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CLINICAL PRACTICE GUIDELINES

MANAGEMENT OF ABDOMINAL TRAUMA IN ADULTS

Ministry of Health Malaysia

Trauma Surgery Society of Malaysia

Academy of Medicine of Malaysia

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STATEMENT OF INTENT

This clinical practice guidelines (CPG) are meant to be guides for clinical practice, based on the best available evidence at the time of development. The guideline should not override the responsibility of the practitioners to make decisions appropriate to the circumstances of the individual. This should be done in consultation with the patients and their families or guardians, taking into account the management options available locally.

UPDATING THE CPG

These guidelines were issued in 2025 and will be reviewed in a minimum period of four years (2029) or sooner if new evidence becomes available. When it is due for updating, the Chairperson of the CPG or National Advisor of the related specialty will be informed about it. A discussion will be done on the need for a revision including the scope of the revised CPG. A multidisciplinary team will be formed, and the latest systematic review methodology used by MaHTAS will be employed.

Every care is taken to ensure that this publication is correct in every detail at the time of publication. However, in the event of errors or omissions, corrections will be published in the web version of this document, which will be the definitive version at all time. This version can be found on the websites mentioned above.

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LEVELS OF EVIDENCE

Level	Study design
I	Properly powered and conducted randomised controlled trial; well-conducted systematic review or meta-analysis of homogeneous randomised controlled trials
II-1	Well-designed controlled trial without randomisation
II-2	Well-designed cohort or case-control analysis study
II-3	Multiple time series, with or without the intervention; results from uncontrolled studies that yield results of large magnitude
III	Opinions of respected authorities, based on clinical experience; descriptive studies or case reports; reports of expert committees

SOURCE: *U.S. Preventive Services Task Force. U.S. Preventive Services Task Force Procedure Manual. Rockville, MD: USPSTF; 2015.*

FORMULATION OF RECOMMENDATION

- In line with the new development in CPG methodology, the CPG Unit of MaHTAS is adapting **Grading Recommendations**, **Assessment**, **Development and Evaluation (GRADE)** in its work process. The quality of body of evidence and related effect size are carefully assessed/reviewed by the CPG DG.
- Recommendations are formulated based on **certainty of evidence** and the wording used denotes the **strength of recommendations**. This takes into account:
    - quality and level of the evidence
    - balance of benefits and harms of the options
    - patient's preference and values
    - resource implications
    - relevancy and applicability to the local target population
- The more criteria being fulfilled, the more certain is the evidence leading to strong recommendations using the word "**should**" being considered. Otherwise, weak recommendations use the word "**may**" in proposing an action to be made.
- In the CPG, a yellow box highlights important message(s) in the management while a blue box contains evidence-based recommendation(s) for the particular condition.

KEY RECOMMENDATIONS

The following recommendations are highlighted by the CPG Development Group as the key recommendations that answer the main questions addressed in the CPG and should be prioritised for implementation.

Pre-hospital Care

- In pre-hospital care of trauma patients, vital signs should be monitored regularly.
- All severely injured trauma patients should be transferred to the nearest appropriate hospital within 60 minutes from time of injury (trauma bypass system).

Early Assessment and Resuscitation

- Video laryngoscopy is the preferred method for intubation of patients with abdominal trauma.
- Initial bolus fluid resuscitation in abdominal trauma should not exceed 1 L (15 ml/kg) except when necessary to maintain a systolic blood pressure of 80–90 mmHg.
- Balanced crystalloid is the preferred fluid in abdominal trauma resuscitation.
- Hypotonic solution should be avoided in all abdominal trauma resuscitation especially with concurrent traumatic brain injury.
- Transfusion of packed red blood cells and plasma (fresh frozen plasma) should be considered early in haemorrhagic trauma patients.

Diagnosis

- Assessment of abdominal trauma patients should include clinical history, mechanism of injury and physical examination.
- Trauma patients with ‘seatbelt sign’ should raise suspicion of intra-abdominal injury and warrants further evaluation.
- Extended Focused Assessment with Sonography in Trauma (e-FAST) should be performed in all abdominal trauma patients by trained healthcare providers.
- All abdominal trauma patients undergoing contrast-enhanced computed tomography (CECT) scan should have at least arterial and portovenous phases which can be obtained by either multiphasic or split-bolus protocol.
- CECT scan should be performed in haemodynamically stable abdominal trauma patients with suspected intra-abdominal injury to guide treatment.

Abdominal Organ Injury Scale

- All abdominal trauma patients should have their injury severity graded using the American Association for the Surgery of Trauma Organ Injury Scale.

Treatment

- All haemodynamically unstable abdominal trauma patients should have acute emergency laparotomy within 90 minutes from arrival to emergency department.
- Laparotomy is the preferred option in stable abdominal trauma patients requiring surgical intervention.
- Laparoscopic surgery may be offered in abdominal trauma patients who are haemodynamically stable and without traumatic brain injury.
  - Laparoscopic surgery should be performed by surgeons experienced and competent in trauma laparoscopy.
- Non-operative management in abdominal trauma should only be performed in haemodynamically stable patients.
  - It should be undertaken in centres with 24-hours availability of surgical services, operating theatres, intensive care units and other supporting resources.
- Patients treated non-operatively should be closely monitored for clinical deterioration (e.g. haemodynamic instability and peritonitis) which warrants urgent intervention.
- For stable anterior penetrating abdominal trauma without peritonitis, peritoneal violation should be determined via either local wound exploration, computed tomography scan or diagnostic laparoscopy.
  - Presence of peritoneal violation requires further operative assessment and treatment via laparoscopy or laparotomy.
- In patients with abdominal trauma, pain should be assessed based on patient self-rated pain score and regular clinical examination.
  - Choice of analgesia should be based on pain severity.
- In blunt abdominal trauma patients undergoing non-operative management, venous thromboembolism prophylaxis should be initiated early, preferably within 48 hours in patients without active bleeding or other contraindications.

Special Population

- Patients with haemodynamically unstable abdominal trauma and concurrent head injury should undergo surgical haemostasis before addressing the head injury.
- Patients with abdominal trauma with concurrent head injury should not undergo laparoscopic surgery.
- In intra-abdominal injuries with concomitant pelvic fracture, patient's haemodynamic status and pelvic ring stability should be identified early in order to provide appropriate management.
- Patients with haemodynamic instability with unstable pelvic ring fracture should have pelvic stabilisation and haemorrhage control.

Abdominal Compartment Syndrome

- All abdominal trauma patients at risk of developing abdominal compartment syndromes should be identified early and monitored closely.
- Treatment strategies for intra-abdominal hypertension (IAH) should be tailored to the cause and severity of IAH.

Referral

- If the initial health facility is unable to provide the patient the required trauma care, a timely referral to an appropriate facility should be made.

GUIDELINES DEVELOPMENT AND OBJECTIVES
GUIDELINES DEVELOPMENT

The members of the Development Group (DG) for these Clinical Practice Guidelines (CPG) were from the Ministry of Health (MoH), Ministry of Higher Education and private healthcare. There was active involvement of a multidisciplinary Review Committee (RC) during the process of the CPG development.

A systematic literature search was carried out using the following electronic databases: mainly Medline via Ovid and Cochrane Database of Systemic Reviews and others e.g. PubMed and Guidelines International Network (refer to **Appendix 1** for **Example of Search Strategy**). The search was limited to literature published on humans, publication from year "2009 to Current" and English language. In addition, the reference lists of all retrieved literature and guidelines were searched, and experts in the field contacted to identify relevant studies. All searches were conducted from 10 January 2023 to 30 January 2023. Literature searches were repeated for all clinical questions at the end of the CPG development process allowing any relevant papers published before 1 February 2025 to be included. Future CPG updates will consider evidence published after this cut-off date. The details of the search strategy can be obtained upon request from the CPG Secretariat.

References were also made to other CPGs on abdominal trauma among which are:

- World Society of Emergency Surgery (WSES). WSES guidelines on blunt and penetrating bowel injury: diagnosis, investigations, and treatment (2022)
- World Society of Emergency Surgery (WSES). WSES guidelines on the management of trauma in elderly and frail patients. (2023)

These CPGs were evaluated using the Appraisal of Guidelines for Research and Evaluation (AGREE) II prior to them being used as references.

A total of 12 clinical questions (CQ) were developed under different sections. Members of the DG were assigned individual questions within these sections (refer to **Appendix 2** for **Clinical Questions**). The DG members met 25 times throughout the development of these guidelines. All literature retrieved were appraised by at least two DG members using Critical Appraisal Skill Programme checklist, presented in evidence tables and further discussed in each DG meetings. All statements and recommendations formulated after that were agreed upon by both the DG and RC. Where evidence was insufficient, the recommendations were made by consensus of the two groups. This CPG was developed largely based on the findings of systematic reviews, meta-analyses and clinical trials, with local practices taken into consideration.

The literature used in these guidelines were graded using the U.S. Preventive Services Task Force Level of Evidence (2015), while the grading of recommendation was done using the principles of GRADE (refer to page i). The writing of the CPG follows strictly the requirement of AGREE II.

On completion, the draft of the CPG was reviewed by external reviewers. It was also posted on the MoH Malaysia official website for feedback from any interested parties. The draft was finally presented to the Technical Advisory Committee for CPG and, the HTA and CPG Council MoH Malaysia for review and approval. Details on the CPG development methodology by MaHTAS can be obtained from Manual on Development and Implementation of Evidence-based Clinical Practice Guidelines published in 2015 (available at https://www.moh.gov.my/moh/resources/CPG_MANUAL_MAHTAS.pdf).

OBJECTIVES

The objectives of the CPG are to provide evidence-based recommendations on the management of abdominal trauma in the following aspects:

- pre-hospital care and transfer
- early assessment and resuscitation
- diagnosis
- treatment
- referral

CLINICAL QUESTIONS

Refer to **Appendix 2**.

TARGET POPULATION

Inclusion Criteria

- Patients (aged ≥12 years) with blunt and penetrating abdominal trauma
- Special consideration: abdominal trauma in pregnancy, geriatric population and abdominal trauma with other concurrent injuries (head, spine, pelvic, chest)

Exclusion Criteria

- Paediatric populations (aged <12years)

TARGET GROUP/USERS

This document is intended to guide healthcare professionals and relevant stakeholders involved in the management of abdominal trauma. This includes:

i. doctors
ii. allied health professionals
iii. trainees and medical students
iv. patients and their advocates
v. professional societies

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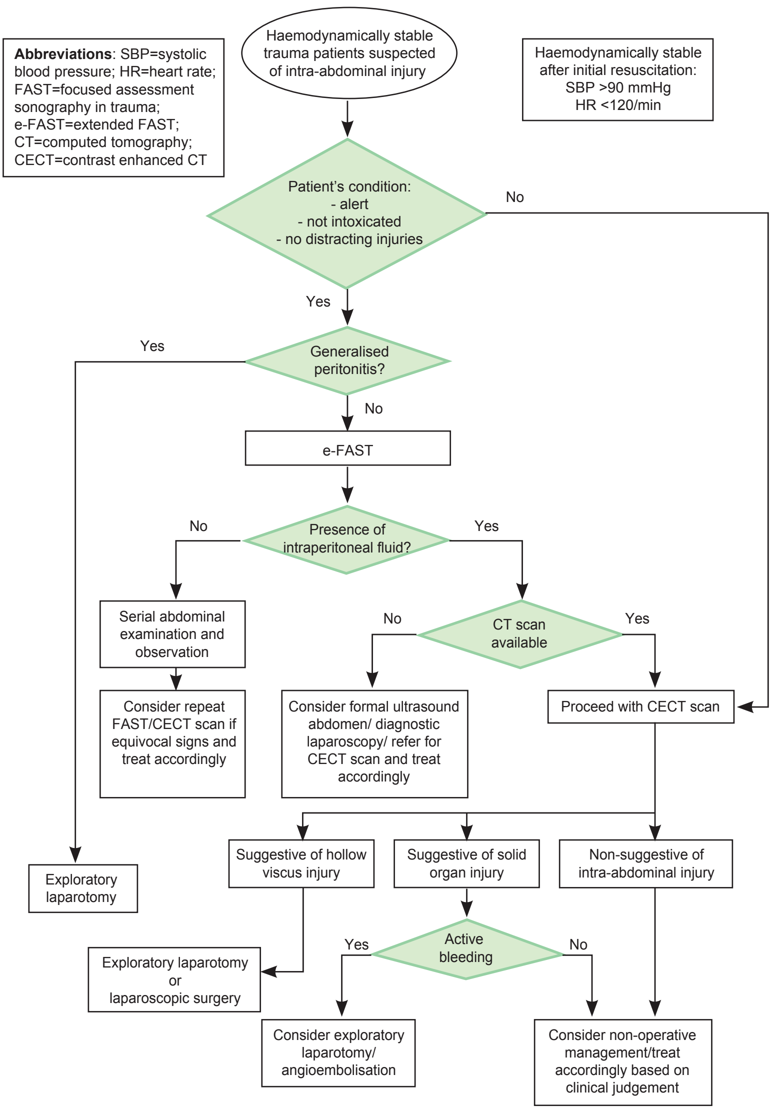
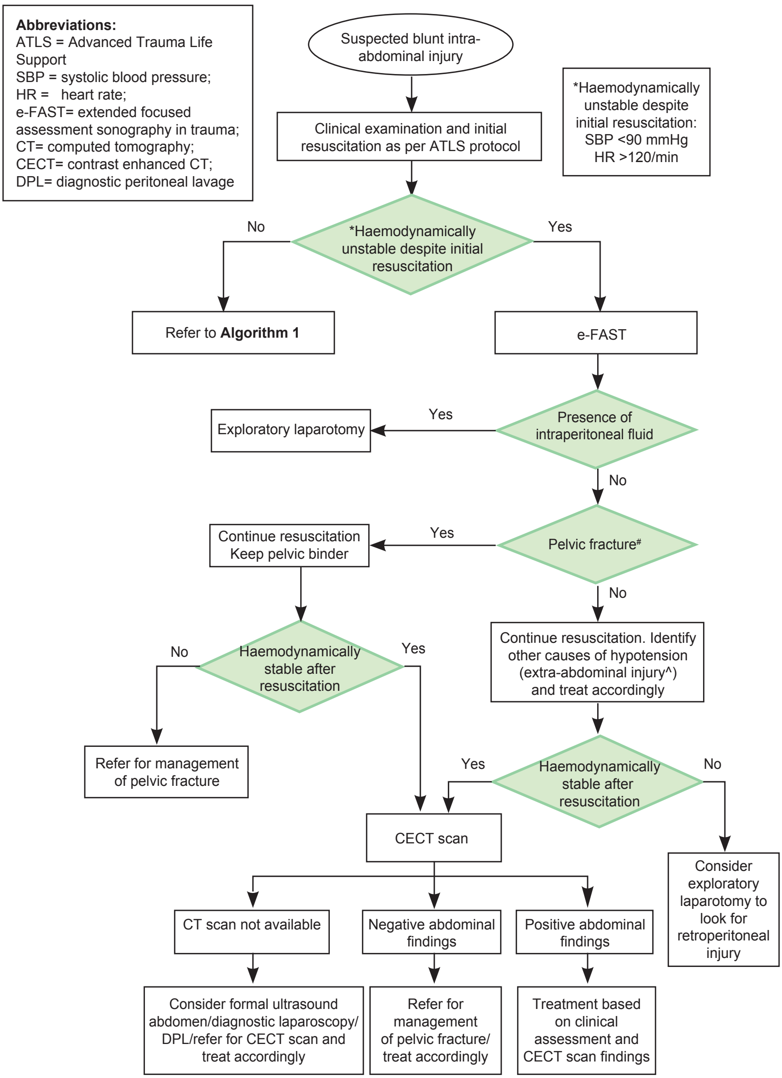
Algorithm 1: Management of Haemodynamically Stable Abdominal Trauma Patients



Note: Complete assessment should be repeated regularly when managing a patient with suspected intra-abdominal injury especially when there is a change in haemodynamic status.

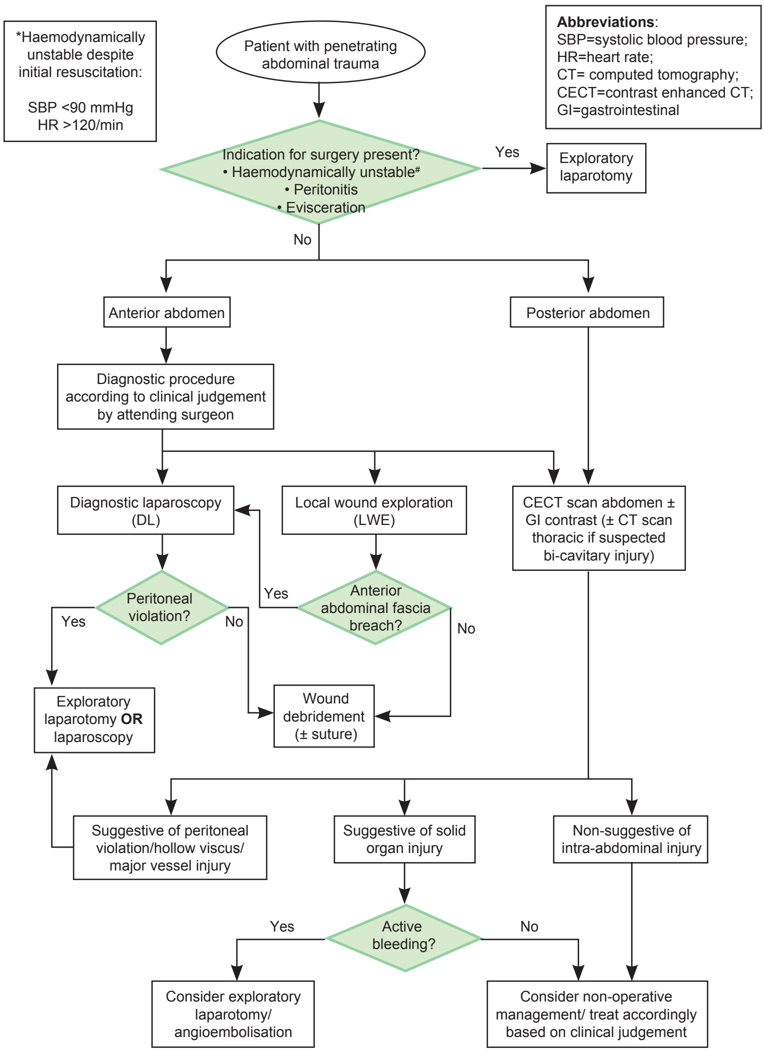
Algorithm 2: Management of Haemodynamically Unstable Abdominal Trauma Patients



#Diagnosis of pelvic fracture should be based on primary survey imaging
^extra-abdominal injury e.g. extremities/thoracic/spine injuries

Note: Complete assessment should be repeated regularly when managing a patient with suspected intra-abdominal injury especially when there is a change in haemodynamic status.

Algorithm 3: Management of Penetrating Abdominal Trauma



Note: Impaled/embedded object to be removed with precaution in operation theatre/controlled environment

1. INTRODUCTION

Trauma which includes intra-abdominal injury is one of the leading causes of morbidity and mortality worldwide. In 2024, the World Health Organization (WHO) reported 4.4 million injury-related deaths worldwide each year where the majority were due to unintentional injuries. About one-third of these deaths were from road traffic accidents. Additionally, tens of millions more people suffered non-fatal injuries, often leading to hospital visits, long-term disability, and ongoing physical and mental health care needs.[1]

Intra-abdominal injury can be divided to blunt and penetrating injuries where the former forms majority of cases in the country.[2] Such injury can be caused by various types of trauma mainly from road traffic accidents, falls from height, domestic and violent assaults and suicidal attempts. Based on the statistics from the Road Transport Department, there was a total of 402,626 road accidents recorded from January till September 2022 showing an increase of 58% from 2021. These also resulted in 4,379 deaths, also an increase of nearly 32% of the previous year. Malaysia Road Fatalities Index has recorded an average of 18 lives being lost in road traffic accidents every day and hence it constitutes a serious public health challenge to the nation.[3] The deaths could be due to various reasons, mainly lethal head injury or intra-abdominal injury. Although there is no exact local data on the cause of lethal deaths from intra-abdominal injury, such injury has been the leading cause of admission to the hospitals nationwide.

Intra-abdominal injury has been defined as injuries to the abdominal organs caused by trauma which may include other associated injuries to the ribs, vertebrae, pelvis and abdominal wall. The most common injury areas are the liver and spleen. A holistic approach ranging from pre-hospital to the complete rehabilitation of the injured patients is required to deliver good outcomes in these patients.

This is the first Clinical Practice Guidelines (CPG) developed to discuss on early management of patients presenting with features of intra-abdominal injuries. It gives the opportunity for clinicians at all levels of healthcare facilities (primary, secondary and tertiary care) to understand the concept, rationale and approach in such patients. A structured pathway is crucial in advocating the correct management strategy in respect to time to obtain desired results in these patients.

Amongst the areas of focus of the CPG are pre-hospital care and transfer, early assessment and resuscitation, diagnostic modalities, treatment and early referral of patients with intra-abdominal injury to a hospital with specialists when indicated.

2. PRE-HOSPITAL CARE AND TRANSFER

2.1. Pre-hospital Care

In Malaysia, the first point of contact with healthcare for injured patients is usually with the pre-hospital care providers via a bystander-initiated Malaysian Emergency Response Services (MERS 999) call to the Medical Emergency Coordinating Centre (MECC). Information given by the caller determines the level of the ambulance (basic or advanced) team dispatched to the scene. Refer to **Appendix 3** on **Management of an Emergency Call in Medical Emergency Coordinating Centre (MECC)**.

The ambulance team will provide basic initial care at the scene and while transporting patients to a hospital. When advanced interventions are needed, they will be instituted via medical direction from MECC (equivalent to ambulance dispatch centre). Prior to hospital arrival, information regarding the patient's clinical status will be relayed to the Emergency and Trauma Department (ETD) including alerts for Trauma Team Activation if indicated.

a. Attending team

Healthcare providers in primary care settings and ambulance service are paramedics trained in Basic Life Support (BLS) and basic trauma care. They initiate interventions e.g. application of cervical collar, splints and pelvic binder at site of incident and continue to monitor patient during transportation to the nearest hospital.

There are also advanced pre-hospital care providers [i.e. trained in Advanced Life Support (ALS)] in selected ambulances who are paramedics trained in provision of advanced care e.g. initiation of airway interventions up to insertion of supraglottic airway devices for adequate oxygenation and ventilation, control of external major haemorrhage, intravenous (IV) access, initiation of fluid boluses/ therapy and administration of drugs.[4] More advanced interventions are initiated by consultation with a specialist in the receiving hospital.

A cross-sectional study comparing ALS and BLS in pre-hospital management on blunt trauma patients via ground transport showed that pre-hospital time was significantly longer in ALS team (median time of 28 min vs 24 min). Pre-hospital time was defined as time of initial arrival by the first emergency medical services (EMS) team and time of arrival to trauma bay. However, there was non-significant (NS) difference in in-hospital mortality, complications or overall length of stay (LOS) after adjustment for severity of injury [based on Injury Severity Score (ISS)].[5, level III]

In a cross-sectional study on pre-hospital severely injured patients, comparison of attendance by physician vs non-physician teams found:[6, level III]

- NS difference in total pre-hospital time (interval from incident to admission) and on-scene time (interval from arrival to departure)
- NS difference in mortality rates within the first 24 hours and at hospital discharge
- significantly more interventions and more transportation to a level-I trauma centre seen in the physician team

In Malaysia, physician-driven pre-hospital care is not yet established. However, in special situations e.g. mass casualty incidents, an advanced team will include clinicians to provide advanced care at the scene and en route.

