

## **Purpose**

To provide guidance for the non-operative management of blunt liver and spleen injuries in children.

## **Definition**

Non-operative management (NOM) of blunt pediatric hepatic and splenic injuries is the standard of care in hemodynamically stable patients, irrespective of the grade of injury. NOM is associated with a low overall morbidity and mortality and does not result in increased length of stay, need for blood transfusions, bleeding complications, or visceral associated hollow viscus injuries as compared with operative management.

## **Guideline Eligibility Criteria**

Any patient with a radiographically identified blunt liver or spleen injury at Dell Children's Medical Center.

## **Guideline Exclusion Criteria**

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.

## **Diagnostic Evaluation**

### **History**

All trauma patients should undergo a thorough history and trauma evaluation per the American College of Surgeons Advanced Trauma Life Support (ATLS) protocol by an ATLS trained attending physician. Based on this evaluation, appropriate diagnostic exams should be conducted in accordance with accepted standards of care.

### **Physical Examination**

- Evaluation of perfusion and hemodynamic status which may include blood pressure, heart rate, capillary refill, and mental status. Shock index, pediatric adjusted (SIPA) may also be used to assess children at risk for hemodynamic instability. SIPA is an age specific risk assessment for instability and is calculated with heart rate divided by systolic blood pressure.
  - [See Appendix A: Shock Index Table](#)
- Serial abdominal exams with careful evaluation for signs of peritonitis.

### **Laboratory Tests**

- Type and cross
- H & H on admission, 6 hours later, and then as needed based on the patient's clinical exam and provider judgement.
- See Hemodynamically Stable and Hemodynamically Unstable Pathways

### **Imaging Tests**

- Focused Assessment of Sonography in Trauma (FAST) is an adjunct screening tool using bedside ultrasound to assess for intra-abdominal free fluid as a sign of bleeding associated with intra-abdominal 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 judgement or further workup.
- Liang et al. demonstrated that up to 37% of those with intra-abdominal injury may have a negative FAST exam with no intra-abdominal fluid seen. However, a negative FAST in those with no abdominal pain and a normal GCS may obviate the need for CT <sup>6</sup>.
- An important limitation of FAST is user dependent variation in results.
- CT abdomen/pelvis with IV contrast is the imaging modality of choice for solid organ injury and provides grading per the American Association of Surgery & Trauma (AAST) guidelines which is helpful for management and guidance in activity restrictions following solid organ injury. A CT will be performed in any patient considered for NOM of solid organ injury.
- See [Evaluation of Blunt Abdominal Trauma Guideline](#).

## **Critical Points of Evidence**

### **Evidence Supports**

- There is ample research to support non-operative management of stable patients with solid organ injuries. According to Notrica et al, NOM of liver and spleen injury should be achievable for more than 95% of children <sup>11</sup>. Basing length of stay on hemodynamic status, and not AAST grade of injury, has been proven cost effective, and can shorten the hospital length of stay <sup>10, 13</sup>. The incidence of delayed bleeding from solid organ injury (SOI) is believed to be 0.3%, with few if any delayed bleeds occurring during the period of hospitalization <sup>4</sup>.
- In the first prospective, multicenter, observational study, conducted by a group of Level I Pediatric Trauma Centers (referred to as ATOMAC--Arizona-Texas-Oklahoma-Memphis-Arkansas Consortium), authors reviewed 1008 patients presenting with blunt liver or spleen injury and found that 69 patients (7%) underwent laparotomy or laparoscopy. However, only 24 (3%) of those underwent operative intervention for failed NOM of a blunt hepatic or splenic injury <sup>7</sup>.
- Notrica et al. conducted an extensive literature review and Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) , to assess the evidence supporting various components of the ATOMAC guideline for NOM of blunt liver and spleen injury <sup>11</sup>.
  - The algorithm was supported by six 1A recommendations including:
    - Manage blunt liver/spleen injury based on patient hemodynamic status rather than grade of injury
    - Observe an abbreviated period of bed rest
    - Use a transfusion threshold of 7.0 g/dL
    - Exclude patients with peritonitis from the standard NOM guideline
    - Account for local resources and concurrent injuries in the management of children failing to stabilize
    - Guidelines can be used in patients with multiple injuries
  - There were also several 1B recommendations included:
    - The use of more than 40mL/kg or 4 units of blood is highly correlated with failure of NOM, and care beyond these thresholds should be individualized.
    - Discharging stable patients with isolated blunt liver or spleen injuries before 24 hours is safe.
- A retrospective cohort study conducted at two Level I Trauma centers evaluated an expedited recovery protocol for management of pediatric SOI. The protocol utilized hemodynamic status to determine need for ICU admission and followed a modified plan for serial labs as well as bedrest (with bathroom privileges) and length of stay. Authors concluded that an expedited, hemodynamic-driven protocol is achievable across hospital systems and surgeons. They cited level II evidence that there was no

