REVIEW ARTICLE

Imaging in trauma in limited-resource settings: A literature review

Jessica K. Willett

San Joaquin General Hospital, 500 W. Hospital Road, French Camp, CA 95204, USA

A R T I C L E   I N F O

A B S T R A C T

Introduction: Trauma is a leading health problem and cause of death throughout both the developed and the developing world. In Africa and South Africa in particular, trauma-related injury has an increased morbidity and mortality when compared to the rest of the world, with numbers approaching a staggering two to six times the global average. Rapid diagnosis is key when it comes to identification and treatment of traumatic injuries. In locations that are limited in finances, infrastructure, and resources, a stepwise approach to imaging in trauma can lead to decreased morbidity and mortality. Tailored recommendations for imaging trauma in resource-limited settings can lead to improved diagnostics and treatment and in turn, decrease mortality.

Methods: A systematic literature review was conducted, using a compilation of English-language articles found on PubMed, EMBASE, Medline, and Cochrane Library searches relevant to imaging in trauma. A total of 31 journals articles, published from 1991 to 2017 were reviewed.

Results: From the search, 26 original articles were selected and reviewed in detail, as well as an additional five original research articles.

Discussion: As imaging continues to evolve, its importance in the role of diagnostic algorithms in trauma settings is important. In most settings, imaging is relied upon as an adjunct to the primary survey. In most developed settings, CT scan remains the mainstay for imaging in trauma, but in limited-resource settings, other imaging studies such as LODOX, X-ray, and especially ultrasound can play a large role. As ultrasound is directly related to user operation, data are limited and variable; more research as this field evolves will be beneficial.

African relevance

- The prevalence of trauma in Africa is one of the highest worldwide.
- The majority of Africa falls into the category of a limited-resource environment.
- Adjustments to trauma imaging algorithms are needed for limited-resource settings.

Introduction

Trauma, worldwide, is a public health problem. Globally, it is one of the highest contributing causes to mortality, with approximately 5.8 million deaths worldwide each year [19]. In perspective, this amounts to more than one-third of the deaths that occur from malaria, tuberculosis and HIV/AIDS combined [19]. Considering that these deaths are only a fraction of the number of traumatic incidents that occur, trauma and its sequelae play large roles in the burden on healthcare systems within societies. Likewise, rapid diagnosis and treatment of traumatic injuries plays an important role in trauma systems. One of the largest contributors to the diagnosis of injuries in a

trauma setting is imaging [19]. Reviewing available imaging in trauma and associating this with current practices in low- and middle-income countries may allow us to more accurately diagnose and treat traumatic injuries.

Methods

A literature review and meta-analysis of published research articles was performed to evaluate current imaging options and recommendations in trauma. Articles published in the English language up to December 2017 were searched in Medline, EMBASE, PubMed, and the Cochrane Library. Our initial search was broad and included the following words: ("trauma" or "ultrasound" or "CT scan" or "penetrating" or "blunt" or "imaging". A large number of articles were published; thus, three separate searches were performed during the entire review process. Bibliographies of the initially chosen articles and the previous meta-analyses were also subjected to a secondary hand search and relevant articles were extracted. No institutional review board approval or consents were needed for this review, as it evaluated published studies without individually identifiable human-subject information.

The inclusion criteria used to select articles were as follows: (a) Original articles that discussed imaging in the setting of trauma; (b) Avoided studies or articles that were not founded on evidence; (c) Met quality standards, as assessed by the 14-item Quality Assessment of Diagnostic Accuracy Studies (QUADAS2) tool.

From the original potential group of articles, 26 were selected for a detailed review. Five additional articles were then hand extracted from bibliographic data and reviewed for further analysis.

Discussion

Thoracic blunt trauma

Blunt trauma encompasses the majority of traumatic injuries to the thorax [9]. In blunt traumatic injury to the chest, over one third of injuries involve the lung itself, most commonly seen in the setting of motor vehicle and motorcycle crashes [2]. The mortality of patients who suffer injuries from blunt chest trauma can be up to 25% [5]. Imaging remains one of the most important diagnostic tools for early detection of these potentially life-threatening injuries.

