

## Blunt Liver and Spleen Injury

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# What is a Clinical Pathway?

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An evidence-based guideline that decreases unnecessary variation and helps promote safe, effective, and consistent patient care.

# Objectives of Pathway

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- Standardize care to decrease variability in the management of patients with blunt spleen and/or liver injury
- Decrease length of stay to conform with current evidence-based guidelines
- Decrease unnecessary laboratory testing
- Avoid unnecessary PICU admissions

# Why is this pathway necessary?

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- Blunt abdominal trauma causing liver and/or spleen injury is one of the most common indications for hospital admission for injured children.
- In the late 1990s, the American Pediatric Surgery Association (APSA) Trauma Committee developed non-operative management guidelines for blunt trauma to the abdomen to help standardize care.
- In 2012, a pediatric trauma consortium, ATOMAC, developed a practice management guideline for blunt liver or spleen injury that is evidence-based and used at many pediatric trauma centers.
- More recently in 2019, the American Pediatric Surgery Association (APSA) Trauma Committee expanded these guidelines and developed non-operative management guidelines for blunt trauma to the abdomen to help standardize care.

# Background

## Spleen Injury Scaling

National Trauma Data Bank (NTDB)

GRADE*	INJURY DESCRIPTION	ICD-9	AIS-90
1	Subcapsular hematoma, <10% surface area; capsular tear, <1 cm parenchymal depth		
2	Subcapsular hematoma, 10%-50% surface area; intraparenchymal, <5 cm in diameter; laceration 1-3 cm parenchymal depth, <10 cm in length which does not involve a trabecular vessel		
3	Subcapsular hematoma, >50% surface area or expanding; ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma >5 cm or expanding; laceration >3 cm parenchymal depth or involving trabecular vessels		
4	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)		
5	Completely shattered spleen; hilar vascular injury which devascularizes spleen	865.04 865.14	5

A radiologist will grade the liver and/or spleen injury using these scales

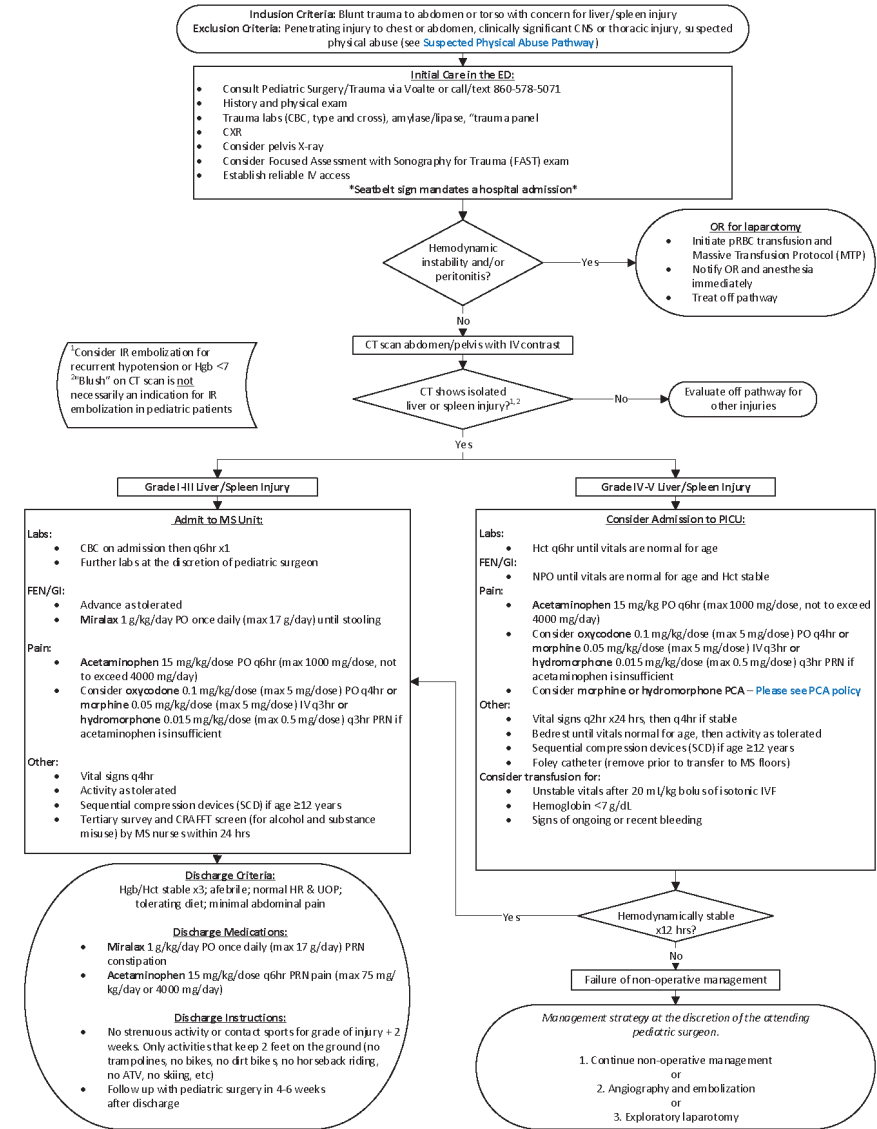
\*Advance one grade for multiple injuries, up to grade 3 From Moore EE, Cogbill TH, Jurkovich GJ, et al. Organ injury scaling V: Spleen and liver (1994 revision). *J Trauma*. 1995;38:323. With permission.

# CLINICAL PATHWAY: Blunt Liver and Spleen Injury

THIS PATHWAY  
SERVES AS A GUIDE  
AND DOES NOT  
REPLACE CLINICAL  
JUDGMENT.

