

Blunt Liver Spleen Injury Clinical Pathway

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What is a Clinical Pathway?

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

Objectives of Pathway

- Standardize care to decrease variability in the management of patients with solid organ injuries
- Conform with current evidence-based guidelines
- Decrease unnecessary laboratory testing
- Avoid unnecessary PICU admissions
- Decrease patient length of stay

Why is Pathway Necessary?

- Abdominal injuries are the third most common cause of traumatic death and affect about 10% of injured children
  - ~10% of pediatric patients with blunt torso trauma have an intrabdominal injury
- Solid organs are the most common structures injured during blunt abdominal trauma with the liver and spleen being the most commonly injured
  - The liver and spleen are very vascular organs, and significant injury can result in life-threatening hemorrhage

Background

- 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.

Injury Classification

Spleen Injury Classification

Grade		Description
I	hematoma	subcapsular, less than 10% surface area
	laceration	capsular tear, less than 1 cm parenchymal depth
II	hematoma	subcapsular, 10 to 50% surface area; intraparenchymal less than 5 cm in diameter
	laceration	1 to 3 cm parenchymal depth which does not involve trabecular vessel
III	hematoma	subcapsular, greater than 50% surface area or expanding; ruptured subcapsular or parenchymal hematoma intraparenchymal greater than 5 cm in diameter or expanding
	laceration	greater than 3 cm parenchymal depth or involving trabecular vessels
IV	laceration	involving segmental of hilar vessels producing major devascularization (greater than 25% of the spleen)
V	laceration	completely shattered spleen
	vascular	hilar vascular injury which devascularizes the spleen
Advance one grade for multiple injuries, up to grade III		

Liver Injury Classification

Grade		Description
I	hematoma	subcapsular, less than 10% surface area
	laceration	capsular tear, less than 1 cm parenchymal depth
II	hematoma	subcapsular, 10 to 50% surface area; intraparenchymal less than 10 cm in diameter
	laceration	1 to 3 cm parenchymal depth, less than 10 cm in length
III	hematoma	subcapsular, greater than 50% surface area or expanding; ruptured subcapsular or parenchymal hematoma intraparenchymal greater than 10 cm in diameter or expanding
	laceration	greater than 3 cm parenchymal depth
IV	laceration	parenchymal disruption involving 25 to 75% of hepatic lobe or 1 to 3 Couinaud segments within a single lobe
V	laceration	parenchymal disruption involving greater than 75% of hepatic lobe or greater than 3 Couinaud segments within a single lobe
	vascular	juxtahepatic venous injuries (i.e. retrohepatic vena cava/central major hepatic veins
VI	vascular	hepatic avulsion
Advance one grade for multiple injuries, up to grade III		