There is no question that computed tomography (CT) is one of the most effective diagnostic tools in evaluating trauma. Chest radiographs often underestimate the extent of chest trauma and, on occasion, fail to identify injury [5]. Due to its increased sensitivity, CT may be helpful in identifying these injuries that are missed on the initial chest X-ray (CXR). Despite CT's superior diagnostic capabilities in identifying pulmonary, pleural, and osseous abnormalities, its routine use in the initial evaluation of blunt thoracic injury has been controversial. The controversy lies in the fact that, in the absence of CXR findings, chest CT scanning frequently identifies abnormalities with limited clinical significance while exposing the patient to significant doses of radiation [5]. Thus, although more sensitive, CT of the thorax has played a limited role in the initial emergent evaluation of victims of blunt torso trauma [1]. Additionally, advanced imaging including CT scan is typically a privilege of the developed world and may not be available in many locations with a high prevalence of traumatic injuries. Thus, available imaging studies must be correlated with comprehensive clinical exams to evaluate traumatic injury.

Pulmonary contusions, the most common pleural injury in blunt chest trauma, are typically seen on CXR within the first six hours after an injury, but findings may take 24–48 h to peak in consolidation [2,5]. During this time, inflammatory markers and blood fill the air spaces, as alveolar and capillary permeability increases, leading to worsening interstitial oedema and infiltrates. Oedema and haemorrhage in the lung parenchyma become visible on imaging as it progressively accumulates. This lung consolidation can lead to increased vascular pressures and ventilation/perfusion mismatch, leading to clinical symptoms of respiratory distress and a predisposition to pneumonia and acute respiratory distress syndrome (ARDS) [2]. In fact, contusion volume has been found to be directly related to the development of ARDS [6].

When a pulmonary contusion is apparent on CXR, it suggests that the trauma to the chest was severe. By this logic then, a CT scan may identify other injuries [2]. Time can play a role in the appearance of pulmonary contusions on CXR and in one study, "using a canine model, Schild and colleagues found that 38% of anaesthetised dogs that sustained blunt chest trauma demonstrated a pulmonary contusion on chest radiograph, compared with 100% on CT" [5].

In some studies [1], CT was proven to be more accurate in diagnosis of pleural effusions and small pulmonary parenchymal lesions. However, in some comparisons of CT to CXR in the role of blunt thoracic injury [1], it was suggested that the clinical significance of pulmonary contusions seen on CT and not identified on CXR was minimal, and did not alter clinical treatment of the patient. Thus, CXR combined with physical exam and clinical correlation may be adequate in many settings, assuming the patient is haemodynamically stable.

Encouraging for limited-resource settings is the use of ultrasound in

blunt thoracic trauma for detection of pulmonary contusions. Ultrasonography is increasingly accurate for the diagnosis of interstitial oedema, presenting an opportunity for diagnosis of pulmonary contusions before their appearance on CXR. In some studies [2], ultrasound showed high sensitivity and specificity for detecting alveo-interstitial syndrome compared to chest CT. Thoracic ultrasound, of course, is operator dependent and focused and supervised training is needed to ensure proper interpretation of the sonographic findings. However, in the absence of CT scan, serial exams with respiratory monitoring along with repeated thoracic ultrasound could predict clinical deterioration due to pulmonary contusion.

Another common blunt trauma injury is pneumothorax, which can quickly become life-threatening. Pneumothoraces are found in one-fifth of major blunt trauma victims and can lead to serious sequelae in blunt trauma victims unless diagnosed and treated promptly [5]. The diagnosis is made clinically or radiologically, with X-ray as the gold standard, however "the reliability of the supine anteroposterior chest radiograph is not absolute and misdiagnosis may occur in up to 30% of all pneumothoraces" [3,4]. An upright CXR is the most sensitive for diagnosis of pneumothorax. In a supine patient, pneumothorax is most commonly seen as an accumulation of air at the anteroinferior aspect of the lung, "potentially producing basal hyperlucency, a deepened lateral costophrenic sulcus, or a double-diaphragm appearance" [8].

The sensitivity of ultrasound in the diagnosis of pneumothorax is high and may allow detection even in the setting of a normal chest radiograph. On ultrasound imaging, respiratory movement is observed as a sliding movement of the interface between the lung surface and the chest wall. The disappearance of this movement is noted in the instance of pneumothorax. Typical artifacts that can appear similar to pleural sliding on ultrasound include "comet-tails, which are reverberation artifacts, and the seashore sign, which is caused by the moving thoracic cavity against the static lung" [4]. However, it is important to note that other underlying medical conditions including emphysema, subcutaneous air, or prior lobectomy or decortication can also obscure lung sliding on ultrasound, leading to delayed or missed diagnosis [4].

Due to the high negative predictive value of ultrasound in detection of pneumothorax, further imaging studies can often be avoided if normal lung sliding is identified [3]. Some studies comparing imaging for detection of pneumothoraces in the setting of trauma demonstrate that CT is able to detect pneumothoraces missed by both ultrasound and CXR, however "all patients requiring a thoracostomy tube based on clinical and CXR findings were detected by ultrasound" [4]. It can be inferred then that the combination of sonography with comprehensive clinical exam and laboratory studies may be adequate in most stable patients with blunt chest trauma (Fig. 1).