Refer to **Appendix 4** on **Management of Trauma Patient by Pre-hospital Ambulance Team at Scene**.

b. Vital signs

During transportation of patients to hospital, regular vital signs (blood pressure, heart rate, respiratory rate and oxygen saturation) monitoring including Glasgow Coma Scale (GCS) scoring are performed to guide management in the ambulance and to prepare the receiving team in Emergency and Trauma Department for continuation of care.

A cross-sectional study looking into the predictors of mortality in trauma patients showed that amongst vital signs recordings during pre-hospital transport, the mean value of continuous oxygen saturation (SpO_2) <90% was the most predictive of subsequent mortality compared with initial recorded value (AUC of 0.76 vs 0.59). However, the prediction was better when SpO2 was combined with pre-hospital GCS score with AUC of 0.88.[7, level III]

c. Oxygen therapy

Oxygen therapy is critical in the pre-hospital management of trauma patients especially for those at risk of hypoxia. However, inappropriate use may potentially cause harm (e.g. acute respiratory distress syndrome). Targeted oxygen therapy ensures administration of oxygen to patients who require it due to shock, respiratory distress or hypoxia, and avoids hyperoxia in those who are already oxygen-sufficient.

In a multinational RCT, there was NS difference in mortality and/or major respiratory complications between early restrictive (first eight hours) and liberal oxygen strategies in severely injured trauma patients.[8, level I]

- For trauma patients, appropriate use of oxygen therapy with careful monitoring is required to maximise benefits and minimise potential risks.
- Oxygen saturation in trauma patients is to be maintained at ≥95%.[9]

d. Fluid treatment

Among the basic interventions provided by the ambulance team is IV fluid administration for volume replacement. Choice of fluid is 0.9% sodium chloride or balanced crystalloid solution as recommended by several guidelines.[10; 11]

A cross-sectional analysis of data from Pan-Asia Trauma Outcome Study (PATOS) showed that adult trauma patients who received pre-hospital crystalloid fluid resuscitation had increased risk of in-hospital mortality (OR=4.26, 95% CI 3.50 to 5.20) and poor functional outcome (OR=2.33, 95% CI 2.16 to 2.51) compared with those who did not receive fluid.[12, level III]

Fluid therapy should be guided by the clinical condition of the patients. For suspected uncontrolled haemorrhage in chest, abdomen or retroperitoneal cavity, IV fluid therapy is titrated to maintain a systolic blood pressure (SBP) of 80 - 90 mmHg.[4] If a traumatic brain injury (TBI) is suspected the target mean arterial pressure (MAP) is ≥80 mmHg.[10]

Refer to **Subchapter 3.2 (b)** on **Fluid resuscitation** for further explanation.

e. Blood transfusion

A multicentre RCT on trauma-related haemorrhagic shock patients showed NS differences between pre-hospital resuscitation using blood products (PRBC-LyoPlas) and 0.9% sodium chloride in terms of mortality, improvement of tissue perfusion and transfusion-related complications in the first 24 hours after ED arrival.[13, level I]

The decision to implement pre-hospital blood transfusion need to consider the readiness of the healthcare system, including adequate capacity of hospitals in handling increased transfusion demands or ability of emergency medical services (EMS) in transporting and administering blood products.

Best practices for pre-hospital blood programmes include being well-planned and resourced, having multiple safeguards in place, adequate training and credentialing processes, and policies ensuring responsible stewardship of blood resources to minimise or eliminate product waste.[14, level III]

f. Tranexamic acid

For patients with evident or suspected haemorrhage, it has been recommended to minimise the time elapsed between injury and bleeding control.[10] It is also recommended to administer tranexamic acid (TXA) within three hours of injury.[15] This treatment can be initiated in pre-hospital settings.[16, level III] The indication and dosage of TXA administration in trauma are shown in **Table 1**.

Table 1: Early administration of Tranexamic Acid in Trauma

Indication	Dosage
TXA to be administered within 3 hours from time of injury in patients with: • suspected haemorrhage • SBP <90 mmHg • GCS ≤12	Loading dose: 1 g over 10 minutes Followed by maintenance: 1 g infusion over 8 hours

Source:
1. Shakur H, Roberts I, Bautista R, et al. Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial. Lancet. 2010;376(9734):23-32.
2. American College of Surgeons. ATLS Advanced Trauma Life Support: Student Course Manual (Tenth Edition). Chicago: American College of Surgeons; 2018.

In a large multinational Clinical Randomisation of Antifibrinolytic in Significant Haemorrhage 2 (CRASH-2) study, TXA was more effective than placebo in reducing all-cause mortality (RR=0.91, 95% CI 0.85 to 0.97) and risk of death due to bleeding (RR=0.85, 95% CI 0.76 to 0.96) in adult trauma patients.[17, level I]

A cohort study on patients with traumatic haemorrhagic shock in pre-hospital setting showed that those who received TXA had better outcomes than those not receiving TXA in terms of:[18, level II-2]

- reduced mortality at 28 days (OR=0.41, 95% CI 0.21 to 0.80)
- less total blood product transfused (difference in median=2 units, 95% CI 1.14 to 2.86)
- shorter hospital LOS (difference in median=4 days, 95% CI 2.35 to 5.64)
- shorter ICU LOS (difference in median=1 day, 95% CI 0.65 to 2.25)

There was also NS difference in adverse events (AEs) between the groups.

g. Pre-hospital ultrasound

In some developed countries, ultrasonography has been introduced in the pre-hospital settings to expedite the management of trauma patients.

A small cross-sectional study in Italy on moderate to severe abdominal trauma patients with liver and spleen injury found that a positive pre-hospital focused assessment with sonography in trauma (FAST) was independently associated with a reduced door-to-computed tomography (CT) scan or operating theatre time (OR=2.58, 95% CI 1.52 to 4.36).[19, level III]

However, pre-hospital ultrasound use is yet to be established in Malaysia.

h. Triaging
Pre-hospital trauma triage is important to identify patients with (or at-risk of) severe injuries and initiate early resuscitative care while transporting them to appropriate centre.

A large systematic review on pre-hospital trauma triage protocols showed that the triage protocols' ability to identify severely injured patients varied with sensitivity ranging from 10% to 100% and specificity from 9% to 100%. In view of the wide accuracies of the triage protocols, a prospective cohort study developed and validated a new pre-hospital trauma triage protocol to improve current triaging. Eight independent predictors identified to be associated with severe injury (ISS>15) were:[20, level III]

- age
- systolic BP
- Glasgow Coma Scale (GCS) score
- mechanism criteria
- penetrating injury to the head, thorax or abdomen
- signs and/or symptoms of head or neck injury
- expected injury in Abbreviated Injury Score (AIS) thorax region
- expected injury in ≥2 AIS regions

A prediction model using the eight predictors showed an AUC of 0.823 (95% CI 0.813 to 0.832). External validation revealed an AUC of 0.831 (95% CI 0.814 to 0.848).

Pre-hospital communication with the MECC should include the above information to determine triage criteria. For severely injured patients, pre-arrival notification by MECC/ambulance dispatch centre to the receiving ETD ensures seamless continuation of resuscitation.

2.2. Transfer of Patient

The main principle in pre-hospital transportation is to transfer patients to the nearest appropriate centre which best caters for the needs of the patients.[10; 4] The optimal destination for severely injured patients is a specialist hospital unless immediate intervention is needed for life-threatening conditions.

a. Transfer time

An important consideration when managing severely injured patients is transfer time, as highlighted in the Golden Hour Concept, in which definitive resuscitative care should be initiated within the first 60 minutes from time of injury.[21, level III; 22, level III]

Asian countries have different and variable EMS systems and provision of trauma care compared with Western countries. Hence, findings from studies done in such places may not be applicable in Asia.

A large multinational Asian retrospective cohort study on trauma patients transported from the scene to hospitals by EMS, showed no association between overall pre-hospital time and 30-day mortality. However, there was a 6% increase in odds of poor functional outcome with every 10-minute delay in total pre-hospital time (OR=1.06, 95% CI 1.04 to 1.08). Therefore, findings from this study support the concept of the "golden hour" for trauma patients during pre-hospital care in the countries studied including Malaysia.[23, level II-2]

b. Transfer destination

Selected patients can be transferred directly to a specialist hospital bypassing a nearby non-specialist hospital, taking into consideration the need for time-critical life-saving interventions and transport time. This arrangement is called a trauma bypass protocol (refer **Figure 1**). Most guidelines on this protocol clearly outline transport time within 60 minutes as one of the deciding factors.[24; 25; 26]

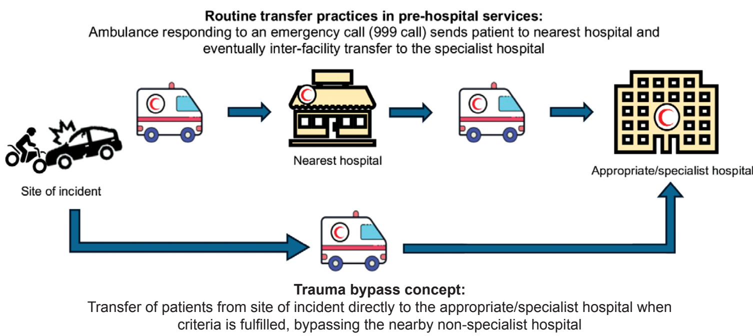


Figure 1: Trauma bypass concept in pre-hospital emergency response system

A cross-sectional study on all patients with major trauma in England Trauma and Audit Research Network dataset, direct transfer to major trauma centre had significantly better outcomes compared with transfer to a trauma unit:[27, level III]

- shorter median time to surgery by 4.37 hours (IQR 3.00 - 6.57) vs 5.37 hours (IQR 3.50 - 7.65)
- shorter time to CT scan by 2 hours (IQR 1.55 - 2.73) vs 3.15 hours (IQR 2.16 - 4.63)
- lower odds of death (OR=0.77, 95% 0.72 to 0.82)

In Malaysia, the CPG DG members advocate trauma patients to be transferred to the nearest most appropriate centre based on the severity of the injury within 60 minutes of transfer time.

- When deciding on suitability of trauma bypass, attending medical personnel needs to consider:
  - the capability to anticipate and manage patient's deterioration during transfer
  - transfer time to the appropriate hospital
- Pre-arrival trauma notification is necessary to ensure seamless continuation of resuscitation.

Recommendation 1
- In pre-hospital care of trauma patients:
  - the attending team should have adequate training in providing basic trauma care
  - vital signs should be monitored regularly
  - fluid resuscitation should be done judiciously
  - tranexamic acid should be administered in suspected bleeding patients without known contraindications
- All severely injured trauma patients should be transferred to the nearest appropriate hospital within 60 minutes from time of injury (trauma bypass system).

3. EARLY ASSESSMENT AND RESUSCITATION

Initial systematic assessment of the injured patient, also known as the Primary Survey, is performed upon arrival in the ETD. It aims to rapidly identify life-threatening conditions for immediate intervention in stabilising patient's physiology.[15]

- During primary survey, cervical spine protection is maintained with the use of rigid cervical collar and pelvic binder is applied in patients where pelvic fracture is suspected.

Primary survey adjuncts include vital sign monitoring, continuous ECG monitoring, arterial blood gas measurement including lactate levels, chest and pelvic X-rays, FAST/e-FAST and diagnostic peritoneal lavage (DPL). In addition to the above, insertion of a gastric and urinary catheter can assist in diagnosis and patient monitoring.[15]

- The CPG DG opines that all major trauma patients should be managed by a specialist-led multidisciplinary team (e.g. Trauma Team Activation involving the Emergency, Surgical and Anaesthesiology teams). This should be initiated early, as soon as the patient arrives at the hospital ETD.

3.1. Early Assessment

a. Triage

- The triaging services counter is the first point of contact for all patients accessing the ETD care. Triage is a dynamic process and patients who come to ETD, either walk-in or brought by ambulance, will be reassessed and re-triage.[28]

The Revised Trauma Score (RTS) is a tool used in trauma triage to assess the severity of injuries and guide treatment decisions, particularly in the field, by evaluating physiological parameters e.g. GCS, SBP and respiratory rate. By assessing these physiological criteria, trauma patient will be triaged to either Critical (Red), Semi-Critical (Yellow) or Non-Critical (Green) zones.[28]

In 2023, MoH released the Malaysian Triage Scale (MTS) for Emergency and Trauma Departments (New Revised Version 2022), which was to be implemented by MoH hospitals. In this new triaging system, the patients will be triaged to five levels:[29]

- Level 1 Resuscitation
- Level 2 Emergency
- Level 3 Urgency

- Level 4 Early Care
- Level 5 Routine

An example of such triaging is shown below:[29]

Level of Triage	**Parameters associated with Chest/ Abdominal Trauma**
Level 1: Resuscitation	• Agonal breathing • Pulseless • Unrecordable BP • Shock index ≥1.4
Level 2: Emergency	• Penetrating injury • High velocity mechanism of injury • Respiratory distress • SpO_2 <95% • Shock index ≥1.0 to <1.4
Level 3: Urgency	• Likely rib fractures • Possibility of pelvic injury • Significant external bruising • Shock index ≥0.6 to <1.0
Level 4: Early Care	• Elderly • Anticoagulant use • Pregnancy • Shock index <0.6
Level 5: Routine	• Mild symptoms

Providing trauma care, including proper trauma triage within a well-organised system, saves many lives and prevents long-term disability.[30, level III]

b. Clinical Assessment

Vital signs monitoring is important in the management of abdominal trauma. Together with clinical examination, it is used to assess the haemodynamic stability of the patients. However, the vital signs can sometimes remain within normal ranges even in patients who are critically ill. This can lead to a delay in recognition of shock, thus contributing to the failure of escalation of care and delayed lifesaving intervention.

The principles outlined in Advanced Trauma Life Support (ATLS) are important to be followed to recognise shock. Refer to **Appendix 5** on **Signs and Symptoms of Haemorrhage by Class**. The ATLS recognises that no single vital sign and no laboratory test, on its own, can definitively diagnose shock. Composite indexes have been developed to aid in the early identification of shock to improve risk stratification and prognostication in the management of trauma patients.

An example of this is the Shock Index (SI) which was first described in 1967. It is the ratio of pulse rate (PR) to systolic blood pressure (SBP) and is meant to measure hypovolaemia in haemorrhagic and infectious states. A normal SI range is 0.5 - 0.7, while values >0.9 predict the need for triage priority and intensive therapy.

As vital signs is a dynamic measure, Delta Shock Index (DSI) has been developed to assess changes in patients' shock status over time and thus identify early deterioration. Calculation and interpretation of both SI and DSI are shown below.

Shock Index (SI)	=	$\frac{\text{Pulse rate (PR)}}{\text{Systolic blood pressure (SBP)}}$	<0.6 = no shock ≥0.6 to <1.0 = mild shock ≥1.0 to <1.4 = moderate shock ≥1.4 = severe shock
Delta Shock Index (DSI)	=	ED SI - Pre-hospital SI	Assume occult shock if DSI >0.1

Source:
1. Mutschler M, Nienaber U, Münzberg M, et al. The Shock Index revisited - a fast guide to transfusion requirement? A retrospective analysis on 21,853 patients derived from the Trauma Register DGU. Crit Care. 2013;17(4):R172.
2. Joseph B, Haider A, Ibraheem K, et al. Revitalizing Vital Signs: The Role of Delta Shock Index. Shock. 2016;46(3 Suppl 1):50-4.
3. Carsetti A, Antolini R, Casarotta E, et al. Shock index as predictor of massive transfusion and mortality in patients with trauma: a systematic review and meta-analysis. Crit Care. 2023; 5;27(1):85.

A cross-sectional analysis of the multinational PATOS study showed that patients with DSI >0.1, when compared with DSI ≤0.1, had:[31, level III]
- higher in-hospital mortality (OR=2.82, 95% CI 2.08 to 3.84)
- higher ICU admission (OR=2.02, 95% CI 1.76 to 2.32)
- higher massive transfusion (OR=5.24, 95% CI 3.10 to 8.85)

Another cross-sectional study using the Japan Trauma Data Bank found that patients with DSI >0.1 had a significantly higher incidence of emergency surgery than those with DSI ≤0.1 (OR=1.22, 95% CI 1.08 to 1.38).[32, level III]

It is unclear if any trauma centres worldwide are utilising DSI in their respective protocols. However, the concept of DSI highlights the importance of dynamic vital signs assessment for identification of occult hypovolaemic shock.

Recommendation 2
- Abdominal trauma patients with Shock Index ≥1.0 should be given priority and monitored closely.

c. Laboratory Tests

Routine laboratory tests typically offer limited utility in the management of trauma patients. Interpretation of individual blood tests should consider the broader context of the patient's overall clinical picture and trends of the results.

The following are essential blood tests in abdominal trauma patients:[33, level III; 9; 34; 15]

- full blood count (FBC) -
  - haemoglobin levels should be interpreted according to time since injury, amount of fluid administration and extent of haemorrhage
  - haematocrit below 30% increases the likelihood of intra-abdominal injury in the setting of blunt abdominal trauma
- renal profile (RP) - to identify and monitor renal dysfunction
- blood glucose level - to identify and manage hypo- or hyperglycaemia due to stress response
- coagulation profile -
  - important parameters are prothrombin time (PT) and international normalised ratio (INR)
  - early and repeated coagulation profiles either by traditional method or viscoelastic method (VEM) in haemodynamically unstable patients with solid organ injury is crucial
  - prolonged PT is often used to define trauma-induced coagulopathy (TIC); it correlates with severity of shock and continued need for blood transfusions
- arterial/venous blood gases -
  - serial blood gas assessment of pH, lactate levels and base excess is done to monitor tissue oxygenation, circulatory status and response to resuscitation
- Group, Screen and Hold (GSH) or Group Crossmatch (GXM) - for high index suspicion of haemorrhage
- liver function test (LFT) - transaminitis may suggest liver injury
- urine pregnancy test - to rule out pregnancy in female of childbearing age

3.2. Resuscitation Strategy

a. Airway management

Establishment of airway patency takes priority over any systemic stability. Trauma patients may be agitated or intoxicated, hemodynamically unstable, bound by cervical spine collars or have soiled airways from vomitus or blood. Once a decision for intubation is made, it becomes time-sensitive as first-pass success is critical to patient's safety and prevention of adverse events e.g. hypoxaemia, hypotension and cardiac arrest. There are many strategies and equipment choices for managing the airway in trauma patients. The highest rates of success are those that are well known and regularly used in a local setting.

A large multicentre cohort study looking at mainly adult patients who had intubation in ETD due to trauma found that the prevalence of first-pass success was 86.8% (95% CI 83.3% to 90.3%). In comparison, video laryngoscopy (VL) had more first-pass success than direct laryngoscopy (DL) even after propensity score matching with OR of 2.2 (95% CI 1.6 to 2.9). Oesophageal intubations occurred more commonly in patients intubated with direct laryngoscopy.[35, level II-2]

The above findings are supported by a recent large meta-analysis of 14 RCTs where intubation using VL was compared with DL in critically ill patients. It showed that VL increased the number of successful intubations on the first attempt (RR=1.12, 95% CI 1.04 to 1.20). It also reduced the risk of oesophageal intubations (RR=0.44, 95% CI 0.24 to 0.80) and aspirations (RR=0.63, 95% CI 0.41 to 0.96). Subgroup analysis showed successful first-attempt intubation still favoured VL regardless of operator's experience status.[36, level I] However, the primary studies included trauma and non-trauma patients in ED and ICU settings. ROB showed most studies were of high risk of bias in the measurement of outcome.

In trauma setting, the challenges in use of VL include view obstruction by fogging, secretions, blood or emesis in the oropharynx and limited experience of the operator.[37, level III]

Recommendation 3
- Video laryngoscopy is the preferred method for intubation of patients with abdominal trauma.

b. Fluid resuscitation

The general aim of fluid management in abdominal trauma is to prevent hypovolaemia and obtain sufficient cardiac output for maintenance of major organ perfusion. The initial bolus of crystalloid used is 1 L (15 ml/kg).[38, level III] Excessive fluid resuscitation in the first 24 hours of trauma may cause detrimental effects e.g. dilutional coagulopathy, acidosis and hypothermia. The CPG DG opines that the initial bolus fluid resuscitation should not exceed 1 L (15 ml/kg) while waiting for blood and blood products.

Ideally, the fluid used for resuscitation should be of similar composition to extracellular fluid, isotonic and not affecting blood coagulation.

However, the currently available fluids do not fulfil these criteria. The fluid commonly used is 0.9% normal saline but its massive usage lead to hyperchloremic metabolic acidosis.[39, level III] Balanced crystalloids, e.g. Sterofundin is the preferred fluid for resuscitation. However, Hartmann's solution should be used cautiously if concurrent head injury is present. Meanwhile, colloids are not recommended for initial fluid management as it can cause renal complications.[40, level III]

A retrospective cohort study on moderate to severe trauma patients in a level I trauma centre demonstrated that:[41, level II-2]

- those who received high-volume (≥2 L) of crystalloid fluid in ED had increased overall mortality compared with those receiving low-volume (<2 L) with OR of 1.88 (95%CI 1.18 to 3.01)
- subgroup analysis also showed increased mortality in the high-volume group among elderly population (OR=2.56, 95% CI 1.01 to 6.45) and blunt injury (OR=2.11, 95% CI 1.28 to 3.48)

The detrimental effect of high-volume crystalloid resuscitation was demonstrated in another cohort study on severely injured blunt trauma patients with haemorrhagic shock. The findings showed that high-volume (>15 L) of crystalloid resuscitation in the first 24 hours were associated with risk of:[42, level II-2]

- acute lung injury and acute respiratory distress syndrome (OR=3.4, 95% CI 1.5 to 7.9), and multiple-organ failure (OR=2.9, 95% CI 1.3 to 6.1) when compared with <5 L
- abdominal compartment syndrome (OR=8.7, 95% CI 2.6 to 28.9) when compared with 5 - 10 L

In a cross-sectional study on critically ill trauma patients, the non-survivors had higher risk of positive fluid balance (OR=1.236, 95% CI 1.008 to 1.515) and volume of fluid infusion (OR=4.10, 95% CI 1.030 to 16.317) compared with survivors.[43, level III]

Several international guidelines recommend the followings regarding initial fluid resuscitation in trauma:[10; 44; 45]

- initiate 0.9% sodium chloride or balanced crystalloid solution in the bleeding hypotensive trauma patients
- limit all crystalloid solutions to a total of 1 L during initial resuscitation
- avoid hypotonic solutions in patients with severe TBI
- restrict the use of colloids due to AEs on haemostasis
- infuse small aliquots of fluids (100 – 200 ml) to maintain systolic blood pressure 80 – 90 mmHg in the presence of uncontrolled haemorrhage and a delay of >30 minutes to operative haemostasis

In resuscitation of obese patients, it is suggested to use adjusted body weight to guide on volume of fluid therapy required. Refer to **Appendix**

6 on **Composition of Different Intravenous Fluids Commonly Used for Initial Volume Replacement in Trauma Patients** including example of body weight calculation for fluid therapy.

c. Blood and blood products transfusion

Severely injured patients with haemorrhagic shock require early transfusion to prevent trauma-induced coagulopathy, acidosis and hypothermia which can lead to mortality.