This is the Blunt Liver/Spleen Injury Clinical Pathway.

We will be reviewing each component in the following slides.



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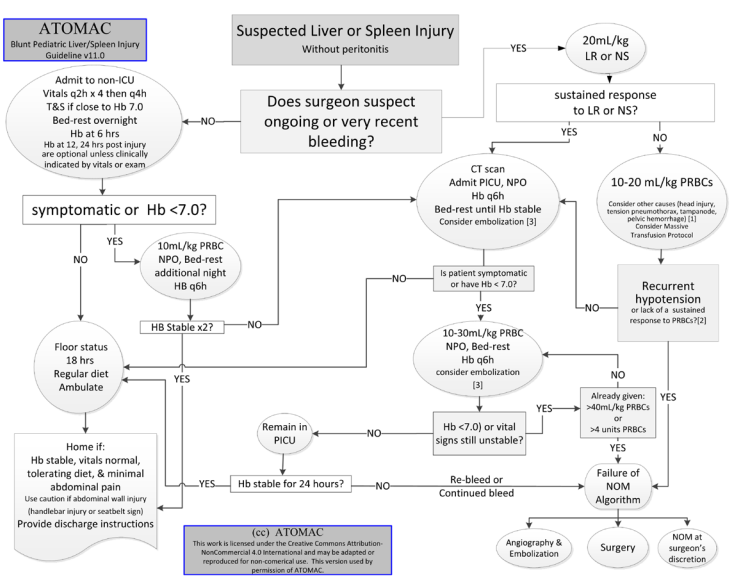
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**CLINICAL PATHWAY:**  
**Blunt Liver and Spleen Injury**

The pathway is modeled after the **ATOMAC** Guideline for the management of pediatric blunt liver spleen injury.



**Figure 1.** ATOMAC guideline for management of pediatric BLSI. <sup>1</sup>More than 50% of injured children with hypotension have no significant intra-abdominal bleeding but do have severe traumatic brain injury. <sup>2</sup>Recurrent hypotension within the first hour because of intra-abdominal bleeding or an SBP of less than 50 mm Hg after transfusion is an ominous sign, and strong consideration should be given to operative or angiographic intervention. <sup>3</sup>Embolizing CT blush may be considered, but more than 80% of children with blush do not require angiography for successful NOM. <sup>4</sup>Interventional modalities such as ERCP, laparoscopy, angiography, or percutaneous drainage may be required to manage complications of bile leak or hemobilia. Hb, hemoglobin; NPO, "non per os" or nothing per mouth; PICU, pediatric ICU; PRBC, packed red blood cell; q6h, every 6 hours; SBP, systolic blood pressure.

The evidence supporting the original guideline development was supplemented by expert opinion. The authors now subject the guideline to analysis based on Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) methodology to rate the level of evidence associated with the PMG.

**PATIENTS AND METHODS**

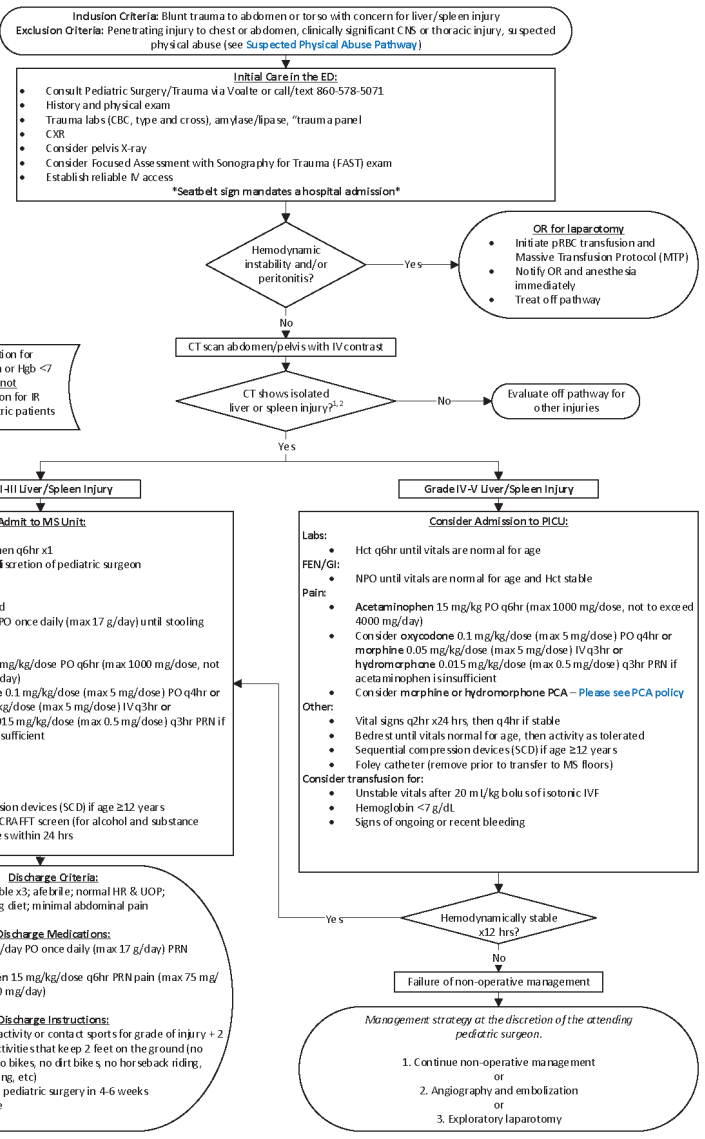
ATOMAC, a research consortium of American College of Surgeons Level I pediatric trauma centers, conducted a systematic literature review of pediatric BLSI to critically appraise data on clinical management. The participating centers in ATOMAC include the following: Phoenix Children's Hospital (Phoenix, Arizona), Dallas Children's Medical Center (Dallas, Texas) and Dell Children's Hospital (Austin, Texas), The Children's Hospital

at Oklahoma University (Oklahoma City, Oklahoma), Le Bonheur Children's Medical Center (Memphis, Tennessee), and Arkansas Children's Hospital (Little Rock, Arkansas).

