfully relocates the joint, immobilise it in the anatomic position with prefabricated splints, pillows, or plaster to maintain the extremity in its reduced position.
- If reduction is unsuccessful, splint the joint in the position in which it was found. Apply splints as soon as possible because they can control haemorrhage and pain.
- However, resuscitation efforts must take priority over splint application. Assess the neurovascular status of the extremity before and after manipulation and splinting.
- Appropriate splinting fractures can significantly decrease bleeding by reducing motion and enhancing the tamponade effect on the muscle and fascia.
- Appropriate fluid resuscitation is an essential supplement to these mechanical measures.

- **X-ray examination:**
  - Although X-ray examination of most skeletal injuries is appropriate during the secondary survey, it may be undertaken during the primary survey when the fracture is suspected as a cause of shock.
  - The decisions regarding which X-ray films to obtain and when to obtain them are based on the patient's initial and obvious clinical findings, the patient's haemodynamic status, and the mechanism of injury.

❖ **Traumatic cardiac arrest (TCA):**

Definition: a trauma patient with no pulse or spontaneous respiratory activity (a low output state rather than a true cardiac arrest state).

Mortality significantly increases as post-arrest time moves beyond 10 minutes. The best outcome in TCA is when the victim is identified in the peri-arrest phase and action is taken either to prevent arrest or rapidly reverse it.

Table 9. Approach to traumatic cardiac arrest

Hemorrhage control	● Secondary to haemorrhage (internal or external) ● Correction in a 2-pronged manner ○ **Direct compression** of potential sources of haemorrhage should be initiated to prevent further losses (bandages, pressure dressings, hemostatic agents, tourniquets) ○ **Coupled with aggressive resuscitation of volume, preferentially with PRBCs** ■ Use a 1:1:1 ratio PRBC to FFP to Platelet as the ideal resuscitation fluid ■ Avoid large-volume crystalloid resuscitation given the increased complications and mortality. ■ Massive transfusion protocol
Oxygenation	● Potential causes: airway obstruction, asphyxia, respiratory failure due to lack of ventilatory drive (brain injury, cervical spinal cord injury). ● Management: placement of a definitive airway by the most experienced provider with in-line stabilization of the cervical spine ● Nasal airways are discouraged (concern of base of skull fractures)
Thoracostomy	● Causes devastating preload elimination ● Preferably finger thoracostomy ● Needle decompression has been described and is still taught in ATLS, but this method is often unsuccessful and has frequent complications. ● Many algorithms recommend immediate bilateral decompression in blunt and ipsilateral decompression in penetrating TCA. ● Eventual placement of the chest tube is indicated in the setting of ROSC and can be deferred until successful resuscitation.

Tamponade	● Evaluate for tamponade with point-of-care ultrasound ● ED Thoracotomy performed within the first 10 minutes following TCA ● Greatest success when performed after loss of pulses in the ED setting ● Blunt traumatic arrest does not share the same success rates with pericardiocentesis or ED thoracotomy

6. Trauma patient transfer

Following a comprehensive primary survey and management of the life-threatening conditions, the decision to transfer the patient to a higher trauma centre or keep them in the primary facility should be made. This is to ensure prompt and timely transfer arrangements are made and the definitive care required for the patient is not compromised.

As mentioned previously, every healthcare facility must develop a local SOP for patient transfer to higher trauma centres. These SOPs must be made with special consideration, as transport of a seriously injured patient is associated with risk and requires expertise and attention.

Proper documentation and handing over the case to a higher centre are essential parts of the transfer to ensure a continuation of care for the patient.

Table 9. Transfer guide for trauma patient

Injury	**Transfer type**	**Transfer mode**	**Transfer centre**	**Escort**
Life-threatening injuries	Immediate	Air	Level I/II	Nurse + Doctor with ability to provide trauma life support
Potentially life-threatening injuries	Immediate	Air	Level I/II	Nurse + Doctor with appropriate competencies

Stable patient with no immediate or potential life threatening injuries but require specialist consultation which is not available at the referring facility	less immediate	Air or sea	Center where required specialty services are available	Nurse with appropriate competencies
Stable patient with no immediate or potential life threatening injuries but require specific imaging not available at the referring facility	less immediate	Air or sea	Center where required imaging and specialty service (in case intervention is required) is available	Nurse with appropriate competencies

7. Mass Casualty Incidents

- Definition: An incident that produces multiple casualties such that emergency services, medical personnel, and referral systems within the normal catchment area cannot provide adequate and timely response and care without unacceptable mortality and/or morbidity.
- Every healthcare facility must develop a hospital emergency response protocol (HERP) to educate its staff on how to respond during an MCI.
- The aims of emergency response management are:
    - To save the lives of all victims regardless of race, religion, economic status and nationality
    - To prevent the escalation of the catastrophe: each agency plays a role in minimizing the effect
    - To relieve suffering: all individuals involved either directly (victims) or indirectly (family)
    - To protect environment and property: what is left and as much as possible
    - Restore normality as soon as possible so that society can get back to its normal duties and responsibilities.

- For detailed preparedness of the healthcare facilities and staff to respond in an MCI, it is recommended to refer to Mass casualty management: Guidelines for Emergency Medical services (EMS), Maldives, published by the Ministry of Health. (https://health.gov.mv/storage/uploads/9qaMMMqy/gancx35i.pdf)

8. Hospital Emergency Response Protocol (HERP)

- Definition: An emergency response framework that will guide the healthcare facility in the event of a mass casualty.
- Every healthcare facility must develop its SOPs, write alert levels for activation of hospital emergency response protocols, and educate staff.
- HERP establishes and describes the emergency response framework that will guide the healthcare facility in promoting and protecting the health, safety, and well-being of civilians involved in a public health emergency that might occur in the region. It would also assist in guiding the hospital in combating a health emergency where the hospital's premises are compromised.
- Level I and II trauma centres should conduct MCI preparation drills annually.

9. References

1. Advanced Trauma Life Support 10th edition
2. Guideline for establishing Emergency medical and trauma centres, 1st Edition, MoH, Bhutan
3. Division of Trauma, Surgical Critical Care, Burns and Acute Care Surgery handbook, University of California San Diego
4. Emergency medicine and trauma service policy, Malaysia
5. (https://www.who.int/news-room/fact-sheets/detail/injuries-and-violence)
6. Prehospital trauma care systems, WHO 2005
7.https://www.amtrauma.org/page/traumalevels#:~:text=The%20different%20levels%20(ie.,both%20Adult%20and%20Pediatric%20facilities.
8. Guidelines for the assessment of trauma centres in South Africa

ANNEX-1

AT-MISTER

A Age and sex of the injured
T Time of incident
M Mechanism of injury
I injuries suspected
S Signs, including vital signs and GCS
T Treatment so far
E Expected time of arrival
R Requirements on arrival

- The ATMIST portion of the pre-alert largely forms the handover once the PHC team arrives at the healthcare facility.
- Messages must be brief, accurate and concise.