Purpose

To provide guidelines for the initial evaluation and treatment of Blunt Abdominal Trauma (BAT) in children.

Incidence

Blunt abdominal trauma in children contributes significantly to both morbidity and mortality. In a study of 2,188 patients with mechanism of blunt abdominal trauma evaluated at 14 Level I Pediatric Trauma Centers, the incidence of intra-abdominal injury (IAI) was cited at 11.9%[12].

Etiology

Use of CT has increased dramatically in the past 20 years and it is now estimated that CT of the abdomen/pelvis is performed in children at a rate >9 per 1,000 individuals in the US each year. Although CT scan is considered the best imaging test for diagnosing IAI, fewer than 15% of pediatric patients with blunt trauma are found to have IAI on CT scan, and the majority are managed nonoperatively[11].

Along with ALARA (as low as reasonably achievable) principles, strategies to reduce the use of abdominal CT when there is very low risk for intra-abdominal injury are important in providing optimum care to children. Multiple studies have demonstrated that the use of a prediction rule or imaging guideline can decrease radiation exposure while still offering high sensitivity in identifying clinically significant abdominal injuries.

Guideline Eligibility Criteria

Children from newborn through adolescence with blunt abdominal trauma and concern for intra-abdominal injury.

Guideline Exclusion Criteria

Infants and young children evaluated with concern for non-accidental trauma are excluded from this guideline. This is a guideline only. Individual circumstances need to be considered, as there may be times when it is appropriate or desired to deviate from this guideline by the discretion and clinical judgment of the trauma surgeon.

Diagnostic Evaluation

Core principles of ATLS apply with primary survey ABCDE addressed first, then once stabilized with secure airway, proceed with remaining secondary survey.

History

Assess for history of blunt abdominal trauma including mechanisms such as MVC, auto versus pedestrian, bicycle accidents, ATV crashes, falls, etc. Assess for history of hypotension, abdominal pain and/or vomiting, referred pain to back (flank) or left shoulder (Kehr sign).

Physical Examination

- The primary clinical assessment of a child with blunt abdominal trauma should focus on assessing for signs of bleeding or peritonitis.
- Assess for abdominal tenderness, distension, bruising/abrasions or seatbelt sign, evidence of chest wall trauma, and concomitant injuries such as head, chest, pelvis, spine or long bone injuries. Abdominal examination is limited in patients with GCS <13 and/or distracting injuries. A high index of suspicion for intra-abdominal injury should be maintained in this population.

Laboratory Tests

- Hemoglobin and hematocrit, liver function studies (ALT, AST), pancreatic enzymes (amylase, lipase), and urinalysis with microscopy are helpful screening tools in the evaluation of abdominal trauma. If there are

concerns for bleeding, a type and screen should be added. See Treatment Recommendations below for specific information.

- Amylase and lipase levels do not peak until 12-72 hours following pancreatic injury. Initial values should be interpreted with caution.