The algorithm gave rise to 27 clinical questions on BLSI management (see Table Supplemental Digital Content 1, <http://links.lww.com/TA/A655>). The literature review, conducted through MEDLINE, identified publications using the search terms *blunt liver trauma pediatric, blunt spleen trauma pediatric, and blunt abdominal trauma pediatric*. Articles were excluded if they were published before the 2000 APSA guidelines or did not address BLSI management. Additional studies were included as needed for specific questions.

Publications on pediatric BLSI were reviewed and the level of evidence was assessed using the GRADE system.<sup>11</sup> GRADE is a two-part process; first, the overall body of research

**Notrica, D. M., et al. (2015)**



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**Inclusion Criteria:** Blunt trauma to abdomen or torso with concern for liver/spleen injury  
**Exclusion Criteria:** Penetrating injury to chest or abdomen, clinically significant CNS or thoracic injury, suspected physical abuse (see [Suspected Physical Abuse Pathway](#))

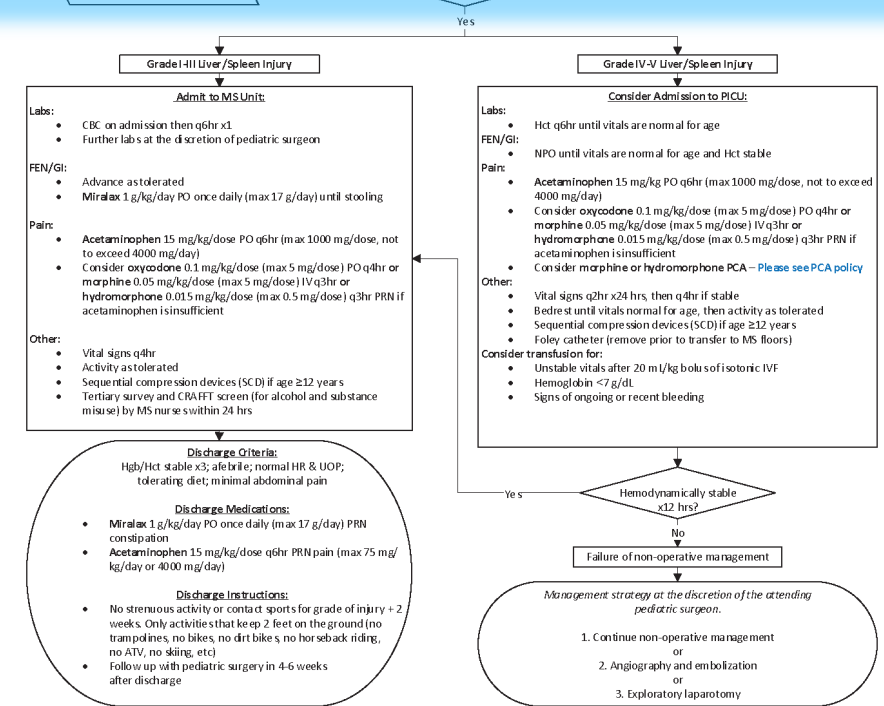
Initial care:

- Pediatric surgery and trauma team should be consulted immediately
  - Contact team via Voalte or by calling/texting 860-578-5071
- Work up includes:
  - History and physical
  - Trauma Labs including amylase/lipase
  - CXR
  - Other exams should be considered based on presentation
- Establish early IV access

Initial Care in the ED:

- Consult Pediatric Surgery/Trauma via Voalte or call/text 860-578-5071
- History and physical exam
- Trauma labs (CBC, type and cross), amylase/lipase, “trauma panel”
- CXR
- Consider pelvis X-ray
- Consider Focused Assessment with Sonography for Trauma (FAST) exam
- Establish reliable IV access

**\*Seatbelt sign mandates a hospital admission\***





## Seatbelt sign

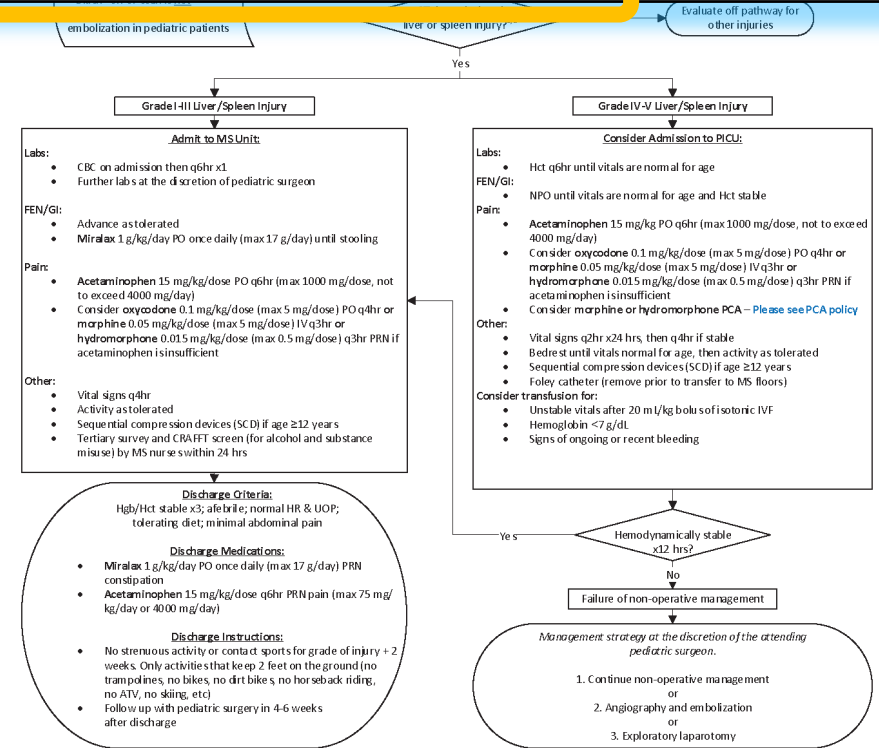
- Seatbelt sign = linear abdominal wall ecchymosis across the abdomen in patients injured in a motor vehicle collision
- Seatbelt sign mandates a hospital admission as it is associated with increased risk of significant intra-abdominal injury