Haemothorax on radiographs is dependent on the amount of blood that has collected in the pleural space. Because haemothorax of some extent is present in almost half of all major trauma patients [8], this is an important diagnosis. Although 5 mL of fluid can be identified on a decubitus radiograph, greater than 200 mL is needed to be visualised on an upright film, with blunting of the costophrenic angle [5]. As with pneumothoraces, even small haemothoraces can be detected with CT scan; there is growing evidence that ultrasound again has a role in detection of abnormal lung findings that may lead to avoidance of advanced imaging. On pleural ultrasound, fluid appears as "B lines" in the pleural space or as a solid fluid collection if large enough. Compared to CT scan, ultrasound may be limited in diagnostic capabilities, but when compared to CXR, ultrasound is at least as specific when diagnosing haemothorax and has the added advantage of often leading to a quicker diagnosis.

Cardiac blunt trauma

Although the heart is more susceptible to injury from penetrating trauma, blunt trauma can cause cardiac contusion or tamponade. Contusion is not typically diagnosed on imaging, however laboratory
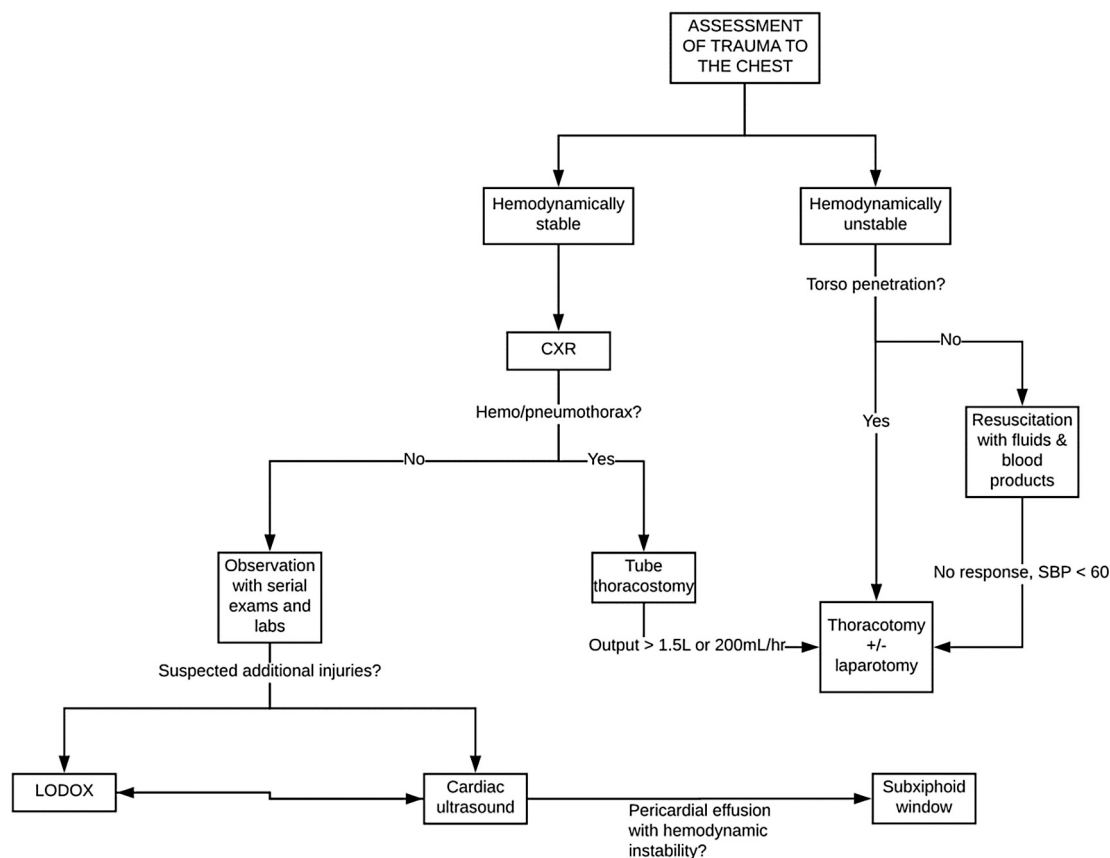
Fig. 1. A proposed algorithm for chest trauma in limited-resource settings. *Note.* CXR, chest X-ray; SBP, systolic blood pressure.

studies combined with an electrocardiogram (EKG) are helpful diagnostic studies. Pericardial tamponade has classic findings on radiograph of an enlarged cardiac silhouette which can be confirmed with ultrasound. If vascular damage is suspected, CT scan with contrast or angiography is needed for further evaluation; however, if unavailable, there should be a low threshold for surgical exploration or intervention.