Diagnostic Studies

- Chest x -ray and pelvic x- ray are important adjuncts to the primary survey and should be used judiciously to aid it resuscitation/intubation efforts and as a guide in the need for early blood transfusion. Abnormal chest or pelvic x-rays raises suspicion and predictive value for concomitant intra abdominal injury.
- CT abdomen/pelvis with IV contrast is the diagnostic study of choice for the evaluation and diagnosis of intra-abdominal injury. CT provides grading per the AAST (American Association of Surgery & Trauma) guidelines which is helpful for management and guidance in activity restrictions following solid organ injury [10]. Evaluation of the renal system and ureters is best accomplished with CT with IV contrast and delayed images which is critical in the evaluation of genitourinary injuries and is the standard of care for trauma patients at DCMC. The addition of oral contrast should be considered in stable patients in whom duodenal hematoma or other hollow viscus organ injury is suspected.
- CT abd/pelvis has limited sensitivity in the identification of hollow viscus injury. Free fluid without solid organ injury may be associated with bowel injury and a high index of suspicion should be maintained. Observation with serial abdominal exams may be helpful in this setting as symptoms of bowel injury may develop insidiously.
- Limitations of CT includes increased cost, personnel needed for transport, and most importantly the risk of ionizing radiation exposure and its resultant measurable increase of malignancy in children.
- FAST (Focused Assessment of Sonography in Trauma) examination is an adjunct screening tool using bedside ultrasound to assess for intra-abdominal free fluid/bleeding associated with solid organ or hollow viscus injury. A positive fast exam may indicate the need for further evaluation including abdomen/pelvis CT and/or operative intervention. A negative fast should be interpreted with caution and not be used to replace or preclude clinical judgment or further workup. Liang et al described that up to 37% of those with intra-abdominal injury may have negative FAST with no intra-abdominal fluid seen[8]. However, negative FAST in those with no abdominal pain and normal GCS may obviate need for CT. Limitation of FAST exam is user dependent.
- Contrast Enhanced Ultrasound (CEUS) is the use of sonography enhanced with contrast as a tool to identify intra-abdominal injury in the trauma patient. Several studies describe the use of CEUS in decreasing exposure to radiation of CT scans in evaluation of the trauma patient. One study described that most abdominal solid organ injuries in children can be detected with CEUS, however there were limitations with body habitus and identification of renal injuries [1]. Further studies and multicenter trials are needed in children before CEUS use can be recommended at DCMC.

Critical Points of Evidence

Evidence Supports

- Multiple studies support the use of a protocol as an effective method of reducing total CT scans without missing clinically significant injuries.
- Streck et al described the first prospective multi-institutional effort to develop a prediction rule using all the clinically relevant variables available in the trauma bay [11].
  - The prediction tool included:
    - AST >200 U/L
    - Abnormal abdominal examination
    - Abnormal CXR

    - Report of abdominal pain and abnormal pancreatic enzymes
  - The prediction tool had a 99.4% negative predictive value for intra-abdominal injury (IAI) and 100% for intra-abdominal injury requiring acute intervention (IAI-I) in patients with none of the prediction rule variables present. The rule safely identifies children at very low risk for IAI for whom CT scan can be avoided. See IAI Risk Stratification for details.
- The Pediatric Emergency Care Applied Research Network (PECARN) published a clinical prediction rule based on history and physical examination findings to identify children at risk for IAI requiring acute intervention (IAI-I). They cited a 99.9% negative predictive value for IAI-I with the following physical findings with sensitivity and specificity of 97% & 42.5% respectively[5].
  - No abdominal or chest wall trauma
  - No abdominal tenderness
  - No complaints of abdominal pain
  - GCS >13
  - No decreased breath sounds
  - No vomiting
- Holmes et al evaluated a prediction tool with a prospective observational study of 1119 pediatric patients with blunt abdominal trauma evaluated at Level I Trauma Centers [6].
  - The absence of any of the following variables indicated a low risk for IAI:
    - Low systolic blood pressure
    - Abdominal tenderness
    - Femur fracture
    - AST/ALT >200/125
    - Hematocrit <30%
    - >5 RBC/hpf on UA
  - Sensitivity of the tool was 94.9% with 37.1% specificity. Application of the tool to the study sample would have reduced the number of CT scans by 33% but missed 8 IAIs with one patient undergoing (non-therapeutic) laparotomy.
- Leeper at el instituted a protocol at a Level I Pediatric Trauma Center and demonstrated a significant decrease in the median low grade injuries (1.3% versus 0.6%) but no difference in high grade injuries (1.3% versus 1.1%)[7]. There were no deaths, readmissions or delayed diagnosis of injuries requiring intervention.
  - The following findings indicated the need for CT scan:
    - Abdominal wall trauma
    - GCS < 13 and concern for abdominal injury
    - Abdominal wall tenderness
    - Abdominal pain or vomiting
    - Positive FAST exam
    - Thoracic wall trauma
    - Decreased breath sounds
    - ALT/AST > 200
    - Amylase/lipase > 100
    - Hematuria or 100+ RBC/hpf
  - There were no clinically significant solid organ injuries missed. Use of abdominal CT scan at the institution decreased by 30%.