**Inclusion Criteria:** Blunt trauma to abdomen or torso with concern for liver/spleen injury  
**Exclusion Criteria:** Penetrating injury to chest or abdomen, clinically significant CNS or thoracic injury, suspected physical abuse (see [Suspected Physical Abuse Pathway](#))

**Initial Care in the ED:**

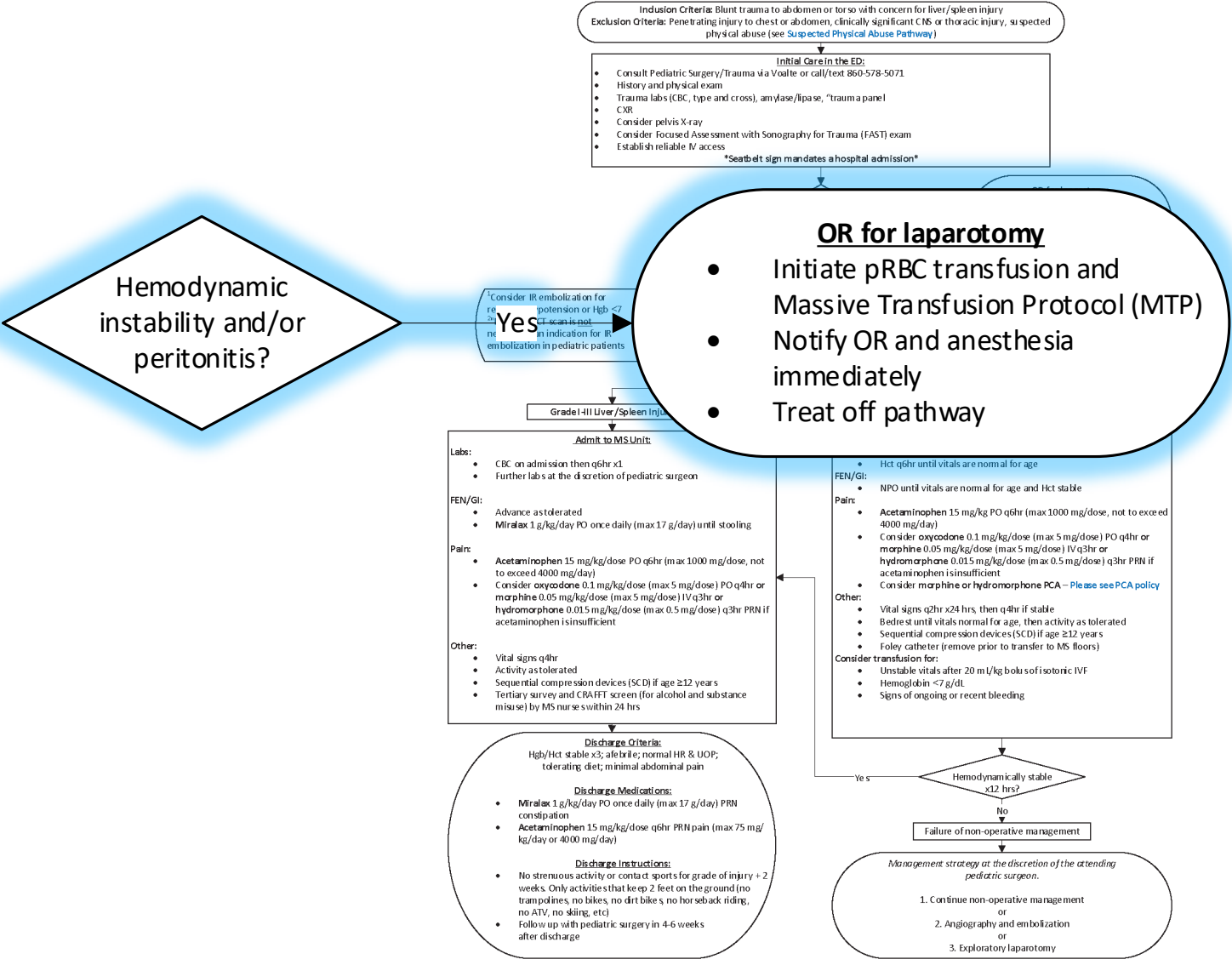
- Consult Pediatric Surgery/Trauma via Voalte or call/text 860-578-5071
- History and physical exam
- Trauma labs (CBC, type and cross), amylase/lipase, “trauma panel”
- CXR
- Consider pelvis X-ray
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- Establish reliable IV

