

## Emergency Assessment and Management of Abdominal Trauma

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### Abstract

**Introduction:** Abdominal trauma is usually classified to two distinctive type: blunt abdominal trauma (BAT) and penetrating injuries. Blunt trauma often coexists with both abdominal and extra-abdominal injuries. For penetrating trauma, experts started to distinguish between higher velocity gunshot wounds that usually occur in warfare, and lower velocity gunshot wounds and stab wounds that sustained by civilians.

**Aim of work:** This review discusses the initial management of abdominal trauma in the emergency department among adults. General management of trauma in adult, management of specific penetrating and blunt abdominal injuries will not be discussed in this review.

**Methodology:** This review is based on comprehensive search of the medical literature and database. Most recent available evidence regarding the evaluation and management of abdominal trauma is presented.

**Conclusions:** Most abdominal stab wounds occurs in the left upper quadrant of the abdomen, followed by the left lower, the right upper, and the right lower. Posterior entrance and flank penetrating wounds have a greater risk of injury to retroperitoneal structures. Blunt abdominal trauma could harm the patient in several pathophysiologic mechanisms including sudden and marked increase in intra-abdominal pressure, compress abdominal viscera against the posterior bony structures, and the shearing forces created by sudden deceleration. Plain radiographs have limited benefits in the assessment of abdominal stab wounds and almost no role in the evaluation of blunt abdominal trauma. Extended Focused Abdominal Sonography for Trauma (eFAST) has a high specificity to detect signs of internal injury from a stab wound, but limited sensitivity. MDCT has a very high sensitivity and specificity to delineate visceral injury.

**Keywords:** Abdominal Trauma; Blunt Trauma; Penetrating Trauma; Evaluation; and Management

### Introduction

Abdominal trauma is a frequent encounter in the emergency department (ED). It is usually classified to two distinctive type: blunt abdominal trauma (BAT) and penetrating injuries. Blunt abdominal trauma may be difficult to diagnose usually due to the lack of adequate history, the presence of distracting injuries, and/or altered mental status. In addition, blunt trauma often coexists with both abdominal and extra-abdominal injuries, rendering the case more difficult to manage.

Historically, nearly all penetrating trauma to the abdomen was managed nonoperatively until the 20<sup>th</sup> century. During the World War I, surgeons observed that management with laparotomy reduced the mortality among soldiers with penetrating abdominal injuries. As a result, the standard management of penetrating wounds included laparotomy for more than 50 years. Later, experts started to distinguish between higher velocity gunshot wounds that usually occur in warfare, and lower velocity gunshot wounds and stab wounds that sustained by civilians [1]. This differentiation led to steady decrease in laparotomy rates for abdominal stab wounds over the ensuing decades [2].

This review discusses the initial management of abdominal trauma in the emergency department among adults. General management of trauma in adult, management of specific penetrating and blunt abdominal injuries will not be discussed in this review.

### Methodology

We conducted a thorough systematic search on scientific database including PubMed search engine and Google Scholar for all studies discussing evaluation and management of abdominal trauma in adults. All relevant available full articles between 2000 and June 2020 were reviewed and included. The terms used in the search were: Abdominal trauma, blunt trauma and penetrating trauma, evaluation, and management.

### Epidemiology

The incidence of different mechanism of abdominal injuries varies according to geographic regions. However, data frequently show that blunt abdominal trauma is more common than abdominal stab wounds, and that abdominal stab wounds are more common than abdominal gunshot wounds in the general population [3]. Penetrating trauma caused by high velocity gunshots are associated with eight folds increase in mortality rates than injuries caused by penetrating stab wounds [4]. Hollow viscus organs as intestines are more commonly injured with abdominal stab wounds [3]. The next most common injured organs are the great vessels, diaphragm, mesentery, spleen, liver, kidney, pancreas, gallbladder, and adrenal glands. However, this depends mostly upon the site and the mechanism of penetrating wound.