Evidence Lacking/Inconclusive

- There is no universally accepted pathway or protocol to guide clinicians in the judicious evaluation of abdominal trauma in the pediatric patient. Subsequently, there is a substantial variability (4-96%) in CT scan use among Level I Trauma Centers [11].

- There is no universally accepted cutoff for lab abnormalities such as liver enzymes (AST, ALT), pancreatic enzymes (amylase, lipase) and RBC/hpf on urinalysis (UA) that correlate to IAI and the need for CT abd/pelvis. Hemoglobin <10 and/or hematocrit <30% have also been suggested as lab indicators suggesting need for CT scan [3, 4, 11].
- Zagory et al recommends increasing the threshold of AST/ALT of 400/200 respectively with a negative predictive value of 96% for the presence of high risk liver injuries[13]. Algorithms or prediction tools with thresholds of 200/125 AST/ALT have been used to safely identify patients who should be evaluated with CT scan [7, 4]. Fallon et al suggests an algorithm with cutoffs of ALT/AST >100[3]. Other studies suggest a cutoff of AST >200 [11, 12].
- There are several studies that utilize RBC/hpf as a reference to identify patients at risk for urologic injury requiring evaluation with CT, although these studies demonstrate different recommendations. The following lists a few of these recommendations.
  - A threshold of 100 RBC/hpf on UA to identify patients[7].
  - A threshold of 50 RBC/hpf [3].
  - A prediction tool with a cutoff of >5 RBC/hpf to suggest risk for IAI [6].
  - Only macroscopic/gross hematuria as an indicator of risk[2].
- Mahajan et al reported that a prediction tool was significantly more sensitive but less specific than clinician suspicion in identifying patients at risk for IAI requiring intervention[9].
  - The tool utilizing the following variables:
    - No evidence of abdominal wall trauma or seatbelt sign
    - GCS >13
    - No abdominal tenderness
    - No thoracic wall trauma
    - No abdominal pain
    - No decreased breath sounds
    - No vomiting

Evidence Against

None

Practice Recommendations & Principles of Clinical Management

Principles of Clinical Management

- While CT abdomen/pelvis with IV contrast is the study of choice to identify intra-abdominal injury (IAI), efforts should be made to reduce the use of CT in patients who have very low risk for IAI.
- Thorough history & physical examination with negative FAST exam, serial abdominal exams, likely with chest X-ray and/or laboratory evaluation can assist the clinician in determining which patients are at very low risk for IAI and subsequently safe to avoid the cost and radiation risks associated with CT.

Treatment Recommendations

Hemodynamically stable patients

- Abdominal exam with 1 or more of the following findings is concerning for intra-abdominal injury (IAI):
  - Abdominal pain
  - Abdominal wall trauma, tenderness, distention
  - Significant chest wall or flank injury/contusion
  - GCS ≤ 13 & concern for abdominal injury
  - Positive FAST exam
  - **Strongly consider CT abd/pelvis with IV contrast for 1 or more of the above findings.**
- Prior to obtaining CT, the clinician may choose to obtain further workup.

  - The following studies should be obtained in all patients with an equivocal abdominal exam. This may include a child with an unreliable exam and/or distracting injury.
    - CBC
    - ALT/AST
    - UA with micro
    - Amylase, lipase
    - Chest x-ray
    - FAST exam
- The following thresholds are concerning for IAI:
  - Hematocrit <30%
  - ALT/AST >200
  - Gross hematuria or ≥ 100 RBC/hpf
  - Amylase or lipase >100
  - Abnormal Chest x-ray
  - Positive FAST exam
  - **Strongly consider CT abd/pelvis with IV contrast for 1 or more of the above findings.**
- If serial abdominal exams are reassuring and further workup (as above) does not meet threshold concerns for IAI, the patient may PO challenge and discharge home as appropriate.
- If serial abdominal exams are concerning, consider CT abd/pelvis or admission for observation and further serial exams.