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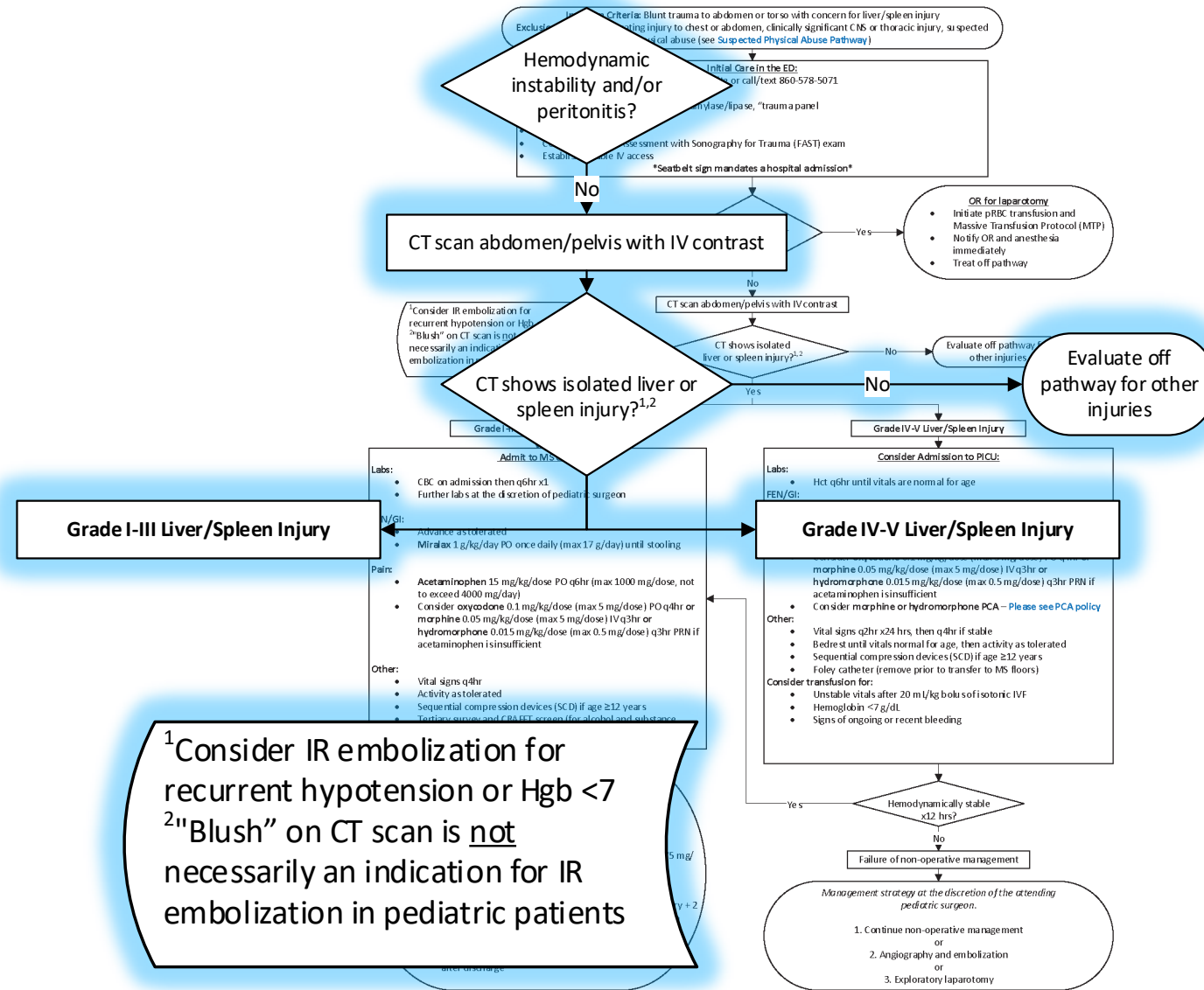
**If the patient is hemodynamically unstable and/or has peritonitis:**

- Patient should go immediately to the operating room (OR) for laparotomy
  - Notify OR and anesthesia STAT
- Initiate blood transfusion and activation of the Massive Transfusion Protocol
- OR should not be delayed for imaging



**Stable patients:**

- Obtain CT scan of Abdomen and Pelvis with Contrast
- CT scan is read by a Radiologist who then Grades the injury
  - Grade I-V, higher the grade the more significant the injury
  - Further management will depend on the grade of injury



## Grade I, II, or III Injuries:

- Patients are admitted to the Med/Surg unit
- A CBC is repeated 6hrs after admission
  - Then again at the discretion of the surgeon
- Pain control with acetaminophen; additional options are available if acetaminophen is insufficient
- Miralax is started once patient starts clears

**There are no longer restrictions on bed rest for Grade I-III injuries, but SCD should be started if ≥12 years old**

Inclusion Criteria: Blunt trauma to abdomen or torso with concern for liver/spleen injury  
 Exclusion Criteria: Penetrating injury to chest or abdomen, clinically significant CNS or thoracic injury, suspected physical abuse (see Suspected Physical Abuse Pathway)

### Grade I-III Liver/Spleen Injury

Trauma labs (CBC, type and cross, amylase/lipase, "trauma panel")  
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#### Admit to MS Unit:

##### Labs:

- CBC on admission then q6hr x1
- Further labs at the discretion of pediatric surgeon

##### FEN/GI:

- Advance as tolerated
- **Miralax** 1 g/kg/day PO once daily (max 17 g/day) until stooling

##### Pain:

- **Acetaminophen** 15 mg/kg/dose PO q6hr (max 1000 mg/dose, not to exceed 4000 mg/day)
- Consider **oxycodone** 0.1 mg/kg/dose (max 5 mg/dose) PO q4hr or **morphine** 0.05 mg/kg/dose (max 5 mg/dose) IV q3hr or **hydromorphone** 0.015 mg/kg/dose (max 0.5 mg/dose) q3hr PRN if acetaminophen is insufficient