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

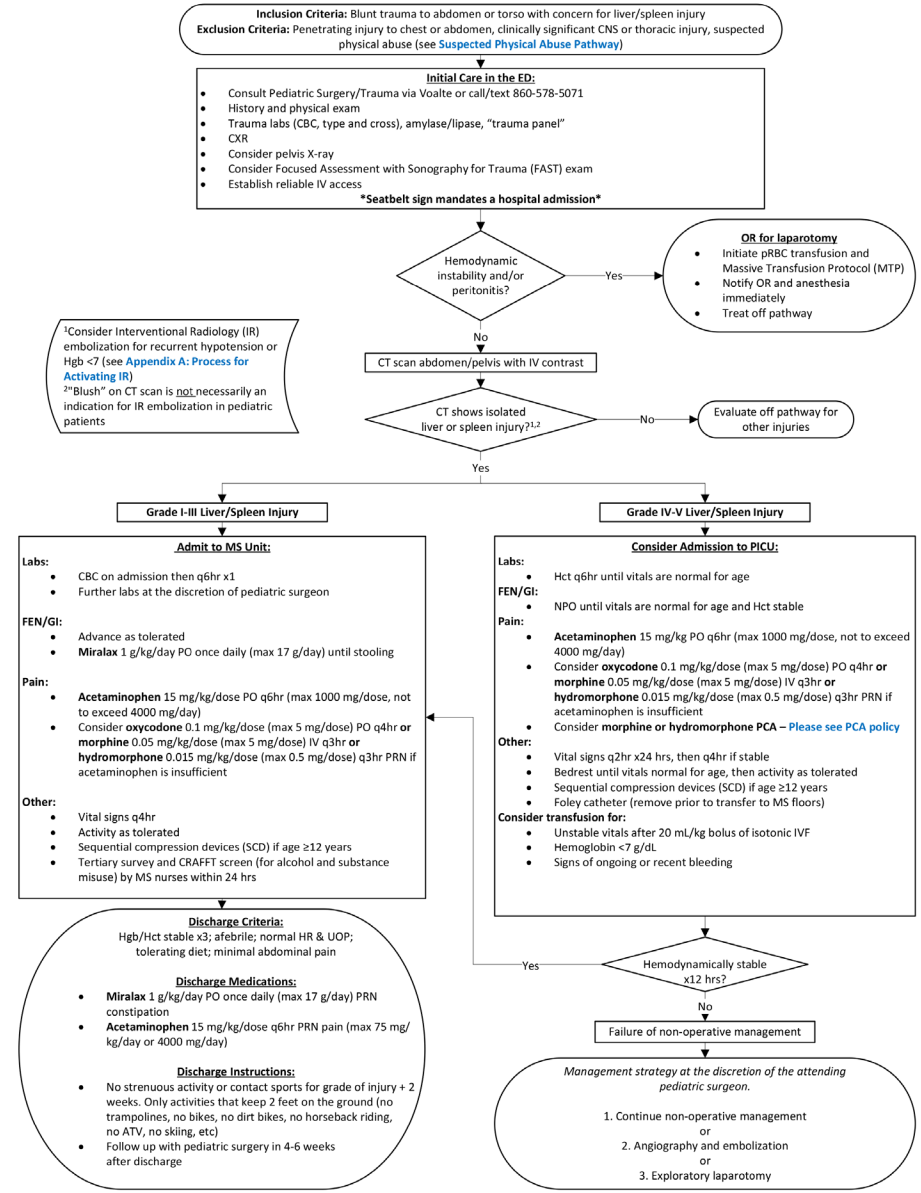
This is the Blunt Liver and Spleen Injury Clinical Pathway.

We will be reviewing each component in the following slides.

CLINICAL PATHWAY:

Blunt Liver and Spleen Injury

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



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

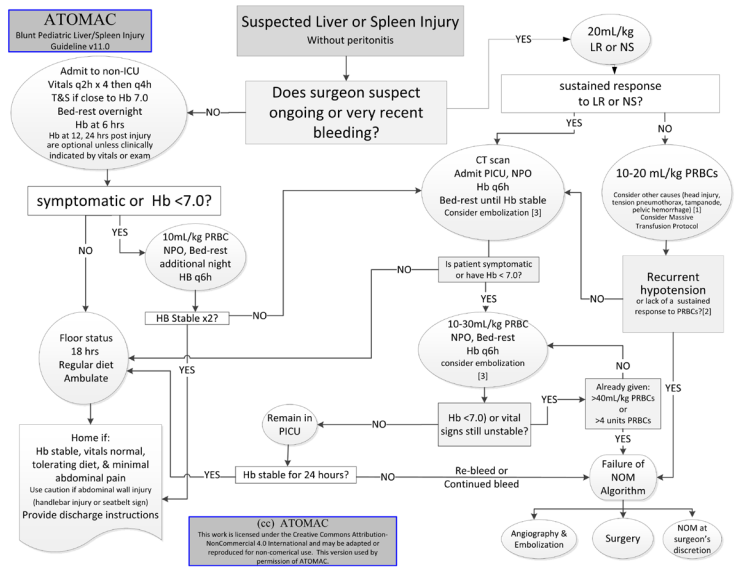


Figure 1. ATOMAC guideline for management of pediatric BLSI. [1]More than 50% of injured children with hypotension have no significant intra-abdominal bleeding but do have severe traumatic brain injury. [2]Recurrent hypotension within the first hour because of intra-abdominal bleeding or an SBP of less than 50 mm Hg after transfusion is an ominous sign, and strong consideration should be given to operative or angiographic intervention. [3]Embolizing CT blush may be considered, but more than 80% of children with blush do not require angiography for successful NOM. [4]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 1 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.[11] GRADE is a two-part process; first, the overall body of research

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

CLINICAL PATHWAY:

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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 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

Hemodynamic instability and/or peritonitis? — Yes → **OR for laparotomy**