compromise in quality of care or increase in complications or readmissions. Use of the protocol offered a decrease in length of stay, ICU utilization, phlebotomy and cost <sup>2</sup>.

- Authors from Alberta Children's Hospital implemented an accelerated clinical care pathway for hemodynamically stable patients with SOI and retrospectively reviewed data both pre and post protocol. They cited level III evidence that an accelerated care pathway with early mobilization, less blood draws and decreased length of stay is safe and effective. There was no difference in the groups in regards to need for operation, embolization or transfusion. They cited an average cost savings per patient of \$5966<sup>3</sup>.

### **Evidence Lacking/Inconclusive**

- A prospective ATOMAC study of pediatric patients admitted for liver or spleen injury over a 3 year period examined the effect of obesity on failure rates of NOM. Injuries were managed based on the ATOMAC protocol and authors concluded that obesity is a risk factor for more severe abdominal injury, specifically liver injury, but without an associated increase in failure of NOM. The possible explanation for this finding is that the presence of hepatic steatosis may make the liver more vulnerable to injury <sup>14</sup>.
- In an ATOMAC prospective observational study of pediatric patients with blunt liver and spleen injury, authors concluded that hypotension occurred in less than half of patients requiring early transfusion, suggesting that hypotension does not consistently predict the need for early transfusion <sup>9</sup>.
- Several studies have been conducted in the use of age-adjusted pediatric shock index (SIPA) in identifying children in need of additional resources. Linnaus et al. validated that SIPA could predict children requiring transfusion, surgical intervention and ICU admission <sup>8</sup>. Similarly, Arbuthnot et al found an elevated SIPA or hematocrit <30% to have a sensitivity of 95% with a negative predictive value of 99% <sup>1</sup>.

### **Evidence Against**

None

## **Practice Recommendations**

### **Consultation & Admission**

A patient with a radiographically identified blunt liver or spleen injury is a trauma patient and as such should be cared for in accordance with the trauma facility's established guidelines, policies and/or procedures. This includes thorough evaluation by an attending pediatric trauma surgeon. The primary admitting service should be the pediatric trauma surgery service.

### **Stable vs. Unstable**

- A patient with a radiographically identified blunt liver or spleen injury will be evaluated for hemodynamic stability by the attending pediatric surgeon. This determination will be used to stratify patients to one of two management algorithms.
- A patient will be declared hemodynamically unstable when, in the opinion of the attending pediatric surgeon, there is evidence of inadequate organ perfusion. Clinical indicators may include, but are not limited to age-specific tachycardia, age-specific hypotension, delayed capillary refill, altered mentation, etc.
- A patient may be declared hemodynamically stable when, in the opinion of the attending pediatric surgeon, there are no signs of shock.

## Hemodynamically Stable Pathway

### Initial Plan

- Admission Unit
  - Surgical Trauma Unit
- Activity
  - Bed rest overnight
- Labs
  - Type and Screen (if not already done)
  - Hgb/Hct at presentation, and then in 6 hours. Serial labs at 12 hours and 24 hours post injury is optional based on clinical status.
- IV Fluids
  - Maintenance intravenous fluids
- Vital Signs
  - Every 4 hours.
  - If closer monitoring with vital signs q2h is required, the nursing ratio on the floor may be adjusted or PICU admission should be considered.