##### Other:

- Vital signs q4hr
- Activity as tolerated
- Sequential compression devices (SCD) if age ≥12 years
- Tertiary survey and CRAFFT screen (for alcohol and substance misuse) by MS nurses within 24 hrs

Acetaminophen 15 mg/kg/dose q6hr PRN pain (max 75 mg/kg/day or 4000 mg/day)

**Discharge Instructions:**  
 • No strenuous activity or contact sports for grade of injury + 2 weeks. Only activities that keep 2 feet on the ground (no trampolines, no bikes, no dirt bike s, no horseback riding, no ATV, no skiing, etc)  
 • Follow up with pediatric surgery in 4-6 weeks after discharge

Failure of non-operative management

Management strategy at the discretion of the attending pediatric surgeon.

1. Continue non-operative management or
2. Angiography and embolization or
3. Exploratory laparotomy

## Grade IV-V Liver/Spleen Injury

Inclusion Criteria: Blunt trauma to abdomen or torso with concern for liver/spleen injury  
 Exclusion Criteria: Penetrating injury, chest or abdomen, clinically significant CNS or thoracic injury, suspected

Grade IV or V Injuries:

- Patients may require PICU level of care, although this is not required.
- Labs, diet, and activity orders are all dependent on the patients vital signs
  - Orders are advanced as vital signs normalize for age
- Pain control with acetaminophen; additional options are available if acetaminophen is insufficient
- Activity can begin once vitals have normalized

Consider Admission to PICU:**Labs:**

- Hct q6hr until vitals are normal for age

**FEN/GI:**

- NPO until vitals are normal for age and Hct stable

**Pain:**

- **Acetaminophen** 15 mg/kg PO q6hr (max 1000 mg/dose, not to exceed 4000 mg/day)
- Consider **oxycodone** 0.1 mg/kg/dose (max 5 mg/dose) PO q4hr **or** **morphine** 0.05 mg/kg/dose (max 5 mg/dose) IV q3hr **or** **hydromorphone** 0.015 mg/kg/dose (max 0.5 mg/dose) q3hr PRN if acetaminophen is insufficient
- Consider **morphine or hydromorphone PCA** – [Please see PCA policy](#)

**Other:**

- Vital signs q2hr x24 hrs, then q4hr if stable
- Bedrest until vitals normal for age, then activity as tolerated
- Sequential compression devices (SCD) if age  $\geq 12$  years
- Foley catheter (remove prior to transfer to MS floors)

**Consider transfusion for:**

- Unstable vitals after 20 mL/kg bolus of isotonic IVF
- Hemoglobin  $< 7$  g/dL
- Signs of ongoing or recent bleeding

weeks. Only activities that keep 2 feet on the ground (no trampolines, no bikes, no dirt bike s, no hor seback riding, no ATV, no skiing, etc)

- Follow up with pediatric surgery in 4-6 weeks after discharge

1. Continue non-operative management or
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## Grade IV-V Liver/Spleen Injury

Inclusion Criteria: Blunt trauma to abdomen or torso with concern for liver/spleen injury  
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**FEN/GI:**

- NPO until vitals are normal for age and Hct stable

**Pain:**

- **Acetaminophen** 15 mg/kg PO q6hr (max 1000 mg/dose, not to exceed 4000 mg/day)
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**Other:**

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**Consider transfusion for:**

- Unstable vitals after 20 mL/kg bolus of isotonic IVF
- Hemoglobin  $< 7$  g/dL
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**Grade IV or V Injuries:**

- Transfusion should be considered with unstable vitals after a bolus, Hgb  $< 7$  g/dL, or signs of ongoing/recent bleeding

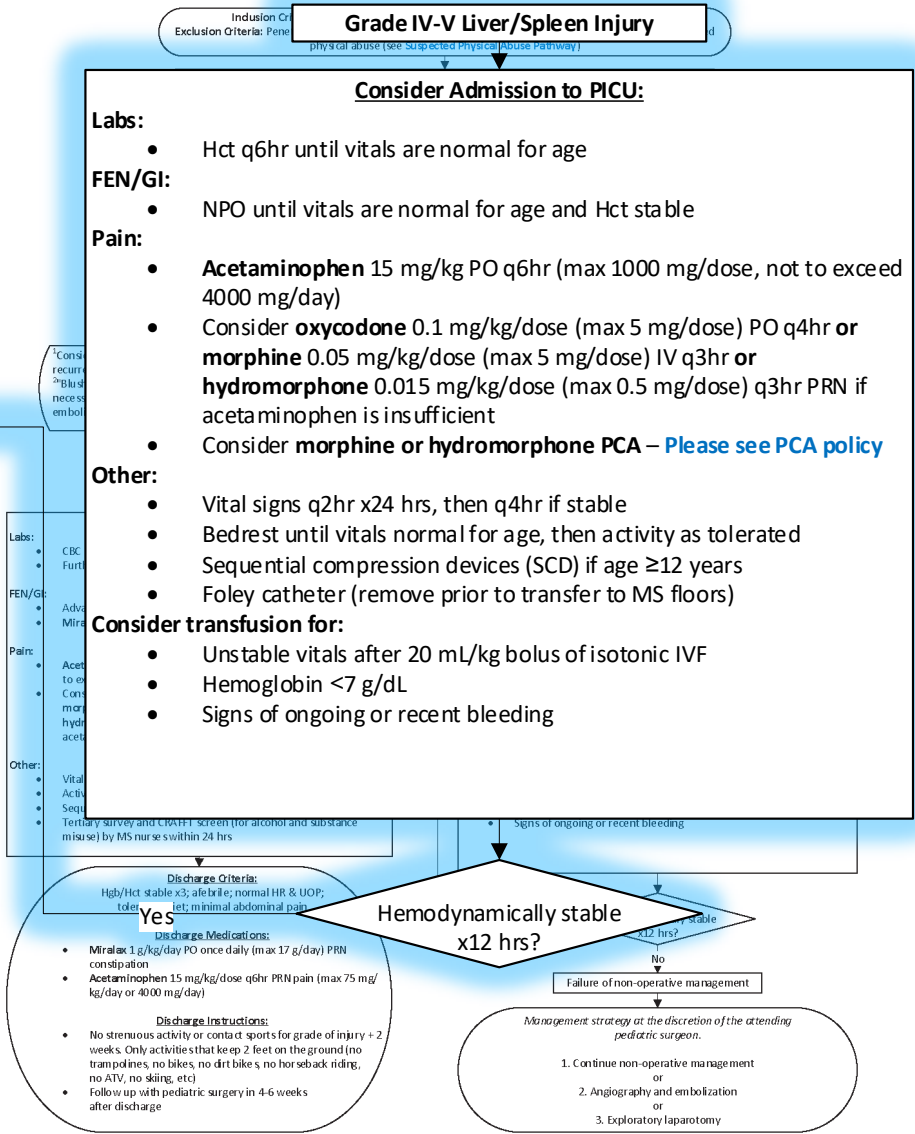
weeks. Only activities that keep 2 feet on the ground (no trampolines, no bikes, no dirt bikes, no horseback riding, no ATV, no skiing, etc)

