Consensus Guideline: ABDOMINAL TRAUMA
In Afghanistan Hospitals
CG008
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ABDOMINAL TRAUMA 
In Afghanistan Hospitals 
CG008

Ministry of Public Health 
General Directorate of Curative Medicine 
Clinical Guideline Development department

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FOREWORD

Excellence in health practice depends on the quality of care provided to patients. The Ministry of Public Health of Afghanistan is committed to advance medical science and to provide the best quality care for those who are using our services.

This is a demanding task as the management of each condition, especially in emergency medicine, is unique and varying according to experience and knowledge of health practitioners. As a result, probably, many different approaches are practiced in our emergency rooms. This variation in making clinical decision can sometimes be confusing both to patients and the clinical staff.

Clinical guidelines are used to reduce this variation and help patients, their caregivers and clinicians to make decisions that are clear, based on evidence and most importantly suit individual patients.

I am pleased that a dedicated Workgroup under the General Directorate of Curative Medicine managed to compile this guideline for the management of abdominal trauma that fulfil the said requirements. This guideline describes good clinical practice and setting standards of care at clinic and hospital levels for treatment of trauma patient’s especially abdominal trauma.

I recommend that this guideline should be used as a benchmark when providing emergency medical care for abdominal trauma patients in emergency rooms and set standards of practice both at public and private hospitals across the country. It should also be considered as a key reference when managing such patients either in the individual clinic and hospital.

I would like to acknowledge the excellent contributions of the workgroup and critical reviewers and thank them for their invaluable hard work and dedication for the development of this essential guideline.

Feda Mohammad Paikan MD, MPH
Deputy Minister for Health Care Service Provision
**ABBREVIATIONS:-**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ABG</td>
<td>Arterial Blood Gas</td>
</tr>
<tr>
<td>ACS</td>
<td>American College of Surgeons</td>
</tr>
<tr>
<td>ATLS</td>
<td>Advanced Trauma Life Support</td>
</tr>
<tr>
<td>AIDS</td>
<td>Acquired Immunodeficiency Syndrome</td>
</tr>
<tr>
<td>BAT</td>
<td>Blunt Abdominal Trauma</td>
</tr>
<tr>
<td>BBV</td>
<td>Blood-Borne Viruses</td>
</tr>
<tr>
<td>BP</td>
<td>Blood Pressure</td>
</tr>
<tr>
<td>CBC</td>
<td>Complete Blood Count</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>COT</td>
<td>Committee On Trauma</td>
</tr>
<tr>
<td>CPAP</td>
<td>Continuous Positive Airways Pressure</td>
</tr>
<tr>
<td>CPR</td>
<td>Cardiopulmonary Resuscitation</td>
</tr>
<tr>
<td>CT</td>
<td>Computed Tomography</td>
</tr>
<tr>
<td>DL</td>
<td>Diagnostic Laparoscopy</td>
</tr>
<tr>
<td>DPA</td>
<td>Diagnostic Peritoneal Aspiration</td>
</tr>
<tr>
<td>DPL</td>
<td>Diagnostic Peritoneal Lavage</td>
</tr>
<tr>
<td>DPT</td>
<td>Diagnostic Peritoneal Tap</td>
</tr>
<tr>
<td>ECG</td>
<td>Electrocardiographic</td>
</tr>
<tr>
<td>ED</td>
<td>Emergency Department</td>
</tr>
<tr>
<td>EMST</td>
<td>Early Management of Severe Trauma</td>
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</table>

**ETCO2** is the partial pressure or maximal concentration of carbon dioxide (CO2) at the end of an exhaled breath, which is expressed as a percentage of CO2 or mmHg. The normal values are 5% to 6% CO2, which is equivalent to 35-45 mmHg.

e.g. (exempli gratia) for example, like, such as

<table>
<thead>
<tr>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>FAST</td>
<td>Focused Abdominal Sonography for Trauma</td>
</tr>
<tr>
<td>FB</td>
<td>Foreign Body</td>
</tr>
<tr>
<td>GDGs</td>
<td>Guideline Development Groups</td>
</tr>
<tr>
<td>GPs</td>
<td>General Practitioners</td>
</tr>
<tr>
<td>HBV</td>
<td>hepatitis B virus</td>
</tr>
<tr>
<td>Hct</td>
<td>Hematocrit</td>
</tr>
<tr>
<td>HCV</td>
<td>Hepatitis C virus</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
</tr>
<tr>
<td>HR</td>
<td>Heart Rate</td>
</tr>
<tr>
<td>HVI</td>
<td>Hollow Viscus Injury</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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</table>
ISS  Injury Severity Score
IV   Intravascular
IVP  Intravenous pyelography
i.e. (id est) (Latin) that is, that is to say
LFT  Liver Function Test
LWE  Local Wound Exploration
MVC  Motor Vehicle Collision
NICE National Institute for Health and Clinical Excellence
OSHA Occupational Safety and Health Administration
P    Pulse
PEA  Pulseless electrical activity
RBC  Red Blood Cells
Resus Resuscitation
RR   Respiratory Rate
Temp Temperature
US   Ultrasonography
WBC  White Blood Cells
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Part-I

Introduction

The treatment of seriously injured patients requires rapid assessment of the injuries and institution of life-preserving therapy. Because time is of the essence, a systematic approach that can be easily reviewed and practiced is most effective. This process is termed "initial assessment" and includes:

- Preparation.
- Triage.
- Primary survey (ABCDEs).
- Resuscitation.
- Adjuncts to primary survey and resuscitation.
- Consider need for patient transfer.
- Secondary survey (head-to-toe evaluation and patient history).
- Adjuncts to the secondary survey.
- Continued post resuscitation monitoring and reevaluation.
- Definitive care.

The primary and secondary surveys should be repeated frequently to identify any deterioration in the patient's status and to determine whether it is necessary to institute any treatment when adverse changes are identified.

The assessment sequence presented in this chapter reflects a linear, or longitudinal progression of events. In an actual clinical situation, many of these activities occur in parallel, or simultaneously. The longitudinal progression of the assessment process allows the doctor an opportunity to mentally review the progress of an actual trauma resuscitation.

ATLS® principles guide the assessment and resuscitation of injured patients. Judgment is required to determine which procedures are necessary, because not all patients require all of these procedures.
1.1.1 Preparation

How do I prepare for a smooth transition from the prehospital to the hospital environment?

Preparation for the trauma patient occurs in two different clinical settings. First, during the prehospital phase, all events must be coordinated with the doctors at the receiving hospital. Second, during the hospital phase, preparations must be made to rapidly facilitate the trauma patient's resuscitation.

Prehospital-Phase. The prehospital system should be set up to notify the receiving hospital before personnel transport the patient from the scene.

Figure 1-1; Reproduced from ATLS Advanced Trauma Life Support for Doctors NINTH EDITION 2012 Chapter 1, Page-4.
PREHOSPITAL PHASE

Coordination with the prehospital agency and personnel can greatly expedite treatment in the field. The prehospital system should be set up to notify the receiving hospital before personnel transport the patient from the scene. This allows for mobilization of the hospital's trauma team members so that all necessary personnel and resources are present in the emergency department (ED) at the time of the patient's arrival.

During the prehospital phase, emphasis should be placed on airway maintenance, control of external bleeding and shock, immobilization of the patient, and immediate transport to the closest appropriate facility, preferably a verified trauma center. Every effort should be made to minimize scene time. Emphasis also should be placed on obtaining and reporting information needed for triage at the hospital, (e.g., time of injury, events related to the injury, and patient history). The mechanisms of injury can suggest the degree of injury as well as specific injuries for which the patient must be evaluated.

The National Association of Emergency Medical Technicians' Prehospital Trauma Life Support Committee, in cooperation with the Committee on Trauma (COT) of the American College of Surgeons (ACS), has developed a course with a format similar to the ATLS Course that addresses prehospital care for injured patients.
**HOSPITAL PHASE**

Advance planning for the trauma patient's arrival is essential. Ideally, a resuscitation area is available for trauma patients. Proper airway equipment (e.g., laryngoscopes and tubes) should be organized, tested, and placed where it is immediately accessible. Warmed intravenous crystalloid solutions should be available and ready to infuse when the patient arrives. Appropriate monitoring capabilities should be immediately available.

A method to summon additional medical assistance should be in place, as well as a means to ensure prompt responses by laboratory and radiology personnel. Transfer agreements with verified trauma centers should be established and operational. See American College of Surgeons Committee on Trauma (ACS COT), *Resources for Optimal Care of the Injured Patient, 2006*. Periodic review of patient care through the quality improvement process is an essential component of each hospital's trauma program.

All personnel who have contact with the patient must be protected from communicable diseases. Most prominent among these diseases are hepatitis and the acquired immunodeficiency syndrome (AIDS). The Centers for Disease Control and Prevention (CDC) and other health agencies strongly recommend the use of standard precaution.¹, (eg, face mask, eye protection, water-impervious apron, leggings, and gloves) when coming into contact with body fluids. The ACS COT considers these to be *minimum* precautions and protection for all health-care providers. Standard precautions are also an Occupational Safety and Health Administration (OSHA) requirement in the United States.
1.1.2 Triage

Triage involves the sorting of patients based on their need for treatment and the resources available to provide that treatment. Treatment is rendered based on the ABC priorities (Airway with cervical spine protection, Breathing, and Circulation with hemorrhage control), as outlined later in this chapter.

Triage also pertains to the sorting of patients in the field and the decision regarding to which medical facility they should be transported. It is the responsibility of the prehospital personnel and their medical director to ensure that appropriate patients arrive at appropriate hospitals. For example, it is inappropriate for prehospital personnel to deliver a patient who has sustained severe trauma to a hospital that is not a trauma center if a trauma center is available at another hospital (see Figure 1-2a, b, c). Prehospital trauma scoring is helpful in identifying severely injured patients who should be transported to a trauma center.

Two types of triage situations usually exist: multiple casualties and mass casualties.

![Clinical practice image](image)

**Clinical practice**

- **Normal clinical practice**
- **Multiple-casualty incident**
- **Mass casualties**

Figure 1-2a; Reproduced from ICRC Sources.
TRIAGE CATEGORIES:-

Triage Documentation

Figure.1-2b; Reproduced from ICRC Sources.

I. **Serious wounds: resuscitation and immediate surgery**

II. **Second priority: need surgery but can wait**

III. **Superficial wounds: ambulatory management**

IV. **Severe wounds: supportive treatment**

Figure.1-2c; Reproduced from ICRC Sources.
1.1.2.1 MULTIPLE CASUALTIES

In multiple-casualty incidents, the number of patients and the severity of their injuries do not exceed the ability of the facility to render care. In such situations, patients with life-threatening problems and those sustaining multiple-system injuries are treated first. The use of prehospital care protocols and online medical direction can facilitate and improve care initiated in the field. Periodic multidisciplinary review of the care provided through quality improvement activities is essential.

1.1.2.2 MASS CASUALTIES

In mass-casualty events, the number of patients and the severity of their injuries exceed the capability of the facility and staff. In such situations, the patients with the greatest chance of survival and requiring the least expenditure of time, equipment, supplies, and personnel, are treated first.

Emergency practitioners routinely encounter patients who suffer from abdominal trauma, be it blunt or penetrating. These injuries are often confounded by altered mental status, distracting injuries, or lack of historical information, and may present challenges in management. However, in the last several year’s new approaches to the diagnosis and management of abdominal trauma, including bedside ultrasound, newer generation computed tomography scans, laparoscopy, and the ability for selected nonoperative management expedite identification of life threatening injury and offer new options in treatment.

Historically, blunt abdominal trauma (BAT) is more frequently encountered in the emergency department (ED) than penetrating abdominal trauma, and usually results from a motor vehicle collision (MVC). When combined with pedestrian versus auto accidents, these types of abdominal traumas account for up to 75% of cases seen, while direct abdominal blows and falls comprise the remainder.

The spleen is the most often injured organ and may be the only intra-abdominal injury in over 60% of cases. Liver and hollow viscus injuries follow in decreasing incidence. Blunt abdominal trauma may herald occult domestic violence or child abuse.

Trauma is a multidisciplinary condition. Pre-hospital care is usually provided by Ambulance staff. Upon arrival at hospital it is imperative that the injured patient is cared for by experienced medical and nursing staff with a methodical approach ensuring optimum care whilst minimizing delays. This is of paramount importance with severely injured patients.
The following guidelines should not be seen as a substitute for other publications such as the ATLS Manual. They are designed as a resource for medical and nursing staff and have been agreed upon by Senior Clinicians involved in trauma care at Hospital.

Fifty-seven million people become trauma victims every year in the United States, making it a significant cause of morbidity and mortality. Trauma is the fourth leading cause of death in the United States overall and the most common cause of death in people under the age of 44. Approximately 20% of injured trauma victims will have residual long-term disabilities. Injuries related to blunt abdominal trauma (BAT) may follow direct impact, acceleration-deceleration, and shearing forces to the human body. These occur most commonly from automobile collisions, followed by falls and assaults. In motor vehicle collisions and falls, the process of rapid deceleration creates a situation where the body’s internal organs continue moving after the musculoskeletal system has been stopped.

The evaluation of patients with suspected blunt abdominal trauma presents a diagnostic challenge. Patients often do not present with the classic signs of intra-abdominal injury such as abdominal pain or unexplained hypotension. In addition, trauma centers often have a high proportion of patients with an altered mental status due to chemical substances or head injury, making the clinical history and physical exam less reliable. In the past, all patients with suspected intra-abdominal injury were surgically explored. With this strategy, negative laparotomies, in which no injury is found, resulted in morbidity 18% of the time and non-therapeutic laparotomies, in which there is no surgical intervention for intra-abdominal injuries, resulted in a morbidity rate of 45%. Exploratory laparotomy following BAT still remains mandatory for certain patients (peritonitis, free air, progressive abdominal distention with unexplained hypotension), but in the absence of these more overt clinical findings several modalities are typically utilized to increase diagnostic accuracy.

In 1965 Dr. Root introduced diagnostic peritoneal lavage (DPL). DPL is a relatively fast procedure, being performed in 3-26 minutes. It can be performed during trauma resuscitations with a sensitivity of 87-99% and a specificity of 97-98%. The procedure requires peritoneal puncture and is associated with only a 1% incidence of significant complications but it is unable to adequately detect retroperitoneal and diaphragmatic injury. DPL is relatively contraindicated in pregnant patients, those with multiple previous operations, pelvic fractures, or clotting disorders.

Computed tomography is increasingly utilized in BAT patients since it is a non-invasive test and has a sensitivity of up to 97% and a specificity 98-99%. CT
permits localization and grading of injuries, but cannot be safely performed on unstable or uncooperative patients due to the requirement for transport to the radiology suite and time constraints. CT can take 60 – 90 minutes to obtain when transport and setup times are included with a cost that is considerably higher than other diagnostic modalities. CT also carries the risk of complications from intravenous contrast injection and allergy.

The use of ultrasound in the United States has become increasingly popular among trauma surgeons for providing a quick, reliable assessment of the thorax and abdomen in BAT. Numerous publications, including one with 1000 patients examined prospectively, have described its speed, portability, and low-cost in this patient population. It has also been shown repeatedly that house staff can interpret US results as reliably as radiology personnel. The ideal assessment of the BAT patient would be sensitive, specific, economical, fast, and without complications. By combining ultrasound with computed tomography (CT) and diagnostic peritoneal lavage (DPL), a potentially cost effective algorithm can be derived to accurately evaluate blunt abdominal trauma patients. We prospectively evaluated a series of patients with suspected blunt abdominal trauma using an algorithm with ultrasound as the initial screening modality to determine if it would be more sensitive, specific, and cost-effective than each diagnostic modality alone.

Penetrating trauma is increasing because of the growth of violence in our society. Stab wounds are encountered three times more often than gunshot wounds, but have a lower mortality because of their lower velocity and less invasive tract. As a result of their greater force and extensive missile tract, gunshot wounds account for up to 90% of the mortality associated with penetrating abdominal trauma. Injury to the bowel (small, then large) is most often found, followed by hepatic injury, regardless of type of penetrating injury.

Evaluation of the abdomen is a challenging component of the initial assessment of the injured patient. The assessment of circulation during the primary survey includes early recognition of the possibility of occult hemorrhage in the abdomen and pelvis in any patient sustaining blunt trauma. Penetrating torso wounds between the nipple and perineum also must be considered as potentially causing intraabdominal injury. The mechanism of injury, injury forces, location of injury, and hemodynamic status of the patient determine the priority and best method of abdominal assessment.

Unrecognized abdominal injury continues to be a case of preventable death after truncal trauma. It is a mistake to assume that rupture of a hollow viscus or
bleeding from a solid organ can be easily recognized. The assessment of affected patients is often compromised by alcohol intoxication, use of illicit drugs, injury to the brain or spinal cord, or injury to adjacent structures such as the ribs, spine, or pelvis.

Significant amount of blood loss also may be present in the abdominal cavity without any dramatic change in appearance or dimension and without obvious signs of peritonitis. Any patient sustaining significant blunt torso injury from a direct blow or deceleration, or a penetrating torso injury, must be considered to have an abdominal visceral or vascular injury.

1.1.2.3 Death Following Injury

Death due to injury occurs in 1 of 3 time periods. The first time period is within seconds to minutes of injury. During this early period, deaths generally result from severe brain or high spinal-cord injury or rupture of the heart, aorta, or other large blood vessel. Due to the severity of injury, few of these patients can be salvaged, and prevention is the only way to reduce such trauma-related deaths. The second peak occurs within minutes to hours following injury. Deaths occurring during this period are usually due to subdural and epidural hematomas, hemopneumothorax, solid organ rupture (spleen or liver), pelvic fractures, or other injuries associated with blood loss. The “golden hour” after injury is characterized by the need for rapid assessment and resolution of these problems. The third peak occurs days to weeks after the initial injury and is most often due to sepsis with associated multiple organ failure.

Three premises guide the approach to injury. The most important is that the greatest threat to life must be treated first. For example, the inability to breathe kills more quickly than the loss of circulating blood volume. The second premise is that lack of a definitive diagnosis should never impede application of indicated treatment. And the third is that a detailed history is not essential to begin evaluation in the setting of acute injury.
In accordance with NICE (National Institute for Health and Clinical Excellence) and after recommendations perseverance of stakeholders and GDGs* (Guideline Development Groups) we provide this guideline step by step and our team passed key stages of clinical guideline development like topic referred to our team, Stakeholders register, Scope, Stakeholders comment, Guideline Development, Stakeholders respond to call for evidence (if applicable), Consultation draft of guideline, Stakeholders comment, Pre-publication check of revised full guideline, Stakeholders check, and Finally Publication. And according to NICE rules this guideline are developed with a scope that defines what the guideline will and will not cover.

Groups that will be covered
All patients, both men and women, suffering from abdominal trauma. This includes blunt and penetrating abdominal trauma, and about these patients general approach (primary survey, immediate resuscitation and management of life, secondary survey and Definitive care), diagnostic tests, Imaging Studies and interventional diagnostic techniques will be covered.

Groups that will not be covered
Patients suffering from abdominal trauma Hollow viscus injury and solid organ injury separately will not be covered.
It is aimed for use by all health professionals and where treatment will be carried out - for example, by Gps (primary care), in hospital (secondary care) or in specialist units (tertiary care).

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1* GDG members include healthcare professionals, technical experts, and patients and carers who have relevant expertise and experience.
**1.1.4 GENERAL APPROACH**

**OVERVIEW** The EMST\textsuperscript{2} /ATLS principles form the basis of assessment and treatment guidelines. Treatment of the seriously injured involves rapid assessment and resuscitation followed by a thorough examination and definitive care. The Systematic EMST approach includes the following:

1- Primary Survey ABCDE
   
   As part of the primary survey, patient monitoring is initiated.
   
   Trauma series of x-rays.

2- Resuscitation
   
   Immediate resuscitation and management of life threatening conditions identified during the primary survey.

3- Secondary Survey Head to toe examination.

4- Definitive care.

**TRAUMA MANAGEMENT:**

Early management of the seriously injured patient requires simultaneous evaluation and treatment. The first goal is to ensure adequate oxygen delivery to vital organs by following an established sequence of priorities that allows identification and treatment of immediately life threatening injuries (primary assessment). The patient’s vital functions must be assessed quickly and efficiently. Patient management should consist of a rapid primary evaluation, resuscitation of vital functions, more detailed secondary assessment (from head to toe), and finally, the initiation of definitive care. This process begins with the ABCDE of trauma care, which guides the identification of life-threatening

\textsuperscript{2} Early Management of Severe Trauma.
conditions through the initial assessment sequence of airway, breathing, circulation, disability, and exposure.

<table>
<thead>
<tr>
<th>Initial Assessment of Trauma.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airway</strong> maintenance with cervical spine precautions.</td>
</tr>
<tr>
<td><strong>Breathing:</strong> ventilation and oxygenation.</td>
</tr>
<tr>
<td><strong>Circulation</strong> with hemorrhage control.</td>
</tr>
<tr>
<td><strong>Disability:</strong> brief neurologic examination.</td>
</tr>
<tr>
<td><strong>Exposure/environment:</strong> undress patient, but avoid hypothermia.</td>
</tr>
</tbody>
</table>

Figure.1-3; Reproduced from Fundamental Critical Care Support, FCCS, 4th Edition, 2007, Chapter 9, Page-3.

A surgeon skilled in trauma management should be consulted early in the course of all serious trauma cases. When a surgeon is not immediately available or when the patient is awaiting transfer, ongoing evaluation (tertiary assessment) and intervention should continue.
1.1.4.1 PRIMARY SURVEY

Primary Survey

What is a quick, simple way to assess the patient in 10 seconds?

Patients are assessed, and their treatment priorities are established, based on their injuries, vital signs, and the injury mechanisms.

Figure 1-4; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 1, Page 4.