Abdominal and pelvic blunt trauma

As with most other modalities of trauma, prompt diagnosis is important in the setting of blunt trauma to the abdomen and pelvis. Clinical signs of intra-abdominal injury can often be masked by additional injuries especially in the setting of major trauma [14]. Historically, diagnostic peritoneal lavage was used to evaluate for intra-abdominal bleeding, which has now given way for the most part to a focused assessment with sonography for trauma (FAST) exam due to the rate of unnecessary exploratory laparotomies associated with positive diagnostic peritoneal lavages [12,14]. A positive FAST exam suggests intraperitoneal bleeding and, if haemodynamically unstable, patients typically undergo emergent surgical intervention. The most commonly injured organs in blunt abdominal trauma are the liver and the spleen [14,15], however in the setting of severe trauma, intrathoracic injury should also be considered. Intra-abdominal injury should be suspected in patients with rising serum amylase, haematuria, or associated lumbar or pelvic fractures [14].

CT scan, if the patient is haemodynamically stable, allows greater evaluation of the extent of injury prior to determination of the treatment plan [12]. However, if CT scan is unavailable in the setting of blunt abdominal trauma, serial exams combined with evaluation of serum amylase and venous blood gas, as well as adjuncts such as nasogastric or urinary catheters, may be able to predict deterioration due to intra-abdominal injury. In the setting of non-reassuring laboratory

values and haemodynamic instability, there is typically a low threshold for exploratory laparotomy or laparoscopy (Figs. 2 and 3).

Bony pelvic trauma is typically associated with vascular injury to branches of the internal iliac arteries. Embolisation is becoming a viable treatment option in many places and with initial evaluation by CT angiogram, arterial injuries can be differentiated from venous injuries that may otherwise be managed conservatively [12,20]. However, in many locations where these treatment options are not viable, a low threshold should be maintained for operative exploration and management. In patients with obvious pelvic trauma and haemodynamic instability, pre-peritoneal packing is typically done, sometimes combined with laparotomy for retroperitoneal exploration for further injury evaluation and bleeding control. Additionally, unstable patients with pelvic trauma, who have had tension pneumothorax and cardiac tamponade diagnostically excluded may benefit from placement of a Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA). This can be positioned at varying levels of the aorta depending on the level of severe injury, and allow for time to resuscitate with blood products and stabilise the patient for repair [20].