- Follow up with pediatric surgery in 4-6 weeks after discharge

1. Continue non-operative management or
2. Angiography and embolization or
3. Exploratory laparotomy

Grade IV or V Injuries:
• If patient remains clinically stable for 12 hours they may then transfer to MS units when appropriate

Admit to MS Unit:
Labs:
• CBC on admission then q6hr x1
• Further labs at the discretion of pediatric surgeon
FEN/GI:
• Advance as tolerated
• Miralax 1 g/kg/day PO once daily (max 17 g/day) until stooling
Pain:
• Acetaminophen 15 mg/kg/dose PO q6hr (max 1000 mg/dose, not to exceed 4000 mg/day)
• Consider oxycodone 0.1 mg/kg/dose (max 5 mg/dose) PO q4hr or morphine 0.05 mg/kg/dose (max 5 mg/dose) IV q3hr or hydromorphone 0.015 mg/kg/dose (max 0.5 mg/dose) q3hr PRN if acetaminophen is insufficient
Other:
• Vital signs q4hr
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Blunt Liver and Spleen Injury

Consider Admission to PICU:

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FEN/GI:

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Pain:

- **Acetaminophen** 15 mg/kg PO q6hr (max 1000 mg/dose, not to exceed 4000 mg/day)
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Other:

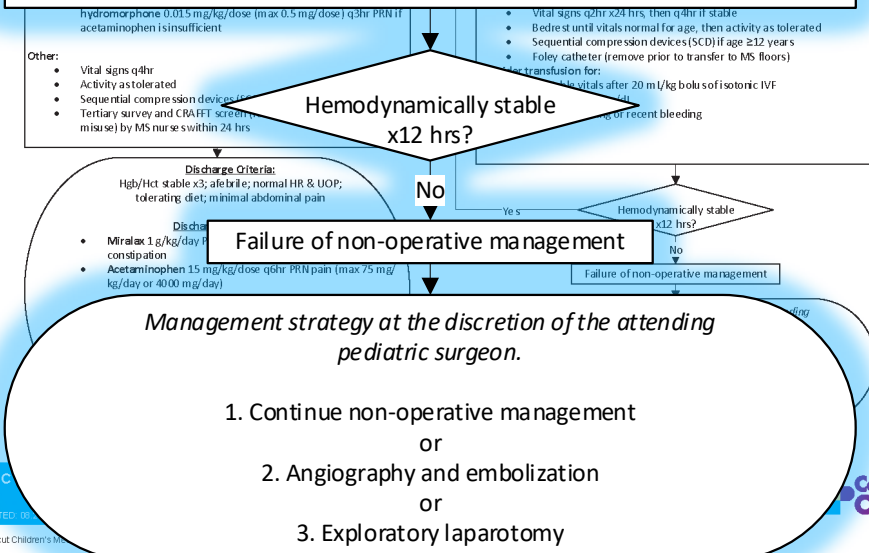
- Vital signs q2hr x24 hrs, then q4hr if stable
- Bedrest until vitals normal for age, then activity as tolerated
- Sequential compression devices (SCD) if age ≥12 years
- Foley catheter (remove prior to transfer to MS floors)

Consider transfusion for:

- Unstable vitals after 20 mL/kg bolus of isotonic IVF
- Hemoglobin <7 g/dL
- Signs of ongoing or recent bleeding

Grade IV or V Injuries:

- However, if the patient is not hemodynamically stable, then there may have been a failure of non-operative management.
- Further management will be at the discretion of the attending pediatric surgeon.