About 80 percent of abdominal trauma seen in the ED are caused by the mechanism of blunt trauma [5]. Hence, they are responsible of substantial morbidity and mortality. Three-quarter of BAT are due to road traffic accidents (RTA) [6]. About 13 percent of patient presenting to ER with BAT have intra-abdominal injury [5]. Unlike penetrating wounds, solid organs such as spleen and liver are the most commonly injured in BAT [7]. Injuries to the pancreas, hollow organs as bowel and bladder, mesentery, and diaphragm, as well as retroperitoneal structures as kidneys and abdominal aorta, are less common. However, they must be considered and checked.

### Mechanism of injury

Any sharp or pointed instrument that could be impaled may inflict a stab wound. Typically these are narrow, sharp, knife-like implements, but items that can inflict stab wounds range from scissors to coat hangers to animal horns. The impaled instrument can injure any tissue it traverses; from skin to bone and all organs in between. One analysis shows that most abdominal stab wounds occurs in the left upper quadrant of the abdomen, followed by the left lower, the right upper, and the right lower [8]. Posterior entrance and flank penetrat-

ing wounds have a greater risk of injury to retroperitoneal structures, including the kidney, colon, and adrenals. Eighteen to 34 of patients presenting with stab wound have Multiple stabs, and as many as 30 percent of penetrating chest injuries may traverse the diaphragm, potentially causing abdominal injuries [9]. Consequently, in addition to chest injuries, anterior stab wounds that are lower than the nipple line (fourth intercostal space) and posterior stab wounds that are lower than the tip of the scapula (seventh intercostal space) should be considered to possibly include diaphragm and intra-abdominal structures.

Blunt abdominal trauma could harm the patient in several pathophysiologic mechanisms [7]. A sudden and marked increase in intra-abdominal pressure created by outward forces can rupture a hollow viscus. A lap-belt wearing without a shoulder attachment can cause injury by this mechanism when the belt forcefully compresses the abdomen. Blunt forces exerted against the anterior abdominal wall can compress abdominal viscera against the posterior bony structures, leading to tissue crushing. Spleen and liver and other solid organs are particularly susceptible to laceration or fracture by this mechanism. In general, older adults and alcoholic patients have lax abdominal walls and are more likely to suffer such incidents.

Both solid and hollow organs could be lacerated at their points of attachment to the peritoneum by the shearing forces created by sudden deceleration. Sudden deceleration may also affect blood vessel in the form of tears at vascular pedicles or stretch injuries to the intima and media layer of arteries, resulting in ischemia. The kidney is particularly susceptible to stretch injury.

### Diagnosis

#### Initial assessment

Patient presenting with stab wound should be undressed to avoid missing a wound that could be secured by clothing, bleeding, or body habitus. Stab wounds can also be hidden in the axilla, scalp, perineum, or groin. Careful examination should be insured for evidence of more than one stab wound. It is worth emphasizing that the most critical wound may not be from the most obvious or immediately apparent injury. In addition, laceration apparent-to-be from blunt trauma may represent penetrating trauma associated with significant internal injury.

The choice of assessment and management of patient with penetrating abdominal wound largely depends on their clinical presentation. Deteriorated patients may need emergency thoracotomy and laparotomy to control hemorrhage or manage other injuries. Indication of emergency laparotomy typically include hemodynamic instability, peritonitis, impalement or evisceration, or frank blood from a nasogastric tube or on rectal examination. If there is no apparent indication for immediate laparotomy, physical examination is both sensitive and specific for detecting significant intra-abdominal injury. In one observational study involving 249 patients with abdominal stab wound, physical examination had 100 percent sensitivity and 98.7 percent specificity for detecting intra-abdominal injury requiring laparotomy.<sup>10</sup> Other evaluation techniques for patients without apparent indications for laparotomy include local wound exploration (LWE), plain radiography, computed tomography (CT), ultrasonography, and diagnostic peritoneal lavage (DPL).