Spinal blunt trauma

Traumatic injury to the spine, especially the cervical spine, can be significant and with great consequence. Based on the National Emergency X-Radiography Utilization Study (NEXUS) [16] and Canadian Cervical Spine Rule [16], clinical exam can be used to rule out injury, however studies have shown that these are nonspecific and missed injuries exist [16]. Patients with altered mental status are especially at increased risk for missed injury. X-rays or LODOX/Statscan hold the advantage of not requiring additional patient transfers, permitting access to ongoing treatment while images are obtained. However, despite these advantages in acute emergency, both modalities are
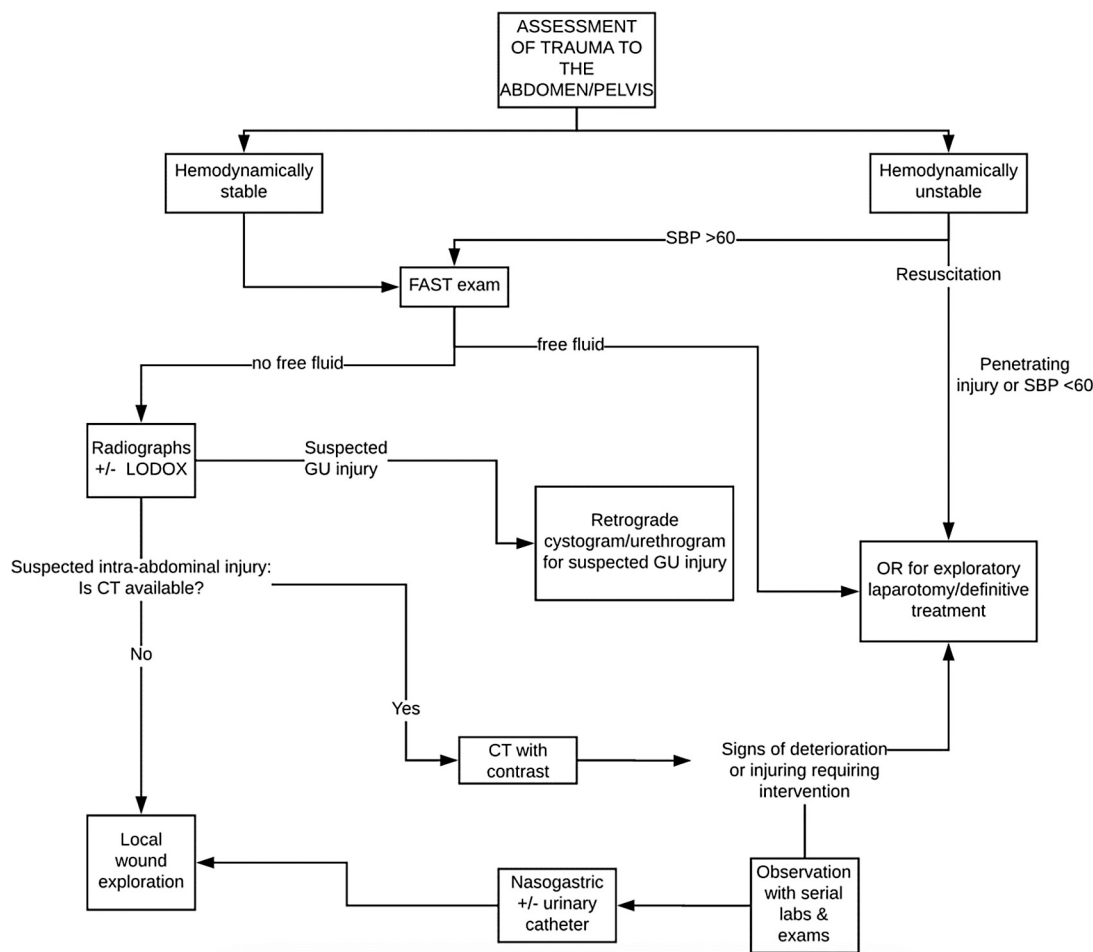
Fig. 2. A proposed algorithm for abdominal trauma in limited-resource settings. *Note.* FAST, focused assessment with sonography for trauma; CT, computed tomography; GU, genitourinary; SBP, systolic blood pressure; OR, operating room/theatre/surgery.
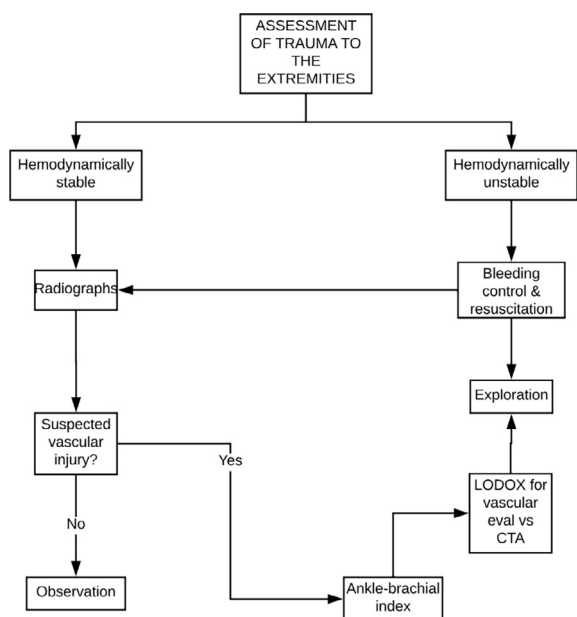

Fig. 3. A proposed algorithm for extremity trauma in limited-resource settings. *Note.* CTA, computed tomography angiogram.

still less effective than CT scan for excluding cervical spine injuries. Therefore, CT scan is still the most commonly used tool to diagnose or rule out fracture. In the absence of CT scan, cervical spine stabilisation can be maintained while ongoing treatment is rendered with a plan to obtain additional imaging once the patient is stabilised.

If ligamentous injury is still suspected after CT scan, MRI can be beneficial, but this is extremely limited by location and available resources. Additionally, some studies have shown that patients with normal CT findings without significant neurologic deficits who undergo MRI do not have any additional benefit that would contribute to their ultimate management and outcome [16]. Therefore, as most ligamentous injuries are seen in conjunction with cervical spine fracture, radiographic studies focusing primarily on fracture identification with clinical exam are appropriate in the setting of trauma in limited-resource settings.