## Discharge Planning:

- Medications for home include Miralax and acetaminophen
- Duration of activity restriction is based on grade of injury + 2 weeks
- Follow up for blunt liver spleen injuries should be done with the pediatric surgery team in 4-6 weeks

**Inclusion Criteria:** Blunt trauma to abdomen or torso with concern for liver/spleen injury  
**Exclusion Criteria:** Penetrating injury to chest or abdomen, clinically significant CNS or thoracic injury, suspected physical abuse (see [Suspected Physical Abuse Pathway](#))

**Initial Care in the ED:**

- Consult Pediatric Surgery/Trauma via Voalte or call/text 860-578-5071
- History and physical exam
- Trauma labs (CBC, type and cross), amylase/lipase, "trauma panel"
- CXR
- Consider pelvis X-ray
- Consider Focused Assessment with Sonography for Trauma (FAST) exam
- Establish reliable IV access

\*Seatbelt sign mandates a hospital admission\*

**Discharge Criteria:**  
 Hgb/Hct stable x3; afebrile; normal HR & UOP;  
 tolerating diet; minimal abdominal pain

- Discharge Medications:**
- **Miralax** 1 g/kg/day PO once daily (max 17 g/day) PRN constipation
  - **Acetaminophen** 15 mg/kg/dose q6hr PRN pain (max 75 mg/kg/day or 4000 mg/day)

- Discharge Instructions:**
- No strenuous activity or contact sports for grade of injury + 2 weeks. Only activities that keep 2 feet on the ground (no trampolines, no bikes, no dirt bikes, no horseback riding, no ATV, no skiing, etc)
  - Follow up with pediatric surgery in 4-6 weeks after discharge

**Discharge Medications:**

- Miralax 1 g/kg/day PO once daily (max 17 g/day) PRN constipation
- Acetaminophen 15 mg/kg/dose q6hr PRN pain (max 75 mg/kg/day or 4000 mg/day)

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- Follow up with pediatric surgery in 4-6 weeks after discharge

Hemodynamically stable x12 hrs?

Yes → Discharge

No → Failure of non-operative management

*Management strategy at the discretion of the attending pediatric surgeon.*

1. Continue non-operative management or
2. Angiography and embolization or
3. Exploratory laparotomy

# Review of Key Points

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- Blunt Liver/Spleen injuries are graded by a Radiologist who reviews the CT scan
- CBCs are not routinely drawn after 6hrs for Grade I-III injuries, and can be stopped once a patients vital signs normalize for age for Grade IV-V injuries
- Pain is mainly controlled with acetaminophen. Oxycodone, morphine or hydromorphone can be given if acetaminophen is not sufficient.
- There is no longer an activity restriction for patients with Grade I-III injuries. Patients with Grade IV-V injuries remain on bed rest until their vital signs and CBC are stable.
- Discharge is based on stable hematocrit and clinical picture, not by grade of injury
- Duration of activity restriction at discharge is based on grade of injury + 2 weeks

# Quality Metrics

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- % Patients with pathway order set
- % Patients transfused
- Grade of injury
- ALOS by grade of injury
- Average time (minutes) arrival to request for interventional radiology
- Average time (minutes) from interventional radiology request to procedure (arterial puncture)

# Pathway Contacts

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- **Brendan Campbell, MD, MPH**
  - Department of Pediatric Surgery and Trauma
- **Evan Fusaro, PA-C**
  - Department of Pediatric Surgery and Trauma
- **Jen Tabak, RN, MSN**
  - Trauma Program Coordinator

# References



- Acker SN, Petrun B, Partrick DA, Bensard DD. Lack of utility of repeat monitoring of hemoglobin and hematocrit following blunt solid organ injury in children. *J Trauma Acute Care Surg*. 2015 Dec;79(6):991-994.
- Acierno, SP, Jurkovich, GJ, Nathens AB. Is Pediatric Trauma Still a Surgical Disease? Patterns of Emergent Operative Intervention in the Injured Child. *J Trauma Acute Care Surg*. 2004 May;56(5):960-4.
- Gates RL, Price M, et al. Non-operative management of solid organ injuries in children: An American Pediatric Surgical Association Outcomes and Evidence Based Practice Committee systematic review. *J Pediatr Surg*. 2019 Aug;54(8):1519-1526.
- Graziano KD, Juang D, Notrica D, et al. Prospective observational study with an abbreviated protocol in the management of blunt renal injury in children. *J Pediatr Surg*. 2014;19(1):198-200; discussion 200-1.
- LeeVan E, Zmora O, Cazzulino F, et al. Management of pediatric blunt renal trauma: A systematic review. *J Trauma Acute Care Surg*. 2016;80(3):519-28.
- McVay MR, Kokoschka ER, Jackson RJ, Smith SD. Throwing out the "grade" book: management of isolated spleen and liver injury based on hemodynamic status. *J Ped Surgery*. 2008 Jun;43(6):1072-6.
- Murphy GP, Gaither TW, Awad MA, et al. Management of Pediatric Grade IV Renal Trauma. *Curr Urol Rep*. 2017;18(3):23.
- Notrica DM, Eubanks JW, Tuggle DW, et al. Nonoperative Management of blunt liver and spleen injury in children: Evaluation of the ATOMAC guideline using GRADE. *J Trauma Acute Care Surg*. 2015 Oct;79(4):683-93.
- Williams RF, Grewal H, Jamshidi R, Naik-Mathuria B, Priace M, Russell RT, Vogel A, Notrica DM, Stylianios S, Petty J. Updated APSA Guidelines for the Management of Blunt Liver and Spleen Injuries. *J Ped Surgery*. 2023 Aug;58(8):1411-1418.

# Thank You!



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## About Connecticut Children's Pathways Program

Clinical pathways guide the management of patients to optimize consistent use of evidence-based practice. Clinical pathways have been shown to improve guideline adherence and quality outcomes, while decreasing length of stay and cost. Here at Connecticut Children's, our Clinical Pathways Program aims to deliver evidence-based, high value care to the greatest number of children in a diversity of patient settings.

These pathways serve as a guide for providers and do not replace clinical judgment.