In severely injured patients, logical and sequential treatment priorities must be established based on overall patient assessment. The patient's vital functions
must be assessed quickly and efficiently. Management consists of a rapid primary survey, resuscitation of vital functions, a more detailed secondary survey, and, finally, the initiation of definitive care. This process constitutes the ABCDEs of trauma care and identifies life-threatening conditions by adhering to the following sequence:

1. Airway maintenance with cervical spine protection.
2. Breathing and ventilation.
3. Circulation with hemorrhage control.
5. Exposure/Environmental control: Completely undress the patient, but prevent hypothermia.

During the primary survey, life-threatening conditions are identified, and management is instituted simultaneously. The prioritized assessment and management procedures described in this chapter are presented as sequential steps in order of importance and for the purpose of clarity. However, these steps are frequently accomplished simultaneously.

Priorities for the care of pediatric patients are the same as those for adults. Although the quantities of blood, fluids, and medications; size of the child; degree and rapidity of heat loss; and injury patterns may differ, the assessment and management priorities are identical.

Priorities for the care of pregnant females are similar to those for nonpregnant females, but the anatomic and physiologic changes of pregnancy may modify the patient's response to injury. Early recognition of pregnancy by palpation of the abdomen for a gravid uterus and laboratory testing (human chorionic gonadotropin, or hCG) and early fetal assessment are important for maternal and fetal survival.

Trauma is a Common cause of death in the elderly. With increasing age, cardiovascular disease and cancer overtake the incidence of injury as the leading causes of death. Interestingly, the risk of death for any given injury at the lower and moderate Injury Severity Score (ISS) levels is greater for elderly males than for elderly females.

Resuscitation of elderly patients warrants special attention. The aging process diminishes the physiologic reserve of elderly trauma patients, and chronic cardiac, respiratory, and metabolic diseases can reduce the ability of these patients to respond to injury in the same manner in which younger patients are able to compensate for the physiologic stress caused by injury. Comorbidities such as diabetes, congestive heart failure, coronary artery disease, restrictive and obstructive pulmonary disease, coagulopathy, liver disease, and peripheral vascular disease are more common in older patients and adversely affect
outcomes following injury. In addition; the long-term use of medications may alter the usual physiologic response to injury, and the narrow therapeutic window frequently leads to over-resuscitation or under-resuscitation in this patient population. As such, early, invasive monitoring is frequently a valuable adjunct to management. Despite these facts, most elderly trauma patients recover and return to their pre injury level of independent activity if appropriately treated. Prompt, aggressive resuscitation and the early recognition of preexisting medical conditions and medication use can improve survival in this patient group.

1.1.4.1.1 AIRWAY MAINTENANCE WITH CERVICAL SPINE PROTECTION

Upon initial evaluation of a trauma patient, the airway should be assessed first to ascertain patency. This rapid assessment for signs of airway obstruction should include inspection for foreign bodies and facial, mandibular, or tracheal/laryngeal fractures that may result in airway obstruction. Measures to establish a patent airway should be instituted while protecting the cervical spine. Initially, the chin-lift or jaw-thrust maneuver is recommended to achieve airway patency.

If the patient is able to communicate verbally, the airway is not likely to be in immediate jeopardy; however, repeated assessment of airway patency is prudent. In addition, patients with severe head injuries who have an altered level of consciousness or a Glasgow Coma Scale (GCS) score of 8 or less usually require the placement of a definitive airway. The finding of nonpurposeful motor responses strongly suggests the need for definitive airway management. Management of the airway in pediatric patients requires knowledge of the unique anatomic features of the position and size of the larynx in children, as well as special equipment.

While assessing and managing the patient’s airway, great care should be taken to prevent excessive movement of the cervical spine. The patient's head and neck should not be hyperextended, hyperflexed, or rotated to establish and maintain the airway. Based on a history of a traumatic incident, loss of stability of the cervical spine should be suspected. Neurologic examination alone does not exclude a diagnosis of cervical spine injury. Protection of the patient's spinal cord with appropriate immobilization devices should be accomplished and maintained. If immobilization devices must be removed temporarily, one member of the trauma team should manually stabilize the patient’s head and neck using inline immobilization techniques (Figure 1-5).
If immobilization devices must be team should manually, one member of the trauma head and neck using inline immobilization techniques.

Figure.1-5; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 1, Page-6.]

The stabilization equipment used to protect the patients spinal cord should be left in place until cervical spine injury has been excluded. Protection of the spine and spinal cord is a critically important management principle. Cervical spine radiographs may be obtained to confirm or exclude injury once immediate or potentially life-threatening conditions have been addressed. Assume a cervical spine injury in any patient with multisystem trauma, especially those with an altered level of consciousness or a blunt injury above the clavicle.

Every effort should be made to promptly identify airway compromise and secure a definitive airway. Equally important is the necessity to recognize the potential for progressive airway loss. Frequent reevaluation of airway patency is essential to identify and treat patients who are losing the ability to maintain an adequate airway.
Figure 1-6a; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 2, Page-26.

Figure 1-6b; Reproduced from ICRC Sources, War Surgery Seminar, Wound Ballistics: Bombs, bullets and blast, Kabul 13-15 June 2011.
**AIRWAY: - ASSESSMENT:**

<table>
<thead>
<tr>
<th>Stridor</th>
<th>Resp Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoarseness</td>
<td>Conscious level</td>
</tr>
<tr>
<td>Facial +/- neck injury</td>
<td></td>
</tr>
</tbody>
</table>

**Airway Maintenance**

- Basic - Suction
  - FB removal
  - Jaw thrust
  - Pharyngeal airway
  - Bag mask ventilation

- Advanced - Rapid sequence induction
  - Endotracheal intubation
  - Difficult airway techniques
  - Oesophageal detector device
  - ETCO2 monitoring

- Rescue - Laryngeal mask
  - Surgical airway – needle cricothyroidotomy
  - mini track cricothyroidotomy

**C-Spine Immobilisation**

- Neutral position
- Semi rigid collar
- Sandbags and tape
- Inline immobilization
- Until clinical and radiological examination
  [if indicated] exclude injury.

### 1.1.4.1.2 BREATHING AND VENTILATION

Airway patency alone does not ensure adequate ventilation. Adequate gas exchange is required to maximize oxygenation and carbon dioxide elimination. Ventilation requires adequate function of the lungs, chest wall, and diaphragm. Each component must be examined and evaluated rapidly.

The patient’s chest should be exposed to adequately assess chest wall excursion, and auscultation should be performed to ensure gas flow in the lungs.
Visual inspection and palpation can detect injuries to the chest wall that might compromise ventilation. Percussion of the thorax during a noisy resuscitation may be difficult or produce unreliable results.

**PITFALLS**

- Despite the efforts of even the most prudent and attentive doctor, there are circumstances in which airway management is exceptionally difficult and occasionally even impossible to achieve. Equipment failure often cannot be anticipated, for example, the light on the laryngoscope burns out or the cuff on the endotracheal tube that was placed with exceptional difficulty leaks because it was torn on the patient's teeth during intubation.
- Tragic pitfalls include patients in whom intubation cannot be performed after paralysis and patients in whom a surgical airway cannot be established expeditiously because of their obesity.
- Endotracheal intubation of a patient with an unknown laryngeal fracture or incomplete upper airway transection can precipitate total airway occlusion or complete airway transection. This may occur in the absence of clinical findings that suggest the potential for an airway problem, or when the urgency of the situation dictates the immediate need for a secure airway or ventilation. These pitfalls cannot always be prevented. However, they should be anticipated, and preparations should be made to minimize their impact.

Injuries that can impair ventilation in the short term include tension pneumothorax, flail chest with pulmonary contusion, massive hemothorax, and open pneumothorax. These injuries should be identified during the primary survey. Simple pneumothorax or hemothorax, fractured ribs, and pulmonary contusion can compromise ventilation to a lesser degree and are usually identified during the secondary survey.

**PITFALLS**

Differentiating between ventilation problems and airway compromise can be difficult:

- A patient who has profound dyspnea and tachypnea gives the impression that his or her primary problem is related to an inadequate airway. However, if the ventilation problem is caused by a pneumothorax or tension pneumothorax, intubation with vigorous bag-valve ventilation can rapidly lead to further deterioration of the patient.
• When intubation and ventilation are necessary in an unconscious patient, the procedure itself can unmask or aggravate a pneumothorax, and the patient's chest must be reevaluated. Chest x-rays should be obtained as soon after intubation and initiation of ventilation as is practical.

**BREATHING:**

**Assessment**
- O₂ sats
- Resp rate
- Tracheal position
- Chest wall movement
- Respiratory pattern
- Percussion
- Auscultation

**Management**
- O₂ [high flow via mask with reservoir bag]
- Treat life threatening injury
- Tension pneumothorax
- Open pneumothorax
- Massive hemothorax
- Flail chest/pulmonary contusion

**Assisted ventilation**
- Bag and mask
- Consider CPAP
- Mechanical

**1.1.4.1.3 CIRCULATION WITH HEMORRHAGE CONTROL**

Circulation issues to consider include blood volume and cardiac output, and bleeding.

**Blood Volume and Cardiac Output**

Hemorrhage is the predominant cause of preventable deaths after injury. Hypotension following injury must be considered to be hypovolemic in origin until proved otherwise; therefore, rapid and accurate assessment of an injured patient's hemodynamic status is essential. The elements of clinical observation that yield important information within seconds are level of consciousness, skin color, and pulse.
**Level of Consciousness:** When circulating blood volume is reduced, cerebral perfusion may be critically impaired, resulting in altered levels of consciousness. However, a conscious patient also may have lost a significant amount of blood.

**Skin Color:** Skin color can be helpful in evaluating the injured patient who has hypovolemia. A patient with pink skin, especially in the face and extremities, rarely has critical hypovolemia after injury. Conversely, the patient with hypovolemia may have ashen, gray facial skin and white extremities.

**Pulse:** The pulse, typically an easily accessible central pulse (femoral or carotid artery), should be assessed bilaterally for quality, rate, and regularity. Full, slow, and regular peripheral pulses are usually signs of relative normovolemia in a patient who is not taking B-adrenergic blocking medications. A rapid, thready pulse is typically a sign of hypovolemia, but the condition may have other causes, a normal pulse rate does not ensure that a patient has normovolemia, but an irregular pulse does warn of potential cardiac dysfunction. Absent central pulses that are not attributable to local factors signify the need for immediate resuscitative action to restore depleted blood volume and effective cardiac output.

**Bleeding**

External hemorrhage is identified and controlled during the primary survey. Rapid, external blood loss is managed by direct manual pressure on the wound. Pneumatic splinting devices also can help to control hemorrhage. These devices should be transparent to allow for monitoring of underlying bleeding. Tourniquets are infrequently used to control severe bleeding. The use of hemostats can damage nerves and veins. The major areas of occult blood loss are the chest, abdomen, retroperitoneum, pelvis, and long bones.
**CIRCULATION:-**

1. Assessment
   - P = Pulse
   - BP = Blood Pressure
   - Skin colour/ temp
   - Capillary refill

2. Management
   1. Assess cardiac output and rhythm – commence CPR if required
   2. External hemorrhage control
      - Direct pressure to wound or proximal blood vessel
      - Pack peripheral wounds, dress and elevate
      - Splint fractures

3. Fluid Resuscitation
   - Insert 2 large bore [≥ 18g] IV cannula
   - Alternative advanced IV techniques:
     - Arrow trauma kit
     - Femoral vein
     - Cut downs
     - Intra osseous cannula/drill – (adult + paeds)
     - Central venous
   - Take blood [through cannula] for
     - CBC
     - U + E³

³ U + E stands for urea and electrolytes and is a measure of kidney function. The healthy kidney excretes urea and is important in maintaining the electrolyte balance of the body, the balance between such chemicals as potassium and sodium and the acid/alkali balance. Sep 2, 2014
- LFT
- Amylase
- x – match
- BBV\(^4^*\)

- Trauma Team Leader will specify other blood tests (e.g. coags) and numbers of units for x-match.

**NOTE:** 5 Potential sources of bleeding
- External
- Chest
- Abdomen
- Pelvis
- Long bones

**INITIAL FLUID RESUSCITATION**
- 2 L warmed crystalloid
  [20 mls/kg] in a child. Consider 2 x 10 ml/kg increments. Reassess hemodynamic response
- Repeat x 1 and reassess hemodynamic response

**O NEGATIVE BLOOD FOR EXSANGUINATING HEMORRHAGE / SEVERE SHOCK**
**EARLY USE OF GROUP SPECIFIC BLOOD OR PREFERABLY X-MATCHED BLOOD IF REQUIRED (10 MLS/KG IN A CHILD)**

**HEMODYNAMIC INSTABILITY**
Consider the patient hemodynamically unstable if despite initial fluid resuscitation the trend indicates:

- HR > 100
- Systolic BP < 100 or age specific abnormal vitals.
- Capillary refill > 3 seconds

\(^4^*\) Blood-Borne Viruses.
• initial fluid volume required  
• 1 unit blood required  
• Ongoing significant fluid requirement  

**NOTE**  
The most important determinant of outcome in unstable trauma victims is **time to definitive surgery**. **Time** should not be wasted with unnecessary monitoring lines such as arterial lines. These can be inserted later.

**1.1.4.1.4 DISABILITY (NEUROLOGIC EVALUATION)**  
A rapid neurologic evaluation is performed at the end of the primary survey. This neurologic evaluation establishes the patient's level of consciousness, pupillary size and reaction, lateralizing signs, and spinal cord injury level.

**PITFALLS**  
Trauma respects no patient population barrier. The elderly, children, athletes, and individuals with chronic medical conditions do not respond to volume loss in a similar or even in a "normal" manner.

- Elderly patients have a limited ability to increase their heart rate in response to blood loss, which obscures one of the earliest signs of volume depletion—tachycardia. Blood pressure has little correlation with cardiac output in older patients. Anticoagulation therapy for medical conditions such as atrial fibrillation, coronary artery disease, and transient ischemic attacks can increase blood loss.
- Children usually have abundant physiologic reserve and often have few signs of hypovolemia, even after severe volume depletion. When deterioration does occur, it is precipitous and catastrophic.
- Well-trained athletes have similar compensatory mechanisms, may have bradycardia, and may not have the usual level of tachycardia with blood loss.
- Often, the AMPLE history, described later in this chapter, is not available, so the health-care team is not aware of the patient's use of medications for chronic conditions.

Anticipation and an attitude of skepticism regarding the patient's "normal" hemodynamic status are appropriate. The GCS is a quick, simple method for determining the level of consciousness that is predictive of patient outcome particularly the best motor response. If it was not performed during the primary survey, the GCS should be performed as part of the more detailed, quantitative neurologic examination during the secondary survey.
A decrease in the level of consciousness may indicate decreased cerebral oxygenation and/or perfusion, or it may be caused by direct cerebral injury. An altered level of consciousness indicates the need for immediate reevaluation of the patient's oxygenation, ventilation, and perfusion status. Hypoglycemia and alcohol, narcotics, and other drugs also can alter the patient's level of consciousness. However, if these factors are excluded, changes in the level of consciousness should be considered to be of traumatic central nervous system origin until proven otherwise.

**DISABILITY:-**

1. **Level of consciousness**  - AVPU  
   - Awake  
   - Responds to verbal stimuli  
   - Responds to pain  
   - Unresponsive  
   - GCS (refer to wall charts in Resus/Trauma Sheets)

2. **Pupillary response and size**
Head injury severity: clinical classification.

**GLASGOW COMA SCORE (GCS)**

<table>
<thead>
<tr>
<th>Eyes open</th>
<th>Spontaneously 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To verbal command 3</td>
</tr>
<tr>
<td></td>
<td>To painful stimulus 2</td>
</tr>
<tr>
<td></td>
<td>Do not open 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Verbal</th>
<th>Normal oriented conversation 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Confused 4</td>
</tr>
<tr>
<td></td>
<td>Inappropriate/words only 3</td>
</tr>
<tr>
<td></td>
<td>Sounds only 2</td>
</tr>
<tr>
<td></td>
<td>No sounds 1</td>
</tr>
<tr>
<td></td>
<td>Intubated patient T</td>
</tr>
</tbody>
</table>

| Motor                      | Obeys commands 6           |
|                           | Localises to pain 5        |
|                           | Withdrawal/flexion 4       |
|                           | Abnormal flexion 3         |
|                           | Extension 2                |
|                           | No motor response 1        |

Mild 13-15, Moderate 9-12, Severe 3-8

Figure 1-7; Redrawn from Bailey & Love’s (26th Ed) Short Practice of Surgery, CHAPTER 25, Page 312.

**1.1.4.1.5 EXPOSURE/ENVIRONMENTAL CONTROL**

The patient should be completely undressed, usually by cutting off his or her garments to facilitate a thorough examination and assessment. After the patient's clothing has been removed and the assessment completed, cover the patient with warm blankets or an external warming device to prevent hypothermia in the ED. Intravenous fluids should be warmed before being infused, and a warm
environment (room temperature) should be maintained. The patient's body temperature is more important than the comfort of the health-care providers.

**PITFALL**

Despite proper attention to all aspects of treating a patient with a closed head injury, neurologic deterioration can occur-often rapidly. The lucid interval classically associated with acute epidural hematoma is an example of a situation in which the patient will "talk and die." Frequent neurologic reevaluation can minimize this problem by allowing for early detection of changes. It may be necessary to return to the primary survey and to confirm that the patient has a secure airway, adequate ventilation and oxygenation, and adequate cerebral perfusion. Early consultation with a neurosurgeon also is necessary to guide additional management efforts.

**EXPOSURE:-**

1. Completely remove all clothing to allow examination.
2. Cover patient as soon as possible to prevent hypothermia.
3. Rewarm the hypothermic patient. Consider:

   - Warm environment
   - Warmed humidified O₂
   - Warmed IV fluids(Hot line or Level 1)
   - Warm Blankets
   - Bair Hugger
   - Rewarming blanket
   - Overhead Radiant Warmer

**Note:** These principles are important for all trauma patients but particularly those of extremes of age.

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5 *A Forced-Air Warming blanket is a medical device designed to keep patients warm during orthopedic surgery and reduce the risk of infections.
1.1.4.2 Resuscitation

Resuscitation

Aggressive resuscitation and the management of life-threatening injuries as they are identified are essential to maximize patient survival. Resuscitation also follows the ABC sequence.

AIRWAY

The airway should be protected in all patients and secured when there is a potential for airway compromise. The jaw-thrust or chin-lift maneuver may suffice as an initial intervention. If the patient is unconscious and has no gag reflex, the establishment of an oropharyngeal airway can be helpful temporarily. A definitive airway (ie, intubation) should be established if there is any doubt about the patient's ability to maintain airway integrity.

BREATHING/VENTILATION/OXYGENATION

Definitive control of the airway in patients who have compromised airways due to mechanical factors, have ventilatory problems, or are unconscious is achieved by endotracheal intubation. This procedure should be performed with continuous protection of the cervical spine. An airway should be established surgically if intubation is contraindicated or cannot be accomplished. A tension pneumothorax compromises ventilation and circulation dramatically and acutely; if one is suspected, chest decompression should be started immediately. Every injured patient should receive supplemental oxygen. If not intubated, the patient should have oxygen delivered by a mask-reservoir device to achieve optimal oxygenation. The use of the pulse oximeter is valuable in ensuring adequate hemoglobin saturation.

CIRCULATION AND BLEEDING CONTROL

Definitive bleeding control is essential, and intravenous replacement of intravascular volume is important. A minimum of two large-caliber intravenous (IV) catheters should be introduced. The maximum rate of fluid administration is determined by the internal diameter of the catheter and inversely by its length—not by the size of the vein in which the catheter is placed. Establishment of upper-extremity peripheral IV access is preferred. Other peripheral lines, cut-downs, and central venous lines should be used as necessary in accordance with the skill level of the doctor, who is caring for the patient.
At the time of IV insertion, draw blood for type and crossmatch and baseline hematologic studies, including a pregnancy test for all females of childbearing age.

**Aggressive and continued volume resuscitation is not a substitute for definitive control of hemorrhage.** Definitive control includes operation, angioembolization and pelvic stabilization. IV fluid therapy with crystalloids should be initiated. Such bolus IV therapy may require the administration of 1 to 2 L of an isotonic solution to achieve an appropriate response in the adult patient. All IV solutions should be warmed either by storage in a warmed environment (37°C to 40°C, or 98.6° F to 104° F) or fluid-warming devices. Shock associated with injury is most often hypovolemic in origin. If the patient remains unresponsive to bolus IV therapy, blood transfusion may be required.

Hypothermia may be present when the patient arrives, or it may develop quickly in the ED if the patient is uncovered and undergoes rapid administration of room-temperature fluids or refrigerated blood. Hypothermia is a potentially lethal complication in injured patients, and aggressive measures should be taken to prevent the loss of body heat and restore body temperature to normal. The temperature of the resuscitation area should be increased to minimize the loss of body heat. The use of a high-flow fluid warmer or microwave oven to heat crystalloid fluids to 39°C (102.2°F) is recommended. However blood products should not be warmed in a microwave oven.

**PITFALL**

Injured patients can arrive in the ED with hypothermia, and hypothermia may develop in some patients who require massive transfusions and crystalloid resuscitation despite aggressive efforts to maintain body heat. The problem is best minimized by early control of hemorrhage. This can require operative intervention or the application of an external compression device to reduce the pelvic volume for patients with certain types of pelvic fractures. Efforts to rewarm the patient and prevent hypothermia should be considered as important as any other component of the primary survey and resuscitation phase.

Treatment of immediate life threatening injuries or abnormalities detected in the primary survey.

Remember:
- Airway maintenance
- Cardiopulmonary resuscitation
- Lifesaving treatment
Should be initiated when the problem is identified. Monitor progress with:

- $O_2$sats
- RR
- ETCO$_2$* [intubated patient]
- Pulse rate / ECG
- BP
- Capillary refill
- Urine output
- Conscious level

Note: Arterial lines are not resuscitation lines and their insertion should not delay definitive surgery or urgent investigation such as head CT. They can be inserted later (in ICU or OT) for ongoing monitoring or sampling.