#### Local wound exploration

The abdominal wall is entirely encased in a layer of fascia. Clinician should insure whether the stab wound in asymptomatic patients have violated the peritoneum. Local wound exploration (LWE) is safely performed at the bedside and allows evaluation the depth and tract of stab wounds [11]. Adequate LWE requires patients' sedation and local anesthesia, sterile technique, good lighting, and sharp and blunt dissection until the bottom of the wound is clearly visualized. The procedure is best undertaken by two individuals. Patient with anterior stab wounds that does not violate the anterior rectus fascia as demonstrated by LWE may be discharged after appropriate wound care [11]. Local wound exploration of anterior stab wound has a sensitivity and specificity as high as 100 percent [12]. However, the ac-

curacy of LWE is compromised by obesity, heavy muscle, or the presence of multiple wounds or other injuries. [13]. If the anterior fascia is not obviously seen, peritoneal injury should not be ruled out; further evaluation is required.

### Imaging

#### Plain radiographs

Plain radiographs have limited benefits in the assessment of abdominal stab wounds. However, the presence of free intraperitoneal air on an upright chest or lateral decubitus radiograph support peritoneal cavity violation; this does not mean sure hollow viscus injury. Thus, plain radiographs lack sensitivity and specificity for significant injuries and are rarely employed in this setting. As exception, plain radiograph could be reliable to look for foreign bodies in cases of impalement where the foreign object or part of it remains in the patient. For patient presenting with BAT, plain radiographs of the abdomen almost have no role and are not routinely obtained. However, some clinical scenario may benefit from plain radiograph as coexistence of blunt chest trauma to check the presence of rib fracture and/or diaphragmatic hernia.

#### Computed tomography

Multidetector computed tomography (MDCT) is a noninvasive techniques that is rapidly performed. MDCT aids clinicians to precisely delineate visceral injury [9]. This modality carries ninety-seven and ninety-eight percent sensitivity and specificity for detecting peritoneal violation respectively; according to a systematic review and observational studies [9]. For detecting intra-abdominal injuries requiring emergency operation, MDCT has a sensitivity of 94 percent and specificity of 95 percent [14]. MDCT has replaced the traditional method that involve triple contrast for anterior penetrating wound, however, Rectal contrast may be needed to assess possible retroperitoneal injury from back or flank wounds [10]. Diaphragmatic or bowel injury should not be ruled out by a negative initial CT scan if there is a high likelihood; further testing, or observation and serial examinations, should be performed as these injuries are the ones most frequently missed [15]. Recent systematic review concluded that patients with anterior abdominal stab wounds and negative initial CT of the abdomen and pelvis was inadequate to exclude surgically significant injury and safely discharge patients. Additional diagnostic studies or a period of observation with serial physical examinations is required for adequate management [16]. In comparison, magnetic resonance imaging (MRI) has greater sensitivity and is particularly useful in evaluating the stable pregnant [17]. In patient with BAT, MDCT has become the primary method for identifying significant intra-abdominal injuries. Negative MDCT in patients with BAT is shown to rarely miss intra-abdominal injuries in these patients (< 0.06 percent) [18]. However, MDCT remains largely restricted to hemodynamically stable patients. Another drawback is that multidetector CT has significant radiation exposure and expense, clinicians should be selective about which BAT patients most likely to benefit from MDCT. Most patients with blunt abdominal trauma will have injury necessitating surgical intervention. Hence, many CT studies are unnecessary [19]. One study has estimated that the percent of patients with BAT and intra-abdominal injuries that necessitate surgery were less than 5 percent [20]. Furthermore, low-risk mechanisms of blunt injury as fall from standing, seated position, or from bed, with normal physical examination has a very low likelihood of positive findings on CT [21].

#### Sonography

Extended Focused Abdominal Sonography for Trauma (eFAST) examination is a bedside study that frequently used to determine the presence of intra-abdominal or thoracic fluids as hemopericardium, hemoperitoneum, or hemothorax as well as pneumothorax. The examination focuses on dependent intraperitoneal sites where blood is most likely to accumulate. It is suggested that the specificity of the FAST to detect signs of internal injury from a stab wound appears high, but sensitivity is limited. Thus, it is useful to diagnose the presence, but not exclude, of internal injuries. The major benefits of eFAST examination is in the initial assessment of hemodynamically unstable patient with a low chest or upper abdominal stab wound because it is able to rapid identification and direction of management. Unstable patients with hemoperitoneum and no sign of hemopericardium or another immediately treatable cause of hypotension should