A cross-sectional study on patients admitted to ED for major trauma showed that patients with trauma coagulopathy, compared with those without coagulopathy, had:[46, level III]

- more frequent blood transfusions (p=0.016) and hospitalisation (p=0.032)
- higher layered Shock Index (SI) (p=0.016)
- more severe ISS score (p=0.016)
- higher number of body district affected (p<0.05)
- NS difference in the need for surgery or mortality

In an RCT on patients with severe trauma and major bleeding, transfusing plasma, platelets and red blood cells in a 1:1:1 ratio was compared with a 1:1:2 ratio, results showed:[47, level I]

- significantly more haemostasis and fewer exsanguination in the 1:1:1 group
- NS difference in mortality at 24 hours or at 30 days
- NS difference in pre-specified complications including acute respiratory distress syndrome, multiple organ failure, venous thromboembolism, sepsis and transfusion-related complications

Another cross-sectional study among patients who underwent emergency surgery for haemorrhage control and were transfused within four hours of hospital arrival found that lower ratios of packed RBC (pRBC) to whole blood (WB) resuscitation were associated with improved survival at 24 hours when compared to WB alone:48, level III

- 2:1 ratio (HR=1.27, 95% CI 0.58 to 2.79)
- 3:1 ratio (HR=2.83, 95% CI 1.18 to 6.77)
- 4:1 ratio (HR=3.67, 95% CI 1.57 to 8.57)

In a meta-analysis of cohort studies, massive transfusion protocol (MTP) in all types of trauma patients decreased overall mortality (OR=0.71, 95% CI 0.56 to 0.90) when compared with group prior to MTP implementation.[49, level II-2] GRADE assessment revealed moderate quality of the primary papers used.

Where available, viscoelastic testing (VET) including thromboelastography and thromboelastometry can provide clinical guidance for emergency resuscitation, predicting massive transfusion, early diagnosis of coagulopathy and guide blood component transfusion. Refer to the Malaysian Consensus Statement of Patient Blood Management 2024 for further details on MTP and VET.[50]

Recommendation 4
- Initial bolus fluid resuscitation (including pre-hospital phase) in abdominal trauma should not exceed 1 L (15 ml/kg) except when necessary to maintain a systolic blood pressure of 80–90 mmHg.
- Balanced crystalloid* is the preferred fluid in abdominal trauma resuscitation.
- Hypotonic solution* should be avoided in all abdominal trauma resuscitation especially with concurrent traumatic brain injury.
- Transfusion of packed red blood cells and plasma (fresh frozen plasma) should be considered early in haemorrhagic trauma patients.

*refer to **Appendix 6**

4. DIAGNOSIS

Abdominal trauma is a critical condition that requires prompt recognition, and effective management to minimise morbidity and mortality. It may result from blunt or penetrating mechanisms and can involve injuries to the solid organs, hollow viscera, blood vessels or retroperitoneal structures.

Complete clinical assessment in-line with ATLS protocol and coupled with appropriate diagnostic modalities play a crucial role in identifying extent of injuries and guiding the interventions. Modalities facilitating diagnosis include laboratory tests, radiography, extended focused abdominal sonography in trauma (e-FAST), computed tomography (CT) scan and diagnostic peritoneal lavage (DPL).

4.1. Clinical Diagnosis

The clinical diagnosis of intra-abdominal injury requires a systematic and integrated approach that incorporates patient history, physical examination, imaging and adjunctive diagnostic tools. Initial assessment follows the principles of ATLS, which include primary trauma survey and stabilisation of airway, breathing and circulation. After stabilisation, evaluating the mechanism of injury is crucial as certain scenarios, e.g. high-speed motor vehicle collisions, falls from height, direct abdominal trauma and penetrating injuries (e.g. gunshots or stab wounds), are highly associated with intra-abdominal injury.

Diagnosis is especially challenging when historical information is limited or when patients are intoxicated or having TBI. A focused history from pre-hospital personnel provides valuable information, especially in cases of blunt abdominal trauma (BAT). In motor vehicle collisions, key details include:

- presence of fatalities at the scene
- vehicle type and speed
- rollover incidents
- seat position
- extent of vehicle damage
- seatbelt usage and type
- airbag deployment

These factors help to determine the likelihood of intra-abdominal injury.

Physical examination may reveal abdominal distension or external signs of trauma (e.g. bruising or abrasions including the “seatbelt sign” [refer to **Figure 2**]), abdominal tenderness, guarding and rigidity. However, these findings may be subtle or unreliable, particularly in patients with altered mental status, distracting injuries or in paediatric and elderly populations. Notably, the absence of abdominal pain or tenderness does not rule out serious injury, as symptoms may develop several hours after the initial trauma. Therefore, repeated assessment and timely imaging are essential.

- Seatbelt signs are redness, bruises or abrasions on patient's chest, abdomen or neck corresponding to the diagonal or horizontal strap of a seatbelt after a road traffic accident, as shown in the pictures below. This sign is associated with intra-abdominal injury and has become an important clinical factor in assessing blunt abdominal trauma related to road traffic accidents.

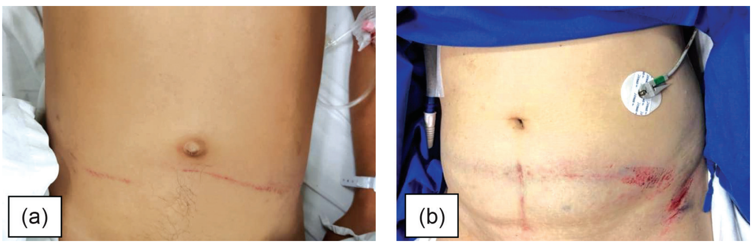


Figure 2: Subtle (a) and obvious (b) seatbelt sign

Associated injuries e.g. fractured ribs or pelvic bones, may also result in secondary intra-abdominal damage. A systematic review identified physical signs of hypotension (SBP <90 mmHg), abdominal distension, rebound tenderness, guarding, and concomitant femur fractures (which can act as distracting injuries) increased the probability of intra-abdominal injury.[51, level III]

Hypotension in trauma patients is often due to intra-abdominal haemorrhage. Even when external bleeding sources are identified, intra-abdominal injuries should not be excluded. Head injuries alone rarely account for shock unless the trauma is severe or involves infants with significant intracranial bleeding or scalp haematoma.

Certain external signs can heighten clinical suspicion of intra-abdominal injury. For example, seatbelt signs located above the anterior superior iliac spine (ASIS) have been linked to a fourfold increased risk of intra-abdominal or lumbar spine injuries.[52] A meta-analysis showed that patients with seatbelt sign had higher odds of intra-abdominal injury (OR=3.61, 95% CI 1.12 to 11.6) and need for surgical intervention (OR=7.34, 95% CI 2.03 to 26.54) compared with those without seatbelt signs.[53, level II-2]

Intra-abdominal injuries may present with referred pain e.g. Kehr's sign (left shoulder pain from splenic injury) or right shoulder pain from liver injury. Digital rectal examination, although has been part of abdominal trauma assessment, should be reserved for cases with suspected rectal or urethral trauma.

Structured physical examination in alert patients has been shown to reduce the risk of missed intra-abdominal injuries, even in the presence of distracting injuries. However, clinicians should maintain a low threshold for performing diagnostic imaging to confirm or rule out intra-abdominal injury based on patients' clinical history or mechanism of injury.

Recommendation 5

- Assessment of abdominal trauma patients should include clinical history, mechanism of injury and physical examination.
- Trauma patients with 'seatbelt sign' should raise suspicion of intra-abdominal injury and further evaluation is warranted.

4.2. Laboratory Tests

Amongst the common laboratory tests, blood and urinary analysis are essential in abdominal trauma assessment to look for associated injuries.

a. Urinary dipstick for haematuria

A small diagnostic study on haematuria in detecting blunt intra-abdominal injury (including non-genitourinary injury) with reference to CT scan in patients admitted to ED found the following:[54, level III]

Haematuria	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC
Microscopic on dipstick	72.2	53.1	46.4	77.3	0.627
Gross	36.1	53.1	76.5	72.3	0.649

In patients with gross haematuria or microscopic haematuria with an episode of hypotension, the European Association of Urology (EAU) guidelines recommend contrast-enhanced computed tomography (CECT) scan to be done to assess for renal injury.[55] CT scan can only be performed once patient is haemodynamically stable.

b. Serum pancreatic enzymes

A small diagnostic study on the role of serum pancreatic enzymes in predicting pancreatic injury among patients with BAT found that:[56, level III]

- raised serum amylase was not specific to pancreatic injury as it can be raised in bowel, craniofacial injuries, etc; however, the enzymes were highly raised in patients with pancreatic injury with

mean serum amylase of 1184 IU (95% CI 493 to 1339) and mean serum lipase 944 IU (95% CI 365 to 1211)
- accuracy of serum pancreatic enzymes, with reference to (CT) scan findings were as below –

Serum pancreatic enzymes	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Amylase	85	79	50	95
Lipase	85	99	97	96
Combined amylase and lipase	85	100	100	96

- Raised serum amylase and lipase levels are time-dependent with the levels found to be non-diagnostic ≤3 hours after trauma.

Recommendation 6
- Urine dipstick test should be done in abdominal trauma patients with suspected genitourinary injury.
    - Patients with gross haematuria or microscopic haematuria should be further investigated.
- Serum amylase may be performed in patients with suspected pancreatic injury.

4.3. Imaging

Imaging is crucial for quick triaging, diagnosis and treatment of trauma patients. The selection of imaging modalities depends on the type of facilities and, patient's condition and clinical findings. Commonly utilised imaging tools include plain radiographs, ultrasound and CT scans. Imaging can provide rapid and potentially life-saving information for decision making.

In facilities with radiography and focused assessment with sonography for trauma (FAST)/extended-FAST(e-FAST) capabilities, these imaging studies are performed during primary survey or after stabilisation of the patient. Bedside imaging is essential in initial injury detection in unstable patients.

a. Radiography

Chest and pelvic X-ray are critical adjuncts during the primary survey of trauma patients.

Performing bedside radiographs without having to move the patient, in the supine anterior-posterior (AP) position, is a practical choice for patients in critical condition in the trauma bay.

The main focus of these initial radiographs is to identify life-threatening injuries e.g.:

- cardiopulmonary injuries – e.g. pneumothorax, haemothorax, rib fractures or pericardial effusion that could compromise breathing or circulation
- pelvic fractures - important because it can signal significant internal bleeding, especially in the case of pelvic ring fractures
- penetrating injuries - to look for foreign bodies (e.g. bullets, knife, etc.) and to assist in trajectory identification

Cervical and skull radiograph is not part of the adjunct to primary survey.

b. Focused Assessment with Sonography for Trauma/e-FAST/ Point-of-Care Ultrasound

The Focused Assessment with Sonography for Trauma (FAST) scan is performed to identify the presence or absence of free fluid in the abdominal cavity.

FAST is the earliest application of bedside ultrasound by trained healthcare providers and is primarily focused on detecting abdominal and pericardial free fluid in trauma patients, which indirectly helps in diagnosis of intra-abdominal and cardiac injuries associated with bleeding. It is not designed to specifically detect parenchymal injuries. The e-FAST expands this examination by including an evaluation of the chest to detect pneumothorax or intrapleural fluid. In recent years, e-FAST has been incorporated as a component of point-of-care ultrasound (POCUS). All these modalities provide rapid, non-invasive and bedside imaging options to identify life-threatening injuries. FAST/e-FAST/POCUS will guide the clinicians on the next steps of management of abdominal trauma.

A study on FAST in adult abdominal trauma patients showed that the most sensitive view to detect free fluid was right upper quadrant with detection rate of 66.7%.[57, level III]

Comparison between initial FAST and initial CT scan in patients with haemodynamically stable torso trauma showed NS difference in terms of in-hospital mortality.[58, level III]

Studies on unstable blunt abdominal injury and life-threatening pelvic fracture patients showed that FAST had sensitivity at 92.6 - 96%, specificity 96 - 100%, PPV 93 - 100% and NPV 92 - 98% in detecting intra-abdominal free fluid in initial assessment compared with ultrasound performed by radiologist/CT scan /DPL/laparotomy findings.[59, level III; 60, level III] This proves that FAST is pivotal in guiding decisions in patients who are unstable as positive FAST may prompt immediate interventions for haemorrhage control. Whereas a negative FAST may rule out massive intra-peritoneal bleeding, redirecting the evaluation to other causes of instability.

In stable patients, FAST may serve as a screening tool in selecting the next diagnostic modality. In a systematic review on hemodynamically stable patients with penetrating torso trauma (stab or gunshot), FAST had high specificity (94.1 - 100%) but wide sensitivity (28.1 - 100%) in detecting free fluid compared with local wound exploration/CT scan/DPL/laparotomy.[61, level III]

A Cochrane systematic review on POCUS for diagnosing thoracoabdominal injuries in patients with blunt trauma showed it had a sensitivity of 74% and specificity of 96% in reference to other diagnostic reference standards (e.g. CT scan, surgery).[62, level III]

A single centre diagnostic study on abdominal e-FAST in morbidly obese patients with blunt abdominal trauma found that it had low sensitivity of 27.1%, high specificity of 91.7% and overall accuracy of 76.2% to detect injury when compared with CT scan. The risk of incorrect e-FAST increased with increasing BMI ≥36 kg/m^2.[63, level III]

While e-FAST is an invaluable tool in evaluating intra-abdominal injury, it also has several limitations that can affect its diagnostic accuracy. It is operator-dependent and cannot reliably detect solid organ injuries or bowel perforation without associated free fluid. Hence, negative e-FAST does not completely exclude the possibility of intra-abdominal injury. Therefore, clinical judgement, patient monitoring and consideration of other diagnostic modalities is imperative for safe management of these patients.

Early-stage injuries with minimal bleeding may be overlooked, hence the CPG DG opines that e-FAST should be performed at regular intervals based on clinical judgements. However, there is a role of ultrasound by radiologist to provide a more comprehensive and detailed assessment of abdominal structures to confirm or further evaluate the findings by initial bedside ultrasounds such as POCUS/FAST/e-FAST.

- In intra-abdominal injury patients, e-FAST is only used for detection of free fluid.
- A negative initial e-FAST does not completely exclude the possibility of intra-abdominal injury, hence it should be repeated together with regular clinical assessment.

Recommendation 7
- Extended Focused Assessment with Sonography in Trauma (e-FAST) should be performed in all abdominal trauma patients by trained healthcare providers.

c. Computed tomography scan

- The principles of performing trauma CT scans are:
  - patient's clinical stability where resuscitation takes priority over imaging
  - information obtained will guide patient's further management
  - coordinated approach for imaging to minimise delays in diagnosis and treatment

The role of a CT scan in trauma is critical for effective patient management. It serves as a comprehensive diagnostic tool to:
- identify organ injuries
- detect active bleeding
- evaluate retroperitoneal injuries
- assess bone and soft tissue damage
- guide management decisions
- monitor progression of intra-abdominal injury

Overall, CT scans are indispensable in trauma care, offering precise, rapid and detailed information that guides life-saving interventions and improves patient's outcomes.

CT scan is performed for haemodynamically stable patients with any of the following:
- equivocal findings on physical examination
- suspicion for intrabdominal injury (e.g. abdominal pain, flank tenderness)
- associated neurological injury
- multiple injuries (e.g. chest injury, haematuria)
- mechanisms of injury suggestive of significant internal injury
- altered mental status (e.g. intoxication)

Two approaches for trauma CT scan of the polytrauma/severely injured patients are:
- selective CT scan protocol where specific body regions are imaged based on clinical judgment
- whole body CT (WBCT) scan which extends imaging from head to pelvis in order to identify a wide range of clinically important occult injuries

IV contrast should be administered when imaging the vascular system and/or abdomen and pelvis if there is no known anaphylaxis to contrast. In major trauma where the clinical scenario warrants the use of contrast, renal function test should not delay the CT scan.[64, level III]

i. CT scan protocol

The CT scan protocol in trauma patients is not standardised across institutions in the country. A variety of protocols are available which differ in timing of acquisition, number of phases and contrast injections. Good compromise between radiation dose, especially in young patients, and diagnostic image quality is essential. In the era where non-operative management of trauma patients is an option, choosing the best protocol capable in detecting and characterising injuries in detail, particularly vascular injuries, is important to guide therapeutic options. Following this approach, the radiologist plays a leading role to ensure timely and accurate diagnosis of trauma-related injuries. The characteristics of different CT scan abdomen protocols are summarised in the following table.

Table 2: Summary of characteristics of different CT scan abdomen protocol with IV contrast administration

CT scan protocol	Single phase	Multiphasic	Split bolus
Technique	• Single contrast media (CM) bolus and single CT scan acquisition in portal venous phase	• Single CM bolus with multiple CT scan acquisitions, at least arterial and portal venous phase	• Two or three CM boluses given sequentially with single CT scan acquisition
Advantages	• Adequate evaluation of parenchymal injuries and venous vessels • Lower radiation exposure in comparison with multiphasic CT scan protocol	• Comprehensive characterisation of vascular injuries (both arterial and venous) and parenchymal injuries	• Concurrent arterial and venous phases in only one scan • Lower radiation exposure in comparison with multiphasic CT scan protocoln
Disadvantages	• Only one phase acquisition may lead to misinterpretation or missed vascular injuries	• Higher radiation exposure compared with single phase CT scan protocol	• Single acquisition may lead to misinterpretation or missed vascular injuries • Higher CM dose compared with single phase or multiphasic CT scan protocol

Adapted: Iacobellis F, Romano L, Rengo A et al. CT Protocol Optimization in Trauma Imaging: A Review of Current Evidence. Curr Radiol Rep. 2020; 8:8

The accuracy of arterial phase CT scan in detecting arterial injury in reference to conventional digital subtraction angiogram based on evidence were as follows:

No.	Objectives	Population	Results	Ref
1.	CT scan diagnosis of arterial injuries due to blunt solid organ injury by performing triple phase scan (plain, arterial and venous phase)	44 patients who presented with clinical manifestations of blunt abdominal injury and CT scan done for diagnosis of arterial injuries due to solid organ trauma and later underwent digital subtraction angiography	High sensitivity and specificity for active extravasation (Sn: 93.3%, Sp: 97.7%, accuracy: 96.6%) Moderate specificity for pseudoaneurysm (Sn: 90%, Sp: 75%, accuracy: 82.8%) Moderate sensitivity for arteriovenous fistula (Sn: 66.7%, Sp: 100%, accuracy: 96.6%)	65, level III
2.	Overall accuracy of single, dual and triple phase contrast CT scan in detecting splenic vascular injuries	88 patients who sustained blunt splenic trauma and underwent contrast-enhanced MDCT scan and subsequent angiography	Triple phase CT scan was more accurate than dual phase CT scan in detection of splenic vascular injury (97.4% vs 76.2%, p=0.015) Dual phase CT scan (arterial and portal phase or portal and delayed phase) was more accurate in detection of splenic vascular injury than single phase CT scan (76.2% vs 37.5%, p=0.029)	66, level III
3.	Dual phase CT scan in detecting arterial injuries in blunt abdominopelvic trauma	83 patients with abdominopelvic trauma diagnosed by CT scan with arterial injuries and compared with DSA	Combining both arterial and portal phases led to improved sensitivity (92.6% for active extravasation and 88.8% for pseudoaneurysm) but similar specificity (90.0% for active extravasation and 91.4% for pseudoaneurysm)	67, level III
4.	Single phase CT scan of late arterial thorax and early venous phase of abdomen/pelvic in detecting vascular injury	89 patients who underwent CECT scan then angiography for the evaluation/treatment of traumatic injuries to the abdomen and pelvis	Moderate sensitivity of 83% but poor specificity of 55% in detecting active extravasation, pooling of contrast (blush), AV shunting, amputated/truncated vessel and pseudoaneurysm	68, level III

Abbreviation: Sn=sensitivity, Sp=specificity, Ref=reference

Recommendation 8
- All abdominal trauma patients undergoing contrast-enhanced computed tomography scan should have at least arterial and portovenous phases which can be obtained by either multiphasic or split-bolus protocol.

ii. Whole-Body CT scan

Delay in timely diagnosis of traumatic injuries can have potentially life-altering implications in the acute setting of trauma care. WBCT scan trauma protocols aim to quickly identify all life-threatening injuries without reliance on exam-directed imaging to decrease the time to intervention.

One diagnostic study included in a local technology review comparing the use of WBCT scan with selective CT scan in adults with blunt trauma patients showed high specificity (97.5% to 99.8%) but low and variable sensitivity in detecting injuries to different body regions (84.6% for head and neck, 79.6% for facial, 86.7% for chest, 85.7% for abdominal and 86.2% for pelvic).[69, level I]

There was conflicting evidence on the effectiveness of WBCT scan in reducing mortality when compared with selective CT scan or non-WBCT scan in trauma. Three meta-analyses showed significant reduction of mortality in WBCT scan with OR ranged from 0.66 to 0.75.[70 - 72, level II-2] While another two meta-analyses including a large and recent one showed NS reduction in mortality.[73, level III; 74, level II-2]

A meta-analysis of five cohort studies on routine WBCT scanning in trauma patients found significant reduction time spent in ED (WMD= -32.39 min, 95% CI -51.78 to -13.00) compared with selective CT scan.[74, level II-2]

However, there was some significant heterogeneity between studies included in all meta-analyses in terms of patients' injury severity and stability as well as CT scan locations/distance from ED.

Imaging protocol that has been used for WBCT scan are as below:[64, level III]
- plain - head and cervical spine
- arterial phase of chest and upper abdomen (included kidneys) or chest to pelvis in suspected pelvis injury
- portal venous phase - abdomen and pelvis

Additional phases of CT scan may be added as indicated by clinical presentation of patients e.g.[75]
- delayed scan for suspected kidney/liver injury

- CT cystogram for suspected bladder injury especially patient with pelvic fracture
- CT scan pelvis with rectal contrast for suspected rectal injury

In a meta-analysis on adult patients with penetrating traumatic abdominopelvic injury, there was NS difference in sensitivity and specificity between CT scan with and without enteric contrast material.[76, level III] This procedure also will cause delay. Therefore, oral contrast is not used in acute WBCT scan in trauma.[64, level III]

Improvements in speed and accuracy of CT scan made immediate WBCT scan feasible as a diagnostic tool for severely injured trauma patients.

Existing evidence divides the criteria to perform WBCT scan in trauma into three categories which are physiological, anatomical and mechanism of injury.[77 - 81, level III] Based on these, the CPG DG suggest that patients who fulfil at least two criteria from any two of the three categories may be considered for WBCT scan as shown in **Table 3**.

Table 3: Criteria to consider for WBCT scan

Physiological	Anatomical	Mechanism
• GCS ≤13 or abnormal pupillary reaction • SBP <100 mmHg • Pulse rate <50 or >120 beats per minute • Respiratory rate <10 or >29 breaths per minute • Oxygen saturation <90% on air • Estimated exterior blood loss ≥500 ml	• Visible injury to >1 body part involving head, neck, chest, abdomen and pelvis (exclude extremity) • Flail chest, open chest or multiple rib fractures • Positive FAST scan • Suspected unstable pelvic fracture • Vertebral fractures/ spinal cord compression	• Fall from a height (>4 m) • Wedged or trapped chest/abdomen • Ejection, rollover or death of passenger in same vehicle • Pedestrian, cyclist or motorcyclist hit by moving vehicle • Explosion

In a sub-analysis of REACT-2 trial, trauma patients with one of the following characteristics are contraindicated for WBCT scan:[77, level III]
- age <18 years old
- pregnancy
- low-energy trauma with blunt injury mechanism
- a stab wound in one body region
- unstable to undergo a CECT scan
- require cardiopulmonary resuscitation or death is imminent
- require immediate operation

However, the CPG DG opines the above patients who are stable may be considered for selective CECT scan if indicated in conjunction with ALARA (As Low As Reasonably Achievable) principle.

Recommendation 9

- Whole body computed tomography scan may be considered in patients with abdominal trauma who fulfill at least two criteria from any two of the three categories (physiological, anatomical and mechanism of injury)*.