1.1.4.2.1 AJDUNCTS TO PRIMARY SURVEY AND RESUSCITATION

Adjuncts that are used during the primary survey and resuscitation phases include electrocardiographic monitoring; urinary and gastric catheters; other monitoring, such as of ventilatory rate, arterial blood gas (ABG) levels, pulse oximetry, and blood pressure; and x-ray examination and diagnostic studies.

ELECTROCARDIOGRAPHIC MONITORING

Electrocardiographic (ECG) monitoring of all trauma patients is important. Dysrhythmias—including unexplained tachycardia, atrial fibrillation, premature ventricular contractions, and ST segment changes—can indicate blunt cardiac injury. Pulseless electrical activity (PEA) can indicate cardiac tamponade, tension pneumothorax, and/or profound hypovolemia. When bradycardia, Aberrant conduction, and premature beats are present, hypoxia and hypoperfusion should be suspected immediately. Extreme hypothermia also produces these dysrhythmias.

*ETCO$_2$ is the partial pressure or maximal concentration of carbon dioxide (CO$_2$) at the end of an exhaled breath, which is expressed as a percentage of CO$_2$ or mmHg. The normal values are 5% to 6% CO$_2$, which is equivalent to 35-45 mmHg.

https://www.google.com.af/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=ETCO2&*
Radiographic studies are important adjuncts to the primary survey.

Figure 1-8; Reproduced from ATLS Advanced Trauma Life Support for Doctors NINTH EDITION 2012 Chapter 1, Page-12.

**PITFALL**
Sometimes anatomic abnormalities (e.g., urethral stricture or prostatic hypertrophy) preclude placement of an indwelling bladder catheter, despite meticulous technique. Nonspecialists should avoid excessive manipulation of the urethra or use of specialized instrumentation. Consult a urologist early.

1.1.4.2.2 **URINARY AND GASTRIC CATHETERS**
The placement of urinary and gastric catheters should be considered as part of the resuscitation phase. A urine specimen should be submitted for routine laboratory analysis.
Urinary Catheters

Urinary output is a sensitive indicator of the patient's volume status and reflects renal perfusion. Monitoring of urinary output is best accomplished by the insertion of an indwelling bladder catheter. Transurethral bladder catheterization is contraindicated in patients in whom urethral transection is suspected. Urethral injury should be suspected in the presence of one of the following:

- Blood at the urethral meatus.
- Perineal ecchymosis.
- Blood in the scrotum.
- High-riding or nonpalpable prostate.
- Pelvic fracture.

Accordingly, a urinary catheter should not be inserted before the rectum and genitalia have been examined. If urethral injury is suspected, urethral integrity should be confirmed by a retrograde urethrogram before the catheter is inserted.

The goals of inserting this tube early in the resuscitation process are to relieve retention, decompress the bladder before performing a DPL, and allow for monitoring of the urinary output as an index of tissue perfusion. Hematuria is a sign of trauma to the genitourinary tract. Caution: The inability to void, an unstable pelvic fracture, blood at the meatus, scrotal hematoma or perineal ecchymoses, or a high-riding prostate on rectal examination mandate a retrograde urethrogram to confirm an intact urethra before inserting a urinary catheter. A disrupted urethra detected during the primary or secondary survey may require the insertion of a suprapubic tube by an experienced doctor.

Gastric Catheters

A gastric tube is indicated to reduce stomach distention and decrease the risk of aspiration. Decompression of the stomach reduces the risk of aspiration, but does not prevent it entirely.

Thick or semisolid gastric content's will not return through the tube, and actual passage of the tube can induce vomiting. For the tube to be effective, it must be positioned properly, be attached to appropriate suction, and be functional. Blood in the gastric aspirate can be indicative of oropharyngeal (swallowed) blood, traumatic insertion, or actual injury to the upper digestive tract. If the cribiform plate is known to be fractured or a fracture is suspected, the gastric tube should be inserted orally to prevent intracranial passage. In this situation, any nasopharyngeal instrumentation is potentially dangerous.
The therapeutic goal of inserting this tube early in the resuscitation process is to relieve acute gastric dilatation, decompress the stomach before performing a DPL, and remove gastric contents, thereby reducing the risk of aspiration. **Caution:** If severe facial fractures exist or there is suspicion of a basilar skull fracture, the gastric tube should be inserted through the mouth to prevent passage of the tube through the cribiform plate into the brain.

Consider gastric decompression with:

- Nasogastric tube
  [Unless significant head / facial injury ] Or
- Orogastric tube

1.1.4.2.3 OTHER MONITORING

Adequate resuscitation is best assessed by improvement in physiologic parameters, such as pulse rate. Blood pressure, pulse pressure, ventilatory rate, ABG levels, body temperature, and urinary output, rather than the qualitative assessment done during the primary survey. Actual values for these parameters should be obtained as soon as is practical after completing the primary survey, and periodic reevaluation is prudent.

**VENTILATORY RATE AND ARTERIAL BLOOD GASES**

Ventilatory rate and ABG levels should be used to monitor the adequacy of respirations. Endotracheal tubes may be dislodged whenever the patient is moved. A colorimetric carbon dioxide detector is a device capable of detecting carbon dioxide in exhaled gas. Colorimetry, or capnography, is useful in confirming that the endotracheal tube is properly located in the respiratory tract of the patient on mechanical ventilation and not in the esophagus. However, it does not confirm proper placement of the tube in the trachea.

**PULSE OXIMETRY**

Pulse oximetry is a valuable adjunct for monitoring oxygenation in injured patients. The pulse oximeter measures the oxygen saturation of hemoglobin colorimetrically, but it does not measure the partial pressure of oxygen. It also does not measure the partial pressure of carbon dioxide, which reflects the adequacy of ventilation. A small sensor is placed on the finger, toe, earlobe, or
another convenient place. Most devices display pulse rate and oxygen saturation continuously.

Hemoglobin saturation from the pulse oximeter should be compared with the value obtained from the ABG analysis. Inconsistency indicates that at least one of the two determinations is in error.

**Blood Pressure**

The blood pressure should be measured. It should be kept in mind, though that it may be a poor measure of actual tissue perfusion.

1.1.4.2.4 X-Ray Examinations and Diagnostic Studies

The radiographer should be present when the patient arrives in Resus. The CXR plate should be placed in the trolley before patient arrival,

In general only three x-rays should be performed in the Resus Room

1. Chest - this will invariably be a supine AP film [but with isolated penetrating trauma may be erect].

2. Pelvis – this may be omitted in some instances when examination of a fully alert patient (with no significant distracting injuries) is negative.

3. Lateral cervical spine - this should be performed with longitudinal traction applied to the upper limbs to minimize the likelihood of the shoulders obscuring the view of the lower cervical spine, unless there is gross neurological deficit [paraplegia, quadriplegia] in which case traction should be avoided. The C-spine x-ray be omitted at the Trauma Team leader’s discretion when CT is indicated e.g. CT Head required.

Other x-rays may be performed in the Resus Room at the discretion of the Trauma Team Leader. This may occur in the situation when transfer to the General X-ray Room may cause delays unacceptable for the particular patient. Examples may include thoracolumbar spine or isolated limb x-rays.

It is acknowledged that quality of x-rays in this circumstance may need to be compromised in order to optimize patient outcome.
X-RAY Studies

1. Screening X-Rays for Blunt Trauma

The lateral cervical spine x-ray, an anteroposterior (AP) chest x-ray, and a pelvic x-ray are the screening films obtained in patients with multisystem blunt trauma. Abdominal x-rays (supine, upright, or lateral decubitus) may be useful in hemodynamically normal patients to detect extra luminal air in the retroperitoneum or free air under the diaphragm, both of which mandate prompt celiotomy. Loss of a psoas shadow also suggests a retroperitoneal injury.

2. Screening X-Rays for Penetrating Trauma

The hemodynamically abnormal patient with a penetrating abdominal wound does not require any screening x-rays in the emergency department. If the patient is hemodynamically normal and has penetrating trauma above the umbilicus or a suspected thoracoabdominal injury, an upright chest x-ray is useful to exclude an associated hemothorax or pneumothorax, or to document the presence of intraperitoneal air. With marker rings or clips applied to all entrance- and exit wound sites, a supine abdominal x-ray may be obtained in the hemodynamically normal patient to determine the track of the missile or the presence of retroperitoneal air. X-ray examination should be used judiciously and should not delay patient resuscitation. Anteroposterior (AP) chest and AP pelvic films often provide information that can guide resuscitation efforts of patients with blunt trauma. Chest x-rays can show potentially life-threatening injuries that require, treatment, and pelvic films can show fractures of the pelvis that indicate the need for early blood transfusion.

PITFALLS

• Placement of a gastric catheter may induce vomiting or gagging and produce the specific problem that its placement is intended to prevent aspiration. Functional suction equipment should be immediately available.

• Combative trauma patients occasionally extubate themselves. They can also occlude their endotracheal tube or deflate the cuff by biting it. Frequent reevaluation of the airway is necessary.

• The pulse oximeter sensor should not be placed distal to the blood pressure cuff. Misleading information regarding hemoglobin saturation and pulse can be generated when the cuff is inflated and occludes blood flow.
• Normalization of hemodynamics in injured patients requires more than simply a normal blood pressure; a return to normal peripheral perfusion must be established. This can be problematic in the elderly, and consideration should be given to early invasive monitoring of cardiac function in these patients.

These films can be taken in the resuscitation area with a portable x-ray unit, but should not interrupt the resuscitation process.

During the secondary survey, complete cervical and thoracolumbar spine films may be obtained with a portable x-ray unit if the patient's care is not compromised and the mechanism of injury suggests the possibility of spinal injury. In a patient with obtundation who requires computed tomography (CT) of the brain, CT of the spine may be used as the method of radiographic assessment. Spinal cord protection that was established during the primary survey should be maintained.

An AP chest film and additional films pertinent to the site(s) of suspected injury should be obtained. Essential diagnostic x-rays should be obtained even in pregnant patients.

Focused assessment sonography in trauma (FAST) and diagnostic peritoneal lavage (DPL) are useful tools for the quick detection of occult intraabdominal blood. Their use depends on the skill and experience of the doctor. Identification of the source of occult intraabdominal blood loss may indicate the need for operative control of hemorrhage.

1.1.4.2.5 NEED FOR PATIENT TRANSFER

During the primary survey and resuscitation phase, the evaluating doctor frequently has obtained enough information to indicate the need to transfer the patient to another facility. This transfer process may be initiated immediately by administrative personnel at the direction of the examining doctor while additional evaluation and resuscitative measures are being performed. Once the decision to transfer the patient has been made, communication between the referring and receiving doctors is essential.
**PITFALL**

Technical problems may be encountered when performing any diagnostic procedure, including those necessary to identify intraabdominal hemorrhage. Obesity and intraluminal bowel gas can compromise the images obtained by abdominal ultrasonography. Obesity, previous abdominal operations, and pregnancy also can make diagnostic peritoneal lavage difficult. Even in the hands of an experienced surgeon, the effluent volume from the lavage may be minimal or zero. In these circumstances, an alternative diagnostic tool should be chosen. A surgeon should be involved in the evaluation process and guide further diagnostic and therapeutic procedures.
Secondary Survey

What is the secondary survey, and when does it start?
The secondary survey does not begin until the primary survey (ABCDEs) is completed, resuscitative efforts are underway, and the normalization of vital functions has been demonstrated.

The secondary survey is a head-to-toe evaluation of the trauma patient, that is, a complete history and physical examination, including reassessment of all vital signs. Each region of the body is completely examined. The potential for missing an injury or failure to appreciate the significance of an injury is great, especially in an unresponsive or unstable patient.

During the secondary survey, a complete neurologic examination is performed, including a GCS score determination, if it was not done during the primary survey, and x-rays are obtained, if indicated by the examination. Such examinations can be interspersed into the secondary survey at appropriate times. Special procedures, such as specific radiographic evaluations and laboratory studies, also are performed at this time. Complete patient evaluation requires repeated physical examinations.

1.1.4.3.1 HISTORY

Every complete medical assessment includes a history of the mechanism of injury. Often, such a history cannot be obtained from a patient who has sustained trauma, and prehospital personnel and family must be consulted to obtain information that can enhance the understanding of the patient's physiologic state. The AMPLE history is a useful mnemonic for this purpose:

A – Allergies.
M – Medications currently used.
P – Past illnesses/Pregnancy.
L – Last meal.
E – Events/Environment related to the injury.

The patient's condition is greatly influenced by the mechanism of injury. Prehospital personnel can provide valuable information on such mechanisms and should report pertinent data to the examining doctor. Some injuries can be
predicted based on the direction and amount of energy behind the mechanism of injury. Injury usually is classified into two broad categories: blunt and penetrating trauma. Other types of injuries for which historical information is important include thermal injuries and those caused by a hazardous environment.

![Image](https://example.com/image.jpg)

Figure.1-9; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 1, Page-11.

1.1.4.3.1.1 **BLUNT TRAUMA**

Blunt trauma often results from automobile collisions, falls, and other injuries related to transportation, recreation, and occupations.

Important information to obtain about automobile collisions includes seat-belt use, steering wheel deformation, and direction of impact, damage to the automobile in terms of major deformation or intrusion into the passenger
compartment, and whether the patient was ejected from the vehicle. Ejection from the vehicle greatly increases the possibility of major injury.

Injury patterns can often be predicted by the mechanism of injury. Such injury patterns also are influenced by age groups and activities.

![Image](https://static01.nyt.com/images/2010/02/08/world/asia/08road-2-inline337395/08road-2-popup.jpg) [Accessed on 10/07/2016].

![Image](https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTqZHlcT4dX8YjX0Nf_le8ooNpdx449DGwV3JfYYaV44mnXMH_dog) [Accessed on 10/07/2016].
1.1.4.3.1.2 **Penetrating Trauma**

The incidence of penetrating trauma (e.g., injuries from firearms, stabbings, and impalement) has increased. Factors determining the type and extent of injury and subsequent management include the region of the body that was injured, the organs in the path of the penetrating object, and the velocity of the missile. Therefore, in gunshot victims, the velocity, caliber, presumed path of the bullet, and distance from the weapon to the wound can provide important clues as to the extent of injury.

1.1.4.3.1.3 **Thermal Injury**

Burns are a significant type of trauma that can occur alone or be coupled with blunt and penetrating trauma resulting from, for example, a burning automobile, explosion, falling debris, the patient's attempt to escape a fire. Inhalation injury and carbon monoxide poisoning often complicate burn injuries. Therefore, it is important to know the circumstances of the burn injury. Specifically, knowledge of the environment in which the burn injury occurred (open or closed space), the substances consumed by the flames (e.g., plastics and chemicals), and any possible associated injuries sustained, is critical for patient treatment.

Acute or chronic hypothermia without adequate protection against heat loss produces either local or generalized cold injuries. Significant heat loss can occur at moderate temperatures (15°C to 20°C or 59°F to 68°F) if wet clothes, decreased activity, and/or vasodilation caused by alcohol or drugs compromise the patient's ability to conserve heat.

1.1.4.3.1.4 **Hazardous Environment**

A history of exposure to chemicals, toxins, and radiation is important to obtain for two main reasons: first, these agents can produce a variety of pulmonary, cardiac, and internal organ dysfunctions in injured patients. Second, these same agents may also present a hazard to healthcare providers. Frequently, the doctor's only means of preparation is to understand the general principles of management of such conditions and establish immediate contact with a Regional Poison Control Center.
1.1.4.3.2 PHYSICAL EXAMINATION

During the secondary survey, physical examination follows the sequence of head, maxillofacial structures, cervical spine and neck, chest, abdomen, perineum/rectum/vagina, musculoskeletal system, and neurologic system.

1.1.4.3.2.1 HEAD

The secondary survey begins with evaluating the head and identifying all related neurologic injuries and other significant injuries. The entire scalp and head should be examined for lacerations, contusions, and evidence of fractures. Because edema around the eyes can later preclude an in depth examination, the eyes should be reevaluated for:

- Visual acuity.
- Pupillary size.
- Hemorrhage of the conjunctiva and/or fundi.
- Penetrating injury.
- Contact lenses (remove before edema occurs).
- Dislocation of the lens.
- Ocular entrapment.

A quick visual-acuity examination of both eyes can be performed by asking the patient to read printed material, for example, a hand held Snellen chart, or words on an IV container or dressing package. Ocular mobility should be evaluated to exclude entrapment of extraocular muscles due to orbital fractures. These procedures frequently identify optic injuries that are not otherwise apparent.

1.1.4.3.2.2 MAXILLOFACIAL STRUCTURES

Maxillofacial trauma that is not associated with airway obstruction or major bleeding should be treated only after the patient is stabilized completely and life-threatening injuries have been managed. At the discretion of appropriate specialists, definitive management may be safely delayed without compromising care. Patients with fractures of the midface can also have a fracture of the cribriform plate. For these patients, gastric intubation should be performed via the oral route.

1.1.4.3.2.3 CERVICAL SPINE AND NECK

Patients with maxillofacial or head trauma should be presumed to have an unstable cervical spine injury (eg, fracture and/or ligament injury), and the neck should be immobilized until all aspects of the cervical spine have been adequately
studied and an injury has been excluded. The absence of neurologic deficit does not exclude injury to the cervical spine, and such injury should be presumed until a complete cervical spine radiographic series and CT is reviewed by a doctor experienced in detecting cervical spine fractures radiographically.

**PITFALLS**

- Facial edema in patients with massive facial injury or in comatose patients can preclude a complete eye examination. Such difficulties should not deter the doctor from performing the components of the ocular examination that are possible.
- Some maxillofacial fractures, such as nasal fracture, nondisplaced zygomatic fractures, and orbital rim fractures, can be difficult to identify early in the evaluation process. Therefore, frequent reassessment is crucial.

Examination of the neck includes inspection, palpation, and auscultation. Cervical spine tenderness, subcutaneous emphysema, tracheal deviation, and laryngeal fracture can be discovered on a detailed examination. The carotid arteries should be palpated and auscultated for bruits. Evidence of blunt injury over these vessels should be noted and, if present, should arouse a high index of suspicion for carotid artery injury. Occlusion or dissection of the carotid artery can occur late in the injury process without antecedent signs or symptoms. Angiography or duplex ultrasonography may be required to exclude the possibility of major cervical vascular injury when the mechanism of injury suggests this possibility. Most major cervical vascular injuries are the result of penetrating injury; however, blunt force to the neck or a traction injury from a shoulder-harness restraint can result in intimal disruption, dissection, and thrombosis.

Protection of a potentially unstable cervical spine injury is imperative for patients who are wearing any type of protective helmet, and extreme care must be taken when removing the helmet.

Penetrating injuries to the neck can potentially injure several organ systems. Wounds that extend through the platysma should not be explored manually, probed with instruments, or treated by individuals in the ED who are not trained to manage such injuries. The ED usually is not equipped to deal with the problems that can be encountered in such a situation. These injuries require evaluation by a surgeon operatively or with specialized diagnostic procedures under the direct supervision of a surgeon. The finding of active arterial bleeding, an expanding hematoma, arterial bruit, or airway compromise usually requires operative evaluation. Unexplained or isolated paralysis of an upper extremity
should raise the suspicion of a cervical nerve root injury and should be accurately documented.

1.1.4.3.2.4 CHEST

Visual evaluation of the chest, both anterior and posterior, can identify conditions such as open pneumothorax and large flail segments. A complete evaluation of the chest wall requires palpation of the entire chest cage, including the clavicles, ribs, and sternum. Sternal pressure can be painful if the sternum is fractured or costochondral separations exist. Contusions and hematomas of the chest wall should alert the doctor to the possibility of occult injury.

Significant chest injury can manifest with pain, dyspnea, and hypoxia. Evaluation includes auscultation of the chest and a chest x-ray examination. Breath sounds are auscultated high on the anterior chest wall for pneumothorax and at the posterior bases for hemothorax.

PITFALLS

- Blunt injury to the neck can produce injuries in which the clinical signs and symptoms develop late and may not be present during the initial examination. Injury to the intima of the carotid arteries is an example.
- The identification of cervical nerve root or brachial plexus injury may not be possible in a comatose patient. Consideration of the mechanism of injury might be the doctor's only clue.
- In some patients, decubitus ulcers can develop quickly over the sacrum and other areas from immobilization on a rigid spine board and from the cervical collar. Efforts to exclude the possibility of spinal injury should be initiated as soon as is practical, and these devices should be removed. However, resuscitation and efforts to identify life-threatening or potentially life-threatening injuries should not be deferred.

Although auscultatory findings can be difficult to evaluate in a noisy environment, they may be extremely helpful. Distant heart sounds and narrow pulse pressure can indicate cardiac tamponade. In addition, cardiac tamponade and tension pneumothorax are suggested by the presence of distended neck veins, although associated hypovolemia can minimize or eliminate this finding. Decreased breath sounds, hyper resonance to percussion, and shock may be the only indications of tension pneumothorax and the need for immediate chest decompression.
A chest x-ray may confirm the presence of a hemothorax or simple pneumothorax. Rib fractures may be present, but they may not be visible on the x-ray. A widened mediastinum or other radiographic signs can suggest an aortic rupture.

1.1.4.3.2.5 Abdomen

Abdominal injuries must be identified and treated aggressively. The specific diagnosis is not as important as recognizing that an injury exists and initiating surgical intervention, if necessary. A normal initial examination of the abdomen does not exclude a significant intraabdominal injury. Close observation and frequent reevaluation of the abdomen, preferably by the same observer, is important in managing blunt abdominal trauma, because over time, the patient's abdominal findings can change. Early involvement of a surgeon is essential.