Markers for high energy trauma should be identified when possible to determine risk stratification for operative intervention. Fractures of the first through third ribs are seen in high velocity trauma "because they are mostly protected by the clavicle, scapula, and upper chest wall musculature" [7]. Additionally, fractures of the lower ribs, generally the eighth to eleventh, are more likely to have associated liver or splenic injuries [5]. Sternal fractures are also seen in high-impact injuries to the anterior chest and, although they can be detected on lateral chest radiographs, these are uncommonly done in the initial trauma assessment.

Other markers for high energy trauma are sterno-clavicular dislocation and scapular fractures, which are often found on CT scan and commonly associated with other underlying injuries. Posterior sterno-
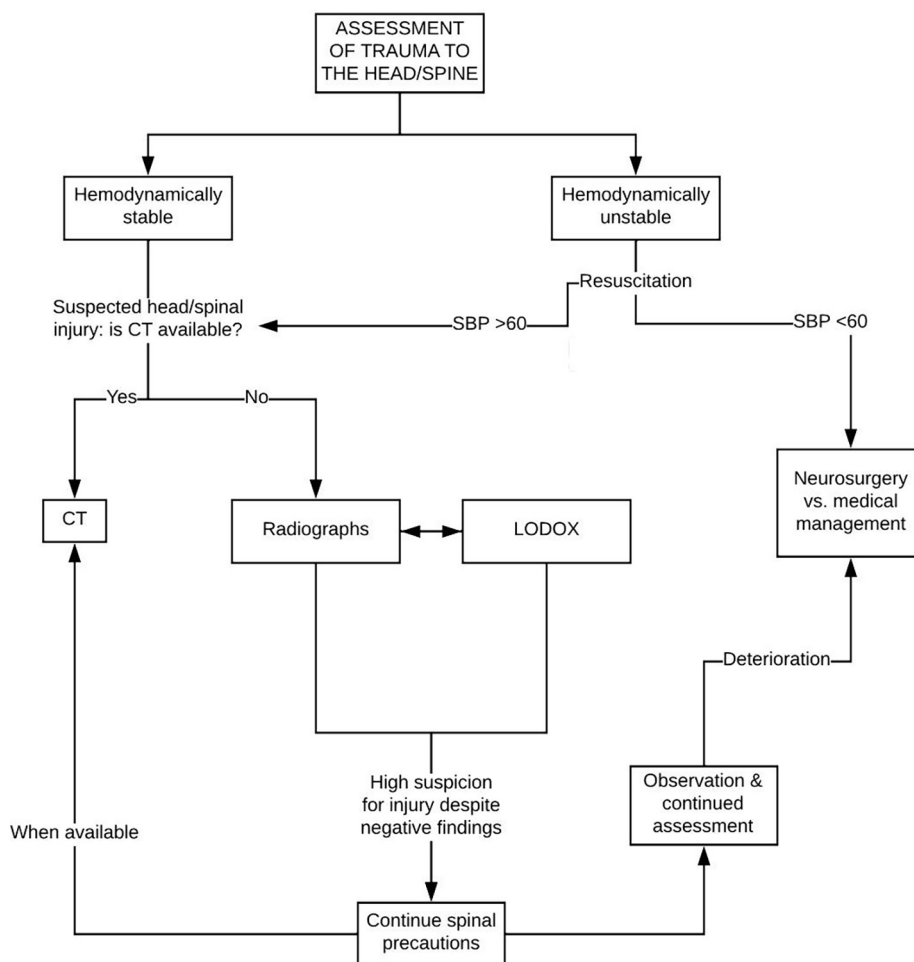
Fig. 4. A proposed algorithm for head/spinal trauma in limited-resource settings. *Note.* CT, computed tomography; SBP, systolic blood pressure.

clavicular dislocation in particular, presents an increased risk for damage to the great vessels, aorta, and oesophagus and thus, in the setting of haemodynamic instability and absence of additional imaging, a low threshold should be maintained for operative exploration and intervention.

Brain: In traumatic head injury, CT scan is the first-line imaging technique for evaluation and is typically done without contrast enhancement. CT demonstrates bony trauma as well as extra-axial injuries and parenchymal damage. Although CT is still gold standard for skull fracture detection and subarachnoid haemorrhage, X-rays or LODOX/Statscan imaging can be beneficial in identification of skull or facial fractures. Combined with serial exams, even basic imaging can be useful in identifying patients who may need urgent operative treatment or evaluation by a neurosurgeon where available (Fig. 4).