*refer to **Table 3**

The Specialist Trauma Advisory Network Guideline recommends the target completion of CT scan for stable patients is 30 minutes, door to door (from the time the patient departs the ED until he/she returns to ED).[75] In local setting, there are various factors influencing time for completion of CT scan e.g. infrastructure, personnel, patient load and policy issues. Priority should be given to trauma patients despite all these adversities. Further improvement to all these factors is important to ensure timely management for all trauma patients.

iii. CT scan for blunt abdominal injury

CT scan, particularly with IV contrast, serves as a pivotal non-invasive tool in the assessment of BAT. It enables not only the detection of solid organ injuries but also facilitates grading based on morphologic imaging features. CT scan also provides critical insights into haemodynamic status by demonstrating signs of hypoperfusion and hypovolaemia. It can pick up injuries that might not be obvious on physical examination or ultrasound which in turn help healthcare providers decide if a patient needs surgery, interventional radiology or can be managed non-operatively. Although CT scan can suggest the severity and scope of injuries, a detailed classification system lies beyond the scope of this CPG.

In a systematic review on patients with thorax and/or abdominal blunt trauma, CT scan features of hypoperfusion and hypovolaemic complex showed that hypovolaemic shock complex (presence of ≥2 vascular and/or visceral CT scan signs of hypovolaemia) had an ROC of 0.88 in predicting mortality.[82, level II-2] The vascular and visceral signs are as below.

Vascular signs (representing true hypovolaemic state)	Visceral signs (Representing hypoperfusion state)
• Flat inferior vena cava/IVC (AP diameter <9 mm infrarenal IVC) • IVC halo (extracellular fluid) • Small aortic calibre (aortic diameter <1.3 cm, measured at 2 cm above and below renal artery origin)	• Shock bowel: bowel wall thickening >3 mm, increased bowel wall enhancement density Hounsfield Unit/HU more than psoas muscle density and bowel dilatation >2.5 cm • Shock liver: altered and/or heterogeneous parenchymal enhancement • Shock pancreas: altered pancreas enhancement and peripancreatic fluid • Adrenal enhancement: higher density compared with IVC • Kidney enhancement: cortical hyper-enhancement more than aortic density in portovenous phase • Spleen hypo-enhancement: <20 HU than liver in portovenous phase • Spleen volume changes: >30% volume loss from baseline scan or to a normal for age and gender • Gallbladder enhancement: >50 HU higher than psoas muscle

In a cross-sectional study on hemodynamically stable patients with blunt abdominal trauma, blush on CT scan was the only independent prognostic factor for surgical or angiographic intervention (OR=11.7, 95% CI 5.1 to 30.8).[83, level III]

In patients with BAT without solid organ injury who are haemodynamically stable but suspicious of having traumatic blunt bowel and mesenteric injury (BBMI), clinical sign of abdominal guarding and free fluid in CT scan, or presence of three or more minor CT scan findings are significant predictors for early surgical repair. Abdominal guarding and, bowel wall discontinuity and extraluminal air warrants exploratory laparotomy with PPV of 100% and 83.3% respectively.[84, level III] The specific and minor CT scan findings of BBMI are as listed below.

Specific CT scan findings of BBMI	Minor CT scan findings of BBMI
• Bowel wall discontinuity • Active bleeding • Extraluminal air	• Intramural air • Bowel wall thickening • Abnormal bowel wall enhancement • Mesenteric stranding • Free fluid

A study examined the performance of CT scan in diagnosis of ischaemic mesenteric laceration after blunt trauma and the predictive value of various CT scan signs for the injury found two predictors of such injuries were segmental bowel hypo-enhancement and abdominal wall injury which yielded an AUC of 0.87.[85, level III]

A CT scan-based predictive model for major arterial injury after blunt pelvic ring disruptions which helped to predict the need for transarterial embolisation (TAE) before clinical deterioration of patients demonstrated that:[86, level III]

- haematoma volume of 433 ml had high PPV in ruling in major vascular injury
- haematoma volume had significantly moderate correlation with 48-hour transfusion requirement

iv. CT scan for penetrating abdominal injury

A diagnostic study on CT scan in penetrating abdominal trauma patients showed high accuracy in detecting penetrating injury at anterior abdomen and posterior/thoracoabdominal transition zone (96.7% and 96.6% respectively).[87, level III]

Two diagnostic studies in haemodynamically stable adults with penetrating injuries involving thoraco/abdominal region found the diagnostic performance of CT scan in detecting solid organ, hollow viscus/mesenteric or diaphragmatic injuries as below.

Organ injury	Results
Solid organ	Moderate to high sensitivity and specificity in detecting injuries of:[88, level III] • gallbladder (Sn 100% and Sp 95%) • pancreas (Sn 100% and Sp 89%) • spleen (Sn 86% and Sp 97%) • liver (Sn 60% and Sp 82%)
Gastrointestinal/ mesentery	Variable sensitivity and specificity in detecting injuries of:[88, level III] • gastrointestinal (Sn 79% and Sp 47%) • mesentery (Sn 24% and Sp 85%)
Diaphragm	Low to moderate sensitivity of 36 to 75%[88 - 89, level III] Moderate to high specificity of 75 to 92%[88 - 89, level III]

Abbreviation: Sn=sensitivity, Sp=specificity

In another diagnostic study on hemodynamically stable adults with abdominal gunshot wounds and without peritonitis with attempted non-operative management, different CT scan findings for hollow viscus injury (HVI) like the absence of intraabdominal free fluid could be used to rule out HVI, while the presence of a mural defect, abnormal wall enhancement, or wall irregularity is considered as a strong predictor of HVI as shown below.[90, level III]

CT scan Findings	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Abdominal free fluid	100	89	69	100
Fat stranding	91	88	65	97
Diffuse free air	70	96	81	93
Mural wall defect	30	99	93	85
Abdominal wall enhancement	70	97	86	93
Wall irregularity	79	96	85	95
Wall thickness	88	95	83	97

Abbreviation: PPV=positive predictive value; NPV=negative predictive value

The evaluation of CT imaging in penetrating abdominopelvic trauma starts from the skin surface and surrounding soft tissues to identify entry and exit wounds - especially in gunshot injuries. Critical findings include intraperitoneal free fluid or blood, which may appear as a sentinel clot (the highest attenuation portion of a blood clot) or as a haematocrit effect (where clotted blood layers dependently within the haemoperitoneum). The presence of pneumoperitoneum is nonspecific, as air may enter the peritoneal cavity along the tract of the penetrating object. Other significant CT scan findings include:[91, level III]

Site of injuries (Organs)	Direct CT scan signs	Indirect CT scan signs
Vascular structures	• Through-and-through transection of the vessel, or partial-thickness wall defect • Laceration with active haemorrhage • Intraluminal flap • Thrombosis or caliber narrowing • Pseudoaneurysm • Arteriovenous fistula • Bullet embolism	• Abnormalities of the perivascular tissues or end-organs
Bowel including rectum	• Discontinuity of bowel wall • Mural hematoma	• Wound tract extending adjacent to a segment of bowel • Pericolonic/Perirectal fat stranding and/or hematoma • Pneumoperitoneum
Mesentery	• Narrowing or occlusion of mesenteric vessels	• Intra-mesenteric free fluid or hematoma

	• Beading of vessels or pseudoaneurysm • Active extravasation of contrast from the mesenteric vessels	• Mesenteric fat stranding
Urinary bladder	• Wound tract coursing near or through the bladder • Extravasation of contrast from the bladder (intra- or extra-peritoneal) • Urinary bladder wall thickening	• Unexplained free fluid in the pelvis • Haemorrhage in the space of Retzius (retropubic/prevesical space)
Solid organs such as liver, spleen,kidney and pancreas	• Haematoma, intraparenchymal and/or subcapsular • Laceration • Active intraparenchymal contrast extravasation	

Recommendation 10

- Contrast-enhanced computed tomography scan should be performed in haemodynamically stable abdominal trauma patients with suspected intra-abdominal injury to guide treatment.

v. CT scan consideration in obese patient

Obese patients with abdominal trauma pose a challenge to be assessed clinically and radiologically. Most modern scanners have high weight limits; however, the scanner bore is the most common limiting factor in these patients. Patient's weight and body circumference should be measured prior to CT scan. A published list of weight limits and bore diameters of scanners within local networks should be available to help plan transfer of severely injured patients to appropriate centres for imaging.[92]

vi. Turn-around time of CT scan report

Royal College of Radiology states that a provisional primary survey report should be issued as soon as possible to the trauma team. The final formal report on severely injured patients is recommended to be provided within one hour of CT scan. This should be provided by a radiologist or by an appropriately experienced radiology trainee, with a consultant addendum added within 24 hours. On-call consultant radiologists are recommended to have teleradiology facilities at home that allow timely review of images.[92]

- In Malaysia, due to multiple variation and constraints i.e. hospital set-up, manpower and logistics, the CPG DG opines that provisional verbal CT scan report of trauma cases should be conveyed to the treating team within 30 minutes after completion of CT scan. Formal report should be provided within the next three hours.

vii. CT scan for monitoring
CT scan monitoring in abdominal trauma may be indicated for assessing the need of delayed exploration or angiography.

A study on early CT scan (within 24 hours) done in post-operative hepatic trauma patients without pre-operative CT scan, in guiding need for angiography, showed presence of hepatic extravasation or pseudoaneurysm had likelihood ratio of 3.33 for predicting positive angiography result. A negative result had likelihood ratio of 5.74 for either not performed or negative later angiography.[93, level III]

A diagnostic study showed that repeat CT scan within 72 hours in blunt abdominal trauma (BAT) patients who were initially managed non-operatively in determining the need for delayed exploration showed increased sensitivity to 100% and also improved specificity to 86%.[94, level III]

- Post-operative or repeat CT scan in abdominal trauma may be indicated based on grade of severity of injury and clinical judgement of treating doctor.

4.4. Procedures

Diagnostic peritoneal tap and lavage (DPL) is a bedside procedure, whereby a catheter is inserted into the peritoneal cavity to aspirate for blood/enteric content and to infuse fluid which is re-aspirated for laboratory analysis. It offers information about intraperitoneal solid organs and hollow viscus injury. DPL does not assess the retroperitoneum.

Because it is an invasive procedure, DPL should only be performed by trained personnels and is reserved for certain clinical scenarios e.g. subcutaneous emphysema impeding ultrasound images, existing or unexplained free fluid (to differentiate ascitic fluid with blood) or to rapidly determine the presence of haemoperitoneum in unstable patients when imaging is not feasible or is non-diagnostic.

A diagnostic study on the accuracy of cell count ratio of WBC/RBC in DPL in haemodynamically stable blunt abdominal trauma patients with suspicious CT scan findings of blunt bowel and mesenteric injury found:[95, level III]

- positive ratio ≥1 had a sensitivity of 100%, specificity of 62% and accuracy of 78% based on laparotomy findings
- ratio of ≥4 increased the specificity to 90% and accuracy to 92%

The role of DPL was demonstrated in a small RCT on abdominal trauma patients where DPL detected more bowel injuries compared with FAST ($p=0.011$) in patients who underwent laparotomy.[96, level I]

- Diagnostic peritoneal lavage is an alternative bedside method to assess for intraperitoneal injury in haemodynamically unstable trauma patients if imaging modalities are not feasible or non-diagnostic in centres with surgical services.

5. ABDOMINAL ORGAN INJURY SCALE

Trauma care demands precise evaluation and swift decision-making to mitigate life-threatening injuries. The Organ Injury Scale (OIS) is an important tool that categorises the severity of organ damage across various body systems. By standardising the grading of injuries, it aids in clinical decision-making, facilitates communication within multidisciplinary teams and ensures consistency in trauma registry/research. This grading system not only guides initial resuscitation and surgical planning but also supports long-term outcome predictions. Understanding and applying the OIS is fundamental to advancing trauma care and improving survival rates in critically injured patients.

- It is important to grade the severity and extent of abdominal trauma using validated severity scoring systems. It can also be used for communication between the various healthcare providers and patients/carers as well as for audit and quality improvements.

5.1. Severity of Abdominal Organ Injury

There are various scoring systems used to score the severity and extent of abdominal trauma e.g. American Association for the Surgery of Trauma (AAST) Organ Injury Scale (OIS), Abbreviated Injury Score (AIS), Injury Severity Score (ISS) and New Injury Severity Score (NISS).

a. American Association for the Surgery of Trauma Organ Injury Scale

The AAST OIS is a system developed by the American Association for the Surgery of Trauma to standardise the classification of trauma-related injuries of various organs. It is a key tool used by healthcare professionals to assess the severity of injuries to specific organs, determine the appropriate treatment and predict the potential outcomes for the patient.[97]

The AAST OIS grades injuries based on their severity, ranging from Grade I (minor) to Grade V (severe). The scale is applied to various organs commonly injured in trauma, including the liver, spleen, kidneys, pancreas and intestines.

The CPG DG opines that the AAST OIS should be used to grade severity of injury in all trauma patients for easier communication and guiding management based of severity grading.

b. Abbreviated Injury Scale

AIS provides a whole-body assessment including fractured bone, soft tissue injury and others. In AIS, every injured organ is assigned a code 1 to 6 based on its severity as shown below.

AIS Code	Description
1	Minor
2	Moderate
3	Serious (non-life-threatening)
4	Serious (life-threatening, survival probable)
5	Critical (survival uncertain)
6	Unsurvivable (with current treatment)

AIS enables ranking of injury severity and correlates with patients' outcomes. The latest AIS 15 was published in 2015.[98]

c. Injury Severity Score

ISS is validated for use in blunt and penetrating injuries among adults and children >12 years of age. It is an anatomical score derived from the AIS on the following six body regions i.e.:

- head and neck
- face
- thorax
- abdomen and visceral pelvis
- bony pelvis and extremities
- external structures (skin, burns)

ISS is defined as the sum of squares of the highest AIS grade in the three most severely injured body regions. Only one injury per body region is allowed. The ISS score ranges from 1 to 75. A score of >15 is considered major trauma. The score correlates with mortality, morbidity and length of hospital stay of the patients. It is also a predictor for post-injury multiple-organ failure.[99, level III]

d. Modified/New Injury Severity Score

Compared with ISS, the NISS is calculated based on the three most severe injuries regardless of body region.

A retrospective cohort study on blunt trauma patients comparing NISS and ISS found that the former was significantly better in predicting trauma outcomes as shown below:[100, level II-2]

- mortality (AUC 0.733 vs 0.708) in severe patients with ISS ≥25; but similar in overall severity
- ICU admission (AUC 0.727 vs 0.713)
- ICU length of stay (AUC 0.772 vs 0.760)

Recommendation 11
- All abdominal trauma patients should have their injury severity graded using the American Association for the Surgery of Trauma Organ Injury Scale.

6. TREATMENT

Abdominal trauma represents a significant clinical challenge due to the risk of rapid deterioration and life-threatening complications. It encompasses a wide spectrum of injuries, from minor contusions to severe damage involving vital organs and major blood vessels. Such trauma can result from blunt forces, penetrating injuries or a combination of both, each requiring a tailored approach to diagnosis and treatment. The trauma can be further subdivided into stable and unstable depending on the haemodynamic status.

Treatment strategies may range from non-operative management for stable patients with isolated injuries to urgent laparotomy for those with uncontrolled bleeding, peritonitis or haemodynamic instability. Multidisciplinary collaboration involving primary care providers, emergency physicians, surgeons, radiologists, anaesthesiologists, intensivists and other specialties is vital to ensure comprehensive care.

Exploratory laparotomy is advocated for patients exhibiting signs of haemodynamic instability and peritonitis to effectively manage haemorrhage and contamination.[101, level III] It has remained the management of choice in certain situations, e.g. in patients who have free intraperitoneal fluid of uncertain origin, signs indicating intestinal ischaemia, mesenteric bleeding or hollow viscus perforation.[102]

- The principles of management in abdominal trauma are:
  - systematic and timely assessment of injuries
  - resuscitation and stabilisation of the patient
  - control of haemorrhage and/or contamination
  - prevention of secondary injuries

6.1. Treatment of Stable Abdominal Trauma

Patients with stable abdominal trauma may undergo more diagnostic imaging e.g. USG, CT scan and angiogram if necessary. This is important to identify organ involvement, grade severity of injury and plan appropriate treatment. This group of trauma patients may be treated with surgery or non-operatively depending on the diagnostic findings.

6.1.1. Stable blunt abdominal trauma

In haemodynamically stable patients without obvious external injury, the diagnosis of blunt abdominal injury is difficult to establish. The role of diagnostic imaging is increasingly useful in identifying solid organ, hollow viscus and retroperitoneal organ injury. The hollow viscus injury can be more apparent within 24 hours when patients start to develop signs of peritonitis. The retroperitoneal structures injury, e.g. in pancreas and duodenum, can be missed at the initial stage of diagnosis.[9]

a. Surgical Intervention

In patients with haemodynamically stable BAT, surgical intervention is warranted in the presence of the following clinical and imaging findings:

- clinical
    - generalised peritonitis
    - failure of non-operative management
    - positive DPL when CT scan is not feasible
- imaging (CT scan findings)
    - vascular blush
    - finding suggestive of bowel injury (e.g. pneumoperitoneum, bowel wall discontinuity, mesenteric stranding etc.)
    - diaphragmatic injury
    - presence of unexplained free fluid without solid organ injury

However, this list is not exhaustive, refer to **Subchapter 4.2 (c)** on **Computed Tomography scan**. The final decision for surgery is the attending surgeon's prerogative depending on patient's condition.

A cross-sectional study on hemodynamically stable patients with BAT showed blush on CT scan was the only independent prognostic factor for surgical or angiographic intervention (OR=11.7, 95% CI 5.1 to 30.8).[83, level III]

In BAT patients, a combination of clinical, radiological and laboratory findings would increase the diagnostic accuracy of surgical hollow viscus injury. The presence of severe fluid collection (isolated free fluid without solid organ injury) on abdominal CT scan is a significant predictor of surgery (OR=13.88, 95% CI 2.09 to 92.23). It has an AUC of 0.863 (95% CI 0.743 to 0.942) for predicting surgery.[103, level II-2]

i. Laparatomy and laparoscopy

Laparotomy has traditionally been the gold standard for abdominal exploration in trauma cases. However, in recent years, laparoscopy has become widely accepted for many general surgery procedures.

Diagnostic and/or therapeutic laparoscopy in abdominal trauma is feasible and safe. Appropriate use of pre-operative imaging, adherence to pre-determined steps of procedure and standard systematic laparoscopic examination can accurately identify intra-abdominal injuries and minimise the rate of missed injuries.[104, level III]

A cross-sectional study on both penetrating and blunt abdominal trauma, laparoscopy was significantly associated with reduced length of hospital stay, lower healthcare costs and fewer post-operative complications compared with laparotomy.[105, level III]

A small cohort study compared therapeutic laparoscopy vs laparotomy in haemodynamically stable abdominal trauma patients and found:[106, level II-2]

- NS difference in median operating time (105 vs 98 min)
- laparoscopy group had significantly lower post-operative complications (1 vs 10), opiate analgesia requirements (34 vs 136 mg of morphine or equivalent/MEQ) and hospital stay (4 vs 9 days)

When diagnostic laparoscopy was compared with non-therapeutic laparotomy in hemodynamically stable trauma patients in a large cross-sectional study, the former was independently associated with:[107, level III]

- lower mortality (OR=0.10, 95% CI 0.04 to 0.29)
- lower major complications (OR=0.38, 95% CI 0.29 to 0.50)
- shorter hospital LOS ($p<0.001$)

A meta-analysis on effectiveness and safety of laparoscopy vs laparotomy for BAT patients found that laparoscopy had:[108, level II-2]

- lesser blood loss (SMD=0.28, 95% CI 0.51 to 0.05)
- shorter hospital stay (SMD=0.67, 95% CI 0.90 to 0.43)

There was NS difference in mortality and operation time. Based on Newcastle-Ottawa Scale (NOS) assessment, the primary papers were of moderate quality.

In patient suspected to have significant hollow viscus and mesenteric injury, another cross-sectional study of similar comparison found laparoscopic surgery had shorter hospital LOS (11.0 days vs 17.6 days, $p<0.001$) and fewer wound infections (5.1% vs 16.1%, $p=0.049$) than laparotomy.[109, level III]

In centres without competent surgeons to perform laparoscopic surgery, exploratory laparotomy is the surgical option in BAT patients.

- Laparoscopic surgery in trauma is different and more challenging from general laparoscopic procedures, therefore careful patient selection for the procedure is crucial to achieve the best outcome.
- Missed injuries may result in morbidity and mortality in abdominal trauma patients. Laparoscopic assessment of the abdominal cavity done systematically will reduce missed injuries in abdominal trauma.
- Laparoscopic surgery should be avoided in patients with traumatic brain injury as it increases intra-abdominal pressure and induces hypercarbia which will increase intracranial pressure and cause long-term adverse neurological outcomes.[110, level II-3; 111]

Recommendation 12
- Laparotomy is the preferred option in stable abdominal trauma patients requiring surgical intervention.
- Laparoscopic surgery may be offered in abdominal trauma patients who are haemodynamically stable and without traumatic brain injury.
  - Laparoscopic surgery should be performed by surgeons experienced and competent in trauma laparoscopy.

b. Non-operative management

According to an International Consensus Conference in 2018, non-operative management (NOM) is defined as an initial non-surgical management strategy of a solid organ injury which usually consists of observation, but may include the use of endovascular, percutaneous or endoscopic procedures.[112, level III] The principles of NOM are to promote haemostasis, maintain clot formation, enhance healing and preserve organ function.[113, level III]

NOM has become the standard of care for haemodynamically stable patients with blunt solid organ injuries without any other indication for exploratory laparotomy, with overall success rates of 80 - 95%. Advantages of NOM are reduction of non-therapeutic and negative laparotomies rates, preservation of organ function, avoidance of overwhelming post-splenectomy infection and reduction of post-operative complications. However, NOM carries a risk of missed injury e.g. hollow viscus perforation, diaphragmatic injury and delayed bleeding. NOM should only be considered in centres with 24-hours availability of surgical services, operating theatres, ICU and other supporting resources due to the need for close monitoring for haemodynamic deterioration or progressive peritonism which will warrant intervention i.e. failure of NOM.[113, level III; 112, level III]

In a local cross-sectional study on management of patients with blunt injury to liver, spleen and/or kidney at a trauma centre, the results were as follows:[114, level III]
- majority of blunt trauma patients (74.6%) underwent initial NOM
- almost all NOM was successful (97.3%)
- NOM was employed more than surgery in both isolated and combined organ injuries ($p<0.001$)
- more high-grade liver and kidney injuries were treated with NOM while high-grade splenic injuries were managed surgically

i. Spleen

Patients with blunt splenic injuries regardless of AAST grade can be managed non-operatively when they are haemodynamically stable and without peritonitis or associated abdominal injuries requiring surgery.