Patients with unexplained hypotension, neurologic injury, impaired sensorium secondary to alcohol and/or other drugs, and equivocal abdominal findings should be considered candidates for peritoneal lavage, abdominal ultrasonography, or, if hemodynamic findings are normal, CT of the abdomen.

Pitfalls
• Elderly patients may not tolerate even relatively minor chest injuries. Progression to acute respiratory insufficiency must be anticipated, and support should be instituted before collapse occurs.
• Children often sustain significant injury to the intrathoracic structures without evidence of thoracic skeletal trauma, so a high index of suspicion is essential.

Fractures of the pelvis or the lower rib cage also can hinder accurate diagnostic examination of the abdomen, because palpating the abdomen can elicit pain from these areas.

In male patients if urethral trauma is suspected, urinary catheterisation should not be attempted before examination of the rectum and genitalia has been performed.

Thoracolumbar spine and back Patient should be removed from spinal boards as soon as possible by immobilizing the patient and sliding the board out or log-rolling.

Log-roll - using three assistants and maintaining inline immobilisation of the neck, the patient should be log-rolled under supervision of the Airway Doctor and the entire thoracolumbar area inspected and palpated including perianal sensation. Formal rectal exam is not routinely required unless spinal cord injury, penetrating injury or urethra/injury is suspected.
The patient should remain supine in a neutral position and treated as a spinal patient until cervical and thoracolumbar spinal injury have been excluded. In patients with altered conscious level or significant distracting injuries, clinical examination of the thoracolumbar spine is unreliable and must be accompanied by thoracolumbar x-ray (or CT).

[NOTE: a scoop stretcher is an efficient way to transfer injured patients onto the CT table.]

1.1.4.3.2.6 PERINEUM/RECTUM/VAGINA

The perineum should be examined for contusions, hematomas, lacerations, and urethral bleeding.

A rectal examination may be performed before placing a urinary catheter. If a rectal examination is required, the doctor should assess for the presence of blood within the bowel lumen, a high-riding prostate, the presence of pelvic fractures, the integrity of the rectal wall, and the quality of sphincter tone.

Vaginal examination should be performed in patients who are at risk of vaginal injury. The doctor should assess for the presence of blood in the vaginal vault and vaginal lacerations. In addition, pregnancy tests should be performed on all females of childbearing age.

PITFALLS

- Excessive manipulation of the pelvis should be avoided, because it may precipitate additional hemorrhage. The AP pelvic x-ray examination, performed as an adjunct to the primary survey and resuscitation, can provide valuable information regarding the presence of pelvic fractures, which are potentially associated with significant blood loss.
- Injury to the retroperitoneal organs may be difficult to identify, even with the use of CT. Classic examples include duodenal and pancreatic injuries.
- Knowledge of injury mechanism, identification of associated injuries, and a high index of suspicion are required. Despite the doctor's appropriate diligence, some of these injuries are not diagnosed initially.
- Female urethral injury, while uncommon, does occur in association with pelvic fractures and straddle injuries. When present, such injuries are difficult to detect.

1.1.4.3.2.7 MUSCULOSKELETAL SYSTEM

The extremities should be inspected for contusions and deformities. Palpation of the bones and examination for tenderness and abnormal movement aids in the identification of occult fractures.
Pelvic fractures can be suspected by the identification of ecchymosis over the iliac wings, pubis, labia, or scrotum. Pain on palpation of the pelvic ring is an important finding in alert patients. Mobility of the pelvis in response to gentle anterior-to-posterior pressure with the heels of the hands on both anterior iliac spines and the symphysis pubis can suggest pelvic ring disruption in unconscious patients. Because such manipulation can initiate unwanted bleeding, it should be done only once (if at all), and preferably by the orthopedic surgeon responsible for the patient's care. In addition, assessment of peripheral pulses can identify vascular injuries.

Significant extremity injuries can exist without fractures being evident on examination or x-rays. Ligament ruptures produce joint instability. Muscle-tendon unit injuries interfere with active motion of the affected structures. Impaired sensation and/or loss of voluntary muscle contraction strength can be caused by nerve injury or ischemia, including that due to compartment syndrome.

Thoracic and lumbar spinal fractures and/or neurologic injuries must be considered based on physical findings and mechanism of injury. Other injuries can mask the physical findings of spinal injuries, and they can remain undetected unless the doctor obtains the appropriate x-rays.

The musculoskeletal examination is not complete without an examination of the patient's back. Unless the patient's back is examined, significant injuries may be missed.

1.1.4.3.2.8 Neurologic
A comprehensive neurologic examination includes not only motor and sensory evaluation of the extremities, but reevaluation of the patient's level of consciousness and pupillary size and response. The GCS score facilitates detection of early changes and trends in the neurologic status.

Early consultation with a neurosurgeon is required for patients with neurologic injury. Patients should be frequently monitored for deterioration in level of consciousness and changes in the neurologic examination, as these findings can reflect progression of the intracranial injury. If a patient with a head injury deteriorates neurologically, oxygenation and perfusion of the brain and adequacy of ventilation (i.e., the ABCDEs) must be reassessed. Intracranial surgical intervention or measures for reducing intracranial pressure may be necessary. The neurosurgeon will decide whether conditions such as epidural and subdural hematomas require evacuation, and whether depressed skull fractures need operative intervention.
PITFALLS

• Blood loss from pelvic fractures that increase pelvic volume can be difficult to control, and fatal hemorrhage can result. A sense of urgency should accompany the management of these injuries.
• Fractures involving the bones of the hands, wrists, and feet are often not diagnosed in the secondary survey performed in the ED. Sometimes, it is only after the patient has regained consciousness and/or other major injuries are resolved that pain in the area of an occult injury is noted.
• Injuries to the soft tissues around joints are frequently diagnosed after the patient begins to recover. Therefore, frequent reevaluation is essential.
• A high level of suspicion must be maintained to prevent the development of compartment syndrome.

1.1.4.4 ADJUNCTS TO THE SECONDARY SURVEY

HOW CAN I MINIMIZE MISSED INJURIES?

Specialized diagnostic tests may be performed during the secondary survey to identify specific injuries. These include additional x-ray examinations of the spine and extremities; CT scans of the head, chest, abdomen, and spine; contrast urography and angiography; transesophageal ultrasound; bronchoscopy; esophagoscopy; and other diagnostic procedures. Often these procedures require transportation of the patient to other areas of the hospital, where equipment and personnel to manage life-threatening contingencies may not be immediately available. Therefore, these specialized tests should not be performed until the patient has been carefully examined and his or her hemodynamic status has been normalized.

1.1.4.4.1 REEVALUATION

Trauma patients must be reevaluated constantly to ensure that new findings are not overlooked and to discover deterioration in previously noted findings. As initial life-threatening injuries are managed, other equally life-threatening problems and less severe injuries can become apparent. Underlying medical problems that can significantly affect the ultimate prognosis of the patient can become evident, a high index of suspicion facilitates early diagnosis and management.
Continuous monitoring of vital signs and urinary output is essential. For adult patients, maintenance of urinary output at 0.5 mL/kg/hr is desirable. In pediatric patients who are older than 1 year, an output of 1 mL/kg/hr is typically adequate. ABG analyses and cardiac monitoring devices should be used. Pulse oximetry on critically injured patients and end-tidal carbon dioxide monitoring on intubated patients should be considered.

The relief of severe pain is an important part of the treatment of trauma patients. Many injuries, especially musculoskeletal injuries, produce pain and anxiety in conscious patients. Effective analgesia usually requires the administration of opiates or anxiolytics intravenously (intramuscular injections should be avoided). These agents should be used judiciously and in small doses to achieve the desired level of patient comfort and relief of anxiety, while avoiding respiratory depression, the masking of subtle injuries, and changes in the patient's status.

**PITFALL**

Any increase in intracranial pressure (ICP) can reduce cerebral perfusion pressure and lead to secondary brain injury. Most of the diagnostic and therapeutic maneuvers necessary for the evaluation and care of patients with brain injury will increase ICP. Tracheal intubation is a classic example; in patients with brain injury, it should be performed expeditiously and as smoothly as possible. Rapid neurologic deterioration of patients with brain injury can occur despite the application of all measures to control ICP and maintain appropriate support of the central nervous system.

Any evidence of loss of sensation, paralysis, or weakness suggests major injury to the spinal column or peripheral nervous system. Neurologic deficits should be documented when identified, even when transfer to another facility or doctor for specialty care is necessary. Immobilization of the entire patient, using a long spine board, semirigid cervical collar, and/or other cervical immobilization devices, must be maintained until spinal injury can be excluded. The common mistake of immobilizing the head but freeing the torso allows the cervical spine to flex with the body as a fulcrum. Protection of the spinal cord is required at all times until a spine injury is excluded. Early consultation with a neurosurgeon or orthopedic surgeon is necessary if a spinal injury is detected.
Secondary Survey

Specialized diagnostic tests may be performed during the secondary survey to identify specific injuries.

Figure 1-11; Reproduced from ATLS Advanced Trauma Life Support for Doctors NINTH EDITION 2012 Chapter 1, Page-19.

1.1.4.5 DEFINITIVE CARE

WHICH PATIENTS DO I TRANSFER TO A HIGHER LEVEL OF CARE? WHEN SHOULD THE TRANSFER OCCUR?

Interhospital triage criteria will help determine the level, pace, and intensity of initial treatment of the multiply injured patient. These criteria take into account the patient's physiologic status, obvious anatomic injury, mechanisms of injury, concurrent diseases, and other factors that can alter the patient's prognosis. ED and surgical personnel should use these criteria to determine whether the patient requires transfer to a trauma center or closest appropriate hospital capable of
providing more specialized care. The closest appropriate local facility should be chosen based on its overall capabilities to care for the injured patient.

1.1.4.5.1 DISASTER

Disasters frequently overwhelm local and regional resources. Plans for management of such conditions must be developed, reevaluated, and rehearsed frequently to enhance the possibility of saving the maximum number of injured patients. ATLS providers should understand their role in disaster management within their health-care institutions and remember the principles of ATLS relevant to patient care.

1.1.4.5.2 RECORDS AND LEGAL CONSIDERATIONS

Specific legal considerations, including records, consent for treatment, and forensic evidence, are relevant to ATLS providers.

RECORDS

Meticulous record keeping, including documenting the time for all events, is very important. Often more than one doctor cares for an individual patient. Precise records are essential to evaluate the patient's needs and clinical status. Accurate record keeping during resuscitation can be facilitated by a member of the nursing staff whose primary responsibility is to record and collate all patient care information.

Medicolegal problems arise frequently, and precise records are helpful for all individuals concerned. Chronologic reporting with flowsheets helps both the attending doctor and the consulting doctor to assess changes in the patient's condition quickly.

1.1.4.5.3 CONSENT FOR TREATMENT

Consent is sought before treatment, if possible. In life threatening emergencies, it is often not possible to obtain such consent. In these cases, treatment should be provided first, with formal consent obtained later.

1.1.4.5.4 FORENSIC EVIDENCE

If criminal activity is suspected in conjunction with a patient's injury, the personnel caring for the patient must preserve the evidence. All items, such as clothing and bullets, must be saved for law enforcement personnel. Laboratory
determinations of blood alcohol concentrations and other drugs may be particularly pertinent and have substantial legal implications.

1.1.4.5.5 **CHAPTER SUMMARY**

1. The correct sequence of priorities for assessment of a multiply injured patient is preparation; triage; primary survey; resuscitation; adjuncts to primary survey and resuscitation; consider need for patient transfer; secondary survey, adjuncts to secondary survey; reevaluation; and definitive care.

2. The principles of the primary and secondary surveys are appropriate for the assessment of all multiply injured patients.

3. The guidelines and techniques included in the initial resuscitative and definitive-care phases of treatment should be applied to all multiply injured patients.

4. A patient's medical history and the mechanism of injury are critical to identifying injuries.

5. Pitfalls associated with the initial assessment and management of injured patients must be anticipated and managed to minimize their impact.

6. The initial assessment of a multiply injured patient follows a sequence of priorities, as do the management techniques for primary treatment and stabilization.
2. ABDOMINAL TRAUMA

Part-II

2.1 INTRODUCTION

When should the abdomen be assessed in the treatment of multiply injured patients?

Evaluation of the abdomen is a challenging component of the initial assessment of injured patients. The assessment of circulation during the primary survey includes early evaluation of the possibility of occult hemorrhage in the abdomen and pelvis in any patient who has sustained blunt trauma.

Penetrating torso wounds between the nipple and perineum also must be considered as potential causes of intraabdominal injury. The mechanism of injury, the force with which the injury was sustained, the location of injury, and the hemodynamic status of the patient determine the best method of abdominal assessment.

Unrecognized abdominal injury continues to be a cause of preventable death after truncal trauma. Rupture of a hollow viscus and bleeding from a solid organ are not easily recognized, and patient assessment is often compromised by alcohol intoxication, use of illicit drugs, injury to the brain or spinal cord, and injury to adjacent structures such as the ribs, spine, or pelvis. Significant amounts of blood may be present in the abdominal cavity with no dramatic change in appearance or dimensions and with no obvious signs of peritoneal irritation. Any patient who has sustained significant blunt torso injury from a direct blow, deceleration, or a penetrating torso injury must be considered to have an abdominal visceral or vascular injury until proven otherwise.

2.1.1 EXTERNAL ANATOMY OF THE ABDOMEN

A. ANTERIOR ABDOMEN

Recognizing that the abdomen is partially enclosed by the lower thorax, the anterior abdomen is defined as the area between the transnipple line superiorly,
inguinal ligaments and symphysis pubis inferiorly, and the anterior axillary lines laterally.

**B. FLANK**

This is the area between the anterior and posterior axillary lines from the sixth intercostal space to the iliac crest. The thick abdominal wall musculature in this location, rather than the much thinner aponeurotic sheaths of the anterior abdomen, acts as a partial barrier to penetrating wound, particularly stab wounds.

**C. BACK**

This is the area located posterior to the posterior axillary lines from the tip of the scapulae to the iliac crests. Similar to the abdominal wall muscles in the flank, the thick back, and paraspinal muscles act as a partial barrier to penetrating wounds.

### 2.1.2 INTERNAL ANATOMY OF THE ABDOMEN

The 3 distinct regions of the abdomen include the peritoneal cavity, the retroperitoneal space, and the pelvic cavity. The pelvic cavity in fact contains components of both the peritoneal cavity and retroperitoneal spaces (Figure 2-1).

The abdomen is partially enclosed by the lower thorax; the anterior abdomen is defined as the area between the transnipple line superiorly, the inguinal ligaments and symphysis pubis inferiorly, and the anterior axillary Lines laterally.

The flank is the area between the anterior and posterior axillary lines from the sixth intercostal space to the iliac crest. The thick musculature of the abdominal wall in this location, rather than the much thinner aponeurotic sheaths of the anterior abdomen, acts as a partial barrier to penetrating wounds, particularly stab wounds.

The back is the area located posterior to the posterior axillary lines from the tip of the scapulae to the iliac crests. Similar to the abdominal-wall muscles in the flank, the thick back and paraspinal muscles act as a partial barrier to penetrating wounds.

**PITFALL**

Delay in recognizing intraabdominal or pelvic injury leads to early death from hemorrhage or delayed death from visceral injury.
2.1.3 PERITONEAL CAVITY

It is convenient to divide the peritoneal cavity into two parts-upper and lower. The upper peritoneal cavity, which is covered by the lower aspect of the bony thorax, includes the diaphragm, liver, spleen, stomach, and transverse colon.

![Diagram of the peritoneal cavity](image)

Figure 2-1; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 5, Page-112.

**PITFALL**

Injuries to hidden areas of the abdomen such as the retroperitoneum must be suspected and evaluated.

This area is also referred to as the "thoracoabdominal component" of the abdomen. As the diaphragm rises to the fourth intercostal space during full expiration, fractures of the lower ribs or penetrating wounds below the nipple line may injure abdominal viscera. The lower peritoneal cavity contains the small
bowel, parts of the ascending and descending colons, the sigmoid colon, and, in females, the internal reproductive organs.

RETROPERITONEAL SPACE
This potential space is the area posterior to the peritoneal lining of the abdomen. It contains the abdominal aorta; the inferior vena cava; most of the duodenum, pancreas, kidneys and ureters; the posterior aspects of the ascending and descending colons; and the retroperitoneal components of the pelvic cavity. Injuries to the retroperitoneal visceral structures are difficult to recognize because the area is remote from physical examination, and injuries do not initially present with signs or symptoms of peritonitis. In addition, this space is not sampled by diagnostic peritoneal lavage (DPL).

2.1.4 PELVIC CAVITY
The pelvic cavity, surrounded by the pelvic bones, is essentially the lower part of the retroperitoneal and intraperitoneal spaces. It contains the rectum, bladder, iliac vessels, and, in females, internal reproductive organs. As with the thoracoabdominal area, examination of pelvic structures is compromised by overlying bones.

2.2 MECHANISM OF INJURY
Why is the mechanism of injury important?
Information provided by prehospital personnel or witnesses can be very helpful in predicting injury patterns. This information should always be considered and evaluated when assessing trauma patients.

2.2.1 BLUNT ABDOMINAL TRAUMA
A direct blow, such as contact with the lower rim of the steering wheel or a door intruding into the passenger space as the result of a motor vehicle crash, can cause compression and crushing injuries to abdominal viscera. Such forces deform solid and hollow organs and may cause rupture, with secondary hemorrhage, contamination by visceral contents, and peritonitis. Shearing injuries are a form of crushing injury that may result when a restraint device, such as a lap-type seat belt or shoulder harness component, is worn improperly (Figure 2-2a & b). Patients injured in motor vehicle crashes also may sustain deceleration injuries, in which
there is a differential movement of fixed and nonfixed parts of the body. Examples include the frequent lacerations of the liver and spleen, both movable organs, at the sites of their fixed supporting ligaments.

Figure.2-2a;
Reproduced from https://www.slideshare.net/sheshto2014/abdtrauma [Accessed on 02/01/2017].
Abdominal Trauma

Lap Belt Injury. Injury can result when a restraint device, such as a lap-type seat belt or shoulder harness component, is worn improperly.

Figure 2-2b; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 5, Page-113.

Air-bag deployment does not preclude abdominal injury. In patients who sustain blunt trauma, the organs most frequently injured include the spleen (40%-55%), liver (35%-45%), and small bowel (5%-10%). In addition, there is a 15% incidence of retroperitoneal hematoma in patients who undergo laparotomy for blunt trauma. Although restraint devices prevent more major injuries, they may produce specific patterns of injury, as shown in Figure 2-3.

- Abdominal examination can form part of the primary survey in the setting where the patient has severe shock and a source of blood loss is being sought.
- Otherwise abdominal examination is usually part of the secondary survey.
- Examination of the patient with abdominal trauma should include gastric tube insertion and urinary catheterisation [unless contraindicated].
- In consultation with the General Surgeon investigation of the patient with blunt abdominal trauma should proceed as follows
Abdominal Trauma

Clear signs of abdominal Injury.

<table>
<thead>
<tr>
<th>CT</th>
<th>LAPAROTOMY</th>
</tr>
</thead>
</table>

No abdominal signs or signs unreliable due to:
- Altered conscious level [GCS ≤ 13]
- Paralysis.
- Significant pelvic or chest injury.

| CT | DPL OR US [ FAST ] OR LAPAROTOMY |

Figure 2-3; Reproduced from NELSON MARLBOROUGH DISTRICT HEALTH BOARD, NMDHB guideline, MAJOR TRAUMA GUIDELINES, Created April 2002, Revised January 2010.

2.2.1.1 **Intra-abdominal Hemorrhage**

Abdominal examination is often misleading in the detection of acute hemoperitoneum, especially in patients with lower chest trauma, rib fractures, spinal cord injury, intoxication, or altered level of consciousness. Any patient who has sustained significant blunt torso injury from a direct blow or deceleration or from a penetrating torso injury must be considered to have an abdominal visceral or vascular injury. Focused assessment sonography in trauma and diagnostic peritoneal lavage are the most expedient and reliable methods of identifying significant intraperitoneal hemorrhage, although the FAST exam has largely replaced the use of DPL in most institutions. When readily available and used by trained individuals, FAST has the sensitivity\(^7\), specificity\(^8\), and accuracy\(^9\) of DPL.

\(^7\) The **validity** of a test is defined as its ability to distinguish between who has a disease and who does not. Validity has two components: sensitivity and specificity. The **sensitivity** of the test is defined as the ability of the test to identify correctly those who **have** the disease.
in detecting hemoperitoneum. When present, hemoperitoneum requires an immediate surgical evaluation to determine the need for an operative intervention. In many cases, abdominal CT scan may be appropriate in stable patients to identify the source of bleeding. Abdominal hemorrhage frequently comes from liver or splenic laceration, visceral injury, or retroperitoneal hematoma. Patients with unstable or abnormal vital signs are usually not candidates for CT scanning and often require surgery to control damage. (See Annex-1).

2.2.1.2 Pelvic Hemorrhage

Assessment of bony stability by means of physical examination and plain radiographs of the pelvis is crucial for early identification of major pelvic fractures. Patients with pelvic fractures are at high risk for major bleeding, which is usually venous. Initial management includes vigorous blood volume replacement and, possibly, mechanical tamponade with a sheet wrapped tightly around the pelvis or other strategies to produce circumferential compression. External skeletal fixation may be helpful if the fracture anatomy is appropriate, and an orthopedic surgeon should be consulted early in the course of treatment. In patients with arterial bleeding associated with pelvic injury, CT scanning will reveal a blush of contrast loss. Pelvic angiography for embolization should be considered in the persistently hypotensive patient due to an increased likelihood for arterial bleeding. Angiography may be required in approximately 10% of patients with pelvic fractures.

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8. The *specificity* of the test is defined as the ability of the test to identify correctly those who do not have the disease.