Thoracic penetrating trauma

Although blunt trauma accounts for the majority of traumatic injuries, penetrating trauma is also a significant cause of morbidity and mortality. The statistical data on stab and puncture wounds and gunshot wounds isn't as concrete as blunt trauma, however gunshot wounds are currently considered the "second leading cause of death after motor vehicle crashes" [9]. Due to the high-velocity nature of gunshot wounds, mortality-rate is higher, as injuries tend to be more complex and severe [9], with a less predictable trajectory of injuries.

Stab and puncture wounds cause injuries via a trajectory of tissue disruption that can be identified on imaging. Ballistic trauma such as a gunshot wound is often more unpredictable and complex due to variation in energy transfer and its effect on tissues. As most penetrating injuries involve the chest wall and lung tissue, initial CXR completed with radiopaque marking of entry and exit wounds is helpful in gauging the trajectory of the injury. Additionally, LODOX/Statscan scans the entire body quickly, while providing precise locations in retained ballistics. Lodox/Statscan has been shown to be faster than conventional radiography with less radiation exposure, holding a clear advantage over plain radiographs, if available (Fig. 1).

Pneumothoraces and haemothoraces are common in penetrating injury to the chest and the imaging approach is similar to that discussed previously regarding blunt chest trauma. Injury to the thorax that does not involve the mediastinum is typically treated with a chest tube and follow up imaging [10]. Immediate output of more than 1000 mL blood or persistent output of 200 m/h or greater for four hours are indications for a thoracotomy [11]. "Patients who have isolated pneumothorax or haemothorax diagnosed on admission on chest radiographs are less likely to need intercostal tube drainage and usually do not deteriorate clinically compared with patients who have haemopneumothorax" [11].

Patients with persistent air leak despite chest tube placement, neck or chest emphysema, or pneumomediastinum are at an increased risk of death due to injuries to the airway. Due to their more anterior location, the cervical trachea and right mainstem bronchus are more commonly injured than the mainstem bronchi or intrathoracic trachea which have a significantly high mortality [9]. These injuries can lead to development of fistulas, stenosis, or other complications if not detected.

Bronchoscopy is currently the imaging study of choice for further evaluation of airway injury [9]. Suspected oesophageal injuries can be explored further with water-soluble gastrografin followed by a barium study if equivocal.

As in blunt trauma, pulmonary contusions can be seen after penetrating traumatic injury and typically develop hours to days after the occurrence of the injury, initially difficult to visualise on CXR, but more visible on CT [9]. In the context of severe penetrating chest trauma, the index of suspicion for development of pulmonary contusion should be high. Additionally, pulmonary lacerations can be seen alongside contusions and often obscured on initial imaging, thus reinforcing the need for further evaluation with CT scan in the setting of significant chest trauma. In the absence of CT scan in a stable patient, close observation with repeat exams can be useful in determining the extent of traumatic parenchymal injuries.

Typically, most patients with injury to the mediastinum or heart will be unstable at the time of presentation and require emergent surgical intervention. "Penetrating cardiac injury is associated with a prehospital mortality rate as high as 94% and an in-hospital mortality rate of 50% among initial survivors" [10]. Thus, it accounts for a very small percentage of hospital admissions. Due to the location of the right ventricle, it is most commonly injured via entry wounds and has a lower mortality rate than injuries to the left ventricle. Ultrasound is now widely used for diagnosis of traumatic haemopericardium and tamponade, as part of the FAST to evaluate for pericardial fluid [9].

If haemodynamics allow, penetrating mediastinal injury is typically evaluated by a combination of imaging depending on clinical correlation. It is important to note that patients with penetrating injury to the mediastinum have high morbidity and mortality. "The growing data suggest that a combination of echocardiography and multi-detector CT can be used to effectively screen these patients and preclude the need for a more invasive work-up" [9]. However, in the absence of CT scan, ultrasound to evaluate for free fluid, combined with LODOX/Statscan to determine the possible trajectory of penetrating ballistics may be useful when combined with serial exams and trending of lab studies.

Due to the complexity of vasculature in these regions, CT angiograms (CTA) remain gold standard for evaluation in the setting of penetrating trauma. In CTA evaluation of penetrating thoracic injuries, a contiguous body part should also be included in the scan, depending on estimated bullet trajectory. For injuries in the supraclavicular region, CTA of the neck and chest can be obtained with particular concern for vascular injury. For injuries in the thoracoabdominal region, CTA of the chest and abdomen should be obtained to assess for potential transdiaphragmatic injuries [9]. When formal angiography is unavailable, some case studies have shown benefit in evaluation of vasculature with administration of intra-arterial contrast agent followed by scan of the area in question by the LODOX/Statscan. However, as contrast needs to be injected in a prograde fashion, proximal to the area in question, this has proved to be beneficial only in evaluation of vasculature in extremities thus far. Patients who are haemodynamically unstable with high suspicion for vascular injury secondary to penetrating trauma to the thorax will likely need operative exploration and intervention.