CECT scan must be performed to identify and assess the severity of splenic injury and evaluate associated injuries in order to determine feasibility of NOM.[112, level III]

A systematic review of 10 cohort studies looked at NOM with or without angiography and angioembolisation for patients with blunt splenic injury and found that the significant prognostic factors for failure were:[115, level II-2]

- age >40 years, ISS >25 and splenic injury grade >3 based on strong level of evidence
- abdominal AIS score >3, TRISS <0.80, intraparenchymal contrast blush and transfusion of >1 U of blood based on moderate level of evidence

The need for RBC transfusion in ED is also a significant risk factor for failure of NOM in blunt splenic trauma.[116, level III]

ii. Liver

The decision for NOM in liver injuries is appropriate if there is the ability to predict the need for surgery before the patient deteriorates; therefore, NOM for liver injuries should only be done in centres where the injury can be diagnosed and graded accurately, and surgeons are able to rapidly respond to changes in patient's status and intervene if complications arise. Constant clinical monitoring and OT availability at all times is mandatory to consider NOM in liver injuries.[112, level III]

In a cross-sectional study on management of patients with blunt liver trauma at a trauma centre over 10 years, the findings were:[117, level III]

- surgically-treated patients had more complications than NOM (23.7% vs 10.5%)
- mortality rate was lower in NOM than surgical management (0% vs 16.9%)
- mean length of hospital stay was longer in surgically-treated patients than NOM (p=0.0004)

Most liver injuries treated with NOM heal without complications. Complication risks increase with injury grade from 1% in grade 1 to 63% in grade 5, and include necrosis, abscess, biliary leaks, biloma, haemobilia and delayed haemorrhage.[112, level III]

iii. Kidneys

NOM is acceptable for all haemodynamically stable renal injuries. Before considering NOM, accurate grading of renal injuries by CECT scan with delayed urographic phase is mandatory to assess vascular blush and urinary leak.[118, level III] The American Urological Association suggests repeating CT scans in high grade renal injury (grade IV and V) and those with clinical signs of complications e.g. high grade fever, worsening/persistent back pain, haematuria after 48 hours of admission.[119] A study looking at 157 CT scans of renal injuries found collecting system involvement in 22 patients, where half of them had urinary leak detected only on follow-up scans.[120, level III]

Data from AAST genitourinary trauma study showed that 80% of high-grade renal trauma (grade III to V) utilised NOM. The rate of nephrectomy was 15% in grade IV and 62% in grade V injuries. Risk factors contributing to failure of NOM are grade V injury and penetrating mechanism.[121, level III]

Presence of urinary contrast leak and ipsilateral hydronephrosis are indications for intervention (uretheric stenting, percutaneous nephrostomy and percutaneous drainage for collections) but they are not absolute contraindication for NOM.[118, level III]

iv. Pancreas

Pancreatic injury is rare (0.2 - 12% of abdominal injuries) but has high morbidity (53%) and mortality (21.2%), especially with delayed diagnosis. NOM is acceptable for low grade injuries (grade I and II). Failure rates for grade III and IV are at 10 - 50% with complication rates of 30% (e.g. pancreatitis, pseudocyst and fistula formation).[122] For major pancreatic duct injuries in haemodynamically stable patients with contained pancreatic enzyme leakage, endoscopic retrograde cholangiopancreatography (ERCP) with transpapillary stenting or sphincterotomy with/without percutaneous drainage is reasonable.[113, level III]

v. Multiple organ injuries

Compared with isolated solid organ injury, multiple concurrent injuries have a higher failure rate of NOM, more associated hollow viscus injury, higher need for blood transfusion and surgeries, higher risk of sepsis, longer hospital stays and increased ventilator days. However, mortality rates are comparable. Blunt multiple solid organ injury nowadays is not a contraindication for NOM, but the surgeon should be aware of higher failure rates and risk of missed injuries.[113, level III]

vi. Extraperitoneal bladder perforation

Blunt extraperitoneal bladder perforation can be treated non-operatively, provided that there is continuous urinary drainage via urethral or suprapubic catheterisation. The diagnosis must be confirmed with a cystogram phase during CECT scan of abdomen/pelvis. Contraindications for NOM include involvement of bladder neck, bone fragments in the bladder wall, concurrent rectal/vaginal injury or entrapment of bladder wall.[55]

The CPG DG opines the following guide should be referred when considering NOM.

Non-Operative Management Guide in Abdominal Trauma
Prerequisites 1. Resources a. 24-hour access to surgeon, operation theatre, ICU care, CT scan and continuous monitoring capability b. Care of patients undergoing NOM should be led by a surgeon 2. Patient factor a. Haemodynamically stable b. No peritonitis 3. Injury factor a. Full extent and severity of injuries determined by CECT scan b. In polytrauma patients, the treatment plan should consider the severity of extra-abdominal injuries such as TBI, chest and extremity injuries, rather than addressing abdominal injuries in isolation.
Monitoring 1. Parameters to monitor a. Vital signs (BP, PR, RR, SpO2, Temperature, pain score) and GCS b. Fluid balance and urine output c. Clinical parameters e.g. presence of peritonitis d. Blood results e.g. blood gases analysis, Hb level, coagulation profile, renal profile, LFT 2. Complications – clinically or by re-imaging
Deciding factors for termination of NOM 1. Deterioration in the patient's haemodynamic status 2. Onset of peritonitis 3. Increased requirement of blood transfusion, suggestive of active bleeding 4. Radiological evidence of complications on reimaging (e.g. bleeding, hollow viscus perforation)
Note: Special population e.g. geriatric, obese, pregnancy, comorbidities, polypharmacy, will have unique characteristics which may affect interpretation of findings

- The keys for successful NOM for solid organ injuries are appropriate patient selection, correct AAST grading and identification of other associated intra-abdominal injuries which preclude NOM.
- For consideration of NOM, constant monitoring for haemodynamic deterioration and peritonitis, and having a contingency plan for failure of NOM is crucial.
- Risk factors for failure of NOM include patients' factors, transfusion requirements, grade of injury and evidence of active bleeding.
- A multidisciplinary approach with improved imaging quality and, endovascular and endoscopic services availability contributes to successful NOM for haemodynamically stable patients with blunt abdominal injuries.

Recommendation 13

- Non-operative management in abdominal trauma should only be performed in haemodynamically stable patients.
    - It should be undertaken in centres with 24-hours availability of surgical services, operating theatres, intensive care units and other supporting resources.
- Patients treated non-operatively should be closely monitored for clinical deterioration (e.g. haemodynamic instability and peritonitis) which warrants urgent intervention.

Refer to **Algorithm 1** on **Management of Haemodynamically Stable Abdominal Trauma Patients**.

6.1.2. Stable penetrating abdominal trauma

Diagnosis of penetrating injury caused by stabbing or gunshot can be challenging and difficult due to various factors (e.g. type of weapon, velocity of penetrating object, etc). Comprehensive clinical assessment and imaging e.g. x-rays and CT scan are required as the trajectory of the penetrating injury may involve two cavities.

a. Laparotomy/laparoscopy

In stable penetrating abdominal trauma, indications for surgery include:

- peritoneal breach including evisceration of bowel or omentum
- active bleeding from wound
- radiological findings suggestive of hollow viscus and/or solid organ injury.

Laparoscopy serves as a minimally invasive diagnostic alternative for assessing peritoneal penetration and ruling out significant intra-abdominal injuries, e.g. bowel perforation. Based on emerging evidence, diagnostic laparoscopy is increasingly supported by reliable data in demonstrating its effectiveness, making it a valuable option in stab wound injuries.

A cross-sectional study on penetrating abdominal trauma reported no missed injuries following standardised sequential operating steps on patients for laparoscopic surgery (45% of cases for diagnostic and 55% therapeutic).[104, level III]

Another cross-sectional study on haemodynamically stable patients with penetrating thoracoabdominal injury showed that diagnostic laparoscopy may reduce non-therapeutic laparotomies. A total of 26% of patients had negative laparoscopies. Among the remaining 74% who had positive findings, 77% had repair done laparoscopically while 23% was non-therapeutic. Diagnostic laparoscopy was especially useful for diaphragmatic injury which may not be detected on pre-operative CT scan with an accuracy of 75%. Thus, negative CT scan did not preclude surgical exploration in this group of patients.[89, level III]

In a cross-sectional study on abdominal trauma patients who had laparoscopic surgery, where majority of them had penetrating mechanism (85.2%) and only 14.8% patients required conversion to laparotomy and none had missed injury or mortality.[123, level III]

Whenever peritoneal violation is deemed likely after penetrating abdominal trauma, exploratory laparoscopy is advocated to rule out peritoneal perforation after initial radiologic survey in patients without clinical signs of peritonitis or evisceration.[102]

- The CPG DG opines that, in cases with transperitoneal gunshot wound trajectory, due to its high-velocity nature, laparotomy should be performed even in hemodynamically stable patients.

b. Serial abdominal examination/NOM

While emergent laparotomy remains the gold standard of treatment for haemodynamically unstable patients or those with clear signs of peritonitis, selective non-operative management is increasingly being adopted for stable patients without overt indications for surgery.

A cross-sectional study on patients with penetrating stab wounds of anterior abdomen who had stable haemodynamic status, GCS ≥12, pain localised at site of stab, no diffuse peritoneal irritation, no alcohol or drug abuse and wound did not need immediate surgery, serial clinical examination (SCE) every six hours had better diagnostic performance compared with CT scan (accuracy 100% vs 96%) in determining further management i.e. surgery or NOM.[124, level III]

In another cross-sectional study, patients with abdominal stab or gunshot wound who underwent a selective NOM (a structured protocolised NOM including CT scan, close observation for 24 - 48 hours and SCE), had failure of NOM and required laparotomy were categorised as delayed laparotomy group. This group was associated with lower risk of complications (OR=0.39, 95 % CI 0.16 to 0.98) compared with early laparotomy group. The analysis also showed that the complications were not attributed directly to the delay of laparatomy.[125, level III]

The CPG DG opines that, within the local setting, NOM of penetrating abdominal injuries may be considered in stab wounds, but not in gunshot wounds.

c. Local wound exploration

Local wound exploration (LWE) is performed to determine anterior abdominal fascia breach which may indicate peritoneal violation when there is no indication for immediate laparotomy. LWE has been primarily studied for anterior abdominal wounds, with limited evidence for gunshot wounds or flank and posterior wounds. The findings of LWE can vary based on clinician’s experience with a risk of false negative results, particularly in smaller stab wounds.

LWE can be safely conducted at the bedside in patients with stab wounds to the anterior abdomen by trained personnel but it requires appropriate patient selection and local anaesthesia. The procedure should be done with sterile technique, good lighting with both sharp and blunt dissection until the bottom of the wound is clearly visualised. Blunt probing with fingers or cotton swabs is unreliable and not advocated.[126, level III]

For anterior stab wounds, if exploration to the deepest extent of the wound demonstrates violation of anterior rectus fascia, patients will require further interventions (e.g. laparoscopy or laparotomy). Excessive fat tissue, dense muscle or presence of multiple wounds/ other injuries can compromise the procedure. If the anterior fascia is not clearly and completely seen, peritoneal injury cannot be ruled out and further evaluation is required (e.g. serial clinical examination, imaging or diagnostic laparoscopy).

In a diagnostic study on patients with anterior stab wounds, the sensitivity and specificity of LWE (performed by general surgeon in the emergency department) for peritoneal violation were both 100% compared with laparotomy.[127., level III]

When CT scan does not identify hard signs of bowel injury, LWE or diagnostic laparoscopy may be performed to investigate peritoneal violation which will guide decision for laparotomy or NOM.[128]

Recommendation 14
- For stable anterior penetrating abdominal trauma without peritonitis, peritoneal violation should be determined via either local wound exploration, computed tomography scan or diagnostic laparoscopy.
  - Presence of peritoneal violation requires further operative assessment and treatment via laparoscopy or laparotomy.

Refer to **Algorithm 3** on **Management of Penetrating Abdominal Trauma**.

6.2. Treatment of Unstable Abdominal Trauma

Patients with unstable abdominal trauma require prompt assessment, resuscitation and management decision plan, usually occurring simultaneously. Haemodynamic instability is defined as SBP <90 mmHg, PR>120 bpm and Shock Index >1.0.[15] The use of damage control resuscitation has been shown to prevent the progression of the lethal triad (hypothermia, acidosis and coagulopathy), thus significantly improves patients' survival and minimises morbidity.[129, level III]

For all major trauma patients with a SBP of <90 mmHg, there is a 50% likelihood of death, which will occur in a third of patients within the next 30 minutes if the bleeding is not controlled.[130, level III]

- The decision of sending the unstable patients straight to the operating theatre for prompt exploration or sending them for diagnostic CT scan can be challenging. This can be overcome by a multidisciplinary team (Trauma Team)'s assessment and collective decision.
- World Society of Emergency Surgery (WSES) Guidelines emphasise that in hemodynamically unstable patients, especially those with pelvic fractures, immediate interventions e.g. pre-peritoneal pelvic packing and external fixation are crucial. Advanced imaging should not delay these life-saving procedures.[128]

In a cross-sectional study on patients with severe abdominal injury and haemodynamic instability, those who underwent abdominal CT scan prior to laparotomy had higher risk of mortality relative to those who were taken to the operating theatre within the first 90-minute post-injury without undergoing abdominal imaging (OR=1.71, 95% CI 1.2 to 2.2).[131, level III]

The Prospective Observational Multicenter Major Trauma Transfusion (PROMMTT) study showed that patients who underwent laparotomy within 90 minutes of presentation with a FAST performed on arrival, increasing time to laparotomy was associated with increased in-hospital mortality at 24 hours (HR=1.50 for each 10-minute increase in time to laparotomy, 95% CI 1.14 to 1.97) and 30 days (HR=1.41, 95% CI 1.18 to 2.10).[132, level II-2]

In a multicentre cross-sectional study of trauma patients who received surgical intervention or TAE within two hours of injury in Asian countries, a longer interval to definitive care was significantly associated with higher 30-day mortality rate and poor functional outcome. Subgroup analyses showed the same association in the major trauma and torso injury groups in the same outcomes.[133, level III]

The significant predictors of mortality of patients with blunt abdominal injury in a cross-sectional study were:[134, level III]

- lower GCS
- lower SBP
- higher ISS
- higher number of transfused blood units

A cohort study on patients who underwent trauma laparotomy following blunt or penetrating abdominal trauma found an overall mortality rate of 59.6%. Several factors significantly associated with the increased mortality included GCS and ISS.[135, level II-2]

- Unstable abdominal trauma can be caused by major intra-abdominal bleeding from solid organs or abdominal vascular injury and peritonitis secondary to contamination following hollow viscus perforation. This group of trauma patients requires immediate arrangement for emergency laparotomy to arrest the bleeding or clear and clean the contamination.
- Immediate surgery, e.g. damage control surgery (DCS), is indicated if the patient remains unstable despite initial resuscitation.
- DO NOT perform CT scan in persistently unstable patients as it may delay definitive surgical intervention.

Recommendation 15

- All haemodynamically unstable abdominal trauma patients should have acute emergency laparotomy within 90 minutes from arrival to emergency department.

6.2.1. Damage control surgery

Damage control surgery (DCS) is widely used and increasingly recognised as life-saving strategy in emergency surgery performed on physiologically deranged patients.[136, level III] It is a method used particularly in the management of severe intra-abdominal injuries where definitive surgical repair is not feasible due to patient's physiological instability. The decision for DCS may be made pre- or intra-operatively depending on the patient's condition.

DCS is a technique whereby the surgeon minimises operating time and surgical intervention in the haemodynamically unstable patient. The primary reason for this is to minimise hypothermia, metabolic acidosis and coagulopathy. It involves three main stages as stated below.

- **Initial abbreviated surgery**: This focuses on rapid control of haemorrhage and contamination, often using techniques like packing or shunting.
- **Physiological resuscitation in the ICU**: The patient is stabilised and their physiological parameters are optimised.
- **Definitive surgical repair**: Once the patient is stable, definitive surgical procedures are performed to restore normal anatomy and function.

While DCS has been shown to improve survival in severely injured trauma patients, it requires careful monitoring and re-evaluation to ensure optimal outcomes.[136, level III]

In a systematic review, indications to perform a DCS included among others:[137, level III]

- acidosis (increased lactate or decreased pH)
- hypothermia (temperature <34°C)
- shock (SBP <90 mmHg)
- >10 units packed RBC transfusion
- ISS >25

Although this technique is widely thought to reduce mortality in critically injured patients, some patients of DCS have been reported to have short-term (fluid and protein loss, sepsis, intestinal fistulae, nursing care challenges and economic costs) and long-term (chronic physical discomfort, physique embarrassment, delayed return to work and poor QoL) complications. Unnecessary use of this technique can lead to increased patients' morbidity and cost.[138, level III]

Refer to **Algorithm 2** on **Management of Haemodynamically Unstable Abdominal Trauma Patients**.

6.3. Interventional Radiology/Angioembolisation

Interventional radiology (IR) has emerged as an important strategy in the management of traumatic injuries. It is increasingly used to stop bleeding in injuries to solid abdominal organs, pelvic areas and peripheral arteries through a procedure called therapeutic transarterial embolisation (TAE). With advancements in expertise and equipment together with growing focus on non-surgical treatments, IR is becoming an adjunct in managing trauma in centres where the service is available.

Specific applications of IR in abdominal trauma include:

- solid organ injuries (e.g. liver, spleen and kidney): TAE of injured arteries to control bleeding and, preserve organs and their functions
- pelvic fractures: TAE is used to control arterial haemorrhage

Blush on CT scan is the only independent prognostic factor for surgical or angiographic intervention in stable BAT patients.[83, level III]

A cross-sectional study on patients with intrahepatic arterial bleeding after BAT showed that indications for selective angioembolisation included:[139, level III]

- an episode of hypotension or decreased Hb level during NOM (41.43%)
- active extravasation on CECT scan (38.57%)
- required angiogram for other injuries e.g. injury of spleen or aorta (12.86%)
- high-grade liver injury demonstrated by CT scan (7.14%)

In a small cross-sectional study of adult patients with splenic injuries who underwent emergency TAE in a mature trauma centre, there was NS difference between patients who were haemodynamically unstable and stable in survival rate (88.2% vs 100%) and re-bleeding rate (23.5% vs 5.0%). Splenectomy was required for 5.9% of unstable patients for re-bleeding.[140, level III]

In another cross-sectional study, there was NS difference in hospital mortality between splenectomy and angioembolisation for severe blunt splenic injury, based on propensity score matched analysis.[141, level III]

TAE has been used in the NOM of renal trauma across all injury grades. When TAE is incorporated into the NOM treatment algorithm, the success rates of treatment is up to 94.9% for grade III injuries, 89% for grade IV, and 52% for grade V injuries.[55]

For high-grade renal injuries, TAE has not only shown a high rate of clinical success but also preservation of renal function. There is NS difference in renal function at six months follow-up between TAE group and other management strategies.[142, level II-2]

A systematic review on the role of TAE in blunt renal injury patients, with most having high-grade trauma (55% with grade IV and 20% with grade V), showed that TAE was successful in 92% of grade III - IV injuries and 76% of grade V injuries. Success was higher in hemodynamically stable patients (90%) compared with unstable patients (63%).[143, level II-2] Most of the primary papers were graded as intermediate or high quality based on NOS quality appraisal score.

- In Malaysia, the IR service is currently limited to regional centres. Where the service is available, TAE plays a role in the treatment of haemodynamically stable patients with arterial bleeding in abdominal trauma.

6.4. Analgesia

The use of analgesia does not interfere with the diagnostic process in abdominal pain.[144, level III] All patients with abdominal trauma should be assessed for pain regularly to ensure they receive adequate pain relief with minimal side effects. Although patients' self-report of pain is the gold-standard, pain must be objectively measured using pain assessment tool e.g.:[145, level III, 146, level III]

- Numerical Rating Scale (NRS) – score from 0 to 10
- Visual Analogue Score (VAS) – a mark made on a line of 100 mm long
- Functional Score – ability to walk, sit, cough etc
- Behavioural Pain Score (BPS) or Critical-care Pain Observation Tool (CPOT) - in critically ill adults unable to self-report

Abdominal findings during physical examination may give additional information in eliciting pain score.

Based on the Modified WHO Analgesic ladder for acute pain management, non-opioid analgesics should be initiated for mild pain. Weak opioids e.g. tramadol, may be prescribed for moderate pain, while strong opioids e.g. fentanyl or morphine are recommended for severe pain.[144, level III; 145, level III] In patients with suspected concurrent TBI, opioids and ketamine should be used with caution due to their AEs.

In a meta-analysis of 10 RCTs on severely injured trauma patients with spontaneous breathing and did not require airway management, the comparison of different analgesic agents was as follows:[147, level I]

- in terms of pain reduction based on numeric rating scale (NRS) –
    - IV ketamine (combination with morphine or monotherapy) was more effective than IV morphine (MD= -1.23, 95% CI -2.2 to -0.18)
    - NS difference in pain status (MD= -0.34, 95% CI -0.97 to 0.29) between IV fentanyl vs IV morphine
- in terms of safety, among the reported AEs were –
    - decreases in SpO_2 occurred in fentanyl, ketamine and morphine (0.55 to 0.58%)
    - occurrence of hypotension was 1.57% in fentanyl and 0.46% in morphine
    - nausea and vomiting were higher in morphine and morphine + ketamine

The quality of the included studies was mostly low and the heterogeneity high.

Refer to **Appendix 7** on **Recommended Analgesia for Acute Pain in Adult Trauma Patients** for commonly used analgesia in initial treatment of abdominal trauma.

An RCT on patients undergoing emergency laparotomy surgeries showed that bilateral ultrasound-guided rectus sheath block (RSB) provided significant extended post-operative analgesia at rest and cough (at one, four, eight and 12 hours) compared with local anaesthetic (LA) infiltration. There was also significant reduction in morphine consumption, incidence of post-operative nausea and vomiting, and prolonged time to first rescue analgesia.[148, level I]

Recommendation 16
- In patients with abdominal trauma, pain should be assessed based on patient self-rated pain score and regular clinical examination.
- Choice of analgesia in abdominal trauma should be based on pain severity.
  - Exercise caution when prescribing opioids and ketamine in patients with suspected traumatic brain injury.

6.5. Anaesthetic Drugs

One of the crucial cares in trauma patients is ensuring adequate oxygenation and ventilation. Trauma patients may require emergency tracheal intubation for various reasons following injury including hypoxia, hypoventilation, or failure to maintain or protect the airway owing to altered mental status.

Multiple factors may pose a challenge to intubate trauma patients e.g. airway trauma with distorted anatomy and potential deterioration in haemodynamic status due to both volume status as well as drug-induced hypotension of resuscitation.

Common indications for intubation in trauma patients include:[149]
- airway obstruction
- hypoventilation
- persistent hypoxaemia (SaO_2 ≤90%) despite supplemental oxygen
- severe cognitive impairment (GCS score ≤8)
- severe haemorrhagic shock requiring surgical intervention
- cardiac arrest

Rapid sequence induction (RSI) is important to produce a safe and optimal intubation condition for trauma patients. This is achieved by administration of a precalculated dose of IV induction agent and neuromuscular blocking agent. It is crucial to secure the airway safely while minimising drug-induced hypotension.

There is no ideal drug of choice for RSI in trauma patient but etomidate, ketamine and propofol remains the drugs of choice by healthcare providers. The characteristics of these drugs are as below.

- Both propofol and etomidate mediate loss of consciousness through Gamma-Aminobutyric Acid (GABA) receptors but exert different cardiovascular effects.[150, level III]
  - Propofol have negative inotropic effects and vasodilation that causes further haemodynamic instability in an unstable trauma patient
  - Etomidate has no effect on systemic vascular resistance, myocardial contractility and heart rate at induction dose.[150, level III] However, a single bolus dose of etomidate causes a dose-dependent adrenal suppression lasting 6 - 12 hours, at risk of impairing a patient's ability to produce an adequate stress response.[151, level III]
- Ketamine acts primarily through non-competitive blockade of N-Methyl-D-Aspartate (NMDA)-receptors. It is known to increase heart rate and blood pressure through a stimulatory effect on the sympathetic nervous system and thus making it potentially suitable for trauma patient.[149]
- Although ketamine is known to increase ICP, recent data does not support this any longer.[152, level III]

The effects of induction and paralytic agents on certain parameters are shown in the following table.