9. *The quality or state of being correct or precise, or, the degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard.*
ALGORITHM FOR THE BLUNT ABDOMINAL TRAUMA:–

Figure 2-4; Reproduced from http://www.thecorrect.com/medical-emergency/img/20.1.jpg [Accessed on 04/22/2014].
ALGORITHM FOR THE INITIAL EVALUATION OF A PATIENT WITH SUSPECTED BLUNT ABDOMINAL TRAUMA:

- CT = Computed Tomography; DPA = Diagnostic Peritoneal Aspiration; FAST = Focused Abdominal Sonography for Trauma; Hct = Hematocrit.

Figure 2-5; Reproduced from file:///F:/algorithm-for-the-initial-evaluation-of-a-patient-with-suspected-blunt-abdominal-trauma.jpg [Accessed on 04/22/2014].
**Algorithm for the Suspected Blunt Abdominal Injury:**

1. **Suspected Blunt Abdominal injury**
   - **Hemodynamically stable**
     - Complete 2nd Survey and CXR/PXR
     - **FAST**
       - **-ve**
         - Observe
       - **+ve**
         - **-ve**
           - Abdomen soft and Non Tender
           - Observation Serial clinical exam by same examiner
           - CT Abdomen With contrast
         - **+ve**
           - Significant mechanism
           - Concomitant head injury or other significant injury
           - Repeat FAST or DPL
   - **No FAST**
     - Abdomen soft and Non Tender
     - Observation Serial clinical exam by same examiner

2. **Hemodynamically Unstable**
   - Early FAST or DPL (15 min)
     - **+ve**
       - Laparotomy
     - **-ve**
       - Complete 2nd Survey* and CXR/PXR
       - Repeat FAST or DPL

*If seat belt stripe (bruising) present, have a low threshold for DPL as it is most sensitive for hollow viscus injury.
Algorithm for the Penetrating Abdominal Trauma:

1. Penetrating Abdominal Trauma
   - Hemodynamically Unstable?
     - Yes
     - LAPARATOMY
     - No
     - Anterior or Lateral Wound?
       - Yes
       - Gunshot Wound?
         - Yes
         - LAPARATOMY
         - No
         - Stable Flank and Back wounds
         - Yes
         - Triple Contrast CT scan, +/- DPL, +/- Diagnostic laparoscopy
       - No
       - Frank Peritonitis?
         - Yes
         - LAPARATOMY
         - No
         - Observation
   - No
     - Observation

*Preferred Investigation DPL/Local Wound Exploration are options but laparoscopy is better.
2.2.2 PENETRATING TRAUMA

Stab wounds and low-velocity gunshot wounds cause tissue damage by lacerating and cutting. High-velocity gunshot wounds transfer more kinetic energy to abdominal viscera. High-velocity wounds may cause increased damage lateral to the track of the missile due to temporary cavitation.

Stab wounds traverse adjacent abdominal structures and most commonly involve the liver (40%), small bowel (30%), diaphragm (20%), and colon (15%) (Figure 2-6).

Gunshot wounds may cause additional intraabdominal injuries based on the length of the missile's path through the body, the greater kinetic energy, the possibility of ricochet off of bony structures, and the possibility of fragmentation, creating secondary missiles. Gunshot wounds most commonly involve the small bowel (50%), colon (40%), liver (30%), and abdominal vascular structures (25%).

![TABLE 5.1 Truncal and Cervical Injuries from Restraint Devices](image)

<table>
<thead>
<tr>
<th>RESTRAINT DEVICE</th>
<th>INJURY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lap Seat Belt</td>
<td>• Tear or avulsion of mesentery (Bucket Handle)</td>
</tr>
<tr>
<td></td>
<td>• Rupture of small bowel or colon</td>
</tr>
<tr>
<td></td>
<td>• Thrombosis of iliac artery or abdominal aorta</td>
</tr>
<tr>
<td></td>
<td>• Chance fracture of lumbar vertebrae</td>
</tr>
<tr>
<td></td>
<td>• Pancreatic or duodenal injury</td>
</tr>
<tr>
<td>Shoulder Harness</td>
<td>• Intimal tear or thrombosis in innominate, carotid, subclavian, or vertebral arteries</td>
</tr>
<tr>
<td></td>
<td>• Fracture or dislocation of cervical spine</td>
</tr>
<tr>
<td></td>
<td>• Rib fractures</td>
</tr>
<tr>
<td></td>
<td>• Pulmonary contusion</td>
</tr>
<tr>
<td></td>
<td>• Rupture of upper abdominal viscer</td>
</tr>
<tr>
<td>Air Bag</td>
<td>• Corneal abrasions</td>
</tr>
<tr>
<td></td>
<td>• Abrasions of face, neck, and chest</td>
</tr>
<tr>
<td></td>
<td>• Cardiac rupture</td>
</tr>
<tr>
<td></td>
<td>• Cervical spine</td>
</tr>
<tr>
<td></td>
<td>• Thoracic spine fracture</td>
</tr>
</tbody>
</table>

Figure 2-6; Reproduced from ATLS Advanced Trauma Life Support for Doctors NINTH EDITION 2012 Chapter 5, Page-126.
Abdominal Trauma

Stab wounds most commonly injure the liver, small bowel, diaphragm, and colon.

Figure 2-7; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 5, Page-114.

Explosive devices cause injuries through several mechanisms, including penetrating fragment wounds and blunt injuries caused by the patient being thrown or struck. Combined penetrating and blunt mechanisms must be considered. Patients close to the source of the explosion may have additional pulmonary injuries and injuries to the hollow viscera related to blast pressure. The potential for high pressure injury should not distract the doctor from a systematic, ABC approach to identification and treatment of the common blunt and penetrating injuries.

**PITFALLS**

Failure to understand the mechanism leads to a lowered Index of suspicion and missed injuries, such as:

- Underestimation of energy delivered to the abdomen in blunt trauma.
- Visceral and vascular injuries caused by small external low-velocity wounds, especially stab and fragment wounds.
- Underestimation of the amount of energy delivered in high-velocity wounds, leading to missed injuries tangential to the path of the missile.
2.2.2.1 ASSESSMENT

How do I know if shock is the result of an intraabdominal injury?

In patients with hypotension, the doctor's goal is to rapidly determine whether an abdominal injury is present and whether it is the cause of the hypotension. The history may predict, and the physical exam, along with rapidly available diagnostic tools, may confirm the presence of abdominal and pelvic injuries that require urgent control of hemorrhage. Hemodynamically normal patients without signs of peritonitis may undergo a more detailed evaluation to determine whether specific injuries that can cause delayed morbidity and mortality are present. This may include repeated examination to determine whether signs of bleeding or peritonitis develop over time.

2.2.2.1.1 HISTORY

When assessing a patient injured in a motor vehicle crash, pertinent historical information includes speed of the vehicle, type of collision (e.g., frontal impact, lateral impact, sideswipe, rear impact, or rollover), vehicle intrusion into the passenger compartment, types of restraints used, deployment of air bags, patient's position in the vehicle, and status of passengers, if any. This information may be provided by the patient, other passengers, the police, or emergency medical personnel. Information about vital signs, obvious injuries, and response to prehospital treatment also should be provided by the prehospital care providers.

When assessing a patient who has sustained penetrating trauma, pertinent information includes the time of injury, type of weapon (e.g., knife, handgun, rifle, or shotgun), distance from the assailant (particularly important with Shotgun wounds, as the likelihood of major visceral injuries decreases beyond the 10-foot, or 3-meter, range), number of stab or gunshot wounds sustained, and the amount of external bleeding noted at the scene. If possible to obtain it, important additional information includes the magnitude and location of abdominal pain and whether this pain is referred to the shoulder.

When injuries are caused by an explosive device, the likelihood of visceral high pressure injuries is increased if the explosion occurred in an enclosed space and with decreasing distance of the patient from the explosion.
2.2.2.1.2 PHYSICAL EXAMINATION

How do I determine whether there is an abdominal injury?
The abdominal examination should be conducted in a meticulous, systematic fashion in the standard sequence: inspection, auscultation, percussion, and palpation. This is followed by assessment of pelvic stability; urethral, perineal, and rectal exam; vaginal exam; and gluteal exam. The findings, whether positive or negative, should be documented carefully in the patient's medical record.

PITFALLS
Hypothermia contributes to coagulopathy and ongoing bleeding.

2.2.2.1.2.1 INSPECTION

In most circumstances, the patient must be fully undressed. The anterior and posterior abdomen, as well as the lower chest and perineum, is inspected for abrasions, contusions from restraint devices, lacerations, penetrating wounds, impaled foreign bodies, evisceration of omentum or small bowel, and pregnancy. The patient should be cautiously logrolled to facilitate a complete examination. At the conclusion of the rapid physical exam, the patient should be covered with warmed blankets to help prevent hypothermia.

2.2.2.1.2.2 AUSSCULTATION

Auscultation of the abdomen may be difficult in a noisy emergency department, but it may be used to confirm the presence or absence of bowel sounds. Free intraperitoneal blood or gastrointestinal contents may produce an ileus, resulting in the loss of bowel sounds; however, this finding is nonspecific, as ileus may also be caused by extraabdominal injuries. These findings are most useful when they are normal initially and then change over time.

2.2.2.1.2.3 PERCUSSION AND PALPATION

Percussion causes slight movement of the peritoneum and may elicit signs of peritoneal irritation. When present, no additional evidence of rebound tenderness need or should be sought as such an examination may cause the patient unnecessary further pain.

Voluntary guarding by the patient may make the abdominal examination unreliable. In contrast, involuntary muscle guarding is a reliable sign of peritoneal irritation. Palpation may also elicit and distinguish superficial (abdominal wall)
and deep tenderness. The presence of a pregnant uterus, as well as estimation of fetal age, also can be determined.

2.2.2.2 ASSESSMENT OF PELVIC STABILITY

Major hemorrhage may occur from a pelvic fracture in patients who sustain blunt truncal trauma. An early assessment of the likelihood of hemorrhage from this source can be made during the physical exam by evaluating pelvic stability.

PITFALL

Repeated manipulation of a fractured pelvis can aggravate hemorrhage.

This begins with manual compression of the anterosuperior iliac spines or iliac crests. Abnormal movement or bony pain suggests fracture, and the exam may stop with this maneuver. If the pelvis seems stable to compression, a maneuver to distract the anterosuperior iliac spines is accomplished, also evaluating for bony movement or pain. Caution should be exercised, as this maneuver can cause or aggravate bleeding. When rapidly available, some doctors substitute x-ray examination of the pelvis to avoid pain and the potential for aggravating hemorrhage.

2.2.2.2.1 URETHRAL, PERINEAL, AND RECTAL EXAMINATION

The presence of blood at the urethral meatus strongly suggests a urethral tear. Inspection of the scrotum and perineum should be performed to look for ecchymoses or hematoma, suggestive of the same injury. In patients who have sustained blunt trauma, goals of the rectal examination are to assess sphincter tone, determine the position of the prostate (a high-riding prostate indicates urethral disruption), and identify any fractures of the pelvic bones. Inpatients with penetrating wounds, the rectal examination is used to assess sphincter tone and look for gross blood from a bowel perforation.

2.2.2.2.2 VAGINAL EXAMINATION

Laceration of the vagina may occur from bony fragments from pelvic fracture(s) or from penetrating wounds. Vaginal exam should be performed when injury is suspected (eg, in the presence of complex perineal laceration).
2.2.2.2.3 Gluteal Examination

The gluteal region extends from the iliac crests to the gluteal folds. Penetrating injuries to this area are associated with an incidence of up to a 50% of significant intraabdominal injuries, including rectal injuries below the peritoneal reflection. Gunshot and stab wounds are associated with intraabdominal injuries; these wounds mandate a search for such injuries.

2.2.2.3 Adjuncts to Physical Examination

Gastric and urinary catheters are frequently inserted as part of the resuscitation phase, once problems with the airway, breathing, and circulation are diagnosed and treated.

2.2.2.3.1 Gastric Tube

The therapeutic goals of inserting gastric tubes early in the resuscitation process are to relieve acute gastric dilation, decompress the stomach before performing a DPL, and remove gastric contents, thereby reducing the risk of aspiration. The presence of blood in the gastric secretions suggests an injury to the esophagus or upper gastrointestinal tract if nasopharyngeal and/or oropharyngeal sources are excluded. If severe facial fractures exist or basilar skull fracture is suspected, the gastric tube should be inserted through the mouth to prevent passage of the tube through the cribriform plate into the brain.

2.2.2.3.2 Urinary Catheter

The goals of inserting urinary catheters early in the resuscitation process are to relieve retention, decompress the bladder before performing DPL, and allow for monitoring of urinary output as an index of tissue perfusion. Hematuria is a sign of trauma to the genitourinary tract and nonrenal intraabdominal organs. The inability to void, unstable pelvic fracture, blood at the meatus, scrotal hematoma, or perineal ecchymoses and a high-riding prostate on rectal examination mandate retrograde urethrography to confirm an intact urethra before inserting a urinary catheter. A disrupted urethra detected during the primary or secondary survey may require the insertion of a suprapubic tube by an experienced doctor and may be performed more safely with ultrasound guidance.

2.2.2.3.3 Other Studies

With preparation and an organized team approach, the preceding evaluation can be performed very quickly. The following additional studies are chosen based on
the hemodynamic status of the patient and the suspected injuries. When intraabdominal injury is suspected, a number of studies can provide useful information; however, these studies should not delay the transfer of a patient to definitive care.

2.2.2.4 **X-Ray Examination for Abdominal Trauma**

Anteroposterior (AP) chest and pelvic x-ray examinations are recommended in the assessment of patients with multisystem, blunt trauma. Patients with hemodynamic abnormalities who have penetrating abdominal wounds do not require screening x-ray examination in the emergency department (ED). If the patient has no hemodynamic abnormalities and has penetrating trauma above the umbilicus or a suspected thoracoabdominal injury, an upright chest x-ray examination is useful to exclude an associated hemothorax or pneumothorax or to document the presence of intraperitoneal air. With marker rings or clips applied to all entrance and exit wound sites, a supine abdominal x-ray may be obtained in patients with no hemodynamic abnormalities to determine the track of the missile or presence of retroperitoneal air.

**PITFALL**

Avoid nasal gastric tube in midface injury. Use oral gastric route.
Computed Tomography Computed tomography (CT) is a diagnostic procedure that requires transport of the patient to the scanner, administration or contrast, and scanning of the upper and lower abdomen, as well as the pelvis. It is a time-consuming procedure that should be used only in patients with no hemodynamic abnormalities in whom there is no apparent indication for an emergency laparotomy. The CT scan provides information relative to specific organ injury and its extent, and can diagnose retroperitoneal and pelvic organ injuries that are difficult to assess by a physical examination, FAST, and peritoneal lavage. Relative contraindications to the use of CT include delay until the scanner is available, an uncooperative patient who cannot be safely sedated, and allergy to the contrast agent when non-ionic contrast is not available. Some gastrointestinal, diaphragmatic, and pancreatic injuries may be missed on CT. In the absence of hepatic or splenic injuries, the presence of free fluid in the abdominal cavity suggests an injury to the gastrointestinal tract and/or its mesentery, and many trauma surgeons find this to be an indication for early operative intervention.

Contrast Studies A number of contrast studies can aid in the diagnosis of specifically suspected injuries, but they should not delay the care of patients with hemodynamic abnormalities. These include:

- Urethrography.
- Cystography.
- Intravenous pyelography.
- Gastrointestinal contrast studies.

Urethrography should be performed before inserting an indwelling urinary catheter when a urethral tear is suspected. It is performed with an #8 French urinary catheter secured in the meatal fossa by balloon inflation to 1.5 to 2 mL. Approximately 15 to 20 mL of undiluted contrast material is instilled with gentle pressure. A radiograph is taken with an oblique projection and with slight stretching of the penis.

An intraperitoneal or extraperitoneal bladder rupture is best diagnosed by a cystogram. A syringe barrel is attached to the indwelling bladder catheter, held 40 cm above the patient, and 300 mL of water-soluble contrast is allowed to flow into the bladder or until: (I) flow stops, (2) the patient voids spontaneously, or (3)
the patient is in discomfort. AP, oblique, and postdrainage views are essential to definitively exclude injury. CT evaluation of the bladder and pelvis (CT cystography) is an alternative study that is particularly useful in providing additional information about the kidneys and pelvic bones.

Suspected urinary system injuries are best evaluated by contrast-enhanced CT scan. If CT is not available, intravenous pyelography (IVP) provides an alternative. A high-dose, rapid injection of renal contrast ("screening IVP") is best performed using the recommended dosage of 200 mg of iodine/kg body weight. This involves a bolus injection of 100 mL, (standard, 1.5 mL/kg for a 70-kg individual) of a 60% iodine solution performed through two 50-mL syringes over 30 to 60 seconds. If only 30% iodine solution is available, the ideal dose is 3.0 mL/kg. The calyces of the kidneys should be visualized on a flat plate x-ray of the abdomen 2 minutes after the injection is completed. Unilateral nonfunctioning indicates an absent kidney, thrombosis, avulsion of the renal artery, or massive parenchymal disruption. Nonfunctioning warrants further radiologic evaluation with contrast enhanced CT or renal arteriography, or surgical exploration, depending on the mechanism of injury and local availability or expertise.

Isolated injuries to retroperitoneal gastrointestinal structures (ie, duodenum, ascending or descending colon, rectum, biliary tract, and pancreas) may not cause peritonitis and may not be detected on DPL. When injury to one of these structures is suspected, CT with contrast, specific upper and lower gastrointestinal contrast studies, and pancreaticobiliary imaging studies may be useful. These studies should be guided by the surgeon who will ultimately care for the patient.

2.2.2.5.1 EVALUATION OF BLUNT TRAUMA

If there is early or obvious evidence that the patient will be transferred to another facility, time-consuming tests, such as contrast urologic and gastrointestinal studies, DPL, and CT, should not be performed. Table 5-2 compares the use of DPL, FAST, and CT, including their advantages and disadvantages, in the evaluation of blunt trauma.

**PITFALL**

Evaluations should not delay the transfer of the patient to a more appropriate level of care for severe injuries that have already been identified.

2.2.2.5.2 EVALUATION OF PENETRATING TRAUMA

The evaluation of penetrating trauma involves special consideration to address penetrating wounds to the abdomen and thoracoabdominal region. Options
include local wound exploration and serial physical examination, DPL, or CT in anterior abdominal stab wounds. Double or triple contrast CT are useful in flank and back injuries. Surgery may be required for immediate diagnosis and treatment.

- Preferred non-clinical examination in the hemodynamically stable patient.
- Double contract preferred [oral and IV] at present if possible but this is controversial.

(Assess on a case by case basis in consultation with surgeon and radiologist)

CT is supremely capable of defining injured organs. It is most accurate for solid visceral pathology. It is often able to distinguish the presence, source, and approximate quantity of intraperitoneal hemorrhage.

### 2.2.2.5.3 Findings on CT

The major findings on CT relate to detection of organ injury and free intraperitoneal fluid. Free fluid alone (absent signs of organ injury) in the adult patient can be suggestive of serious disease. One retrospective study showed that exploratory laparotomy was therapeutic in 94% of patients with isolated intraperitoneal fluid on CT scan. Other studies support this conclusion. The presence of intra-abdominal free air on CT is not an indication for laparotomy. This is due to the fact that free intraperitoneal air can be generated by mediastinal or pulmonary injury as well as barotrauma[^10^], and thus is not pathognomonic of hollow viscus perforation. In contradistinction to DPL and US, CT scanning coincidentally evaluates the retroperitoneum and therefore can be helpful in the evaluation of hematuria. If a hemodynamically stable patient has a hemoperitoneum demonstrated by DPL or ultrasound, a subsequent CT can evaluate organ injury and assist in the decision of whether nonoperative, expectant management is appropriate. If CT is performed after DPL, inform the radiologist of this fact to avoid confusing residual lavage fluid with hemoperitoneum.

[^10^]: Injury caused by a change in atmospheric pressure (usually to the ear).
2.2.2.5.4 ADVANTAGES

The value of the CT in trauma management depends on a number of variables. Patient factors include hemodynamic stability and cooperation (either voluntary or pharmacologic). Scanner issues relate to the distance the scanner is located from the ED and the generation of the machine. Helical (spiral) scanners provide faster examinations, with improved visualization of solid organs, and reduced CT artifacts. Spiral CT may even demonstrate areas of active hemorrhage and can help predict the success (or failure) of nonoperative management. An important caveat is that the accuracy of abdominal CTs in trauma is very reader-dependent.

The use of intravenous contrast allows better visualization of solid organs and sharpens the distinction between normal and injured tissue. However, oral contrast does not provide any significant benefit. Several studies prove that oral contrast rarely adds to diagnostic accuracy and causes considerable lengthening of the time required for study completion. One retrospective study showed that 60% of patients given oral contrast had inadequate opacification\(^\text{11}\) of the gut.

2.2.2.5.5 DISADVANTAGES

The greatest hazard of CT follows from ill-advised or poorly supervised studies wherein the dynamics of illness cause stable patients to crash and unstable patients to die. In one large review of blunt trauma, the authors described two preventable deaths, both secondary to operative delay associated with obtaining an abdominal CT. Other disadvantages of CT include its modest sensitivity for injury of the pancreas, small bowel, and mesentery. The latter two are of particular concern, as hollow viscus injury may occur in approximately 5% of patients with significant blunt abdominal trauma. Complications, albeit uncommon, can stem from reactions to intravenous or oral contrast. In addition, oral contrast is associated with an increased likelihood of emesis, early aspiration, and the cost of CT scanning can be substantial, particularly when employed in an overly liberal pneumonia. Fashion. In one prospective study, intra-abdominal injuries were identified in only 11% of patients undergoing CT scans of the abdomen.