### Branch Decision Points

- A patient who demonstrates possible evidence of hemodynamic instability and/or suboptimal end-organ perfusion during their management plan should be treated in accordance with established standards. This should include examination by the attending trauma surgeon and consideration for the hemodynamically unstable branch of the management algorithm.
- If during the first 24 hours, the hemoglobin is less than 7.0 mg/dL on any measurement, or the patient is felt to have symptomatic anemia, they should be [transfused with PRBC](#) in accordance with the [DCMC Transfusion Guideline](#) (preferably type and Rh specific), bed rest continued for an additional 24 hours and hemoglobin measured every 6 hours until stable (defined as a difference of less than 0.5 mg/dL for two serial measures). This step may be repeated once at the discretion of the attending surgeon. If a patient remains hemodynamically unstable after [resuscitation with packed red blood cells \(PRBC\)](#), the patient should be considered eligible for the hemodynamically unstable management algorithm.
  - See Hemodynamically Unstable Pathway
- When hemoglobin is stable x 2 measurements, proceed to the [Hemodynamically Stable-Progression Plan](#) below.

### Transfusion

- For patients < 20kg an aliquot of 10- 15 cc/kg should be administered.
- For patients >=20kg 1 unit should be ordered (note average PRBC unit is 350 mls (range 200-400 mls)

### Progression Plan

- Activity
  - As tolerated, ground level.
  - No strenuous activity or activity that involves running, jumping, or risk of fall.
- Labs
  - None further, unless clinically indicated
- IV fluids
  - Saline lock

### Discharge Criteria

Patients may be discharged to home when hemoglobin is greater than or equal to 7.0 mg/dL, they are tolerating a regular diet and are hemodynamically stable with little to no abdominal tenderness. Exceptions to these discharge criteria include patients with:

- Multisystem injuries that take priority over the liver or spleen injury
- Multiple intra-abdominal injuries
- Pancreatic injury
  - [See Pancreatic Injury Guideline](#)

### Hemodynamically Unstable Pathway

#### Initial Plan

- Fluid volume resuscitation
  - If ongoing bleeding is suspected, you may begin [resuscitation with packed red blood cells \(PRBC\)](#). If blood is not yet available or not deemed necessary yet, resuscitation may start with 20 mL/kg isotonic crystalloid fluid bolus
  - If still hemodynamically abnormal and or there is evidence of suboptimal organ perfusion, continue [resuscitation with PRBC](#).
  - While performing resuscitation:
    - Consider other sources of shock that may result from multi-system trauma (i.e. head injury, tension pneumothorax, tamponade, pelvic hemorrhage, etc)
    - If patient does not have sustained response to [PRBC resuscitation](#), consider activating the [Massive Transfusion Protocol \(MTP\)](#) and progression to the Failure of NOM Algorithm
      - See [Solid Organ Injury Algorithm](#) and [Branch Decision Points](#).
    - If the patient has a sustained response to transfusion, then proceed to CT abd/pelvis (if not already done) and [Progression Plan](#) below.

#### Branch Decision Points

- If after 24 hours, the patient is hemodynamically stable with hemoglobin > 7, they may transition to a hemodynamically stable-progression plan
  - See [Solid Organ Injury Algorithm](#)
- If the patient remains hemodynamically unstable and/or there is evidence of suboptimal organ perfusion after initial crystalloid fluid bolus and blood product replacement of 10-40ml/kg packed red blood cells, the attending trauma surgeon must evaluate patient and manage according to established clinical standards and consider massive transfusion protocol, embolization, and/or laparotomy with surgical control of bleeding.
- If hemoglobin is less than 7.0 mg/dL on any measurement, or the patient is symptomatic from anemia, they should be [transfused with PRBC](#) in accordance with the [DCMC Transfusion Guideline](#) (preferably type and Rh specific), bed rest extended for an additional 24 hours and hemoglobin measured every 6 hours until stable (defined as a difference of less than 0.5 mg/dL in 12 hrs). Embolization may be considered.