Table 4: Effects of common induction and paralytic agents on cardiovascular and central nervous system

Agent	**Induction Dose**	**PR**	**MAP**	**CBF**	**CMRO2**	**ICP**
Induction agents						
Propofol*	1 - 2.5 mg/kg	-	↓↓↓	↓↓↓	↓↓↓	↓↓↓
Etomidate*	0.2 - 0.3 mg/kg	-	↓	↓↓↓	↓↓↓	↓↓↓
Ketamine*	1 - 2 mg/kg	↑↑	↑↑	↑↑	↑	↑/↔
Paralytic agents						
Suxamethonium	1 - 1.5 mg/kg	-	-	-	-	↑/↔
Rocuronium	1 - 1.2 mg/kg	-	-	-	-	-

Abbreviation: PR=heart rate; MAP=mean arterial pressure; CBF=cerebral blood flow; CMRO2=cerebral metabolic rate of oxygen consumption; ICP=intracranial pressure; ↓=reduces; ↑=increases; ↔=equivocal

*Lower doses may be appropriate for haemodynamically unstable patient

Adapted: Sikorski RA, Koerner AK, Fouche-Weber LY et al. Choice of General Anesthetics for Trauma Patients. Curr Anesthesiol Rep. 2014;4:225–232.

A cross-sectional study in two level I trauma centres on trauma patients undergoing RSI within 24 hours of admission showed:[153, level III]

- etomidate was commonly used in ETD (89.6%) whereas propofol was preferred in the operation theatre (OT) (67.4%)
- ketamine was commonly used in severe trauma patients (ISS score: median=22, IQR 13 to 29) with high SI (median=0.81, IQR 0.65 to 1.05)
- peri-induction haemodynamics were stable in all groups but etomidate and ketamine groups were associated with a higher rate of vasopressor need at 24-hour post-intubation compared with propofol (p=0.03)
- etomidate had a significantly higher mean number of complications (IRR=1.7, 95% CI 1.2 to 2.5) and highest in-hospital mortality (25.5%, p<0.001) compared with others

In another cross-sectional study, when ketamine was used in trauma patients with higher SI (>0.9), more patients developed hypotension within nine minutes post-induction than those with low SI (26% vs 2%).[154, level III]

- Ketamine, propofol and etomidate are the drugs of choice for RSI, however, they must be used with caution in trauma patients.

6.6. Intensive Care Unit/High-Dependency Unit Admission

Admission to Intensive Care Unit (ICU)/High-Dependency Unit (HDU) for abdominal trauma patients may be considered if the patients have injuries that can lead to haemodynamic instability, multiple organ involvements, severe organ damage or major haemorrhage. They might appear initially stable but due to the severity of their injuries, they could be admitted to the ICU/HDU to manage potential complications.

Haemorrhagic risk is significant in the first 24 hours of abdominal trauma which may require monitoring of those severely injured in ICU/HDU.[102]

A cross-sectional study analysed the 2017 Trauma Quality Program database and, developed and validated the Clinical Risk of Acute ICU Status during Hospitalisation (CRASH) score to predict the risk of unplanned ICU admission.[155, level III]

- unplanned ICU admission rate increased from 0.1% to 3.9% and then 9.4% at scores of 0, 6 and 12 respectively with AUC of 0.78% (95% CI 0.77 to 0.79)
- CRASH score cut-off point 12 can aid decision-making in patients who may need ICU care

Table 5 below shows the CRASH Score.

Table 5: Clinical Risk of Acute ICU Status during Hospitalisation (CRASH) Score

Variable	Points
Demographics	
Age ≥65	1
Co-morbidities	
Alcoholism	2
Anticoagulant use	1
Cirrhosis	2
Dementia	1
Chronic heart failure	1
Hypertension	1
Peripheral arterial disease	1
Mental disorder	1
Chronic renal failure	1

Variable	Points
Injury	
Multiple rib fractures	2
Pneumothorax	1
Haemothorax	1
Pelvis fracture	1
Small intestine	1
Bladder	1
Spinal cord	1
Lower extremity long bone fracture	1
Traumatic brain injury	2
Cervical fracture	1
Major surgery for respiratory system	3
Major surgery for gastrointestinal system	2
Major surgery for hepatobiliary system	1
Major surgery for urinary system	1
Maximum score	**32**

The Modified Early Warning Score (MEWS), as shown in **Table 6**, was evaluated to identify the correct level of care for patients after emergency surgical procedures to avoid inappropriate admission to ICU and to enhance the use of HDU. The use of MEWS reduced ICU admission by 6% ($p<0.01$) and increased HDU admission by 7% ($p<0.05$) compared with before it was used. There was NS difference in mortality.[156, level II-2]

Table 6: The Modified Early Warning Score (MEWS)

Systolic blood pressure (mmHg)	<70	71 - 80	81 - 100	101 - 199	-	200	-
Heart rate (beats/min)	-	<40	41 - 50	51 - 100	101 - 110	111 - 129	≥130
Respiratory rate (breath/min)	-	<9	-	9 - 14	15 - 20	21 - 29	≥30
Temperature (^{o}C)	-	<35	-	35.1 - 38.4	-	≥38.5	-
Neurological status	-	-	-	Alert	Reacting to voice	Reacting to pain	Unresponsive
Scores	3	2	1	0	1	2	3

Note: Patients with a MEWS of 3 or 4 were transferred to the HDU, whereas a MEWS score of ≥5 was considered criteria for ICU admission.

- Severely injured abdominal trauma patients are indicated for admission to ICU/HDW. The utilisation of CRASH or MEWS score is useful in aiding identification of such patients for early ICU/HDW referral.

6.7. Venous Thromboembolism Prophylaxis

Trauma patients, particularly those with severe injuries or prolonged immobility, are at increased risk of developing venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE). The pathophysiology of VTE in trauma patients is multifactorial, with contributors e.g. the inflammatory response to injury, coagulopathy, injury-induced hypercoagulability and immobility during recovery. Without adequate prevention, VTE can lead to serious, life-threatening complications, including post-thrombotic syndrome, long-term disability and death.[157]

The goal of VTE prophylaxis in trauma is to balance the prevention of thrombotic events while minimising the risks of bleeding, particularly in patients who may have concurrent injuries or surgical needs. Prophylactic strategies typically involve a combination of pharmacologic approaches, e.g. low molecular weight heparin (LMWH) or unfractionated heparin (UFH), and mechanical interventions, e.g. compression stockings or intermittent pneumatic compression devices.[52, level III]

A cross-sectional study on BAT patients undergoing NOM of solid organ injury showed that patients receiving chemical thromboprophylaxis (CTP) had significantly reduced rate of DVT and PE compared with those not receiving it, and the preventive effects were more pronounced in those started early (≤48 hours of injury) than those started late at >48 hours of injury. There was NS difference between the groups with regards to failure of NOM, PRBC transfusion or mortality.[158, level III]

In a meta-analysis on BAT patients undergoing NOM, early initiation of VTE prophylaxis using LMWH or UFH (<48 hours) lowered risk of DVT (OR=0.36, 95% CI 0.22 to 0.59) but slightly increased risk of NOM failure (OR=1.76, 95% CI 1.01 to 3.05) compared with those where on delayed VTE prophylaxis (after 48 hours). There was NS difference in risk of transfusion or mortality between the groups.[159, level II-2]

The American Association for the Surgery of Trauma Critical Care Committee Clinical Consensus Document recommends that for patients with blunt solid organ injury (SOI) undergoing NOM, VTE prophylaxis with LMWH should be initiated within 48 hours from time of injury in the absence of ongoing bleeding or other contraindications. Pharmacological prophylaxis should be delayed in patients with active bleeding or coagulopathy, until these conditions have been controlled or reversed and mechanical prophylaxis should be employed in these patients.[160, level III] National CPG on Prevention and Treatment of VTE recommends to offer combined VTE prophylaxis with mechanical and pharmacological methods to patients with major trauma.[157]

Recommendation 17

- In blunt abdominal trauma patients undergoing non-operative management, venous thromboembolism prophylaxis should be initiated early, preferably within 48 hours in patients without active bleeding or other contraindications.

7. SPECIAL POPULATION

In trauma care, certain populations e.g. geriatric group and pregnant mothers have unique physiological, psychological and social characteristics that make them more vulnerable to injuries or complications and more challenging to manage. Adjusting standard trauma protocols to accommodate these needs is key to providing safe and effective care.

7.1. Pregnancy

Pregnancy should be considered when assessing every female of reproductive age. Management of abdominal trauma patients with pregnancy requires understanding of the changes in anatomy and physiology that can alter injury presentation. These patients should be co-managed with the obstetric team. The disproportionate increase in plasma volume compared to red blood volume during pregnancy allows 35% of maternal blood to be lost before the mother exhibits clinical signs of shock.[52, level III]

An important risk factor in assessing pregnant trauma patients in motor vehicle accidents is the correct usage of seatbelt. In one cross-sectional study on the impact of seatbelt use in pregnant women, mean ISS was higher among unrestrained/non-pregnant than their restrained counterparts ($p<0.001$). Restraint use was also significantly associated with:[161, level III]

- decreased injury severity
- reduced need for emergent operation
- shortened hospital LOS

In another cross-sectional study involving pregnant trauma patients (≥26 weeks gestation) who underwent abdominopelvic CT scan for trauma diagnostic evaluation and has imaging abnormalities consistent with placental abruption, early delivery protocol in which emergent caesarean section was performed at the first sign of non-reassuring foetal status for abruptions grade ≥2 improved foetal outcome reaching 100% survival rate.[162, level III]

In known Rh(D) negative pregnant patients, abdominal trauma may cause foetal-maternal transfusion (mixing of maternal and foetal circulation), which might lead to Rh(D) alloimmunisation. It is advised to administer anti-Rh(D) immunoglobulin as prophylaxis.[163, level III] Anti-D immunoglobulin is to be administered as soon as possible within 72 hours of the event.[164]

The need for transfusion of Rh(D) positive red cells to a Rh(D) negative pregnant mother in life-threatening haemorrhage (i.e. Rh(D) negative blood is not available and patient require large volume of red cells in a short period of time) shall be decided by the treating clinician with transfusion specialist.[164]

Pregnancy contributes to higher risk of venous thromboembolism due to venous stasis, endothelial injury and hypercoagulable state. Therefore, it is very important to have a documented thromboembolism risk re-assessment in pregnant trauma patients during the ward admission. Thromboprophylaxis is advocated during the transient period of surgical procedures and immobility.[165; 157]

- In order to optimise outcomes for the mother and foetus, clinicians must assess and resuscitate the mother first and then assess the foetus before conducting a secondary survey of the mother.[15]
- Imaging in the pregnant patients should be similar to the non-pregnant patient if life-threatening injuries are suspected.[166]

7.2. Geriatric

The geriatric population in Malaysia is projected to reach 15.3% of the total population by 2030. It is therefore important to address issues related to abdominal trauma among them to improve outcomes of management. Recognising the importance of this issue, various societies have made guidelines for geriatric trauma care, including the World Society of Emergency Surgery (WSES) and American College of Surgeons.[167; 168]

a. Low energy mechanisms

Careful attention should be placed on the mechanism of injury to avoid under triage of geriatric trauma patient. Major trauma can occur in the elderly even through low energy mechanism, such as fall from height of <1 metre.[167]

b. Geriatric Trauma Protocol

Both the WSES and American College of Surgeons recommend that it is best practice for trauma centres to have dedicated geriatric trauma protocols. A cross-sectional multicentre study on adult trauma patients with damage control laparotomy (DCL) found that institutions without dedicated geriatric trauma protocols or consulting geriatric services had higher overall in-hospital mortality compared with those having them (OR=2.1, 95% CI 1.3 to 3.4).[169, level III]

There should be low thresholds for activation of geriatric trauma protocols in order to administer early resuscitation in the elderly with triage set points of heart rate >90 bpm and systolic blood pressure <110 mmHg.[167, 168]

A composite index suggested to help identify occult shock in the elderly would be the Age Shock Index (Age SI), which is calculated using patient's age times the SI score. In the elderly, Age SI is a better predictor of 48-hour mortality compared with HR, SBP or SI.[170, level III]

A retrospective study on a Korean emergency department-based injury database comparing Age SI, modified SI (MSI) and SI, showed that Age SI had the best predictive power for in-hospital mortality in geriatric trauma patients with the best sensitivity (73.0%) and specificity (74.9%) at cut-off point of 49.[171, level III]

Apart from that, early blood gas (arterial or venous) for baseline base-deficit or a lactic acid assessment in geriatric trauma patients is advocated.[167]

c. Frailty Assessment

In addition to the ABCDE assessment of ATLS, it is also needed to assess F which is Frailty in all elderly trauma patients. Frailty is a recognised geriatric syndrome, characterised by age-related depletion of physiological reserves. Increase frailty leads to increased vulnerability to external stressors and delayed recovery.

A frailty assessment tool helps to identify those patients who would benefit from early interventions or conservative management.[167] The Best Practice Tariff for Major Trauma included the Clinical Frailty Score component for the elderly population aged >65 years.[172] The Clinical Frailty Score (CFS), a 9-point scale, was found to be highly correlated (r=0.80) with the Frailty Index.[173, level II-2]

A cohort study classified geriatric patients admitted to a major trauma centre into non-frail (CFS 1 - 4), mild to moderate frailty (CFS 5 - 6) and severe frailty (CFS 7 - 9). Frail patients were found to have higher risk of 30-day mortality compared with non-frail patients (i.e. mild - moderate frailty: OR=5.68 95%, CI 1.75 to 18.47; severe frailty: OR=10.38, 95% CI 2.08 to 51.62).[174, level II-2]

CFS is advocated to be assessed at triage to assist in identifying direction of care, predicting outcomes and identifying those who will benefit from comprehensive geriatric assessment.[175 - 176, level III]

d. Anti-coagulant history

Drug history is especially important as many elderly patients are on multiple medications. Particular attention should be paid to type of anti-coagulants, so that coagulopathy can be addressed immediately. A cross-sectional study among geriatric patients on anticoagulants with blunt traumatic injury, direct oral anticoagulant (DOAC) had significantly less mortality (8.3% vs 29.5%) and blood products transfusion (2.8±1.8 units vs 6.7±6.4 units) compared with warfarin.[177, level III]

Common coagulation tests recommended in elderly patients to assess anticoagulant exposure include the Activated Partial Thromboplastin Time (aPTT), Thromboplastin Time (TT), PT and INR.[167]

e. Imaging

In terms of imaging in geriatric trauma patients, cross-sectional studies showed that:

- positive findings on CXR and/or pelvic X-ray were associated with both intra-abdominal injury and the need for laparotomy[178, level III]
- in those with severe injury to the chest, abdomen and/or pelvis requiring admission to ICU showed that WBCT scan at initial evaluation was associated with lower mortality compared with conventional radiography or ultrasound (OR=0.21, 95% CI 0.07 to 0.68)[179, level III]

WSES and ACS recommend that there should be a low threshold on the use of CT scans in secondary survey of geriatric trauma patients, as occult injuries are common in this population.[167; 168]

- The management of elderly trauma patients requires:
    - knowledge of ageing physiology
    - a focused triage, including mechanism of injury, drug history and frailty assessment using validated tool e.g. CFS (including medical and nutritional status)
    - early activation of trauma protocol to improve outcomes.

7.3. Concurrent Injuries

Polytrauma refers to a condition where a person sustains multiple traumatic injuries affecting more than one organ or body region. It typically involves both blunt and penetrating trauma, and may include a combination of injuries to bones, tissues, blood vessels and internal organs, e.g. intra-abdominal injury with concurrent injuries to head/chest/pelvis. These injuries are often severe and life-threatening, requiring immediate and complex medical intervention. Early intervention, careful monitoring and a multidisciplinary approach are essential for improving survival rates and optimising recovery for these patients.

i. Head/spinal injury

Head injury remains one of the most important organ-specific injuries which has a great impact on the patients with concurrent abdominal injury. This is due to the importance of determining the severity of head injury in deciding the need for surgical intervention. In general, surgical management of the abdominal injury in addressing hypotension is the most important management in prevention of secondary brain injury.

There are only small percentages of vascular injury (intra-abdominal) presented with concurrent head injury.[180, level III] Patients had good prognosis when blood pressure is maintained and operation for traumatic brain injury is performed first. However, in haemodynamic unstable patients, secondary brain injury may be worsened when there is a delay in addressing hypotension due to abdominal injury. Patients who had operation on head and torso simultaneously have extremely low survival rates.[181, level III]

The standard neurological assessment for patients with head injury is the clinical assessment of the conscious state by using the GCS score, pupillary reactivity and sizes, and any localising signs e.g. abnormal limb posturing, hemiparesis/hemiplegia, paraparesis/paraplegia, absence of anal tone, etc. The presence of clinical evidence to suggest skull vault and skull base injury with evidence of bruising (racoon's eye and/or battle's sign, scalp swelling or haematoma) and cerebrospinal fluid leakage may also indicate head injury.

- The accuracy of GCS assessment may be influenced by haemodynamic instability or certain drugs in patients who sustain polytrauma. Polytrauma is defined as two or more organ-specific/ region-specific injuries following a traumatic event.

Based on evidence, the characteristics of patients who sustained abdominal injury with concomitant head injury included:

- likelihood of concomitant head injury was significantly higher among patients with multiple extracranial SOI than those with single extracranial SOI[134, level III]
- patients with multiple SOI had significantly lower mean GCS at ED and higher ISS than those with single SOI[134, level III]
- mortality was greater in patients with head injury than those without head injury[182, level III]
- severe extracranial injury was significant independent predictor of mortality among patients with TBI[183, level III]
- patients who sustained polytrauma presented with arrival GCS of 3; significant predictors of survival were the absence of bilateral dilated and fixed pupils, and GCS improved to >3 after resuscitation[184, level III]
- patients with abdominal injury and concurrent head injury had significantly higher intra-abdominal pressure compared with those having isolated traumatic brain injury at multiple time points[185, level II-2]

The safe and effective surgical management of abdominal trauma with concomitant head injury include:

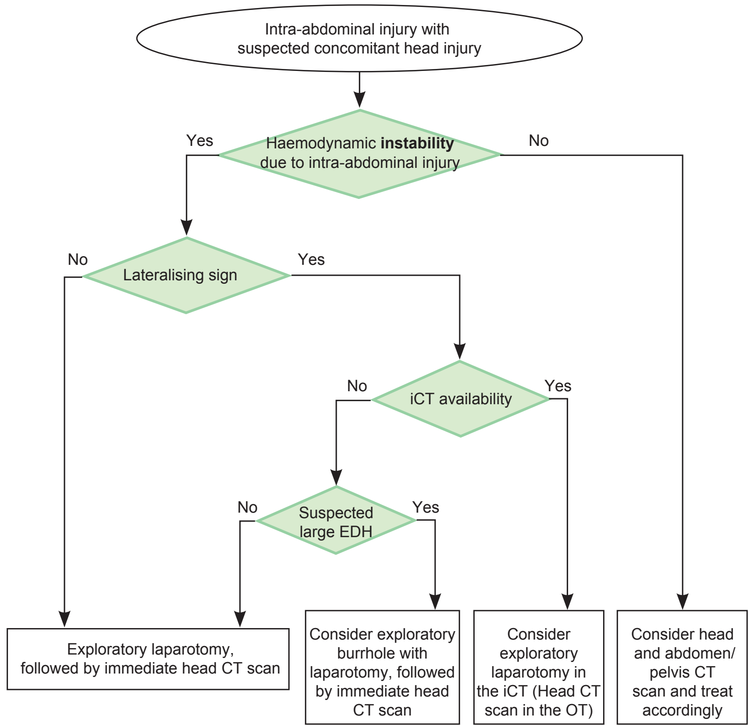
- abdominal insufflation in the typical range of pressures used for standard laparoscopy may affect cerebral perfusion pressure/ ICP and should be used cautiously in patients who present with baseline elevated ICP or head trauma[110, level III]
- in hypotensive patients with a GCS score >8, it may be safer to proceed with a laparotomy first and then, address the CT scan of the head at a later stage[186, level III]

The predictors of patients with abdominal injury and concomitant head injury requiring a craniotomy include:

- GCS <8[186, level III]
- presence of lateralising neurological signs[110, level III]

Haemodynamically stable patients who sustained abdominal trauma with significant concomitant head injury should be sent to the nearest hospital with neurosurgical services, without the need for any subsequent transfer. However, haemodynamically unstable intra-abdominal injury patients with head injury should be optimised at the primary centre prior to transfer to any neurosurgical centre for definitive head injury management.

All management of patients with blunt acute abdominal injury and concomitant head injury should include consultation with a neurosurgeon. Suggested flow of management of patients with concurrent traumatic abdominal trauma and head injury is as shown in **Figure 3** below.



*Avoid laparoscopy surgery if suspected raised ICP. All management related to head injury should have been discussed with a neurosurgeon

Abbreviations: EDH=extradural haematoma; iCT=intraoperative CT; OT=operation theatre

Adapted: Jakob DA, Benjamin ER, Cho J, et al. Combined head and abdominal blunt trauma in the hemodynamically unstable patient: What takes priority? J. Trauma Acute Care Surg. 2021;90(1):170-6.

Figure 3: Management of patients with blunt acute abdominal trauma with concomitant head injury

Recommendation 18

- Patients with haemodynamically unstable abdominal trauma and concurrent head injury should undergo surgical haemostasis before addressing the head injury.
- Patients with abdominal trauma with concurrent head injury should not undergo laparoscopic surgery.

ii. Chest injury

Rib fractures are a common cause of morbidity and mortality, and are often associated with abdominal solid organ injuries.

A retrospective cohort study of patients aged over 15 years who sustained blunt chest trauma showed concurrent abdominal injuries observed in 34.9% of patients and there was a significant association between middle zone rib fractures and abdominal solid organ injuries.[187, level II-2]

iii. Pelvic injury

Patients with abdominal injury may also have associated pelvic injury with an incidence of 30.7%. The mortality rate approximates 50% if the pelvic fracture is open or associated with a major vessel injury.[188] Implementation of ATLS on patients with the injuries lead to low mortality (4.3 - 4.9%) and morbidity (9.3 - 9.9%) rates.[189, level III]

In patients with pelvic fracture and unstable haemodynamically, pelvic external fixation with pre-peritoneal packing or pelvic binder with pelvic angiography showed NS difference in mortality rates at day 7 (10.5% vs 21.1%), day 30 (21.1% vs 26.3%) and overall mortality rates (26.3% vs 26.3%) for patients who underwent various haemostatic procedures.[190, level III]

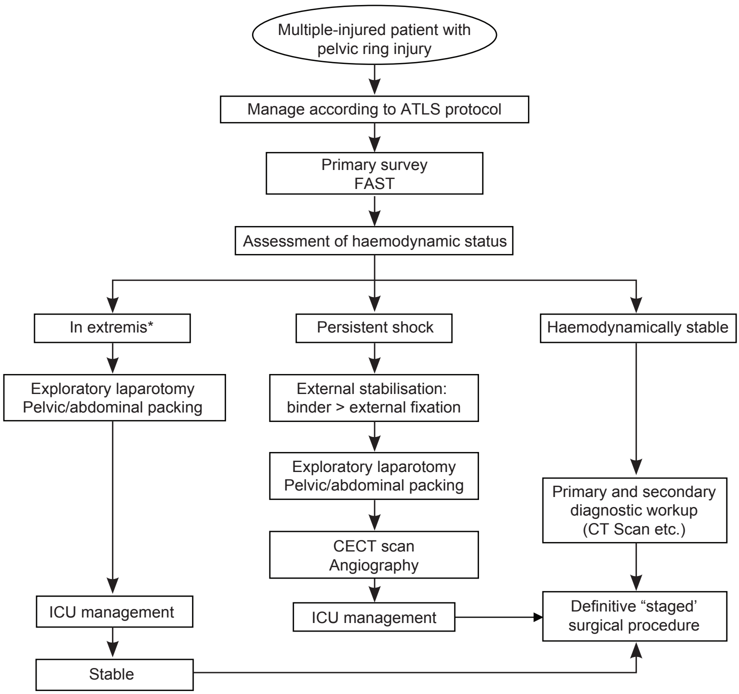
FAST has high sensitivity of 85.4% (95% CI 76.3 to 92), specificity of 98.7% (95% CI 97.8 to 99.3) and accuracy of 97.7% (95% CI 96.7 to 98.5) in detecting intrabdominal free fluid in patients with BAT with pelvic fractures.[191, level III]

During acute management phase of patients after damage control orthopaedics:[188]

a. patients who are hemodynamically stable with a stable pelvic ring require a thorough clinical and diagnostic imaging examination for definitive treatment
b. patients who are hemodynamically stable but have an unstable pelvic ring require close observation for at least 48 hours to monitor for potential occult or late pelvic bleeding
c. patients who are hemodynamically unstable with stable pelvic ring require resuscitation based on ATLS principles, followed by thorough assessment to identify non-pelvic sources of bleeding; pelvic stabilisation is not required
d. patients who are hemodynamically unstable with an unstable pelvic ring require reduction to reduce blood loss from the pelvis through sheets, pelvic binders and external fixation devices; if fails, preperitoneal pelvic packing may be used for initial DCS and subsequently, definitive management of the pelvic injury can be considered

The management of pelvic injury by orthopaedic damage control is summarised in **Figure 4**.