proceed to immediate laparotomy. If the patient is hemodynamically stable and has a positive eFAST, further diagnostic modalities as CT or diagnostic laparoscopy can identify specific injuries and effectively guide management. Again, negative eFAST should not rule out the possibility of serious injury and further diagnostic measure is essential. The use of US in penetrating abdominal trauma continue to evolve. Although not being routinely used to diagnose peritoneal penetration, a small preliminary study reported excellent specificity of US to assess fascial violation deep to the stab wound; however, this does not apply on sensitivity [22]. In the setting of blunt abdominal trauma, ultrasound have many limitations including inadequacy for detecting solid parenchyma, the retroperitoneum, or the diaphragm. In addition, the quality of US is largely compromised in obesity, bowel gas, subcutaneous air, and uncooperative patients. Extended FAST does not appear to improve diagnostic ability following negative CT [23], cannot distinguish blood from ascites or urine, cannot detect subcapsular injuries, and insensitive for detecting bowel injury.

### Treatment

#### Management of penetrating wounds

Patient with abdominal trauma regardless of the type should be initially evaluated and resuscitated according to the protocols from Advanced Trauma Life Support (ATLS). After necessary resuscitation, patient with abdominal trauma and hemodynamic instability, peritonitis, impalement or evisceration, or frank blood from a nasogastric tube or on rectal examination should undergo emergency laparotomy [24]. The first treatment decision of the remaining patients is whether there is a breach of the peritoneum or retroperitoneum. For anterior abdominal stab wounds, the main decision point is peritoneal penetration. Local wound exploration (LWE) may sometimes establish this, but when appropriate, advanced imaging studies are sensitive and specific. Peritoneal violation is sure with omental or visceral evisceration, and most experts agree that this warrants laparotomy due to the high risk of gastrointestinal perforation [24,25]. Stab wound in the flank or the back carries a risk of retroperitoneal as well as peritoneal penetration. Similarly, lower stab wound in the lower anterior thorax may cause peritoneal violation; retroperitoneum injury may occur with lower posterior chest wounds. These wounds are considered complex and serious and warrant careful evaluation that may include CT imaging and repeated observation and examination even in hemodynamically stable patients. Signs of upper or lower gastrointestinal hemorrhage (as hematemesis, hematochezia) suggest gastroduodenal or colorectal injury and generally warrant laparotomy without further investigation by imaging study. Additionally, patient presenting with penetrating tool in situ ordinarily needs surgical intervention, even if he is stable. This is because the risk of implement being inside an intraperitoneal vessel and its removal would lead to substantial hemorrhage. The exception is in a high risk surgical candidates and pregnant patients, an attempt for implement removal could be done without general anesthesia, but in the operating room should they deteriorated.

Fifty to seventy percent of patients with penetrating abdominal wound have peritoneal violation. However, only half of those with peritoneal violation sustain an intra-abdominal injury requiring operative intervention [25]. Thus, about 25 percent of all patients with stab wound would require surgery. In most major trauma centers, local wound exploration (LWE) is performed to determine peritoneal penetration for anterior abdominal stab wounds. If no violation of the anterior rectus fascia is seen, safely discharge of the patient after local wound care could be done, assuming there are no other injuries of concern. In resource-limited centers without extensive experience with abdominal stab wounds, the alternative tests to evaluate for peritoneal penetration are diagnostic peritoneal lavage or CT scanning. Negative results require at least another 12 hours of observation because of the risk of missing a gastrointestinal perforation.

Broad spectrum antibiotics are prescribed to patients with penetrating abdominal injury requiring surgical management; however, antibiotics are not warranted in wounded patients who are undergoing non-operative management.