- Initiate pRBC transfusion and Massive Transfusion Protocol (MTP)
- Notify OR and anesthesia immediately
- Treat off pathway

No → CT scan abdomen/pelvis with IV contrast

CT shows isolated liver or spleen injury?[1,2] — No → Evaluate off pathway for other injuries

Yes

[1]Consider Interventional Radiology (IR) embolization for recurrent hypotension or Hgb <7 (see Appendix A: Process for Activating IR)
[2]"Blush" on CT scan is not necessarily an indication for IR embolization in pediatric patients

Grade I-III Liver/Spleen Injury

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

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

Grade IV-V Liver/Spleen Injury

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 ≥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

Hemodynamically stable x12 hrs? — Yes → Admit to MS Unit

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

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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
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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

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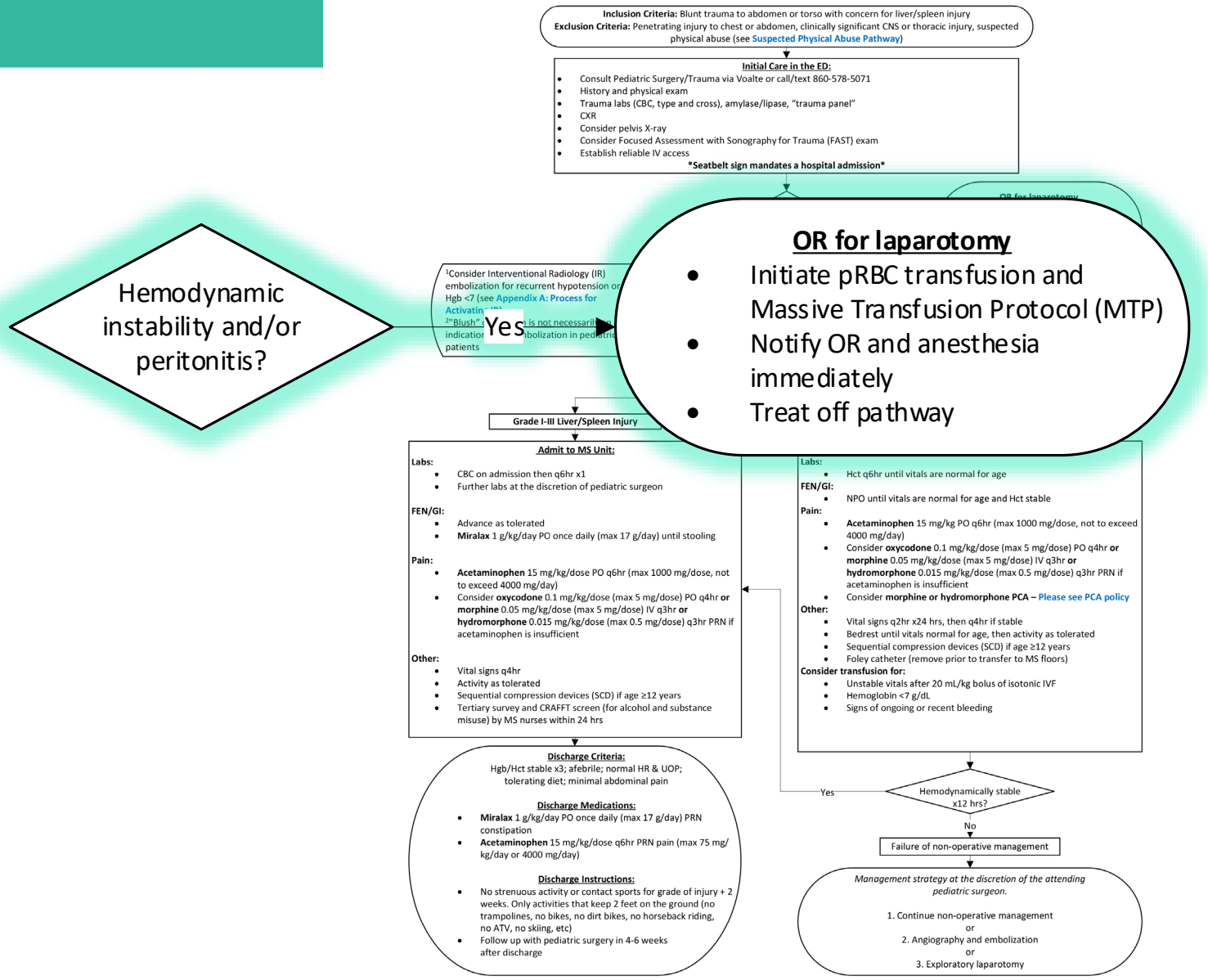
If the patient is hemodynamically unstable and/or has peritonitis:

- 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

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Blunt Liver and Spleen Injury

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Stable patients:

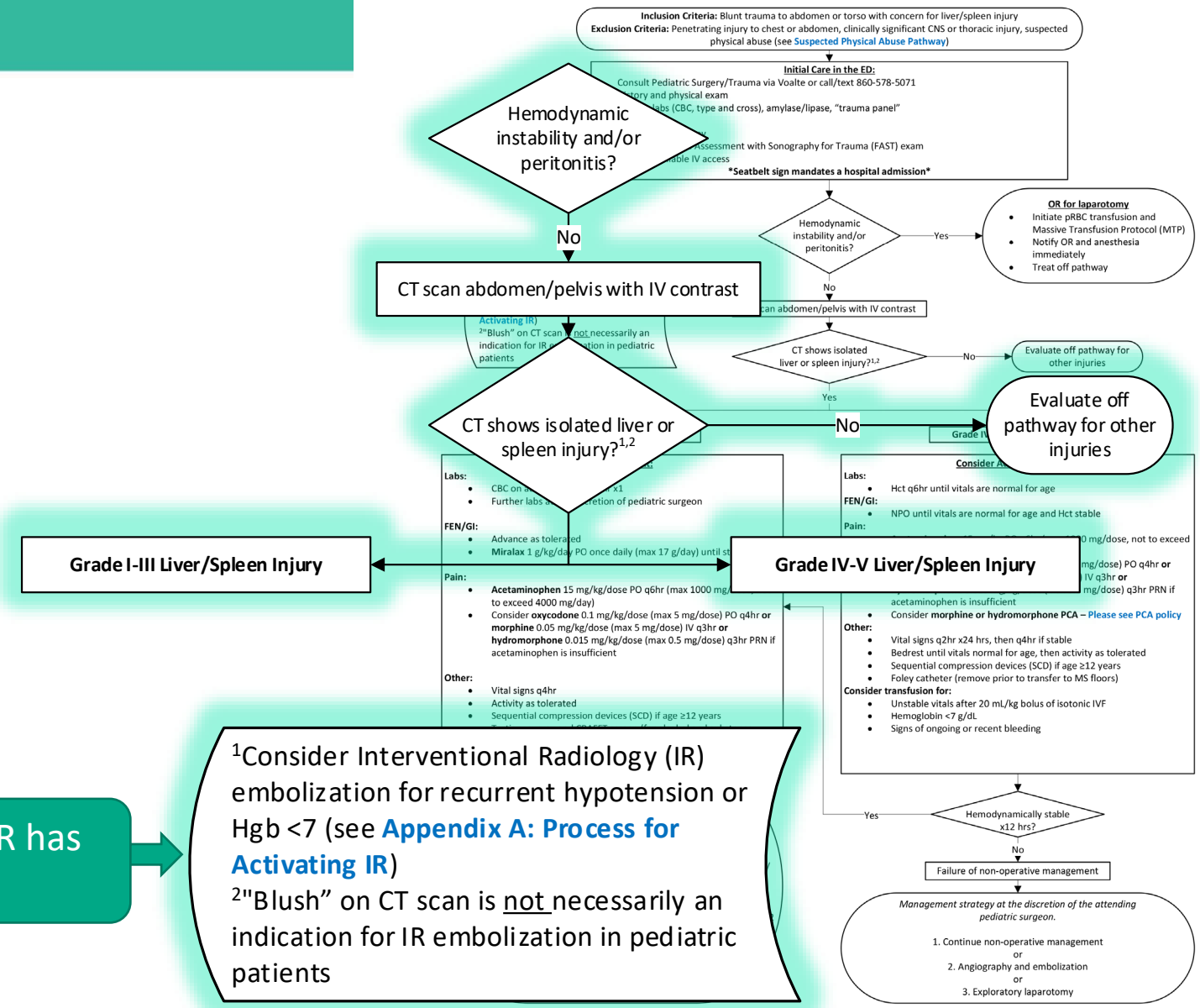
- Obtain CT scan of Abdomen and Pelvis with Contrast
- CT scan is read by a Radiologist who then Grades the injury
  - Grade I-V, higher the grade the more significant the injury
  - Further management will depend on the grade of injury