Refer to **Appendix 8** on **Pelvic Fracture Stability Classification and The Modified Tile Classification**.



*very unstable patient, imminent death

Figure 4: Orthopaedic damage control of pelvic injury

Operative treatment normally starts at the end of the first week, including definite open reduction and internal fixation of all fractures, joint reconstruction and additional reconstructive procedures. If possible, all secondary procedures should be finished at the end of the second week (window of opportunity 5 - 14 days) due to increased risk of infection.

Recommendation 19
- In intraabdominal injuries with concomitant pelvic fracture, patient's haemodynamic status and pelvic ring stability should be identified early in order to provide appropriate management.
- Patients with haemodynamic instability with unstable pelvic ring fracture should have pelvic stabilisation.

8. ABDOMINAL COMPARTMENT SYNDROME

Abdominal Compartment Syndrome (ACS) is a serious and life-threatening condition that occurs when intra-abdominal pressure (IAP) rises to a level that compromises the function of organs within the abdominal cavity which may lead to systemic dysfunction. In the context of trauma, ACS is typically associated with severe abdominal injuries, but it can also result from other trauma-related conditions e.g. fractures, burns or overzealous fluid resuscitation.

Increased IAP leads to increased intrathoracic pressure and reduced venous return. These will cause hypotension and impairment of both renal and pulmonary function. Hence, it results in reduced perfusion of abdominal organs, systemic ischaemia, multi-organ failure and eventually death if left untreated.

Overzealous fluid resuscitation in abdominal trauma patients is the commonest cause for intra-abdominal hypertension (IAH) by causing bowel oedema and ascitic fluid accumulation. Thus, monitoring of IAP is essential to recognise and, treat IAH and its potential sequelae. IAP can be measured using direct bladder pressure via a urinary catheter, which is a common and low-risk technique.[192]

Normal IAP is <12 mmHg, however this may vary according to individual characteristics e.g. obesity or cardiac failure. IAH is graded according to World Society of the Abdominal Compartment Syndrome guidelines as shown below:

Table 7: Grades of Intra-Abdominal Hypertension

Intra-abdominal Hypertension Grading	Pressure
Grade I	12 - 15 mmHg
Grade II	16 - 20 mmHg
Grade III	21 - 25 mmHg
Grade IV	>25 mmHg

Source: Kirkpatrick AW, Roberts DJ, De Waele J, et al. Intra-abdominal hypertension and the abdominal compartment syndrome: updated consensus definitions and clinical practice guidelines from the World Society of the Abdominal Compartment Syndrome. Intensive Care Med. 2013;39(7):1190-206.

Increased IAP is defined as IAP ≥12 mmHg. IAP Grade III and above are considered critical which can lead to organ dysfunction:

- decreased urine output (renal impairment)
- respiratory distress (due to diaphragm compression)
- cardiovascular dysfunction (due to reduced venous return and cardiac output)

ACS is defined as sustained IAH of Grade III/IV with new onset of one or multiple organ dysfunction/failure. Hence, serial IAP monitoring is imperative in early detection of potential ACS.[192]

In a cross-sectional study on trauma patients who underwent trauma laparotomy within 24 hours of admission, patients with the following factors are at risk of IAH Grade III/IV (IAP ≥21) and ACS:[193, level III].

- hypothermia; (increasing body temperature reduced risk with OR=0.74, 95% CI 0.57 to 0.96)
- higher levels of lactate (OR=1.33, 95% CI 1.08 to 1.64)
- larger base deficit (OR=1.11, 95% CI 1.06 to 1.16)
- additional factors at six hours after trauma laparotomy:
  - coagulopathy (OR=1.01, 95% CI 1.01 to 1.02)
  - higher total resuscitation volume ($p<0.001$) and PRBC transfusion ($p<0.001$) in first 24 hours

With IAH Grade III/IV (IAP ≥21), one should monitor for potential organ dysfunction, and if presence, should consider the following strategies:

i. increase sedation/neuromuscular blockade/body positioning
ii. evacuate intra-abdominal fluid collections
iii. correct positive fluid balances e.g. diuresis, fluid restrictions
iv. surgical abdominal decompression strategies e.g. laparostomy

The treatment strategies that can be done based on severity of IAH/ ACS are summarised below.

No IAH/Grade I/II IAH	Increasing IAH	ACS
To prevent development or progression of IAH: • avoid fluid overload • aim for zero or negative fluid balance • provide adequate sedation and analgesia	If IAH is present, IAP increasing and risk of ACS is high, consider: • aggressive negative fluid balance in cases of hypervolaemia (diuresis) • gastric decompression • prokinetics, rectal enemas • colonoscopy with bowel decompression in cases of colonic distension • drainage of intra-abdominal and retroperitoneal fluid collection if present • increase sedation • reduction of enteral nutrition	If ACS is present: Stop enteral nutrition Consider: • deep sedation • temporary neuromuscular blockade • surgical decompression e.g. haematoma evacuation, laparostomy, bowel decompression

Adapted: Padar M, Reintam Blaser A, Talving P, et al. Abdominal Compartment Syndrome: Improving Outcomes With A Multidisciplinary Approach - A Narrative Review. J Multidiscip Healthc. 2019;12:1061-1074.

Temporary abdominal closure (TAC) i.e. leaving the rectus unopposed after DCS, should also be considered as a prevention strategy for ACS especially if the patient is severely injured and requires massive blood and fluid resuscitation.

Following TAC, early definitive primary fascial closure is advocated to facilitate the restoration of normal abdominal domain and mitigates the risk represented by prolonged exposure of the viscera e.g. enterocutaneous fistulas.[194, level II-2]

A cross-sectional study found that negative pressure wound therapy in trauma patients who had DCL had no effect on IAP measurement.[195, level III]

A study on the International Register of Open Abdomen showed linear correlation between days of open abdomen and complications ($r=0.326$, $p<0.0001$) including fistula development ($r=0.146$, $p=0.016$).[196, level II-2]

ACS is uncommon which leads to inadequate high-level evidence on its treatment options. A lot of management strategies are based on observational studies, expert opinion or derived from pathophysiology. If the patient has obvious ACS with severe organ dysfunction, decompressive laparotomy is indicated. However, timely observation and appropriate medical management can either delay or avoid development of ACS.[192]

Refer to **Appendix 9** on **Intra-Abdominal Hypertension/Abdominal Compartment Syndrome Medical Management Algorithm**

- Overzealous fluid resuscitation in abdominal trauma patients is the commonest cause for IAH.
- Factors in patients with abdominal trauma that will require IAP monitoring are presence of:
  - hypothermia
  - higher levels of lactate
  - larger base deficit
  - coagulopathy
- Direct bladder pressure monitoring is one of the common and low-risk methods of measuring IAP. Refer to **Appendix 10** on **Measurement of Intra-abdominal Pressure**.
- The recommended interval for IAP monitoring is every 4 - 6 hours in patients who have IAP ≥12 mmHg.[192]

Recommendation 20
- All abdominal trauma patients at risk of developing abdominal compartment syndromes should be identified early and monitored closely.
- Treatment strategy for intra-abdominal hypertension (IAH) should be tailored to the cause and severity of IAH.
    - Surgical treatment should not be delayed in IAH patients who are refractory to medical therapy.

9. REFERRAL

Trauma referral systems are designed to ensure patients with major injuries receive timely care by directing them to the most appropriate facility. These systems involve a co-ordinated approach in communication and transport between primary teams in different facilities. The objective is to facilitate safe and timely transfer of injured patients to a facility able to provide definitive care after initial resuscitative efforts.

The MoH has a myriad of health services within its umbrella ranging from health clinics to specialist hospitals that provide trauma services with variation in practices and level of care. There could be many limitations in smaller health clinics and district hospitals which might not be equipped with the proper manpower, diagnostic tools and intervention strategies.

Established designated referral systems (interhospital transfer service) is available within MoH with the aim to provide optimum management for patients.[197] Hospitals with specialists are the mainstay referral centres for the trauma patients. Timely referrals to appropriate centres are advocated once the primary survey is completed and life-threatening conditions addressed. However, utilisation of trauma bypass is recommended in whenever feasible. Refer to **Appendix 11** on **Interfacility Transfer Checklist**.

Recommendation 21
- If the initial health facility is unable to provide the patient the required trauma care, a timely referral to an appropriate facility should be made.

10. IMPLEMENTING THE GUIDELINES

The management of abdominal trauma should be guided by an evidence-based approach, in order to provide quality care to the patients. Several factors may affect the implementation of recommendations in the CPG.

10.1. Facilitating and Limiting Factors

Existing facilitating factors for application of the recommendations in the CPG include:
- nationwide dissemination of the CPG to healthcare providers
- regular scientific meetings/trainings/conferences on trauma which incorporate management of abdominal trauma at various levels
- National Subspecialty Trauma Surgery Committee that oversees the development and implementation of trauma surgery services in Malaysia
- National Peri-operative Mortality Review Committee which discuss on shortfalls in the management of peri-operative patients including abdominal trauma patients

Existing barriers for application of the recommendations of the CPG are:
- inadequate knowledge, skills and experience on abdominal trauma management among healthcare providers in general
- lack of resources for comprehensive management of abdominal trauma
- inadequate establishment of trauma system in the healthcare settings

10.2. Potential Resource Implications

The recommendations in this CPG require additional resources in terms of human resources/expertise, funds and healthcare infrastructures for their successful implementation and these are discussed below.

The challenges in implementing most of the recommendation in this CPG are mainly related to level of skill/competency in the personnel involved, e.g. video laryngoscopy, e-FAST, various CECT scan modalities, interventional radiology and trauma laparoscopy. Collaborated efforts to enhance training programs imparting these skills and provide platforms for safe practices amongst inexperienced personnel are crucial. There should also be an effort in establishing a system for consultation and monitoring of clinical oversight. These combined strategies ensure patient safety and good clinical outcome.

Hurdles related to infrastructures such as limited and inadequately equipped ambulance services, availability of advanced diagnostic imaging facilities, dedicated trauma OT, trauma wards and allocation of ICU beds in hospitals with specialists, should be addressed. Other hospitals without specialist must be well equipped to stabilise an unstable severe trauma patient prior to transfer to a higher-level center when indicated. The provision of efficient service is paramount to be addressed in order to achieve best outcomes in patients with abdominal trauma.

Based on the key recommendations, the following are proposed as clinical audit indicators for the CPG:

- Percentage of stable trauma patient suspected of intra-abdominal injury who underwent abdominal CECT scan =

$$\frac{\text{Number of stable trauma patients suspected of intra-abdominal injury who underwent abdominal CECT scan in a period}}{\text{Total number of stable trauma patients suspected of intra-abdominal injury in the same period}} \times 100\%$$

- Percentage of abdominal trauma patient undergoing CECT scan having at least arterial and portovenous phases done =

$$\frac{\text{Number of abdominal trauma patient undergoing abdominal CECT scan having at least arterial and portovenous phases in a period}}{\text{Total number of abdominal trauma patient undergoing abdominal CECT scan in the same period}} \times 100\%$$

- The percentage of blunt abdominal trauma patients* undergoing non-operative management and who have venous thromboembolism prophylaxis initiated within 48 hours =

$$\frac{\text{Number of blunt abdominal trauma patients* undergoing non-operative management and have venous thromboembolism prophylaxis initiated within 48 hours in a period}}{\text{Number of blunt abdominal trauma patients* undergoing non-operative management in the same period}} \times 100\%$$

*patients without active bleeding or other contraindications.

Implementation strategies will be developed following the approval of the CPG by MoH which include Quick Reference and Training Module.

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Appendix 1

EXAMPLE OF SEARCH STRATEGY

Clinical Question: What is the safe and effective pre-hospital care in patients suspected of abdominal trauma?

Database: Ovid MEDLINE(R) ALL <1946 to April 10, 2023>
Search Strategy:
----

1. ABDOMINAL INJURIES/
2. (abdominal adj1 injur*).tw.
3. ABDOMEN/
4. abdom*.tw.
5. WOUNDS, PENETRATING/
6. (penetrating adj1 wound*).tw.
7. WOUNDS, NONPENETRATING/
8. (blunt adj1 injur*).tw.
9. (nonpenetrating adj1 (injur* or wound*)).tw.
10. (non-penetrating adj1 (injur* or wound*)).tw.
11. (non penetrating adj2 (injur* or wound*)).tw.
12. trauma*.tw.
13. 1 or 2
14. 3 or 4
15. 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12
16. 14 and 15
17. 13 or 16
18. EMERGENCY MEDICAL SERVICES/
19. ((emergency or prehospital) adj1 care).tw.
20. (prehospital adj2 emergency care).tw.
21. (emergency adj2 (medical service* or health service*)).tw.
22. emergicenter*.tw.
23. 18 or 19 or 20 or 21 or 22
24. 17 and 23
25. limit 24 to (english language and humans and ("all adult (19 plus years)" or "adolescent (13 to 18 years)") and last 15 years)

Appendix 2

CLINICAL QUESTIONS

1. **Pre-hospital care and transfer**
   1.1. What is the safe and effective pre-hospital care in patients suspected of abdominal trauma?
   1.2. What is the safe and effective transfer protocol of patients suspected of abdominal trauma to hospital?
2. **Early assessment and resuscitation**
   2.1. What is the safe and effective early assessment in patients suspected of abdominal trauma?
   2.2. What is the safe and effective resuscitation strategy in patients suspected of abdominal trauma?
3. **Diagnosis**
   3.1. What is the accurate diagnostic tool for abdominal trauma?
4. **Abdominal Organ Injury Scale**
   4.1. How is the severity of abdominal organ injury graded?
5. **Treatment**
   5.1. What are the indications for the following measures in abdominal trauma?
   - non-operative management
   - surgical intervention
   - angioembolisation
   - intensive care unit/high dependency unit admission

   5.2. What are the safety and effectiveness of the following interventions in abdominal trauma?
   - analgesia
   - anaesthetic drugs
   - tranexamic acid
   - non-operative management
   - surgical intervention
   - angioembolisation

   5.3. What are the safe and effective management of abdominal trauma in the following population?
   - pregnancy
   - geriatric age
   - abdominal trauma with concurrent injuries (head, spine, chest and pelvic)
6. **Abdominal Compartment Syndrome**
   6.1. What is the role of monitoring intrabdominal pressure in abdominal trauma?

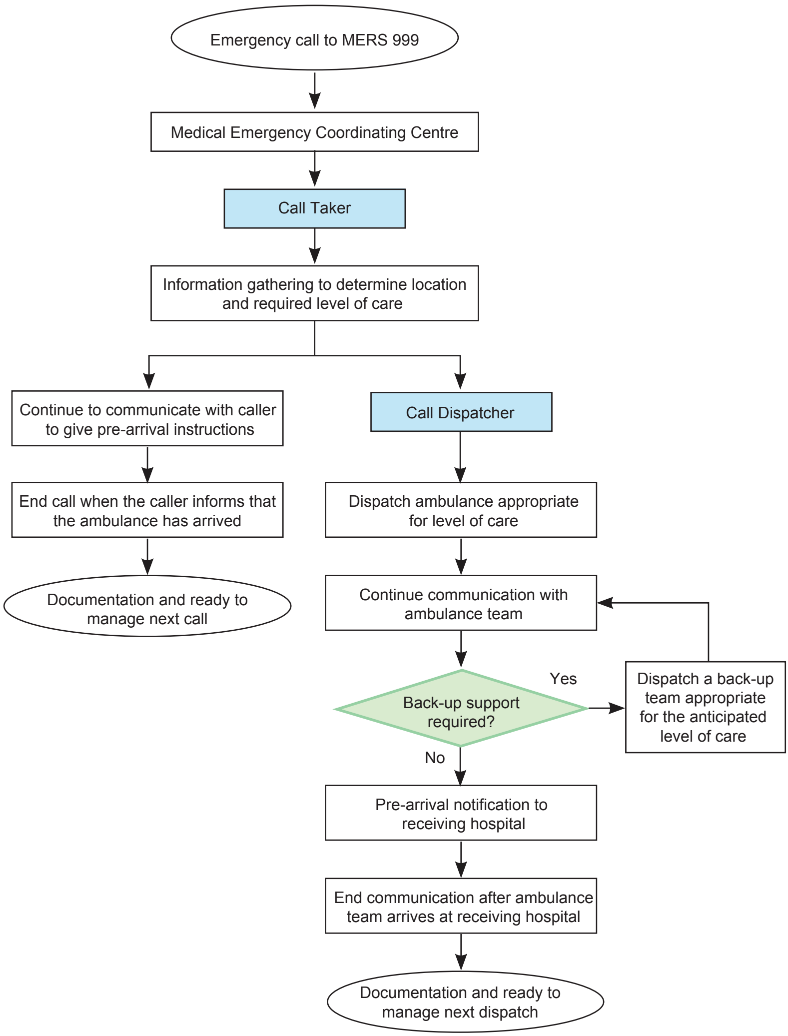
6.2. What are the safe and effective treatment strategies in abdominal compartment syndrome in abdominal trauma?

7. Referral

7.1. What are the recommended criteria for referral to higher level trauma facilities in abdominal trauma?

Appendix 3

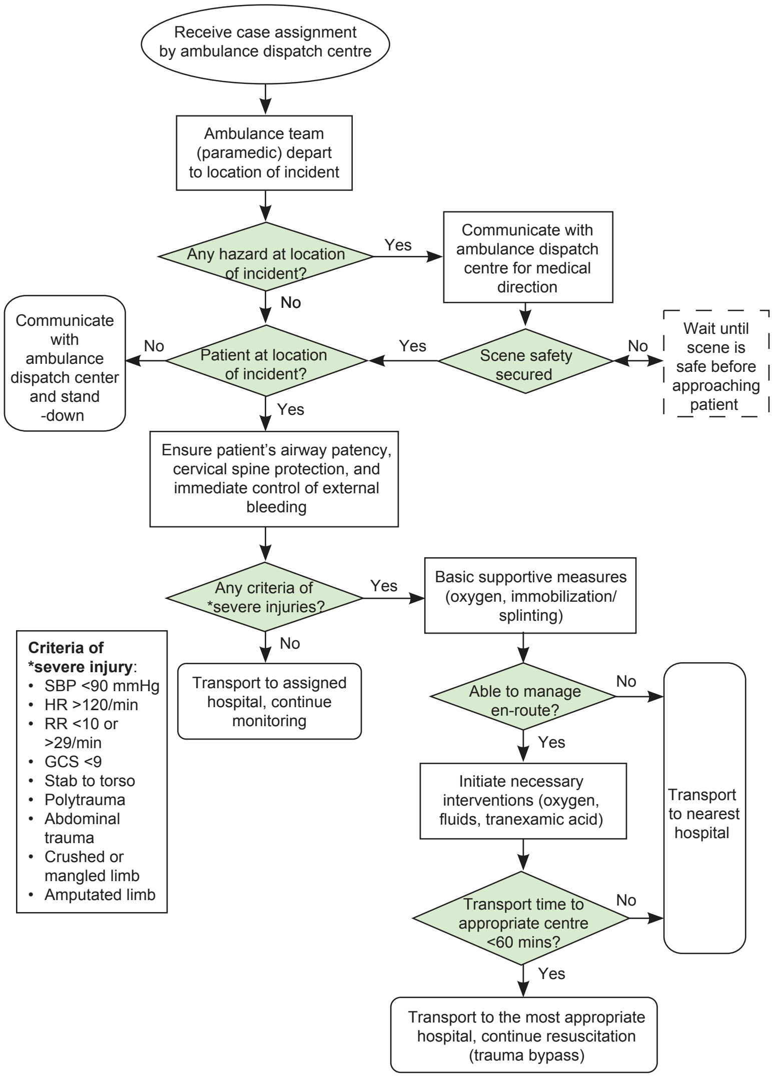
Management of an Emergency Call in Medical Emergency Coordinating Centre



Source:
1. Jabatan Kesihatan Negeri Johor. Polisi Perkhidmatan Pra Hospital Negeri Johor Edisi Ke-2. Johor: JKN Johor; 2024.)
2. Jabatan Kesihatan Negeri Selangor. Garis Panduan dan Polisi Perkhidmatan Rawatan Pra Hospital dan Ambulans. JKN Selangor; 2018. (Available at: https://jknselangor.moh.gov.my/documents/pdf/2018/info/polisiprpa.pdf)

Appendix 4

Management of Trauma Patient by Pre-hospital Ambulance Team at Scene



Adapted:

1. Jabatan Kesihatan Negeri Johor. Polisi Perkhidmatan Pra Hospital Negeri Johor Edisi Ke-2. Johor: JKN Johor; 2024.)
2. Jabatan Kesihatan Negeri Selangor. Garis Panduan dan Polisi Perkhidmatan Rawatan Pra Hospital dan Ambulans. JKN Selangor; 2018. (Available at: https://jknselangor.moh.gov.my/documents/pdf/2018/info/polisiprpa.pdf)

Appendix 5

SIGNS AND SYMPTOMS OF HAEMORRHAGE BY CLASS

Parameters	Class I	Class II	Class III	Class IV
Approximate blood loss	<15%	15 to 30%	31 to 40%	>40%
Pulse rate	↔	↔/↑	↑	↑/↑↑
Blood pressure	↔	↔	↔/↓	↓
Pulse pressure	↔	↓	↓	↓
Respiratory rate	↔	↔	↔/↑	↑
Urine output	↔	↔	↓	↓↓
GCS Score	↔	↔	↓	↓
Base deficit*	0 to -2 mEq/L	-2 to -6 mEq/L	-6 to -10 mEq/L	≤ -10 mEq/L
Need for blood products	Monitor	Possible	Yes	Massive Transfusion Protocol

*a Base excess is the quantity of base (HCO3–, in mEq/L) that is above or below the normal range in the body. A negative number is called a base deficit and indicates metabolic acidosis.

Abbreviations: GCS=Glasgow Coma Scale; ↔=normal; ↑=increase, ↑↑=marked increase, ↓=decrease, ↓↓=marked decrease

Source: American College of Surgeons. ATLS Advanced Trauma Life Support: Student Course Manual (Tenth Edition). Chicago: American College of Surgeons; 2018.