#### Management of blunt abdominal trauma

Patients with blunt abdominal trauma (BAT) require expeditious evaluation to determine the need for operative care. The need for laparotomy is determined by using some combination of physical examination, ultrasound (US), computed tomography (CT), and diag-

nostic peritoneal tap and/or lavage (DPT/DPL). In some cases, such as patients with a severe pelvic fracture, angiography may be necessary to control hemorrhage and stabilize the patient [26]. Unstable patient with BAT should be evaluated to determine the presence or absence of intraperitoneal hemorrhage. Immediate trauma surgery consultation is required and eFAST exam should be performed on all hemodynamically unstable BAT patients as part of their initial evaluation. Unstable patients with a positive FAST finding should typically be transferred directly to the operating room for emergent laparotomy. If the FAST exam is inconclusive or unavailable and the patient is unstable, the surgeon must decide whether suspicion for intra-abdominal injury is sufficiently high to warrant emergent laparotomy. Diagnostic peritoneal lavage (DPL) could be used in that case to identify signs of intra-abdominal injury. If BAT patient is stabilized or can be resuscitated adequately, experts recommend CT search for intra-abdominal injuries. If all these evaluation modalities cannot be performed, aspiration of 10 mL of gross blood by DPL or DPT confirms the presence of a significant intra-abdominal wound that warrants emergent laparotomy. Resuscitative endovascular balloon occlusion of the aorta (REBOA) can be used to control bleeding setting of management of some unstable BAT patients. REBOA is promising methods that could be performed at the bedside. However, some reports claimed its association with higher mortality, morbidity, and lower extremity amputation [27]. Further data are needed to conclude the benefit and harm of this approach.

### Risk stratification

Patient with blunt abdominal trauma and in stable hemodynamic condition should be assessed for the risk of significant intra-abdominal injuries. The selected approach of assessment will vary depending upon many factors to fit clinical scenario. These factors include patient's age and comorbidities, mechanism of injury, examination findings, and hospital resources.

Patients considered as at low-risk by clinical presentation, vital signs, and laboratory tests, could be observed for a nine-hour. During the observation clinician should take serial vital signs measures and abdominal examinations. Generally, this approach is sufficient to identify patients with occult intra-abdominal injury [28]. High risk examination findings include hypotension, peritoneal signs as abdominal guarding and rebound tenderness, abdominal distension, and seatbelt sign. Ultrasound may be incorporated during the assessment period, although the benefit it adds to the diagnosis of intra-abdominal injury in low-risk patients remains unclear.

If the patient is considered at low-risk at presentation but the laboratory findings suggest the possibility of intra-abdominal injury, CT imaging is the preferred method for further evaluation. Suggestive laboratory includes hematocrit < 30 percent, high AST or ALT (> 130 units/L), and microscopic hematuria > 25 red blood cells [RBCs] per high power field. If the CT results are negative, a similar nine-hour period of observation is adequate for safe discharge. During the observation, persistence of pain and tenderness in the serial examinations performed 30 minutes apart should warrant admission for longer observation or even surgical consultation. There is controversy about the benefit of routine whole-body CT compared with selective site imaging for better outcomes among high-risk patients with blunt abdominal trauma.

### Conclusion

Most abdominal stab wounds occur in the left upper quadrant of the abdomen, followed by the left lower, the right upper, and the right lower. Posterior entrance and flank penetrating wounds have a greater risk of injury to retroperitoneal structures. Blunt abdominal trauma could harm the patient in several pathophysiologic mechanisms including sudden and marked increase in intra-abdominal pressure, compress abdominal viscera against the posterior bony structures, and the shearing forces created by sudden deceleration.

Local wound exploration (LWE) is safely performed at the bedside and allows evaluation of the depth and tract of stab wound. Adequate LWE requires patients' sedation and local anesthesia, sterile technique, good lighting, and sharp and blunt dissection until the bottom of the wound is clearly visualized. Plain radiographs have limited benefits in the assessment of abdominal stab wounds and almost no role in the evaluation of blunt abdominal trauma. Extended Focused Abdominal Sonography for Trauma (eFAST) has a high specificity to



detect signs of internal injury from a stab wound, but limited sensitivity. Multidetector computed tomography (MDCT) is a noninvasive techniques that is rapidly performed. MDCT has a very high sensitivity and specificity to delineate visceral injury.

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