Process for activating IR has been added

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[1]Consider Interventional Radiology (IR) embolization for recurrent hypotension or Hgb <7 (see **Appendix A: Process for Activating IR**)

[2]"Blush" on CT scan is not necessarily an indication for IR embolization in pediatric patients

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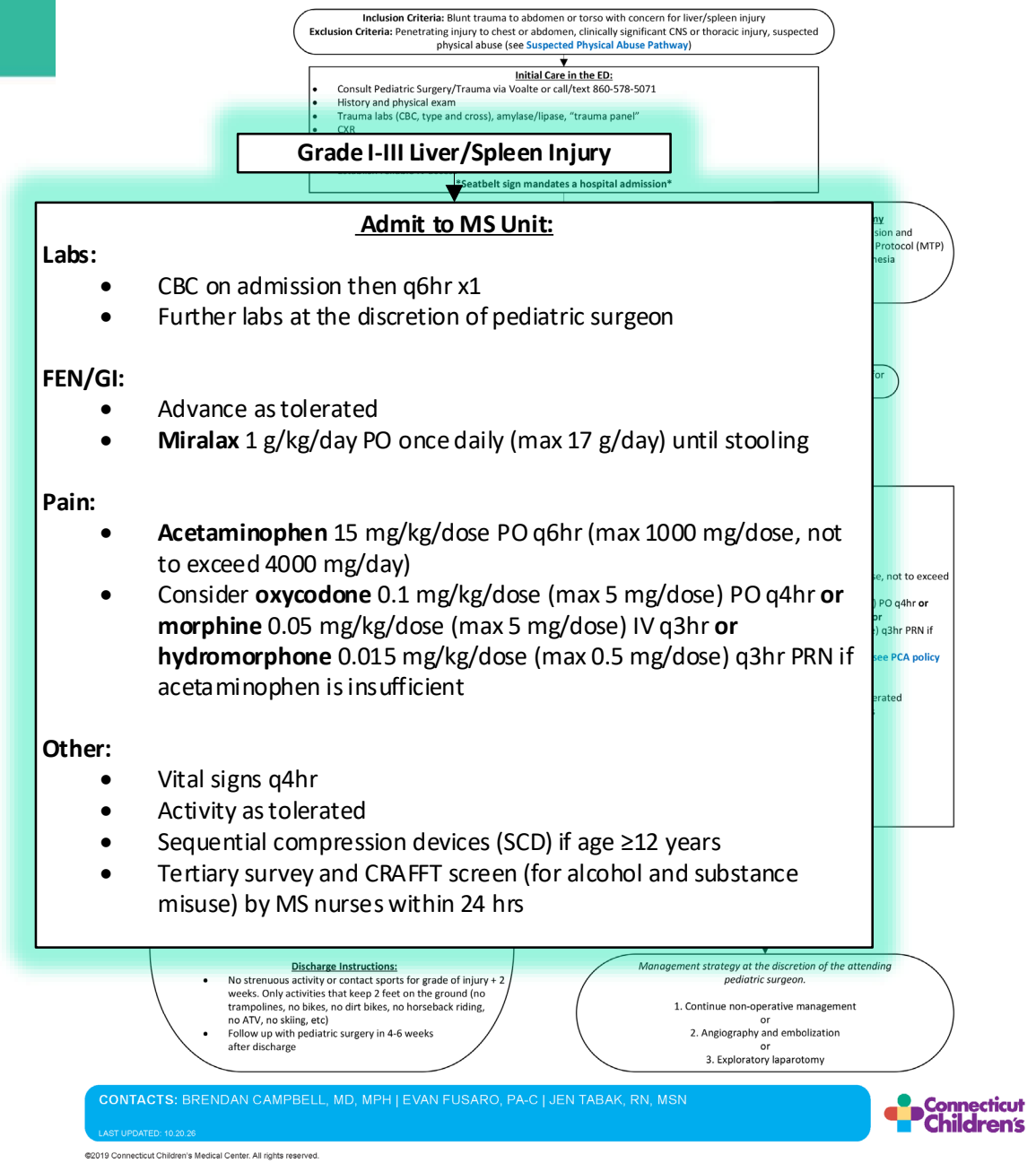
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Grade I, II, or III Injuries:

- 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



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Grade IV-V Liver/Spleen Injury

- CXR
- Consider pelvis X-ray

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 ≥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

3. Exploratory laparotomy

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

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Grade IV-V Liver/Spleen Injury

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- Hemoglobin <7 g/dL
- Signs of ongoing or recent bleeding

3. Exploratory laparotomy

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

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- CXR
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- Consider Focused Assessment with Sonography for Trauma (FAST) exam
- Establish reliable IV access

Grade IV-V Liver/Spleen Injury

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- 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 ≥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:

- If patient remains clinically stable for 12 hours they may then transfer to MS units when appropriate

tolerating diet; minimal abdominal pain

Discharge Medications:

- **Miralax** 1 g/kg/day PO once daily (max 17 g/day) PRN constipation
- Acetaminophen

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

Yes

Hemodynamically stable x12 hrs?

No

Hemodynamically stable x12 hrs?

pediatric surgeon.