\(^{11}\) Act of making opaque; act of making dull.
Focused Assessment Sonography in Trauma

Focused assessment sonography in trauma (FAST) is one of the two most rapid studies for the identification of hemorrhage or the potential for hollow viscus injury. In FAST, ultrasound technology is used by properly trained individuals to detect the presence of hemoperitoneum Figure.2-8. With specific equipment and in experienced hands, ultrasound has a sensitivity, specificity, and accuracy in detecting intraabdominal fluid comparable to DPL and abdominal computed tomography. Thus, ultrasound provides a rapid, noninvasive, accurate, and inexpensive means of diagnosing hemoperitoneum that can be repeated frequently. Ultrasound scanning can be done at the bedside in the resuscitation room while simultaneously performing other diagnostic or therapeutic procedures. The indications for the procedure are the same as for DPL. Factors that compromise the utility of ultrasound are obesity, the presence of subcutaneous air, and previous abdominal operations.

Ultrasound scanning to detect hemoperitoneum can be accomplished rapidly. Furthermore, it can detect one of the nonhypovolemic reasons for hypotension: pericardial tamponade. Scans are obtained of the pericardial sac, hepatorenal fossa, splenorenal fossa, and pelvis or pouch of Douglas. After the initial scan is completed, a second or "control" scan should ideally be performed after an interval of 30 minutes. The control scan can detect progressive hemoperitoneum in patients with a low rate of bleeding and short intervals from injury to the initial scan.
Focused Abdominal Sonography for Trauma (FAST). In FAST, ultrasound technology is used to detect the presence of hemoperitoneum.

Rapid bedside assessment with ultrasound has emerged as the investigation of choice in the hemodynamically unstable patient with no reliable clinical signs of abdominal injury. The examination is limited to 4 views: Morrison’s Pouch, Perisplenic, Pelvis, and Pericardium. FAST is aimed at the detection of free fluid. Free fluid in the abdomen in the unstable patient usually mandates laparotomy.

In the past decade, US has come to the forefront as a cornerstone study in the initial evaluation of the blunt trauma patient. Its primary role is in the detection of free intraperitoneal blood via scan of Morison’s pouch (RUQ), the splenorenal recess (LUQ), and the pouch of Douglas (pelvis), all dependent portions of the intraperitoneal cavity where blood is likely to accumulate. The Focused Assessment with Sonography in Trauma (FAST) includes these three views plus a subxiphoid cardiac view for the purpose of determining hemopericardium. One prospective observational study used increasing aliquots of lavage fluid in hemodynamically stable patients undergoing DPL. Trendelenburg positioning allowed recognition of only 400 cc of intraperitoneal fluid, compared to 700 cc in the supine position.

2.2.2.6.1 ADVANTAGES

Ultrasound has many advantages. First of all, it’s accurate. A recent study examined 2576 patients who underwent US for blunt abdominal trauma. Fewer
than 2% had a false-negative examination. Overall, US had a sensitivity of 86%, a specificity of 98%, and an accuracy of 97% for detection of intra-abdominal injuries. One study showed that in the hypotensive patient with blunt abdominal trauma, ultrasound is 100% sensitive and specific. The instrument is portable, routinely housed in the trauma resuscitation room, and can accomplish the FAST exam in fewer than five minutes. Sensitivity for detection of as little as 100 mL, but more typically 500 mL, of intraperitoneal fluid ranges from 60%-95% with excellent specificity.

US can replace DPL in rapidly answering the key question of whether hemoperitoneum is present. In contrast to DPL, US can also evaluate the mediastinum, is not invasive, and can be performed repeatedly by multiple individuals. In contrast to CT, it poses no radiation or contrast hazard, and usage is not restricted to radiologists. Accuracy of performance is correlated with length of training and experience, but competence can readily be acquired. In one study, physicians were able to detect hemoperitoneum more than 90% of the time after only two hours of training (one hour, theory; one hour, practical). All in all, US provides a relatively accurate, rapid, safe, and less expensive diagnostic screening tool.

2.2.2.6.2 DISADVANTAGES

It’s important to understand that, in the United States at least, US is not used to image solid parenchymal damage, the retroperitoneum, or the diaphragm. Technical difficulties can occur in obese patients, as well as those with a great deal of bowel gas or subcutaneous emphysema. In general, US is less sensitive than DPL for the presence of hemoperitoneum. Like DPL, US is insensitive when there is organ injury but no free intraperitoneal blood, as in subcapsular hematoma of the spleen. In one retrospective review, surgical or angiographic intervention (or both) was required in 26 patients (17%) without hemoperitoneum; such patients would be expected to have a negative FAST examination. As is often true for CT, US often fails to recognize bowel injury directly but relies instead on the visualization of small amounts of intraperitoneal fluid. Studies show that the majority of patients with isolated bowel and mesenteric injury have a negative US of the abdomen.
2.2.2.7 **SPECIAL PROCEDURES**

**Diagnostic Peritoneal lavage** Diagnostic peritoneal lavage (DPL) is the second of the two most rapid studies for the identification of hemorrhage or the potential for hollow viscus injury. DPL is an invasive procedure that significantly alters subsequent examinations of the patient and is considered 98% sensitive for intraperitoneal bleeding (Figure.2-9). It should be performed by a surgical team caring for a patient with hemodynamic abnormalities and multiple blunt injuries, especially when any of the following situations exists:

- Change in sensorium--brain injury, alcohol intoxication, and use of illicit drugs.
- Injusry to adjacent structures-lower ribs, pelvis, and lumbar spine.
- Equivocal results on physical examination.

**Diagnostic Peritoneal Lavage (DPL).**
DPL is a rapidly performed, invasive procedure that is considered 98% sensitive for intraperitoneal bleeding.
Figure.2-9; Reproduced from ATLS Advanced Trauma Life Support for Doctors Eighth edition 2008 Chapter 5, Page-117.
• Prolonged loss of contact with patient anticipated general anesthesia for extraabdominal injuries, lengthy x-ray studies (eg, angiography in a patient with or without hemodynamic abnormalities).

• Lap-belt sign (abdominal wall contusion) with suspicion of bowel injury.

DPL also is indicated in patients with no hemodynamic abnormalities when the same situations are present, but ultrasound and computed tomography (CT) are not available. The only absolute contraindication to DPL is an existing indication for laparotomy. Relative contraindications include previous abdominal operations, morbid obesity, advanced cirrhosis, and preexisting coagulopathy. Either an open or closed (Seldinger) infraumbilical technique is acceptable in the hands of trained doctors. In patients with pelvic fractures or advanced pregnancy, an open supraumbilical approach is preferred to avoid entering a pelvic hematoma or damaging the enlarged uterus. Free aspiration of blood, gastrointestinal contents, vegetable fibers, or bile through the lavage catheter in patients with hemodynamic abnormalities mandates the use of laparotomy.

**PITFALL**

A single physical exam or adjunct should not allay clinical suspicion based on the mechanism of injury. Repeated exams and complementary adjuncts may be necessary.

If gross blood (> 10 mL) or gastrointestinal contents are not aspirated, lavage is performed with 1000 mL of warmed isotonic crystalloid solution (10mL/kg in a child). After ensuring adequate mixing of peritoneal contents with the lavage fluid by compressing the abdomen and moving the patient by logrolling or tilling him or her into head-down and head-up positions, the effluent is sent to the laboratory for quantitative analysis if gastrointestinal contents, vegetable fibers, or bile are not obviously present. A positive test for blunt trauma is indicated by > 100,000 red cells per cubic millimeter, 500 white cells per cubic millimeter, or the presence of bacteria shown on Gram staining.
DIAGNOSTIC PERITONEAL LAVAGE (DPL)

Alternative to US
Criteria for positive DPL

ASPIRATION

> 10mls of frank blood
Obvious enteric contents

LAVAGE FLUID

RBC Count > 100 000/ml
WBC Count > 500/ml
Exit of lavage fluid via:
  Chest drain [diaphragm injury]
  Urinary catheter [bladder perforation]
Diagnostic peritoneal lavage

After nearly 40 years, DPL remains a valued tool in abdominal trauma. It entails two steps. First is the attempted aspiration of free intraperitoneal blood (known as peritoneal aspiration or peritoneal tap); second is the lavage portion, in which fluid is used to wash the peritoneal cavity, then is recovered by gravity drainage and subsequently analyzed.

A DPL is a rapidly performed, invasive procedure that significantly alters subsequent examinations of the patient and is considered a 98% sensitive for intraperitoneal bleeding. It should be performed by the surgical team caring for a hemodynamically abnormal patient with multiple blunt injuries, especially when any of these situations are present:

a. Change in sensorium-brain injury, alcohol intoxication, and use illicit drugs.

b. Change in sensation-injury to spinal cord.

Figure.2-10; Reproduced from https://image.slidesharecdn.com/abd-trauma-130629064725-phpapp01/95/abdominal-trauma-33-638.jpg?cb=1372488972 [Accessed on 03/03/2017].

Diagnostic Peritoneal Lavage

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A DPL is a rapidly performed, invasive procedure that significantly alters subsequent examinations of the patient and is considered a 98% sensitive for intraperitoneal bleeding. It should be performed by the surgical team caring for a hemodynamically abnormal patient with multiple blunt injuries, especially when any of these situations are present:

a. Change in sensorium-brain injury, alcohol intoxication, and use illicit drugs.

b. Change in sensation-injury to spinal cord.
c. Injury to adjacent structures-lower ribs, pelvis, and lumbar spine.
d. Equivocal physical examination.
e. Prolonged loss of contact with patient anticipated-General anesthesia for extra abdominal injuries, lengthy x-ray studies, e.g., angiography (hemodynamically normal or abnormal patient).
f. Lap-belt sign (abdominal wall contusion) with suspicion of bowel injury.

DPL also is indicated in hemodynamically normal patients when the same situations are present, but when ultrasound or CT is not available.

The only absolute contraindication to DPL is an existing indication for celiotomy. Relative contraindications include previous abdominal operations, morbid obesity, advanced cirrhosis, and preexisting coagulopathy. Either an open or closed (Seldinger) infraumbilical technique is acceptable in the hands of trained doctors. In patients with pelvic fractures or advanced pregnancy an open supra umbilical approach is preferred to avoid entering a pelvic hematoma or damaging the enlarged uterus. Free aspiration of blood, gastrointestinal contents, vegetable fibers, or bile through the lavage catheter in the hemodynamically abnormal patient mandates celiotomy. If gross blood (>10mL) or gastrointestinal contents are not aspirated, lavage is performed with 1000mL of warmed Ringer’s lactate solution (10mL/kg in a child). After ensuring adequate mixing of peritoneal contents with the lavage fluid by compressing the abdomen and logrolling the patient, the effluent is sent to the laboratory for quantitative analysis if gastrointestinal contents, vegetable fibers, or bile are not obviously present. A positive test is indicated by >100,000 RBC/mm$^3$, ≥500 WBC/mm$^3$, or a Gram stain with bacteria present.

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12* The Seldinger technique, also known as Seldinger wire technique, is a medical procedure to obtain safe access to blood vessels and other hollow organs. It is named after Dr. Sven-Ivar Seldinger (1921–1998), a Swedish radiologist who introduced the procedure in 1953.
## DPL versus FAST versus CT in Blunt Abdominal Trauma

<table>
<thead>
<tr>
<th></th>
<th>DPL</th>
<th>FAST</th>
<th>CT SCAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indication</strong></td>
<td>• Document bleeding if hypotensive</td>
<td>• Document fluid if hypotensive</td>
<td>• Document organ injury if BP normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>• Early diagnosis</td>
<td>• Early diagnosis</td>
<td>• Most specific for injury</td>
</tr>
<tr>
<td></td>
<td>• All patients</td>
<td>• All patients</td>
<td>• Sensitive: 92%-98% accurate</td>
</tr>
<tr>
<td></td>
<td>• Performed rapidly</td>
<td>• Noninvasive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 98% sensitive</td>
<td>• Performed rapidly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Detects bowel injury</td>
<td>• Repeatable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Transport: No</td>
<td>• 86%-97% accurate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>• Invasive</td>
<td>• Operator- dependent</td>
<td>• Cost and time</td>
</tr>
<tr>
<td></td>
<td>• Specificity: Low</td>
<td>• Bowel gas and subcutaneous air distortion</td>
<td>• Misses diaphragm, bowel, and some pancreatic injuries</td>
</tr>
<tr>
<td></td>
<td>• Misses injury to diaphragm and retro peritoneum</td>
<td>• Misses diaphragm, bowel, and pancreatic injuries</td>
<td>• Transport: required</td>
</tr>
</tbody>
</table>

Figure.2-11; Reproduced from (ATLS) Advanced Trauma Life Support Manual, American College of Surgeons, 7th Edition, 2004, Chapter 5, Page-137.

Note: Standard precautions are required whenever caring for the trauma patient.

1. **Diagnostic Peritoneal Lavage: Open Technique**
   A. Decompress the urinary bladder by inserting a urinary catheter.
   B. Decompress the stomach by inserting a gastric tube.
   C. Surgically prepare the abdomen (e.g., costal margin to the pubic area and flank to flank, anteriorly).
   D. Inject local anesthetic midline and just below the umbilicus. Use lidocaine with epinephrine to avoid blood contamination from skin and subcutaneous tissue.
E. Vertically incise the skin and subcutaneous tissue to the fascia.

F. Grasp the fascial edges with clamps, elevate and incise the fascia down to the peritoneum. Make a small nick in the peritoneum, entering the peritoneal cavity.

G. Insert a peritoneal dialysis catheter into the peritoneal cavity.

H. After inserting the catheter into the peritoneum, advance the catheter into the pelvis.

I. Connect the dialysis catheter to a syringe and aspirate.

J. If gross blood is not obtained, instill 1 liter of warmed Ringer’s lactate solution/normal saline (or 10 mL/kg in a child) into the peritoneum through the intravenous tubing attached to the dialysis catheter.

K. Gentle agitation of the abdomen distributes the fluid throughout the peritoneal cavity and increases mixing with the blood.

L. If the patient’s condition is stable, allow the fluid to remain a few minutes before allowing it to drain. This is done by putting the Ringer’s lactate solution/normal saline container on the floor and allowing the peritoneal fluid to drain from the abdomen. Make sure the container is vented to promote flow of the fluid from the abdomen. Adequate fluid return is >30% of the infused volume.

M. After the fluid returns, send a sample to the laboratory for Gram stain, and erythrocyte and leukocyte counts (unspun). A positive test and the need for surgical intervention are indicated by 100,000 RBCs/mm$^3$ or more, greater than 500 WBCs/mm$^3$, or a positive Gram stain for food fibers or bacteria.

N. A negative lavage does not exclude retroperitoneal injuries, i.e., pancreas or duodenum, or diaphragmatic tears.
II. **Diagnostic Peritoneal Lavage: Closed Technique**

A. Decompress the urinary bladder by inserting a urinary catheter.
B. Decompress the stomach by inserting a gastric tube.
C. Surgically prepare the abdomen (e.g., costal margin to the pubic area and flank to flank, anteriorly).
D. Inject local anesthetic midline and just below the umbilicus. Use lidocaine with epinephrine to avoid blood contamination from skin and subcutaneous tissue.
E. Elevate the skin on either side of the proposed needle insertion site with the fingers or forceps.
F. Insert the #18-gauge beveled needle attached to a syringe through the skin and subcutaneous tissue. Resistance is encountered when traversing the fascia and again when penetrating the peritoneum.
G. The flexible end of the guidewire is then passed through the #18-gauge needle until resistance is met or 3 cm is still showing outside the needle. The needle is then removed from the abdominal cavity so that only the guidewire remains.
H. A small skin incision is made at the entrance site of the catheter, and the peritoneal lavage catheter is inserted over the guidewire into the peritoneal cavity. The guidewire is then removed from the abdominal cavity so that only the lavage catheter remains.
I. Connect the dialysis catheter to a syringe and aspirate.
J. If gross blood is not obtained, instill 1 liter of warmed Ringer’s lactate solution/ normal saline (or 10 mL/kg in a child) into the peritoneum through the intravenous tubing attached to the dialysis catheter.
K. Gentle agitation of the abdomen distributes the fluid throughout the peritoneal cavity and increases mixing with the blood.
L. If the patient’s condition is stable, allow the fluid to remain a few minutes before allowing it to drain. This is done by putting the Ringer’s lactate solution/ normal saline container on the floor and allowing the peritoneal fluid to drain from the abdomen. Make sure the container is vented to promote flow of the fluid from the abdomen.
M. After the fluid has returned, send a sample to the laboratory for Gram stain, and erythrocyte and leukocyte counts (unspun). A positive test and
the need for surgical intervention are indicated by 100,000 RBCs/mm³ or more, greater than 500 WBCs/mm³ or a positive Gram stain for food fibers or bacteria.

2.2.2.7.1 ADVANTAGES

The signal virtue of DPL is in the multiple trauma patient with hemodynamic instability. DPL, like US, can promptly discover or refute the presence of intraperitoneal hemorrhage. It is sensitive to bowel perforations, where other diagnostic tests (CT, US) often fail. It’s especially valuable in patients who are poor candidates for ongoing clinical evaluation, due to severe head injury.

DPL AND PELVIC FRACTURES

The incidence of false-positive peritoneal lavage in pelvic fracture is as high as 29%. Therefore, authorities recommend an open supraumbilical approach in order to avoid transgressing a preperitoneal hematoma that has dissected out of the pelvis to the anterior abdominal wall. It is estimated that a lag of at least two hours is required before this dissection can occur, but the accuracy of this in humans is unknown. In the hemodynamically stable patient with a pelvic fracture, a positive DPL by red cell criteria should ordinarily prompt CT to better define the need for laparotomy.

### Preferred Site Of Diagnostic Peritoneal Lavage.

<table>
<thead>
<tr>
<th>Clinical Circumstance</th>
<th>Site</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard adult</td>
<td>Infraumbilical midline</td>
<td>Closed or semi-open</td>
</tr>
<tr>
<td>Standard pediatric</td>
<td>Infraumbilical midline</td>
<td>Closed or semi-open</td>
</tr>
<tr>
<td>Second and third trimester pregnancy</td>
<td>Supra-uterine</td>
<td>Fully open</td>
</tr>
<tr>
<td>Midline scarring</td>
<td>Left lower quadrant*</td>
<td>Fully open*</td>
</tr>
<tr>
<td>Pelvic fracture</td>
<td>Supra-umbilical*</td>
<td>Fully open*</td>
</tr>
</tbody>
</table>

*Empirical data to support these recommendations are limited.

Figure.2-12; Reproduced from EMERGENCY MEDICINE PRACTICE, May 2001, Volume 3, and Number 5.
2.2.2.7.2 DISADVANTAGES
On the one hand, thanks to the exquisite sensitivity of DPL for blood, the threshold of 100,000 RBC/cc can produce unnecessary laparotomy for trivial injury, typically to the spleen or liver. On the other hand, injury to certain structures—notably the bowel and the diaphragm—produces limited hemorrhage, such that RBC counts of 20,000-100,000 RBC/cc should be considered carefully in clinical context and for an observation period of 12-24 hours.

2.2.2.7.3 COMPLICATIONS OF PERITONEAL LAVAGE
1. Hemorrhage, secondary to injection of local anesthetic, incision of the skin, or subcutaneous tissue providing a false positive study.
2. Peritonitis due to intestinal perforation from the catheter.
3. Laceration of urinary bladder (if bladder not evacuated prior to procedure).
4. Injury to other abdominal and retroperitoneal structures requiring operative care.
5. Wound infection at the lavage site (late complication).

2.2.2.8 LAPAROSCOPY
Laparoscopy has been most useful in assessing penetrating trauma; however, very little experience has been acquired in the setting of blunt trauma.

The most established role for laparoscopy in trauma is for the diagnosis of abdominal injuries. It may be the best diagnostic test available to assess peritoneal penetration from questionable knife or gunshot wounds. Laparoscopy is the most reliable diagnostic technique to identify, and in many cases repair, diaphragmatic injuries. Specific injuries to solid organs and viscera can be accurately identified to determine the need of actual repair. Laparoscopic screening and diagnosis allows for more accurate use of open laparotomy when significant injuries are identified, thus avoiding the morbidity associated with nontherapeutic laparotomy. Therapeutic applications continue to be limited to repair of minor injuries to the visceral structures and solid organs. Watch for the emergence of SIL\(^{13}\) into the management of trauma patients. It is not only more cosmetic, but more importantly may have the advantage of better access to all areas of the abdominal compartment over standard laparoscopic techniques. Complex injuries

\(^{13}\) Single incision laparoscopy.
occasionally may be undertaken in the stable patient with the application of hand-assisted laparoscopy, minilaparotomy, or angiographic embolization.

It is important to emphasize the unpredictable and potentially unstable nature of traumatic injuries. The surgeon must always be prepared to rapidly open the abdomen to gain control of hemorrhage. The patient should always be in a supine position, and all instruments needed for an open laparotomy should be in the room and open, available for immediate use.

PELVIC TRAUMA

Assessment of the pelvis is by clinical and when indicated radiological examination.
Clinical examination should include inspection, particularly of the perineum for bruising, rectal and genitourinary examination, and careful palpation for pelvic instability.
Pelvic fractures present two major problems:

1. Bleeding [most commonly venous associated with an open book pelvic disruption]

2. Associated injury to bladder, urethra, bowel, other solid organs

Patients who have a pelvic fracture and blood at the external urethral meatus should have a retrograde urethrogram. A retrograde urethrogram should also be undertaken in patients with a significant pelvic fracture who have not passed urine.
The hemodynamically unstable patient with a pelvic fracture requires a supraumbilical DPL or FAST ultrasound, in consultation with the General and Orthopaedic Surgeon.
If the DPL is positive or significant free fluid on FAST present, laparotomy is required.
If the patient with a pelvic fracture remains hemodynamically unstable a tightly applied sheet or SAM\textsuperscript{14*} splint around the pelvis and urgent orthopaedic consultation is required. Continued instability may require pelvic angiography and embolisation, and/or operative stabilization.