Appendix 6

COMPOSITION OF DIFFERENT INTRAVENOUS FLUIDS COMMONLY USED FOR INITIAL VOLUME REPLACEMENT IN TRAUMA PATIENTS

	Na (mmol/L)	Cl (mmol/L)	K (mmol/L)	Ca (mmol/L)	Mg (mmol/L)	Lactate (mmol/L)	Other components	Osmolarity (mOsm/L)
Saline-based crystalloids								
Normal saline (0.9%)	154	154	-	-	-	-	-	308
Hypertonic saline (3%)	513	513	-	-	-	-	-	1026
Balanced crystalloids								
Lactated Ringer	130	109	4	0.67	-	28	-	273
Hartmann solution	131	112	5	2	-	28	-	279
Sterofundin ISO	145	127	4	2.5	1		Acetate 24 mmol/L	309
Colloids								
Albumin 5%	140	125	-	-	-	-	Human albumin 50 g/L octanoate 8 mmol/L	260 mOsm/kg osmolality
Albumin 20%	125	100	-	-	-	-	Caprylate 16 mmol/L, N-acetyl-D,L-tryptophan 16 mmol/L	130 mOsm/kg osmolality
Gelofusine	154	120	-	-	-	-	Succinylated gelatine 40 g/L	274

Abbreviations: Na=sodium; Cl=chloride; K=potassium; Ca=calcium; Mg=magnesium; mmol/L=millimoles per Litre; mOsm/L=milliosmoles per Litre; mOsm/kg=milliosmoles per kilogram

Sources:

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2. National Institute for Health and Care Excellence. Intravenous fluid therapy in adults in hospital. London: NICE; 2017
3. Medsafe. Data Sheets and Consumer Medicine Information [Internet]. Wellington: New Zealand Medicines and Medical Devices Safety Authority; 2024. (Available at: https://www.medsafe.govt.nz/Medicines/infoSearch.asp).
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5. Monthly Index of Medical Specialities (MIMS) Malaysia. Search Drug Information, Images & Medical News. (Available at: https://www.mims.com/malaysia)

Calculation of adjusted body weight (ABW) for intravenous fluid therapy in obese patients:
ABW = IBW + 0.4 (actual weight - IBW)

Ideal body weight (IBW) estimation:
Male: 50.0 kg + 0.91 (height in cm - 152)
Female: 45.5 kg + 0.91 (height in cm - 152)

Source: Ministry of Health Malaysia. Clinical Practice Guidelines on Management of Dengue Infection in Adults (Third Edition). Putrajaya: MoH; 2015

Appendix 7

RECOMMENDED ANALGESIA FOR ACUTE PAIN IN ADULT TRAUMA PATIENTS

Drugs	Patient's Characteristics	Dose and Interval	Adverse Effects	Cautions
Paracetamol				
Intravenous (IV)	33 - 50 kg	15 mg/kg at least 4-hourly; infusion over 15 min Max: 3 g/day	Common adverse reactions at injection site: - Pain or burning sensation Potential fatal adverse reactions: - Anaphylaxis - Hepatic injury - Rare skin reaction: Stevens-Johnson Syndrome, toxic epidermal necrolysis	<u>Caution use in:</u> - G6PD deficiency - Mild to moderate hepatic impairment - Severe renal impairment - Chronic alcoholic/malnutrition - Dehydration - Severe hypovolaemia - Pregnancy or lactation <u>Contraindication:</u> - Severe hepatic impairment - Hypersensitivity to paracetamol
	>50 kg	1 g every 6-hourly; infusion over 15 mins Max: 4 g/day		
	Renal impairment	Follow above dosing and adjust interval as follows: GFR 10 - 30 ml/min - dosing interval 6-hourly GFR <10 ml/min - dosing interval 8-hourly		
	Hepatic impairment Chronic alcoholic Chronic malnutrition	Follow above dosing and adjust maximum dose to 3 g/day		
Ketamine				
IV	Adults	(Bolus) 0.3 - 0.5 mg/kg - Recommended not exceeding 0.35 mg/kg without close monitoring because of AEs (Infusion) 0.1 - 0.2 mg/kg/hour - Recommended not exceeding 1 mg/kg/hour without close monitoring because of AEs	Central nervous system (CNS): - Hallucination, agitation, increased CSF pressure, nystagmus, diplopia, lacrimation Cardiovascular system (CVS): - Tachycardia, arrhythmia, hypertension Respiratory system: - Laryngospasm Gastrointestinal (GI) tract: - Hypersalivation, nausea, vomiting	<u>Contraindication:</u> - Hypertension - Severe coronary artery disease - Cerebral trauma - Cerebrovascular accident - Eclampsia or pre-eclampsia

Drugs	Patient's Characteristics	Dose and Interval	Adverse Effects	Cautions
Tramadol				
Intramuscular (IM) or IV	Adults (aged ≤75 years)	50 - 100 mg 4- to 6-hourly For IV - to give as slow bolus over 3 mins (due to cardiovascular effect) Max: 400 mg/day	CNS: - Dizziness, somnolence, seizure CVS: - Palpitation, tachycardia GI tract: - Nausea, vomiting	Caution use in: - Concurrent head injury - Reduced conscious level Contraindication: - Poorly-controlled epilepsy - Acute alcohol or substance intoxication - Intake of monoamine oxidase inhibitor
	Elderly (aged >75 years) Renal impairment Hepatic impairment	To increase dosage interval		
Fentanyl				
IV For abdominal pain or fracture/dislocation		Initial dose: 25 - 50 µg	CNS: - Sedative, dizziness CVS: - Hypotension, bradycardia Respiratory system: - Muscle rigidity including thoracic muscles, respiratory depression/ apnoea GI tract: - Nausea, vomiting	- Following IV injection, hypotension may occur especially in hypovolaemic patient - Dose higher than recommended may cause respiratory depression or thoracic wall rigidity - Resuscitation equipment and opioid antagonist should be readily available - Fentanyl should be given where monitoring and resuscitation can be provided by personnel who can handle the airway
For procedures (combined with local anaesthesia)	Aged <65 years	1 - 2 µg/kg, followed by 0.5 - 1 µg/kg		
	Aged ≥65 years	0.5 - 1 µg/kg, followed by 0.25 µg/kg		
Morphine				
IV	Aged <60 years	Titrate 1 mg every 5 mins until pain score <6	CNS - Drowsiness, euphoria	Caution use in: - Bronchial asthma - Reduced respiratory reserve

Drugs	Patient's Characteristics	Dose and Interval	Adverse Effects	Cautions
	Aged ≥60 years	Titrate 0.5 mg every 5 mins until pain score <6	CVS: - Hypotension, orthostatic hypotension, bradycardia Respiratory system: - Bronchospasm, respiratory depression GI tract: - Nausea, vomiting, constipation, paralytic ileus Renal system: - Urinary retention Skin: - Rashes, pruritus	e.g. morbid obesity - Sleep-related breathing disorder - Hepatic/renal impairment
Maintenance	Aged <60 years	2.5 - 10 mg 4-hourly (slow injection)		
	Aged ≥60 years Hepatic impairment Renal impairment	Need to reduce dose and increase interval		
IM or subcutaneous	Aged <60 years	5 - 10 mg 4-hourly		
	Aged ≥60 years	Initiate at lower end of dose range		

Abbreviations: kg=kilogram; mg/kg=milligram per kilogram; min=minute; max=maximum; g=gram; GFR=glomerular filtration rate; ml/min=millilitre per minute; CNS=central nervous system; CSF=cerebral spinal fluid; CVS=cardiovascular system; GI=gastrointestinal; AEs=adverse effects; IV=intravenous; G6PD= glucose-6-phosphate dehydrogenase; IM=intramuscular; µg=microgram

References:

1. Monthly Index of Medical Specialities (MIMS) Malaysia. Search Drug Information, Images & Medical News. (Available at: https://www.mims.com/malaysia)
2. Schwenk ES, Viscusi ER, Buvanendran A, et al. Consensus Guidelines on the Use of Intravenous Ketamine Infusions for Acute Pain Management from the American Society of Regional Anesthesia and Pain Medicine, the American Academy of Pain Medicine, and the American Society of Anesthesiologists. Reg Anesth Pain Med. 2018;43(5):456-466.
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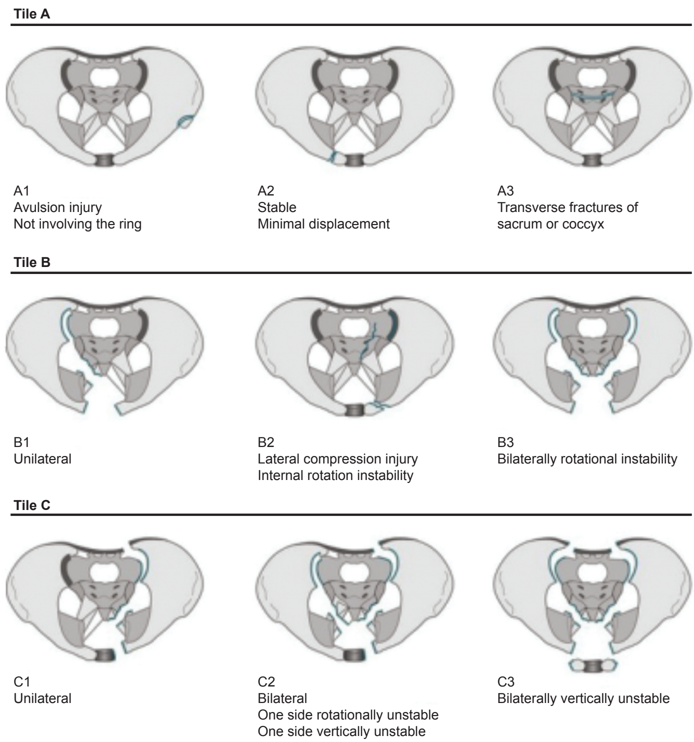
4. Electronic Medicines Compendium (EMC). (Available at: https://www.medicines.org.uk/emc)

Appendix 8

PELVIC FRACTURE STABILITY CLASSIFICATION

Type	Stability	Description
A	Stable (posterior arch intact)	A1: Avulsion of innominate bone iliac A2: Wing or anterior arch fracture caused by a direct blow A3: Transverse fractures of sacrum and coccyx
B	Partially stable (incomplete disruption of posterior arch)	B1: Open book injury (external rotation) B2: Lateral compression injury (internal rotation) B3: Bilateral B injuries
C	Complete unstable (complete disruption of posterior arch)	B1: Unilateral B2: Bilateral, with one side type B, one side type C B3: Bilateral

THE MODIFIED TILE CLASSIFICATION

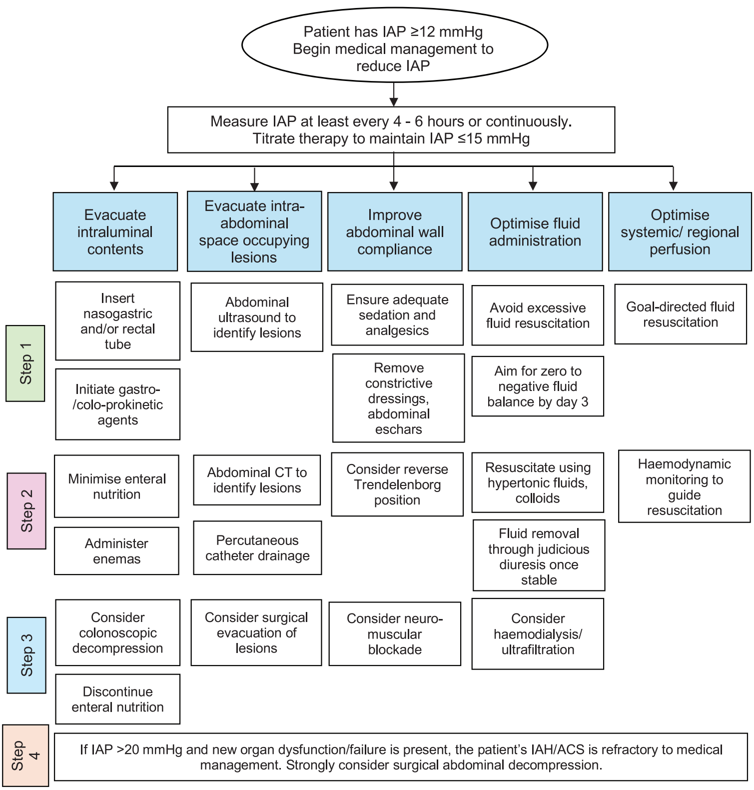


Source: Physiopedia. Pelvic Fractures. Physiopedia; 2024. (Available from:https:/ www.physio-pedia.com/index.php?title=Pelvic_Fractures&oldid=363897}

Appendix 9

INTRA-ABDOMINAL HYPERTENSION (IAH)/ABDOMINAL COMPARTMENT SYNDROME (ACS) MEDICAL MANAGEMENT ALGORITHM

- The choice (and success) of the medical management strategies listed below is strongly related to both the aetiology of the patients's IAH/ACS and the patient's clinical situation. The appropriateness of each intervention should always be considered prior to implementing these interventions in any individual patient.
- The interventions should be applied in a stepwise fashion until the patient's intra-abdominal pressure (IAP) decreases.
- If there is no response to a particular intervention, therapy should be escalated to the next step in the algorithm.



Source: Kirkpatrick AW, Roberts DJ, De Waele J, et al. Intra-abdominal hypertension and the abdominal compartment syndrome: updated consensus definitions and clinical practice guidelines from the World Society of the Abdominal Compartment Syndrome. Intensive Care Med. 2013;39(7):1190-206.

Appendix 10

MEASUREMENT OF INTRA-ABDOMINAL PRESSURE

Techniques:
To measure intra-abdominal pressure (IAP) using a Foley catheter, you'll need a manometer, a sterile saline solution and a Foley catheter already inserted into the patient. Finally, level the manometer with the patient's body at the level of the iliac crest (mid-axillary line) and read the pressure at end-expiration.

Preparation:
- ○ Ensure the patient is in a supine position.
- ○ Confirm the Foley catheter is properly placed and draining urine.
- ○ Prepare the manometer and connect it to the Foley catheter's drainage port, creating a closed system.
- ○ Prime the manometer with sterile saline (usually 20-25ml).

Zeroing the Transducer:
- ○ Zero the pressure transducer of the manometer at the level of mid-axillary line.

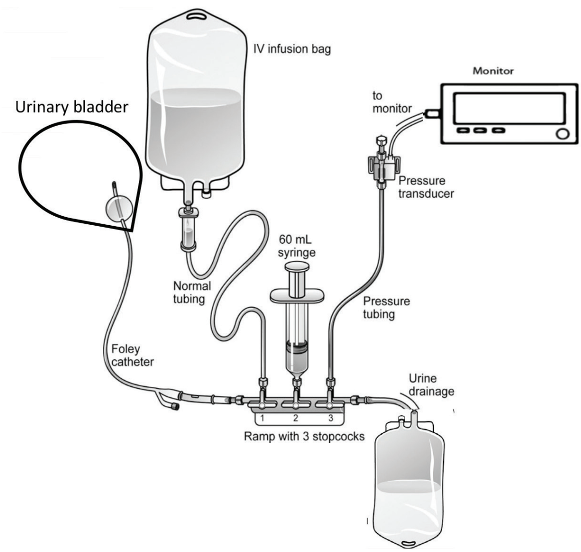
Instilling Saline:
- ○ Instil a small, measured amount of sterile saline (e.g. 20-25ml) into the bladder

Reading the Pressure:
- ○ Ensure the patient is relaxed and not contracting their abdominal muscles.
- ○ Record the pressure reading at end-expiration (when the patient exhales).

Post-Measurement:
- ○ Release the clamp on the Foley catheter tubing to allow for continued urine drainage.
- ○ Consider repeating the measurement periodically, especially in critically ill patients.

Interpreting IAP Measurements:
- Intra-abdominal hypertension (IAH) is defined as a sustained or repeated pathological elevation in IAP greater than or equal to 12 mmHg, according to the World Society of the Abdominal Compartment Syndrome (WSACS).
- IAH is graded by severity:
  - ○ Grade I: IAP 12-15 mmHg
  - ○ Grade II: IAP 16-20 mmHg
  - ○ Grade III: IAP 21-25 mmHg
  - ○ Grade IV: IAP > 25 mmHg

Note: 1 mmHg=1.36 cmH_2O



Adapted: Desie N, Willems A, De Laet I, et al. Intra-abdominal pressure measurement using the FoleyManometer does not increase the risk for urinary tract infection in critically ill patients. Ann Intensive Care. 2012 Jul 5;2 Suppl 1(Suppl 1):S10.

Appendix 11

INTERFACILITY TRANSFER CHECKLIST

		Inter-facility Transfer Process Checklist	☑
1	Transfer decision and arrangements	Decision for transfer by a senior doctor (specialist/consultant). *Consideration of risk vs benefit*	
		Reason for transfer, level of patient preparation and stability prior to transfer, and expected interventions by the receiving team is agreed upon by both referring and receiving teams.	
		Decisions, risks and management plans are communicated to the next of kin.	
		Documentation of names of referring and receiving doctors.	
		Transfer process coordinated by the most qualified medical personnel.	
2	Activation of patient transport system	Activate patient transport system, highlighting information regarding level of care required by the patient to ensure appropriate level of ambulance is deployed.	
		Document time of activation, response time and time of departure. *Determine an agreed upon response time for transfer of a critically ill patient when establishing a transport system.*	
3	Prepare escort team	Determine patient's level of care during transfer and select suitable escort team members. Advanced level of care requires at least ONE escort team member to be ALS-trained, capable of initiating emergency interventions on the patient during transfer.	
		The other two escort team members are personnels trained to handle medical equipment during transportation and trained in transportation safety.	
		Escort team members are prepared to continue patient care during the journey including frequent checks on stability status, with immediate interventions when indicated.	
4	Prepare patient for the transfer	Repeat patient assessment and evaluation at all steps of movement: after transfer to ambulance stretcher, after loading into the ambulance and before departure. Example of brief patient assessment: • **Airway**: patent and secured • **Breathing**: adequate with appropriate respiratory variables, appropriate ventilator setting (patient on mechanical ventilation) • **Circulation**: haemodynamically stable with venous access secured, functioning infusions, adequate haemostasis • **Drains** functional and secured, underwater seal not clamped	
5	Prepare equipment and drugs for continuation of patient care during transfer	Equipment should be appropriate for use according to patient's clinical needs and level of care.	
		All equipment alarms switched on, properly restrained and positioned to ensure clear visibility to the escort members for regular monitoring and documentation.	
		Equipments should be functional to last the journey. **calculate oxygen requirements and ensure supply will last the journey*	

		Inter-facility Transfer Process Checklist	✓
6	Prepare documents and medical records	Documentation of patient's clinical status prior to departure, therapy and interventions performed, and pertinent clinical events. Imaging films (or digital). Patients' identification documents.	
7	Pre-departure procedures	Notification to receiving team regarding the expected time of arrival to destination.	
		Use item checklist to facilitate final checks before departure e.g. equipment, drugs, imaging films, notes	

Reference:
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LIST OF ABBREVIATIONS

AAST	American Association for the Surgery of Trauma
ACS	abdominal compartment syndrome
AE	adverse event/effect
AGREE II	Appraisal of Guidelines, Research and Evaluation II
AIS	Abbreviated Injury Scale
ALS	advanced life support
AP	anterior-posterior
aPTT	activated partial thromboplastin time
ASIS	anterior superior iliac spine
ATLS	Advanced trauma life support
AUC	area under the curve
BAT	blunt abdominal trauma
BBMI	blunt bowel and mesenteric injury
BLS	basic life support
BPS	Behavioral Pain Score
CECT	Contrast-enhanced computed tomography
CFS	Clinical Frailty Score
CI	confidence interval
CM	contrast media
CNS	central nervous system
CPG	clinical practice guidelines
CPOT	Critical-care Pain Observation Tool
CT	computed tomography
CTP	chemical thromboprophylaxis
CVS	cardiovascular system
CXR	chest x-ray
DCS	damage control surgery
DCL	damage control laparotomy
DG	Development Group
DL	direct laryngoscopy
DPL	diagnostic peritoneal lavage
DSI	Delta Shock Index
DOAC	direct oral anticoagulant
DVT	deep vein thrombosis
EAU	European Association of Urology
ECG	electrocardiogram
ED	Emergency Department
e.g.	example
e-FAST	extended FAST
EMS	emergency medical services
ERCP	endoscopic retrograde cholangiopancreatography
ETD	Emergency and Trauma Department
FAST	focused assessment with sonography in trauma
FBC	full blood count
FMS	Family Medicine Specialist
G6PD	glucose-6-phosphate dehydrogenase
GCS	Glasgow Coma Score
GFR	glomerular filtration rate
GI	gastrointestinal
GRADE	Grading of Recommendations, Assessment, Development and Evaluations

GSH	Group, Screen and Hold
GXM	Group Crossmatch
Hb	haemoglobin
HDU	High-dependency Unit
HR	hazard ratio
HU	Hounsfield Unit
IAH	intra-abdominal hypertension
IAP	intra-abdominal pressure
ICU	intensive care unit
IM	intramuscular
INR	international normalised ratio
IQR	interquartile range
IR	interventional radiology
IRR	incidence rate ratio
ISS	Injury Severity Score
IU	international unit
IV	intravenous
IVC	inferior vena cava
L	liter
LA	local anaesthetic
LFT	liver function test
LMWH	low molecular weight heparin
LOS	length of stay
LWE	local wound exploration
max	maximum
MD	mean difference
MECC	Medical Emergency Coordinating Center
MEQ	milliequivalent
MERS	Malaysian Emergency Response Services
MEWS	Modified Early Warning Score
mg	milligram
µg	microgram
min	minutes
mISS	modified Injury Severity Score
ml/kg	milliliter per kilogram
mmHg	millimeter mercury
MoH	Ministry of Health
MTP	massive transfusion protocol
MTS	Malaysian Triage Scale
NISS	New Injury Severity Score
NOM	non-operative management
NPV	negative predictive value
NRS	Numerical Rating Scale
NS	non-significant
OIS	Organ Injury Scale
OR	odds ratio
OT	operation theatre
p	p-value
PATOS	Pan-Asia Trauma Outcome Study
PE	pulmonary embolism
PPV	positive predictive value
POCUS	point-of-care ultrasound

PR	pulse rate
pRBC	packed red blood cells
PT	prothrombin time
PXR	pelvic x-ray
RC	Review Committee
RCT	randomised controlled trial
ROB	Risk of Bias
RP	renal profile
RR	relative risk/risk ratio
RSB	rectus sheath block
RSI	rapid sequence induction
RTS	Revised Trauma Score
RUQ	right upper quadrant
SBP	systolic blood pressure
SCE	serial clinical examination
SD	standard deviation
SI	Shock Index
SIGN	Scottish Intercollegiate Guidelines Network
SMD	standardised mean difference
Sn	sensitivity
SOI	solid organ injury
Sp	specificity
SpO_2	Oxygen saturation
TAC	temporary abdominal closure
TAE	transarterial embolisation
TBI	traumatic brain injury
TIC	trauma-induced coagulopathy
TRISS	Trauma Score and Injury Severity Score
TSFI	Trauma-Specific Frailty Index
TT	thromboplastin time
TXA	tranexamic acid
U	unit
UFH	unfractionated heparin
VAS	Visual Analogue Score
VEM	viscoelastic method
VL	video laryngoscopy
VTE	venous thomboembolism
WB	whole blood
WBCT	whole body CT
WHO	World Health Organization
WMD	weighted mean difference

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