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

CONTACTS: BRENDAN CAMPBELL, MD, MPH | EVAN FUSARO, PA-C | JEN TABAK, RN, MSN

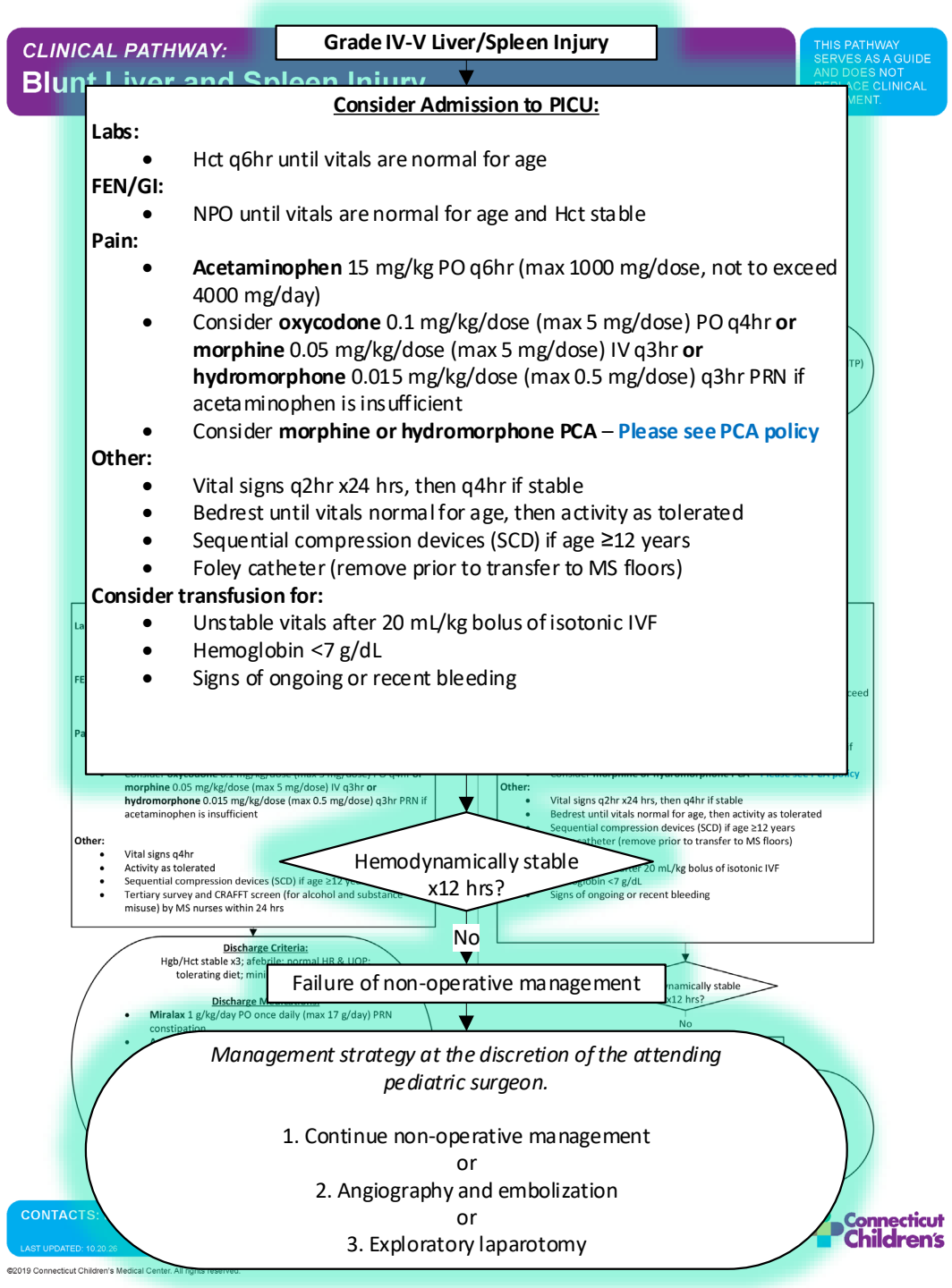
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Grade IV or V Injuries:

- 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.