\textsuperscript{14* FOR STABILIZATION OF PELVIC FRACTURES WITH THE CORRECT FORCE
It is still the only force-controlled circumferential pelvic belt scientifically proven in peer-reviewed studies to safely and effectively reduce and stabilize open-book pelvic ring fractures. Video URL; https://www.spservices.co.uk/item/SAM_SAMPelvicSlingII-Single_0_1_378_50.html}
INDICATIONS FOR CELIOTOMY (LAPAROTOMY) IN ADULTS

In individual patients, surgical judgment is required to determine the timing and need for operation. The following indications are commonly used to facilitate the surgeon’s decision-making process in this regard.

1. Blunt abdominal trauma with hypotension and clinical evidence of intraperitoneal bleeding.
2. Blunt abdominal trauma with positive DPL or FAST.
3. Hypotension with penetrating abdominal wound.
4. Gunshot wounds traversing the peritoneal cavity or visceral/vascular retroperitoneum.
5. Evisceration.
6. Bleeding from the stomach, rectum, or genitourinary tract from penetrating trauma.
7. Presenting or subsequent peritonitis.
8. Free air, retroperitoneal air, or rupture of the hemidiaphragm after blunt trauma.
9. Contrast-enhanced CT demonstrates ruptured gastrointestinal tract, intraperitoneal bladder injury, renal pedicle injury, or severe visceral parenchymal injury after blunt or penetrating trauma.

Figure 2-13; Reproduced from (ATLS) Advanced Trauma Life Support Manual, American College of Surgeons, 7th Edition, 2004, Chapter 5, Page-139.
2.2.2.9 Initial Assessment

Historical data, while often lacking, may provide invaluable information to the emergency practitioner when evaluating a patient with abdominal trauma. If the patient was involved in a MVC, information regarding fatalities at the scene, vehicle type and velocity, roll over, intrusion, steering wheel deformity, use of seatbelts and air bags, and the patient’s location within the vehicle offer guidance in management.

2.2.2.9.1 Physical Examination

While some studies cite physical examination as only 55% to 65% sensitive for diagnosing injury in those sustaining BAT, it is still the cornerstone for primary assessment. Patients with BAT may present to the ED anywhere on the spectrum from normotensive and alert to obtunded and in shock. Careful attention to physical findings helps drive decision making and proper sequencing of diagnostic tests.

Hypotension after BAT typically results from visceral organ injury and hemorrhage, usually of the spleen. These patients need emergent evaluation of the peritoneal cavity, and coincident appraisal of any extra abdominal injury creating hemorrhage or hemodynamic instability, such as long bone fracture, scalp laceration, hemothorax, pneumothorax, or, in infants, severe head injury.

In awake, hemodynamically stable patients with isolated BAT, abdominal pain, tenderness, and peritoneal signs are the most reliable findings for intra-abdominal injury and can be found in up to 90% of those with injury. However, several studies demonstrate that even in these patients, significant injury may be missed with physical exam alone. Therefore, absence of physical findings does not preclude injury and the need for further observation and diagnostic testing.

When extra-abdominal injuries are present, suspicion for concomitant intra-abdominal injury is paramount. Up to 10% of those with closed head injury, and 7% of those with a distracting extremity injury, will have an abdominal injury even with no signs or symptoms of abdominal trauma. Pleuritic left costal margin pain may indicate underlying splenic injury. Ecchymosis across the lower
abdomen, a “seatbelt sign,” portends intra-abdominal injury in up to one third of patients. Some recent small studies suggest that in awake, hemodynamically stable adult patients who are going to the operating room for extra-abdominal injuries, physical exam will exclude most intra-abdominal injuries requiring immediate operative intervention.

2.2.2.9.2 LABORATORY TESTING

Most hematologic and blood chemistries serve only as adjuvants in the management of patients with abdominal trauma. A baseline hematocrit may be useful, but rarely will alter emergent management. Blood typing should routinely be sent for any patient with abdominal trauma and signs of hemorrhage or potential need for transfusion. Base deficit is often used as a marker for hemorrhagic shock, but as with all laboratory values, it must be interpreted in context of the clinical scenario and what resuscitation has occurred, as correction of the metabolic acidosis will lag behind physiologic correction. White blood cell count, pancreatic enzymes, and liver function tests have all been used as markers of intra-abdominal injury in the past; however, most studies now show these are nonspecific and may not provide much guidance in the acute decision-making for patients with abdominal trauma. Urinalysis with detection of hematuria (both microscopic and gross) indicates renal injury, and coupled with abdominal tenderness predicts intra-abdominal injury following BAT with 65% sensitivity and 94% specificity. Toxicologic studies have little value in the acute management of abdominal trauma, unless there is unexplained altered mental status.

Blood-Borne Viruses (BBV) studies is also important, because:-

Needlestick Injury: the accidental puncture of the skin by a needle during a medical intervention.

Accidental exposure to blood: the unintended contact with blood and or with body fluids mixed with blood during a medical intervention.
**Risks**

Accidental exposure to blood caused by needle injuries or injuries following, cutting, biting or splashing incidents carries the risk of infection by blood-borne viruses such as the hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV).

- HBV risk = 5 - 40%
- HCV risk = 3 - 10%
- HIV risk = 0.2 - 0.5%

HBV prevalence is higher than average in intravenous drug users, homosexual men and in people from developing countries.

HCV prevalence is higher in people who have had multiple blood transfusions, in dialysis patients and intravenous drug users.

HIV prevalence is also higher in homosexual men, in intravenous drug users and in people from areas where the condition is endemic.

**Accidental contact with blood occurs especially in the following situations:**

1. During re-capping.
2. During surgery, especially during wound closure.
3. During biopsy.
4. When an uncapped needle has ended up in bed linen, surgery clothing etc.
5. When taking an unsheathed used needle to the waste container.
6. During the cleaning up and transporting of waste material.
7. When using more complex collection & injection techniques.
2.2.2.10 Emergency Management

Management of blunt and penetrating trauma to the abdomen includes:
1. Reestablishing vital functions and optimizing oxygenation and tissue perfusion.
2. Delineating the injury mechanism.
3. Meticulous initial physical examination, repeated at regular intervals.
4. Selecting special diagnostic maneuvers as needed, performed with a minimal loss of time.
5. Maintaining a high index of suspicion related to occult vascular and retroperitoneal injuries.

2.2.2.10.1 Unstable Patients

Determining need for emergent operative care is the top priority in the evaluation of patients sustaining BAT. In those patients who are hemodynamically unstable, the presence of intra-abdominal hemorrhage must be expeditiously established. Risk of death from isolated intra-abdominal injury increases with time spent in the emergency department and severity of hypotension.
ALGORITHM FOR THE UNSTABLE PATIENTS WITH BLUNT ABDOMINAL TRAUMA:-

Hemodynamically Unstable

FAST

Extraabdominal injury or Hemorrhage?

Yes

Stabilization* and Resuscitation

No

DPT

LAPARATOMY

Stable

Yes

CT

Non-operative management/ Laparotomy

No

Observation

DPT + if ≥ 10 cc gross blood aspirated

Hemodynamically Unstable

Unstable patients with blunt abdominal trauma. +, ≥ 10 cc blood aspirated; DPT −, < 10 cc blood aspirated.

*Pelvic wrap, Chest tube placement, whip stitch

FAST = Focused Abdominal Sonography for Trauma

DPT = Diagnostic Peritoneal Tap; + if ≥ 10 cc gross blood aspirated

CT = Computed Tomography
Traditionally, bedside diagnostic peritoneal lavage or tap (DPL or DPT) quickly triages unstable patients with multisystem trauma. If 10 cc of gross blood is aspirated then intra-abdominal hemorrhage is present and the patient requires urgent laparotomy. This knowledge is especially useful when multisystem trauma is present and the physician must decide which therapeutic path to tread, be it exploratory laparotomy or angiography with embolization. However, with the advent of bedside ultrasonography (US), DPL is being employed less and is no longer the standard diagnostic procedure in these unstable patients.

Recent literature shows mixed opinion on the use of US in the unstable patient. While some studies cite near 100% sensitivity for hemoperitoneum requiring surgical intervention in the hypotensive patient, others show a wide range of sensitivity and caution against its sole use in this patient population, especially when no intraperitoneal free fluid is detected.

Because intra-abdominal injury cannot be entirely ruled out in those unstable patients with a negative FAST, further diagnostic testing, bedside DPL or DPT, or once more stabled CT, must be performed to completely evaluate for intra-abdominal injury, while concurrently pursuing possible extra-abdominal injury as a cause of instability.

Chest and pelvic radiographs determine the presence of extra-abdominal causes of hypotension or hemorrhage, namely pneumothorax or hemothorax and pelvic ring fracture, respectively. Needle decompression, chest tube placement, or pelvic wrapping and subsequent angiography control further blood loss and aid in resuscitation. Large scalp lacerations may also prove a source of hemorrhage and should be whip-stitched (or Rainey clipped) closed.
Figure 2-15; Nasogastric tube in left chest with diaphragmatic rupture. Adapted from Advances in abdominal trauma, EMERGENCY MEDICINE CLINICS OF NORTH AMERICA 25 (2007) 713–733.

2.2.2.10.2 Stable Patients

New advances in computed tomography and ultrasound continue to alter the management of stable patients with BAT. Hemodynamically stable patients allow for a more time intensive evaluation and alternative testing to diagnose intra-abdominal injury. While physical exam in the stable, alert, nonintoxicated patient is reasonably accurate, it is not infallible and clinical observation with serial examinations is warranted.

Furthermore, one recent study advocates for CT evaluation in all patients sustaining BAT. The authors cite missed significant injury, one requiring alteration of treatment, at a rate of 7% in a patient population with no signs of external trauma and normal abdominal examination.

Most centers employ US as part of their initial survey in trauma resuscitation. Studies demonstrate a range in sensitivity for hemoperitoneum from 65% to 95%, although most recent studies cite ranges of 86% to 89%. If the FAST is noted to be positive, these stable patients then proceed to CT for delineation of intraperitoneal injury and quantification of the hemoperitoneum.

If the FAST is negative, concern for intra-abdominal injury is still present, as US is notoriously poor at identifying solid organ subcapsular injury, bowel injury,
or injury to the retroperitoneum or diaphragm. However, some report that a negative FAST coupled with a negative physical exam, followed by an observation period of 12 to 24 hours in an alert, stable patient virtually excludes intra-abdominal injury. Others recommend serial abdominal US to increase the sensitivity of the FAST exam.

Figure 2-16; Free fluid in Morrison’s Pouch. Adapted from Advances in abdominal trauma, EMERGENCY MEDICINE CLINICS OF NORTH AMERICA 25 (2007) 713–733.
ALGORITHM FOR THE STABLE PATIENTS WITH BLUNT ABDOMINAL TRAUMA:

Concerning Mechanism*
Or
Unreliable exam**

Yes

No

FAST

+ or -

CT

+ or -

Non-operative management/
Laparotomy

Observation

Discharge

FAST

Serial abdominal
exam/
Secondary US

* Concerning mechanism: fatality at scene, rollover, intrusion, prolonged extrication
** Unreliable exam: altered mental status, intoxication, distracting injury.

FAST = Focused Abdominal Sonography for Trauma
CT = Computed Tomography
Stable patients with blunt abdominal trauma. DPT +, ≥ 10 cc blood aspirated; DPT -, < 10 cc blood aspirated

Figure.2-17; Reproduced from Advances in abdominal trauma, EMERGENCY MEDICINE CLINICS OF NORTH AMERICA 25 (2007).
The advent of 64-slice helical CT scanners has improved diagnosis of both solid and hollow viscus injury post-BAT. Recent studies advocate the use of CT, even in patients with no signs of injury, be it intra- or extra-abdominal. Most admit to its low yield in those patients who are alert with no signs of trauma; however, missed injury in these studies was at times significant and, therefore, routine use of CT cannot be abandoned in certain patient populations, namely those with extra-abdominal injuries, ethanol ingestion, and otherwise unreliable abdominal examination.

The 2004 American College of Emergency Physicians Clinical Policy statement, based on review of the literature, touts CT as reliably excluding liver and spleen injury after BAT. This clinical policy also states that CT alone could not reliably rule out hollow viscus, diaphragmatic, or pancreatic injury.

Hollow viscus injury (HVI) remains difficult to detect despite advances in diagnostic modalities. Coincident solid organ injury often masks CT findings of HVI, increasing morbidity and mortality because of delay in diagnosis. Recent studies suggest physical examination for signs of peritonitis, coupled with CT with intravascular (IV) contrast only, may be adequate for diagnosing bowel injury. However, the low incidence of HVI makes large prospective studies for noncontrast CT identification difficult.

If liver or splenic injury is detected by CT in a hemodynamically stable patient, nonoperative management with close observation, serial examinations, and hematocrits is now standard. This is in part due to improved resolution on CT, which allows better definition of the injury and quantification of hemorrhage. Even high-grade liver lacerations can be initially managed nonoperatively; however, complications and the possible need for therapeutic laparotomy should be expected.

**SPECIAL CONSIDERATIONS**

Pelvic fracture is routinely managed nonoperatively with angiography. Therefore determination of concurrent hemoperitoneum in unstable patients is paramount, as need for laparotomy in these patients may require external fixator placement in the operating room for fracture stabilization. Ultrasound and DPT have both proven efficacious in the management of this patient population.
Closed head injury renders physical exam less useful in the triage of patients with BAT. Furthermore, the ability perform more time intensive diagnostic testing, such as CT, may be limited. When no lateralizing signs are present, the need for urgent craniotomy is less and a quick head CT follow by abdominal CT may be possible. However, those with lateralizing signs and hemodynamic instability may need a burr hole with concurrent laparotomy. Others that respond to resuscitative measures may have time for a ‘‘quick’’ head CT just before abdominal CT.

There is evidence that patients with serious abdominal trauma, especially those requiring surgical intervention, do better at regional trauma centers. Consultation and transfer should occur early in the evaluation of patients. However, a subset of patients with hemodynamic instability and known hemoperitoneum will benefit from laparotomy with hemorrhage control before transfer.
2.2.2.11 PENETRATING ABDOMINAL TRAUMA

Penetrating Wounds

Most gunshot wounds to the abdomen are managed by exploratory laparotomy, as the incidence of significant intraperitoneal injury approaches 90%. Tangential gunshot wounds often are not truly tangential, and concussive and blast injuries can cause intraperitoneal injury without peritoneal penetration. Slab wounds to the abdomen may be managed more selectively, but approximately 30% do cause intraperitoneal injury. Thus, indications for laparotomy in patients with penetrating abdominal wounds include:

- Any patient with hemodynamic abnormalities.
- Gunshot wound.
- Signs of peritoneal irritation.
- Signs of fascial penetration.

When there is suspicion that a penetrating wound is superficial and does not appear to travel below the abdominal musculoaponeurotic layer, an experienced surgeon may elect to explore the wound locally to determine the depth of penetration. This procedure is not used with wounds overlying the ribs because of the risk of causing a pneumothorax, and it is not indicated in patients with peritonitis or hypotension from suspected abdominal injury. Because 25% to 33% of stab wounds to the anterior abdomen do not penetrate the peritoneum, laparotomy for such patients is often nonproductive. Under sterile conditions, local anesthesia is injected, and the wound track is followed through the layers of the abdominal wall or until its termination. Confirmation of penetration through the anterior fascia places the patient at higher risk for intraperitoneal injury, and many trauma surgeons view this as an indication for laparotomy. Any patient in whom the track cannot be followed because of obesity, lack of cooperation, or soft-tissue hemorrhage or distortion should be admitted for continued evaluation or surgical exploration (laparotomy).

2.2.2.11.1 THORACOABDOMINAL LOWER CHEST WOUNDS

Diagnostic options in asymptomatic patients with possible injuries to the diaphragm and upper abdominal structures include serial physical and chest x-ray examinations, thoracoscopy, laparoscopy, and CT (for right thoracoabdominal wounds). Despite all these options, late posttraumatic left-sided diaphragmatic hernias continue to occur after thoracoabdominal stab wounds; thus early or immediate surgical exploration (laparotomy) for such wounds also is an option.
For left-sided thoracoabdominal gunshot wounds, the safest alternative is laparotomy.

2.2.2.11.2 Local Wound Exploration and Serial Physical Examinations versus DPL in Anterior Abdominal Stab Wounds

Approximately 55% to 60% of patients with stab wounds that penetrate the anterior peritoneum have hypotension, peritonitis, or evisceration of omentum or small bowel. These patients require emergency laparotomy, in the remaining patients, in whom anterior peritoneal penetration can be confirmed or is strongly suspected after local wound exploration, approximately 50% eventually require operation. Laparotomy remains a reasonable option for all such patients. Less invasive diagnostic options for relatively asymptomatic patients (who may have pain at the site of the stab wound) include serial physical examinations over a 24-hour period, DPL, or diagnostic laparoscopy.

**PITFALL**

These evaluations are seeking to prove that there is no injury in the patients with no hemodynamic abnormalities. They should not delay laparotomy in patients with hemodynamic abnormalities that likely have an abdominal source.

Although a positive FAST may be helpful in this situation, a negative FAST does not exclude the possibility of significant intraabdominal injury producing small volumes of fluid. Serial physical examinations are labor-intensive, but have an overall accuracy rate of 94%. DPL may allow for earlier diagnosis of injury in relatively asymptomatic patients. The accuracy rate is greater than 90% when specific cell counts, rather than gross inspection of the fluid, are used. Use of lower thresholds for penetrating trauma increases sensitivity and decreases specificity, Diagnostic laparoscopy can confirm or exclude peritoneal penetration, but it is less useful in identifying specific injuries.

2.2.2.11.3 Serial Physical Examinations versus Double- or Triple-Contrast CT in Flank and Back Injuries

The thickness of the flank and back muscles protects the underlying viscera from injury from many stab wounds and some gunshot wounds to these areas. Although laparotomy is a reasonable option for all such patients, less invasive diagnostic options in patients who are initially asymptomatic include serial
physical examinations, double- or triple-contrast CT, and DPL. Serial physical examination in patients who are initially asymptomatic and then become symptomatic is very accurate in detecting retroperitoneal and intraperitoneal injuries with wounds posterior to the anterior axillary line. Double- (intravenous and oral) or triple- (intravenous, oral, and rectal) contrast-enhanced CT assesses the retroperitoneal colon on the side of the wound. The accuracy is comparable to that of serial physical examinations, but should allow for earlier diagnosis of injury in relatively asymptomatic patients when CT is performed properly.

On rare occasions, these retroperitoneal injuries may be missed by serial examinations and contrast CT. Early outpatient follow-up is mandatory after the 24-hour period of in-hospital observation because of the subtle presentation of certain colonic injuries.

DPL can also be used as an early screening test in such patients. A positive DPL is an indication for an urgent laparotomy.

2.2.2.12 **INDICATIONS FOR LAPAROTOMY IN ADULTS**

*In which patients is a laparotomy warranted?*

In individual patients, surgical judgment is required to determine the timing and need for laparotomy. The following indications are commonly used to facilitate the surgeon's decision-making process.

- Blunt abdominal trauma with hypotension with a positive FAST or clinical evidence of intraperitoneal bleeding.
- Blunt abdominal trauma with positive DPL.
- Hypotension with penetrating abdominal wound.
- Gunshot wounds traversing the peritoneal cavity or visceral/vascular retroperitoneum.
- Evisceration.
- Bleeding from the stomach, rectum, or genitourinary tract from penetrating trauma.
- Peritonitis.
- Free air, retroperitoneal air, or rupture of the hemidiaphragm after blunt trauma.
- Ruptured gastrointestinal tract, intraperitoneal bladder injury, renal pedicle injury, or severe visceral parenchymal injury after blunt or penetrating trauma, as demonstrated on contrast-enhanced CT.
Surgical judgment is required to determine the timing and need for laparotomy. Figure 2-18; Reproduced from ATLS Advanced Trauma Life Support for Doctors NINTH EDITION 2012 Chapter 5, Page-134.

Penetrating Abdominal Trauma:

- Early surgical consultation in all cases
- Evidence of
  - Hemodynamically instability
  - Evisceration
  - Peritonism
  - Free gas on x-ray
  - Other evidence of internal injury

→ Mandates laparotomy
- If no evidence of the above, requires local wound exploration by the general surgeon or additional investigation/observation at the discretion of the surgeon.
Small holes

Figure 2-19a; Reproduced from ICRC Sources.

Close distance

Figure 2-19b; Reproduced from ICRC Sources, War Surgery Seminar, Wound Ballistics: Bombs, bullets and blast, Kabul 13-15 June 2011.
2.2.2.13 **INITIAL ASSESSMENT**

For those with penetrating abdominal trauma, it is important to note in stab wounds the implement used, its trajectory, and length, and in gunshot wounds, the type of gun, number of shots heard, the position of the patient during the assault, and the distance of the patient from the gun. Shotgun wounds create a special scenario, as their velocity and trajectories differ from gunshot wounds. As distance is gained, shotgun pellets disperse and thus mortality is decreased; however, debris carried into these resulting multiple wounds increases morbidity.

2.2.2.13.1 **PHYSICAL EXAMINATION**

It is vital that patients sustaining penetrating trauma be completely undressed and thoroughly examined for injury. Often these patients will present with an obvious wound to the anterior abdomen, only to have a secondary wound in an axilla, perineum, scalp, or skin fold that may be unnoticed and perhaps lethal.
The tenet of evaluating penetrating abdominal trauma is to determine peritoneal violation and then peritoneal injury. Physical exam may reveal peritonitis, evisceration, or other indications of peritoneal violation, and thus the need for operative management. Those patients with unstable vital signs may have an intra-abdominal injury with hemorrhage; however, tension pneumothorax, hemothorax, and pericardial tamponade must be considered and evaluated.