Hemodynamically unstable patients

- Patients with peritonitis and/or with profound instability and signs of shock/hemorrhage require immediate intervention according to Advanced Trauma Life Support (ATLS) guidelines and the Solid Organ Injury Guideline.
- Signs of ongoing or very recent bleeding may include tachycardia, hypotension, delayed capillary refill, and/or hypoperfusion. The critical stage for bleeding is within the first 12 hours following injury. If the patient demonstrates these findings:
  - Consider giving 20cc/kg crystalloid.
  - If the patient is a non-responder, demonstrates ongoing signs of bleeding/shock, or is a transient responder, give 10-20ml/kg PRBCs. If there are clear signs of ongoing bleeding, blood should be given as soon as possible, avoiding crystalloid resuscitation.
  - Massive Transfusion Protocol (MTP) should be initiated as appropriate.
- If the patient stabilizes with the above interventions, CT abdomen/pelvis should be obtained.
- Non-responders with ongoing signs of bleeding/shock who remain unstable despite resuscitation will require operative intervention or embolization. Unstable patients should not undergo CT scanning and should undergo immediate operative intervention. Please refer to the Solid Organ Injury Guideline for further information.

CT abdomen/pelvis results

Negative CT abdomen/pelvis:

- Patients with negative CT abdomen/pelvis who are otherwise well appearing with a benign abdominal exam may PO challenge and discharge home as appropriate.
- Patients with ongoing abdominal pain and/or vomiting may need to be admitted for observation to rule out bowel injury.
- Elevated amylase and/or lipase is concerning for occult pancreatic injury. Serial levels should be obtained with further imaging with ERCP or MRCP as indicated.

- Gross hematuria and/or ≥ 100 RBC/hpf is concerning for occult urologic injury. Consider CT cystogram and/or urology consultation.
- If there are signs of recent or ongoing hemorrhage, consider further imaging to rule out intracranial hemorrhage, thoracic injuries and long bone fractures as the cause for bleeding.
- ALT/AST >200 is concerning for occult liver injury and consistent with liver contusion. Please refer to the Solid Organ Injury Guideline for activity restrictions.

CT abd/pelvis with free fluid and no solid organ injury identified OR concern for bowel injury*

(*CT findings that suggest bowel injury include free fluid with no solid organ injury, bowel thickening or enhancement, extraluminal air, mesenteric stranding or bowel discontinuity)

- Consult Trauma Service
- Admit for serial abdominal exams or surgical intervention as appropriate
- *Patients with signs of peritonitis or free air require immediate operative intervention.

Solid organ or other injury identified

- Consult Trauma Service
- See Solid Organ Injury Guideline as appropriate.
- Further subspecialty consultation (i.e. urology, nephrology) as appropriate.

Outcome Measures

Patients who are activated as CAT 3 Traumas and require a CT abdomen/pelvis will meet at least one of the following criteria:

- Complaints of abdominal pain
- Abdominal wall trauma, tenderness, or distention
- Significant chest wall trauma or flank contusion
- GCS ≤ 13 & concern for abdominal injury
- Positive FAST exam
- AST or ALT >200
- Elevated amylase or lipase
- Abnormal chest x-ray
- Hematocrit < 30
- Gross hematuria or > 100 RBC/hpf

Related Policies

Abuse & Neglect-Reporting-Child	Sep-2016
Procedure - Required Documentation - CT Non-Contrast	May-2018
Procedure - Required Documentation - CT Contrast	May-2018

Key Contributors

Name	Revision	Title	Role
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Approvals

The signatures below indicate support for the attached guideline, protocol and/or algorithm. The intent is not to be prescriptive but to provide a cohesive, standardized, and evidence-based (when available) approach to patient care. The physician must consider each patient and family's circumstance to make the ultimate judgment regarding best care.