#### Transfusion

- For patients < 20kg an aliquot of 10- 15 cc/kg should be administered.
- For patients >=20kg 1 unit should be ordered (note average PRBC unit is 350 mls (range 200-400 mls))

#### Progression Plan

- Admission Unit
  - Pediatric Intensive Care Unit with Intensivist consultation

- Activity
  - Bed rest until Hgb stable
- Labs
  - Type and crossmatch for two units PRBC, if not already done
  - Hgb/Hct q6 hours
- Diet & IV fluids
  - NPO with maintenance intravenous fluids
- Vital Signs
  - As dictated by clinical situation, minimally every hour until hemodynamically stable, then every four hours thereafter.
- Once the patient meets stable clinical criteria, they should transition to the hemodynamically stable protocol and transfer to the floor.

#### **Late Presentation**

- Management of stable patients presenting 24-48 hours post injury is at the discretion of the trauma surgeon and may be based on the reason for finally seeking care (pain, ileus, etc.)
- Consider observation for serial abdominal exams vs. discharge with follow up and ground level activity.
  - See [Follow-Up Care](#)
- Hemoglobin rechecks are optional and based on clinical status
- Diet and activity restrictions are based on clinical status

### **Follow-Up Care**

- Upon discharge from the hospital, the patient may return to school and resume ground level activities, avoiding wheeled equipment and/or sports for a time period equivalent to Solid Organ Injury Grade plus 2 weeks (Grade + 2 = total weeks of activity restrictions).
- Patients with Grades 1 and 2 injuries may follow up in trauma clinic in 2 weeks or with a follow up phone call.
- Patients with Grades 3, 4 or 5 spleen or liver injury will follow up in trauma clinic in 2 weeks. Routine follow up imaging is not required. Imaging should be based on clinician determination and clinical situation.
- No aspirin, ibuprofen, or NSAID products.
- Call trauma services or go to ED for increasing pain, pallor, dizziness, vomiting, worsening shoulder pain, GI bleeding or black tarry stools, or jaundice.

### **Outcome Measures**

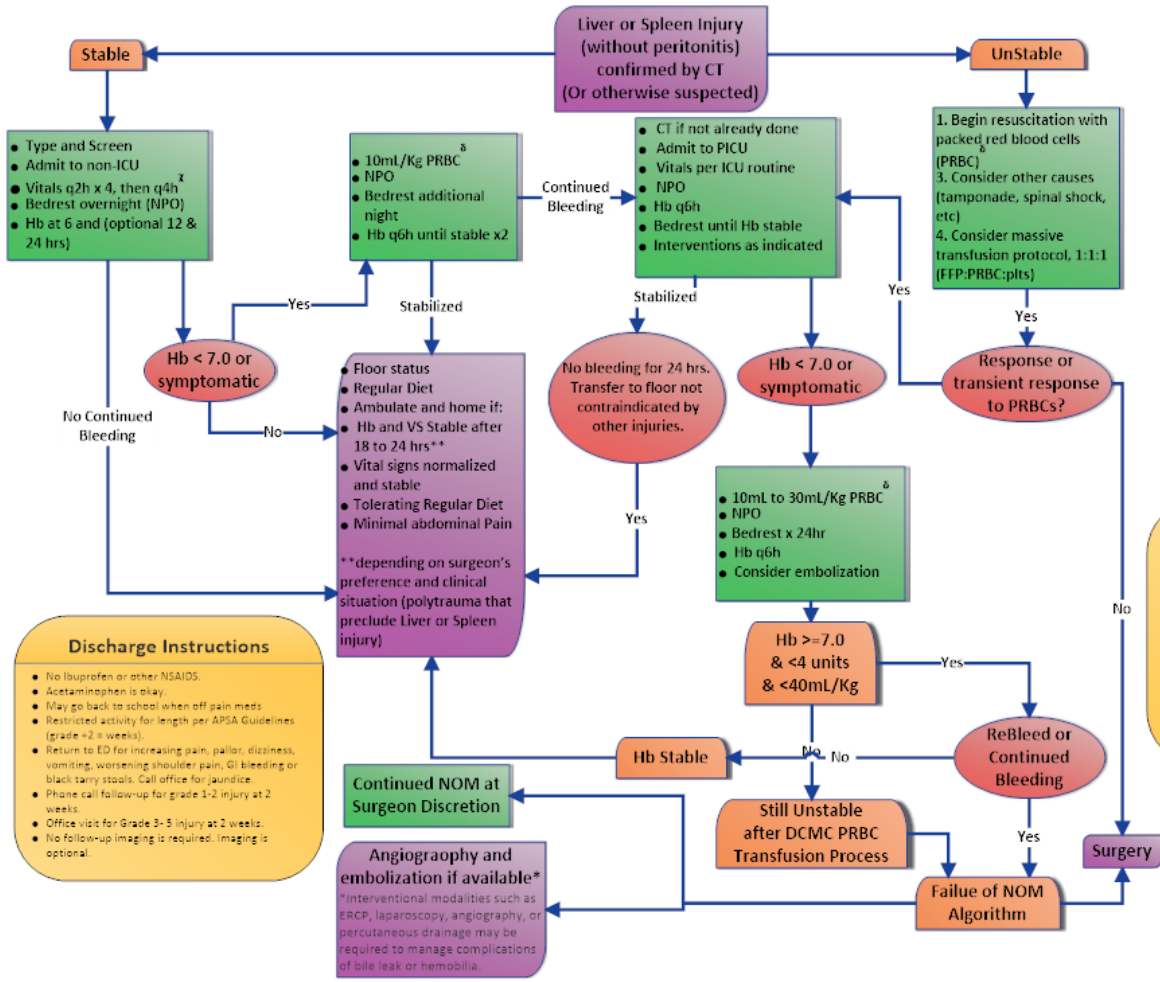
The Solid Organ Injury Algorithm continues to be followed by pediatric trauma centers in the ATOMAC study group and outcome data will be further evaluated to clarify clinical outcomes for children with solid organ injury.