Usually, penetrating injury to the diaphragm is diagnosed at the time of surgical exploration rather than on imaging, which is attributed to its proximity to other anatomic structures [8]. Diaphragmatic injuries are subtle on imaging and although they can be commonly missed, they carry a risk of strangulation to the viscus months to years after the injury [9]. "A stab or gunshot wound in the thoracoabdomen (nipple to costal margin from midline to anterior axillary line) will penetrate the diaphragm and abdomen 15 percent and > 45 percent of the time, respectively" [15]. On initial CXR, poor definition or elevation of the hemi-diaphragm, mediastinal shift, or air-fluid levels in the lower thorax are all findings suggestive of diaphragmatic injury. As these are all nonspecific, if diaphragmatic injury is suspected and the patient is unstable or suspicion is high, exploratory laparoscopy or laparotomy should be undertaken.

Although gunshot wounds to the diaphragm typically do not affect one side more than the other, stab wounds are seen more commonly to the left hemidiaphragm "attributed to the higher incidence of right-handedness in the general population and assaults occurring when facing the victim" [9]. Most penetrating injuries to the left hemi-diaphragm will need to be repaired surgically, but due to the protective location of the liver on the right, these can often be managed with conservative observation [8].

Abdominal penetrating trauma

In the setting of penetrating trauma to the abdomen, plain radiographs can be useful if the patient is haemodynamically stable and the time can be taken to obtain further studies prior to exploration in the operating room. Radiographs can be used to evaluate free air, haemothorax or pneumothorax, and foreign bodies. If further imaging is needed to explore the extent of the injury, a LODOX/Statscan can be useful to assist in determining trajectory of a penetrating injury. Of course, if the patient is haemodynamically unstable or expected to clinically deteriorate quickly, an urgent exploratory laparotomy is indicated. A classically accepted indication for exploratory laparotomy is penetrating abdominal trauma with hypotension [15]. Additionally, if the patient is noted to have free air under the diaphragm on upright CXR or has clinical signs of an acute abdomen, a low threshold should be maintained for operative intervention (Fig. 2).

Penetrating trauma to the anterior abdomen will penetrate the peritoneal cavity up to one-third of the time and many patients will present without peritonitis or evisceration on exam. Additionally, penetrating injury to the flank or back may violate the retroperitoneum or peritoneal cavity without additional symptoms. Although serial physical exams may be beneficial in further evaluation of these patients, CT with contrast is the most commonly used diagnostic test [15]. However, as CT scans remain a privilege of the developed world, patients in countries lacking additional resources may benefit from focused abdominal sonography and low radiation imaging such as LODOX/ Statscan combined with a thorough clinical exam and laboratory studies.

Conclusion

Although there have been various advances in trauma imaging, it is clear that radiographs remain a staple when it comes to initial trauma assessment. Based on current literature, in limited-resource settings, ultrasound may be of as much use in gathering initial data as radiographs, as well as having a distinct advantage in its simplicity and portability. Although there is also a user error component, the learning curve is short and the implications for use in a critical setting are numerous. Sonography has earned itself a place in trauma evaluation with the FAST exam, and will likely have a role beyond this, however more information regarding ultrasound in the extended evaluation of trauma is needed in order to make further recommendations.

CT scan still goes above and beyond both ultrasound and plain radiographs in its diagnostic capabilities, considering the spectrum of injuries that can exist in the trauma setting. It is able to provide a larger depth of information; however, the down-side is that it may also include a large amount of data that does not require treatment while also providing larger doses of radiation exposure. In addition, CT imaging may be widely unavailable in locations with limited resources. Using a combination of LODOX/Statscan, X-rays, ultrasound, careful lab evaluation, and clinical assessment may provide useful information in the absence of availability of CT scan (Fig. 1). In regard to trauma assessment, mechanism of injury and careful physical exam remain the cornerstone of diagnosis in trauma.

This literature review is limited in regard to its approach to paediatrics and pregnancy, two special populations which may have a different approach when it comes to imaging in trauma. Additionally,

the reliability of ultrasound is difficult to measure, when operational skill has the ability to skew both measurement and interpretation.

Conflicts of interest

The author declares no conflicts of interest.

Author contribution

The author contributed the conception and design of the work; the acquisition, analysis, and interpretation of data for the work; and drafting the work and revising it critically for important intellectual content. The author approved the version to be published, and agreed to be accountable for all aspects of the work.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.afjem.2018.07.007.

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