Approved by Trauma Council: 7Feb2020

By: _____<Signature on File>_____ _____
Dr. Jessica Naiditch, Trauma Council Chair Date

By: _____<Signature on File>_____ _____
Dr. Nilda Garcia, Surgeon in Chief Date

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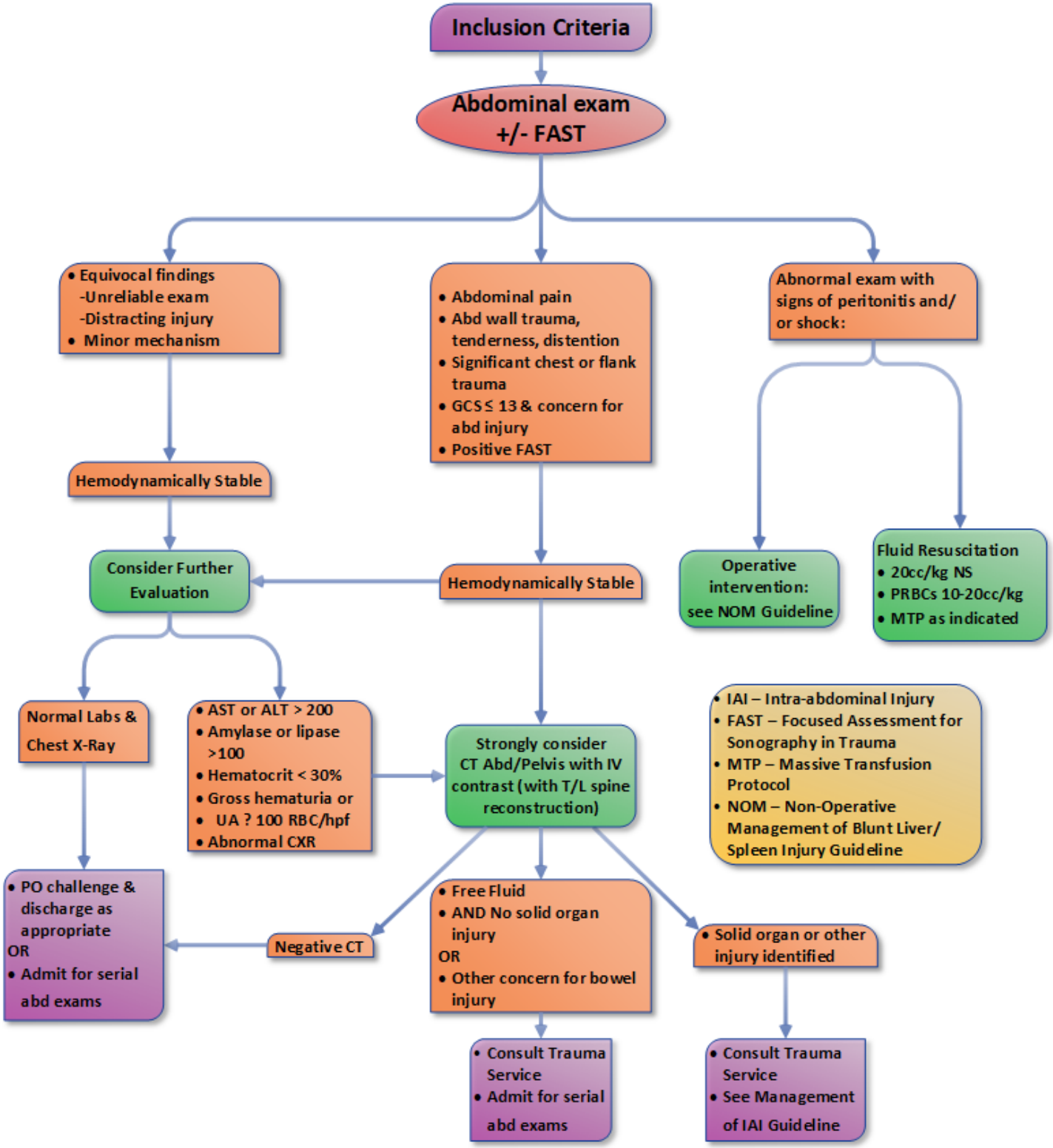
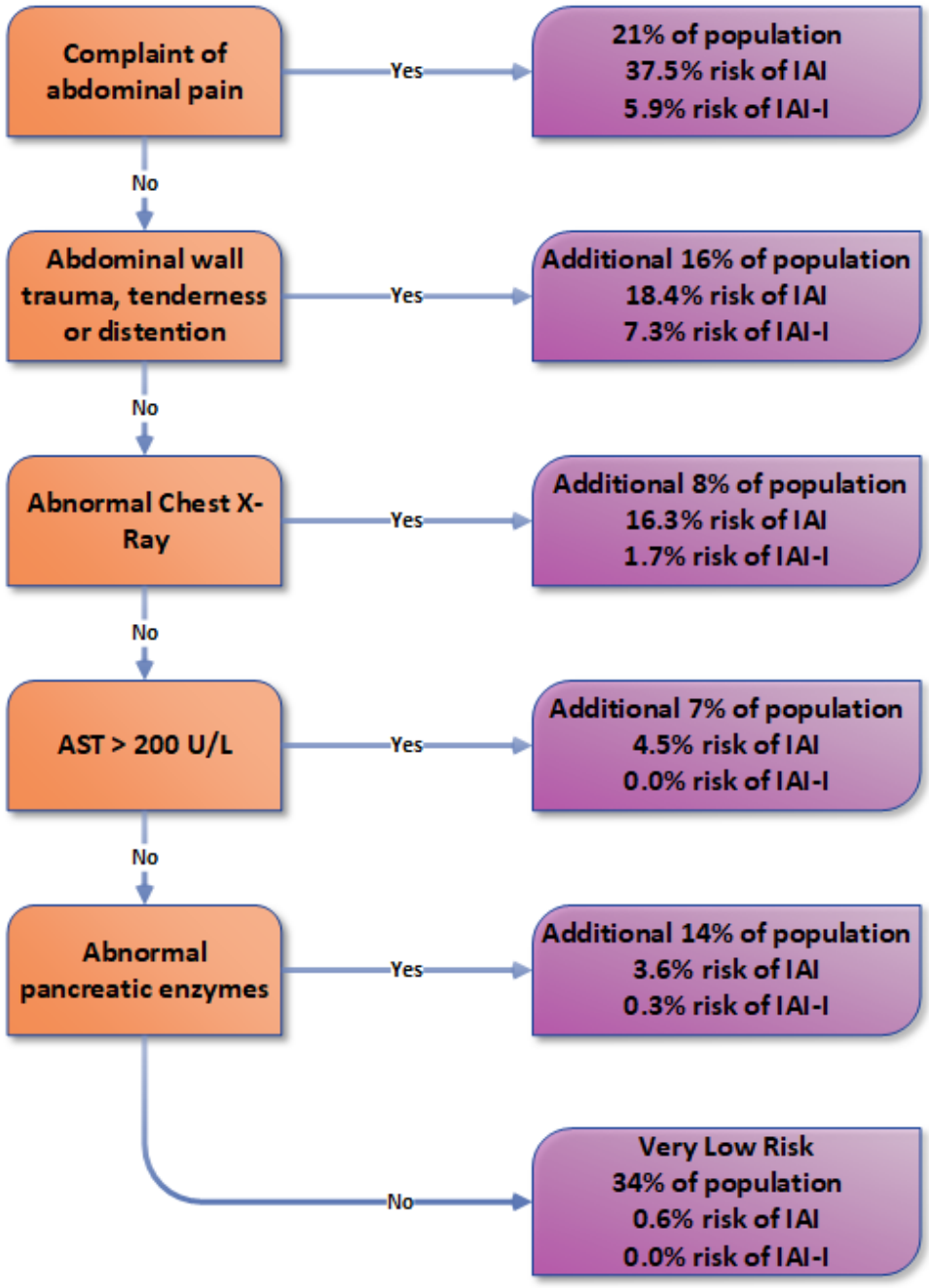
Evaluation of Blunt Abdominal Trauma



Very Low Risk For Intra-Abdominal Injury (IAI) Clinical Risk Stratification (Streck et al, 2017)



- Patients with only 1 positive variable had IAI 4.5% of the time.
- Patients with 2 positive variables had IAI 16.8% of the time.
- Patients with >2 positive variables had IAI 37.8% of the time.

- IAI – Intra-abdominal Injury
- IAI-I – Intra-abdominal Injury patients receiving acute intervention (transfusion, embolization, or surgery)
- Abnormal pancreatic enzymes = amylase or lipase higher than lab reported norms