2.2.2.13.2 EMERGENCY MANAGEMENT

With the advent of anesthesia, sterilization, and surgical training, post-World War I treatment of penetrating injury to the abdomen was mandatory laparotomy. This dogmatic approach was predicated by battlefield experience with trauma laparotomies and translated to civilian populations in the post-war era. However, as nontherapeutic laparotomy rates approached 30%, surgeons found that the injuries and morbidity associated with noncombat penetrating wounds differed from those produced by military weapons. In 1960 Shaftan published a paper advocating nonoperative management in select patient populations sustaining stab wounds, and the tenet of mandatory laparotomy was lost. Today, nonoperative treatment of abdominal gunshot wounds is also gaining favor.

2.2.2.13.3 INDICATION FOR MANDATORY LAPAROTOMY

The mainstay of evaluation of those with penetrating abdominal trauma is identification of the need for immediate surgical intervention. Physicians agree that immediate laparotomy is indicated if there is hemodynamic instability or the presence of peritoneal signs on physical examination. When evisceration is present, surgical intervention is generally accepted as the next step in management.
2.2.2.13.4 **IDENTIFICATION OF PERITONEAL INJURY**

**2.2.2.13.4.1 STAB WOUNDS**

Stab wounds produce peritoneal violation in up to 70% of instances, but of these only one fourth to one third will require operative intervention. For those patients without evisceration, peritonitis, or hemodynamic instability, studies show that judicious use of local wound exploration, CT, DPL, laparoscopy, and US, coupled with physical examination, can safely select patients appropriate for nonoperative management.

Local wound exploration is easily and safely performed at the bedside in those patients with abdominal stab wounds. If the stab wound tract ends before violation of the abdominal fascia, studies show these patients are safe for discharge. However, if the tract is not completely visualized because of body habitus, other injuries, or technical inability then further testing is necessary.

Most centers employ CT as the next step in evaluation of these stable patients as it is noninvasive, offers information about the extent of injury to visceral organs, and can help plan both operative and nonoperative management. While triple contrast CT is still routinely used for its 97% sensitivity and 98% specificity, one recent study evaluated the use of CT with only IV contrast and found a similar sensitivity and specificity. This protocol reserves use of oral and rectal contrast for specific patient populations, thus decreasing the amount of time needed to perform the diagnostic test in most patients. Injuries to the bowel, diaphragm, and pancreas are poorly visualized on CT (even with triple contrast), and in those patients with high suspicion for injury (such as those with hepatic injury and right-sided hemothorax), further diagnostic testing with laparoscopy or DPL may be warranted despite negative CT.

The role of ultrasound in penetrating abdominal trauma is still evolving. A positive FAST may indicate intraperitoneal hemorrhage and injury, but in this group of stable patients, more definitive testing must follow as there is potential for nonoperative management. A negative FAST does not exclude injury and requires further evaluation.
ALGORITHM FOR THE ABDOMINAL STAB WOUNDS:-

Hemodynamically Unstable?  
Or  
Peritoneal signs?  
Yes  
No  

Evisceration  

LAPAROTOMY  

Peritoneal Penetration?  

LWE, CT, DL, US  

Non-Op Management  

Peritoneal Injury?  

CT, DPL, DL  

LAPAROTOMY  

Non-Op Management  

Observation 12-24 H  

Equivocal?  

Discharge

LWE = Local Wound Exploration / CT = Computed Tomography / DL = Diagnostic Laparoscopy  
DPL = Diagnostic Peritoneal Lavage / Abdominal stab wounds. US, Ultrasonography.  
Figure.2-20; Reproduced from Advances in abdominal trauma, EMERGENCY MEDICINE CLINICS OF NORTH AMERICA 25 (2007).
At some centers, diagnostic laparoscopy (DL) is used as a screening tool for those with abdominal stab wounds. It is useful for inspecting the diaphragm and evaluating the depth of wound tracts. Its routine use for penetrating trauma, however, is controversial.

Other advocates of DL point to decreased cost and length of stay when laparoscopy is employed rather than exploratory laparotomy; albeit, this is at centers adept at DL.

Diagnostic peritoneal lavage performed at the bedside determines both peritoneal violation and peritoneal injury. This rapid, yet invasive, test provides information about solid viscus, bowel, and diaphragmatic injury. While there has been debate over what red blood cell counts to use for detecting injury, most agree that the presence of greater than 10,000 red blood cells per high-power field (RBCs/hpf) indicates visceral injury in penetrating abdominal wounds. A reduced range of 5 to 10,000 RBCs/hpf should be used for thoracoabdominal wounds. When coupled with physical management. However, as other less invasive diagnostic modalities are gaining favor, routine use of DPL is decreasing.
Gunshot Wounds

2.2.2.13.4.2 Gunshot Wounds

Determining trajectory of gunshot wounds helps to determine the presence of intraperitoneal injury. Once a thorough physical exam is completed and the number of wounds counted, plain film radiographs elucidate the missile path. Radio-opaque markers on any wounds, coupled with anteroposterior and lateral films, create a three dimensional estimation of trajectory path. Caution should prevail, as even wounds suggesting a superficial path may have intraperitoneal injury. If an odd number of wounds are present, careful attention to radiographs should reveal the missile location.

Computed tomography scanning is frequently employed after abdominal gunshot wounds, as it allows for determination of trajectory path, identifies organ injury and, therefore, optimal patients for nonoperative management. As discussed previously, sensitivity and specificity remain high for this modality, even when IV contrast is solely used. Many studies use CT as an adjuvant to nonoperative management. It is especially helpful for defining hepatic injury that may be ideal for conservative treatment with observation only.

While more invasive, DPL has known high sensitivity for intra-abdominal injury after gunshot wounds. It is an excellent means of determining peritoneal violation: using 10,000 RBCs/hpf as the threshold, it has a sensitivity of 96%.

Conversely, laparoscopy is slowly gaining favor in the management of abdominal gunshot wounds. Laparoscopy serves primarily to determine the presence of peritoneal violation and to inspect the diaphragm. Drawbacks include the need for anesthesia, inability to repair certain injuries (requiring conversion to laparotomy), and difficulty in visualizing the posterior diaphragm, subtle bowel injuries, and the retro peritoneum. As for stab wounds, as trauma centers become more adept at this procedure laparoscopy may be used more frequently, especially in those patients with left sided thoracoabdominal injuries in which diaphragmatic injury must be ruled out.
Algorithm for the Abdominal Gunshot Wounds:

1. Hemodynamically Unstable? Peritoneal signs Evisceration
   - Yes: LAPAROTOMY
   - No: Peritoneal Penetration?
     - Yes: CT, Plain film radiographs, DL
       - Yes: Peritoneal Injury
         - Yes: LAPAROTOMY
         - No: Observation
           - CT, DPL, DL Serial Exams
             - Yes: LAPAROTOMY
             - No: Observation
               - Discharge
     - No: Observation

CT = Computed Tomography.
DL = Diagnostic Laparoscopy.
DPL = Diagnostic Peritoneal Lavage.

Figure 2-21; Reproduced from Advances in abdominal trauma, EMERGENCY MEDICINE CLINICS OF NORTH AMERICA 25 (2007).
2.2.2.13.4.3 **SPECIFIC DIAGNOSES**

The liver, spleen, and kidney are the organs predominantly involved after blunt trauma, although the relative incidence of hollow visceral perforation, lumbar spinal injuries, and uterine rupture increases with incorrect seat-belt usage. Difficulties in diagnosis may occur with injuries to the diaphragm, duodenum, pancreas, genitourinary system, or Small bowel.

2.2.2.13.4.3.1 **DIAPHRAGM INJURIES**

Blunt tears may occur in any portion of either diaphragm; however, the left hemidiaphragm is more commonly injured. The most common injury is 5 to 10 cm in length and involves the posterolateral left hemidiaphragm. Abnormalities on the initial chest x-ray include elevation or "blurring" of the hemidiaphragm, hemothorax, an abnormal gas shadow that obscures the hemidiaphragm, or the gastric tube being positioned in the chest. However, the initial chest x-ray may be normal in a small percentage of patients.

Figure 2-22; Reproduced from ICRC Sources.
2.2.2.13.4.3.2 DUODENAL INJURIES

Duodenal rupture is classically encountered in unrestrained drivers involved in frontal-impact motor vehicle collisions and patients who sustain direct blows to the abdomen, such as from bicycle handlebars. Bloody gastric aspirate or retroperitoneal air seen on a flat-plate x-ray film of the abdomen or abdominal CT should raise suspicion for this injury. An upper gastrointestinal x-ray series or double contrast CT is indicated for high-risk patients.

2.2.2.13.4.3.3 PANCREATIC INJURIES

Pancreatic injuries most often result from a direct epigastric blow that compresses the organ against the vertebral column. An early normal serum amylase level does not exclude major pancreatic trauma. Conversely, the amylase level may be elevated from nonpancreatic sources. However, persistently elevated or rising serum amylase levels should prompt further evaluation of the pancreas and other abdominal viscera. Double-contrast CT may not identify significant pancreatic trauma in the immediate post injury period (up to 8 hours); it should be repeated later if pancreatic injury is suspected. Should there be concern after equivocal results on CT, surgical exploration of the pancreas is warranted.
2.2.2.13.4.3.4 GENITOURINARY INJURIES

Direct blows to the back or flank that result in contusions, hematomas, or ecchymosis are markers of potential underlying renal injury and warrant an evaluation (CT or IVP) of the urinary tract. Additional indications for evaluating the urinary tract include gross hematuria or microscopic hematuria in patients with: (1) a penetrating abdominal wound, (2) an episode of hypotension (systolic blood pressure less than 90 mm Hg) in conjunction with blunt abdominal trauma, and (3) intraabdominal injuries associated with blunt trauma. Gross hematuria and microscopic hematuria in patients with an episode of shock indicate that they are at risk for non-renal abdominal injuries. An abdominal CT scan with IV contrast can document the presence and extent of a blunt renal injury, 95% of which can be treated nonoperatively. Thrombosis of the renal artery or disruption of the renal pedicle secondary to deceleration is a rare upper tract injury in which hematuria may be absent, although the patient may have severe abdominal pain. With either injury, IVP, CT, or renal arteriography may be useful in diagnosis.

An anterior pelvic fracture usually is present in patients with urethral injuries. Urethral disruptions are divided into those above (posterior) or below (anterior) the urogenital diaphragm. A posterior urethral injury usually occurs in patients with multisystem injuries and pelvic fractures. In contrast, an anterior urethral injury results from a straddle impact and may be an isolated injury.

Figure 2-24; Reproduced from ICRC Sources, War Surgery Seminar, Basic Principles of War Wound Management, Kabul 13-15 June 2011.
2.2.2.13.4.3.5 SMALL BOWEL INJURIES

Blunt injury to the intestines generally results from sudden deceleration with subsequent tearing near a fixed point of attachment, especially if the patient's seat belt was used incorrectly. The appearance of transverse, linear ecchymosis on the abdominal wall (seat-belt sign) or the presence of a lumbar distraction fracture (Chance fracture) on x-ray examination should alert the doctor to the possibility of intestinal injury. Although some patients have early abdominal pain and tenderness, diagnosis may be difficult in others, especially because only minimal bleeding may result from torn intestinal organs. Early ultrasound and CT are often not diagnostic for these subtle injuries, and DPL is a better choice when abdominal wall ecchymosis are present.

Figure 2-25; Reproduced from ICRC Sources.

2.2.2.13.4.3.6 SOLID ORGAN INJURIES

Injuries to the liver, spleen, and kidney that result in shock, hemodynamic instability, or evidence of continuing bleeding are indications for urgent laparotomy. Solid organ injury in patients with no hemodynamic abnormalities can often be treated nonoperatively. Such patients must be admitted to the
hospital for careful observation, and evaluation by a surgeon is essential. Concomitant hollow viscus injury occurs in less than 5% of patients initially thought to have isolated solid organ injuries.

Figure 2-26; Reproduced from ICRC Sources.

### 2.2.2.14 PELVIC FRACTURES AND ASSOCIATED INJURIES

**How do I treat patients with pelvic fractures?**

The sacrum and innominate bones (ilium, ischium, and pubis), along with many ligamentous complexes, comprise the pelvis. Fractures and ligamentous disruptions of the pelvis suggest that major forces were applied to the patient. Such injuries usually result from auto-pedestrian, motor vehicle, and motorcycle crashes. Pelvic fractures have a significant association with injuries to intraperitoneal and retroperitoneal visceral and vascular structures. The incidence of tears of the thoracic aorta also appears to be significantly increased in patients with pelvic fractures, especially anteroposterior fractures. Therefore, hypotension
may or may not be related to the pelvic fracture itself when blunt trauma is the mechanism of injury.

Patients with hemorrhagic shock and unstable pelvic fractures have four potential sources of blood loss: (1) fractured bone surfaces, (2) pelvic venous plexus, (3) pelvic arterial injury, and (4) extra pelvic sources. The pelvis should be temporarily stabilized or "closed" using an available commercial compression device or sheet to decrease bleeding. Intraabdominal sources or hemorrhage must be excluded or treated operatively. Further decisions to control ongoing pelvic bleeding include angiographic embolization, surgical stabilization, and direct surgical control.

2.2.2.4 MECHANISM OF INJURY/CATEGORIZATION

The four patterns of force leading to pelvic fractures are the following: (1) AP compression, (2) lateral compression, (3) vertical shear, and (4) complex (combination) pattern.

An AP compression injury may be caused by an auto-pedestrian collision or motorcycle crash, a direct crushing injury to the pelvis, or a fall from a height greater than 12 feet (3.6 meters). With disruption of the symphysis pubis, there often is tearing of the posterior osseous ligamentous complex (sacroiliac, sacrospinous, sacrotuberous, and fibromuscular pelvic floor) represented by a sacroiliac fracture and/or dislocation or sacral fracture.

With opening of the pelvic ring, there may be hemorrhage from the posterior pelvic venous complex and, occasionally, branches of the internal iliac artery. Figure 5-8 shows an "open book" fracture.

Lateral compression injuries often result from motor vehicle crashes and lead to internal rotation of the involved hemipelvis. This rotation drives the pubis into the lower genitourinary system, injuring the bladder and/or urethra. The pelvic volume is actually compressed in such an injury, so life-threatening hemorrhage is not common. Figure 5-7 shows a "closed" fracture.

A high-energy shear force applied in a vertical plane across the anterior and posterior aspects of the ring disrupts the sacrospinous and sacrotuberous ligaments and leads to a major pelvic instability. Figure 5-9 shows a vertical shear fracture.

In some cases of severe injury, combinations of compression and shear forces result in complex combination patterns. These injuries are associated with major bleeding.
PITFALL
Delay in stabilization of the pelvis allows continued hemorrhage.

2.2.2.14.2 ASSESSMENT

The flank, scrotum, and perianal area should be inspected quickly for blood at the urethral meatus; swelling or bruising; or laceration in the perineum, vagina, rectum, or buttocks, which is suggestive of an open pelvic fracture. Palpation of a high-riding prostate gland also is a sign of a significant pelvic fracture.

Mechanical instability of the pelvic ring can be quickly ascertained during physical examination of the pelvis. Once instability has been verified, a source of hemorrhage has been suggested; no further maneuvers to demonstrate instability are necessary. A rapidly available x-ray may avoid the pain and potential hemorrhage associated with manipulating the pelvis.

The first indication of mechanical instability is seen on inspection for leg-length discrepancy or rotational deformity (usually external) without a fracture of that extremity. Because the unstable pelvis is able to rotate externally, the pelvis can be closed by pushing on the iliac crests at the level of the anterior superior iliac spine. Motion can be felt if the iliac crests are grasped and the unstable hemipelvis is pushed inward and then outward (compression distraction maneuver). With posterior disruption, the involved hemipelvis can be pushed cephaled as well as pulled caudally. This translational motion can be felt by palpating the posterior iliac spine and tubercle while pushing or pulling the unstable hemipelvis. When appropriate, an AP x-ray film of the pelvis confirms...
the clinical examination. When time, availability, and patient condition permit, the x-ray may be used in lieu of manipulation to make the diagnosis.

2.2.2.14.3 MANAGEMENT

Simple techniques may be used to splint unstable pelvic fractures and close the increased pelvic volume prior to patient transfer and during the resuscitation with crystalloid fluids and blood. These techniques include: (1) a sheet wrapped around the pelvis as a sling, causing inter-nal rotation of the lower limbs, (2) commercially available pelvic splints, and (3) other pelvis-stabilizing devices (Figure.2-28).

Reduction of an acetabular fracture by longitudinal traction of the lower extremity also can be useful. Although definitive management of pelvic fractures varies. Since significant resources are required to care for patients with severe pelvic fractures, early consideration of transfer to a trauma center is essential.
2.2.2.14.4 CHAPTER SUMMARY

1- The three distinct regions of the abdomen are the peritoneal cavity, the retroperitoneal space, and the pelvic cavity. The pelvic cavity contains components of both the peritoneal cavity and retroperitoneal spaces.

2- Early consultation with a surgeon is necessary whenever a patient with possible intraabdominal injuries is brought to the emergency department. Once the patient's vital functions have been restored, evaluation and management vary depending on the mechanism of injury as described herein.

3- Patients with hemodynamic abnormalities and multiple blunt injuries should be rapidly assessed for intraabdominal bleeding or contamination from the gastrointestinal tract by performing a FAST or diagnostic peritoneal lavage. Patients with no hemodynamic abnormalities and no peritonitis should be evaluated by contrast-enhanced CT, with the decision to operate based on the specific organ(s) involved and the magnitude of injury.
All patients with penetrating wounds in proximity to the abdomen and associated hypotension, peritonitis, or evisceration require emergency laparotomy. Patients with gunshot wounds that obviously traverse the peritoneal cavity or visceral/vascular area of the retroperitoneum on physical or routine x-ray examination also require emergency laparotomy. Asymptomatic patients with anterior abdominal stab wounds that are shown on local wound exploration to penetrate the fascia or peritoneum are evaluated by serial physical examinations or DPL. However, laparoscopy or laparotomy remains an acceptable option. Asymptomatic patients with flank or back stab wounds that are not obviously superficial are evaluated by serial physical examinations or contrast-enhanced CT. Exploratory laparotomy is an acceptable option with these patients as well. It is safer to perform a laparotomy in patients with gunshot wounds to the flank and back.

4- Management of blunt and penetrating trauma to the abdomen and pelvis
Includes:
• Reestablishing vital functions and optimizing oxygenation and tissue perfusion.
• Prompt recognition of sources of hemorrhage with efforts at hemorrhage control (such as pelvic stabilization).
• Delineating the injury mechanism.
• Meticulous initial physical examination, repeated at regular intervals.
• Selecting special diagnostic maneuvers as needed, performed with a minimal loss of time.
• Maintaining a high index of suspicion related to occult vascular and retroperitoneal injuries.
• Early recognition for surgical intervention and prompt laparotomy.
2.2.2.15 **SELECTIVE NON OPERATIVE MANAGEMENT**

Once the need for mandatory laparotomy is ruled out, patients may be triaged to nonoperative management. These patients must be serially observed with frequent physical examination. If peritoneal signs develop, conversion to laparotomy follows. Some centers use additional diagnostic testing (as described above) to further stratify patients for nonoperative management. Numerous studies have touted this approach for management of abdominal stab wounds, showing it safely reduces rates of nontherapeutic and negative laparotomies, as well as decreasing the length of hospital stay and cost.

Now studies confirm that similar algorithms for abdominal gunshot wounds are also safe practice in centers able to perform frequent re-examination of patients and transition to laparotomy when indicated.

2.2.2.16 **SPECIAL CONSIDERATIONS**

Flank and back penetrating injury present a difficult situation, as visualization of those areas via local wound exploration, US, DPL, and laparoscopy is challenging, if not impossible. Computed tomographic scan with triple contrast has become the test of choice in hemodynamically stable patients, and may safely allow triage to nonoperative management.

There is growing evidence for nonoperative management, but these studies remain small and are only applicable at trauma centers. As most patients with these injuries have indication for mandatory laparotomy, larger more translatable studies are probably not forthcoming.

Thoracoabdominal wounds are especially difficult, as the trajectory of penetration cannot be reliably determined because of movement of the diaphragm. As noted above, if DPL is used in this group, then a lowered RBC/hpf threshold of 5000 must be used. While exploratory laparotomy has been mandatory for these types of injuries in the past, use of laparoscopy continues to gain favor. This approach reduces negative and nontherapeutic laparotomy rates previously documented.
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ANNEX 1:

**Damage control surgery**
- Arrest haemorrhage.
- Control sepsis.
- Protect from further injury.
- Nothing else.

**Damage control resuscitation**
These concepts have been combined into a new paradigm for the management of trauma patients with active haemorrhage called damage control resuscitation (DCR). The four central strategies of DCR are:
1. Anticipate and treat acute traumatic coagulopathy.
2. Permissive hypotension until haemorrhage control.
3. Limit crystalloid and colloid infusion to avoid dilutional coagulopathy.
4. Damage control surgery to control haemorrhage and preserve physiology.

Damage control resuscitation strategies have been shown to reduce mortality and morbidity in patients with exsanguinating trauma and may be applicable in other forms of acute hemorrhage.

Figure 2-29; Reproduced from ICRC Sources.
نام: رهنمود کلینیکی ترضیضات بطنی در افغانستان.

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VISION  All citizens reach their full potential in health contributing to peace, stability and sustainable development in Afghanistan.

VALUES  Equity, Integrity, Right to Health, Accountability, Trust

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The Mission Statement of the Ministry of Public Health of the Government of the Islamic Republic of Afghanistan is to prevent ill health and achieve significant reductions in mortality in line with the national targets and sustainable development goals and to reduce impoverishment due to catastrophic health expenditure. Also to be responsive to the rights of citizens through improving access and utilization of quality, equitable, affordable health and nutrition services among all communities especially mother and children in rural areas, and through changing attitudes and practices, promoting healthy lifestyles and effectively implementing other public health interventions. All in coordination and collaboration with other stakeholders within the framework of strong leadership, sustained political will and commitment, good governance, and effective and efficient management; in its continuous pursuit to become a ministerial ‘institution of excellence’

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