### **Guideline Adherence**

Solid Organ Injury cases will be evaluated for the following criteria being met:

- Admission to Acute Care
- Appropriate admit unit for Clinical Status
- Hgb at 6h
- Type and Screen Completed

# Solid Organ Injury Algorithm



1. Follow ATLS protocol first.  
 2. Patients with peritonitis are managed per surgeon discretion. Per surgeon discretion peritonitis requires operative interventions.  
 3. Guideline was based on pediatric studies with younger patients, use caution in patients 16 or older.  
 4. May be used for polytrauma patients where not contraindicated  
 5. Continued bleeding is defined by the symptoms. Examples: inadequate Hb increase to transfusion, hemodynamic signs of hypovolemia +/- anemia  
 6. "Stable Hb" means a Hb value not dropping more than 0.5mg/dL at 6 hrs. Repeat Hb at 12 & 24hrs is optional.  
 7. Any lab suspected to be erroneous may be repeated prior to medical decision-making  
 8. Late presentation: Management of patients presenting within 48 are at surgeon discretion with consideration of observation and optional Serial Hb.

**χ**  
 If Q2 vitals are needed, then admit with IMC status

**δ**

- For patients < 20kg, an aliquot of 10-15 cc/kg should be administered.
- For patients >=20kg, 1 unit should be ordered (note average PRBC unit is 350 ml (range 200-400 ml))
- If blood is not yet available or not deemed necessary yet, resuscitation may start with 20 ml/kg isotonic crystalloid fluid bolus

**Discharge Instructions**

- No Ibuprofen or other NSAIDS.
- Acetaminophen is okay.
- May go back to school when off pain meds
- Restricted activity for length per APSA Guidelines (grade <= 2 = 2 weeks).
- Return to ED for increasing pain, pallor, dizziness, vomiting, worsening shoulder pain, GI bleeding or black tarry stools. Call office for jaundice
- Phone call follow-up for grade 1-2 injury at 2 weeks.
- Office visit for Grade 3-5 injury at 2 weeks.
- No follow-up imaging is required. Imaging is optional.

**Angiography and embolization if available\***  
 \*Interventional modalities such as ERCP, laparoscopy, angiography, or percutaneous drainage may be required to manage complications of bile leak or hemobilia.

**Related Policies**

None

July-2020

**Key Contributors**

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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: 10July2020**

By: \_\_\_\_\_<br>
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**Appendix A: Shock Index Table**

High Risk Shock Index Values	
Shock Index Pediatric Adjusted (SIPA)	
<b>(Heart Rate/Systolic BP)</b>	
<b>Age</b>	<b>SIPA (Greater Than)</b>
4-6 Years	1.22
7-12 Years	1.00
13-16 Years	0.90