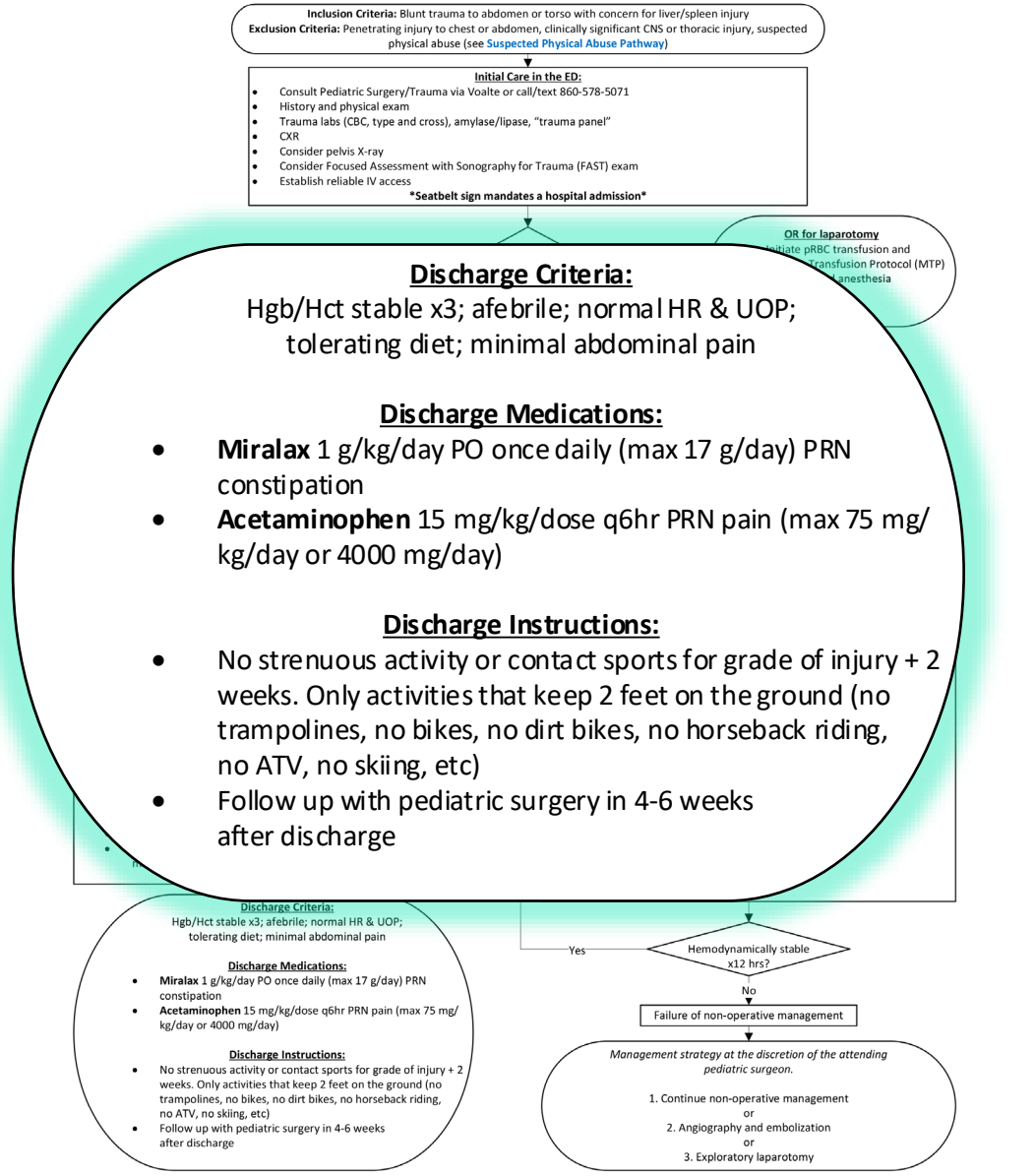
Discharge Planning:

- 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

CLINICAL PATHWAY:

Blunt Liver and Spleen Injury

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



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Review of Key Points

- 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 hydromorphine 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 CBCs 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

- % Patients with pathway order set (automated, collected by Surgical Quality)
- % Patients transfused (automated, collected by Surgical Quality)
- ALOS by Grade of Injury (Table by Month/Grade) (Collected by Trauma Program)
- Average time (minutes) arrival to request for interventional radiology (Collected by Trauma Program)
- Average time (minutes) from interventional radiology request to procedure (arterial puncture) (Collected by Trauma Program)

Pathway Contacts

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Thank You!

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.