

Scientific discussion

I. INITIAL ASSESSMENT AND MANAGEMENT

KMQ-1. What are key considerations in the initial assessment and management in patients with suspected or confirmed blunt splenic injury?

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
None	Developed new recommendations based on expert opinion of the SAG and the B.C. trauma system.

II. OPERATIVE MANAGEMENT

KMQ-2. What are the indications for operative management (OM) of blunt splenic injuries?

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE	
<ul style="list-style-type: none"> Patients who have diffuse peritonitis or who are hemodynamically unstable after blunt abdominal trauma should be taken urgently for laparotomy. [EAST 2012: Level 1] OM should be performed in patients with hemodynamic instability and/or with associated lesions like peritonitis or bowel evisceration or impalement requiring surgical exploration. [WSES 2017: 2A] 	<p>Accepted hemodynamic instability as an indicator of OM but rejected diffuse peritonitis and bowel evisceration (A).</p>	
<ul style="list-style-type: none"> Splenectomy should be performed when NOM with AG/AE failed, and patient remains hemodynamically unstable or shows a significant drop in hematocrit levels or continuous transfusion are required. [WSES 2017: 2A] 	<p>Accepted continued hemodynamic instability as an indicator of OM (A). Emphasized a balance of clinical presentation and other situational contexts, including site-specific resources and feasibility of transfer/transport to reflect the BC trauma system (B).</p>	
<ul style="list-style-type: none"> OM should be performed in moderate and severe lesions even in stable patients in centers where intensive monitoring cannot be performed and/or when AG/AE is not rapidly available. [WSES 2017: 2A] 	<p>Accepted the concept of resource requirements for OM. Emphasized early consult with general surgery and initiation of PTN call to discuss transport versus onsite splenectomy and to encourage site-to-site communication.</p>	
PEDIATRIC	<ul style="list-style-type: none"> In the pediatric patient, NOM (non-operative management) is considered to have failed if continued hypotension exists after appropriate crystalloid and blood product resuscitation. [ATOMAC: 1A] 	
	<ul style="list-style-type: none"> In the pediatric patient, splenectomy and/or angioembolization should be performed when NOM has failed. [ATOMAC: 1A] 	

III. NON-OPERATIVE MANAGEMENT

KMQ-3. What are the indications for non-operative management (NOM) in blunt splenic injuries?

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<p>Indications for NOM</p> <ul style="list-style-type: none"> • A routine laparotomy is not indicated in the hemodynamically stable patient without peritonitis presenting with an isolated splenic injury. [EAST 2012: Level 2] • NOM in splenic injuries is contraindicated in the setting of unresponsive hemodynamic instability or other indicators for laparotomy (peritonitis, hollow organ injuries, bowel evisceration, impalement). [WSES 2017: 1A] 	<p>Adapted EAST and WSES recommendations to create a new recommendation (A) indicating a trial of NOM in patients who are hemodynamically stable after resuscitation.</p>
<p>Non-contraindications for a trial of NOM</p> <ul style="list-style-type: none"> • The severity of splenic injury (as suggested by CT grade or degree of hemoperitoneum), neurologic status, age >55 and/or the presence of associated injuries are not contraindications to a trial of non-operative management in a hemodynamically stable patient. [EAST 2012: Level 2] • Age above 55 years old alone, large hemoperitoneum alone, hypotension before resuscitation, GCS < 12 and low-hematocrit level at the admission, associated abdominal injuries, blush at CT scan, anticoagulation drugs, HIV disease, drug addiction, cirrhosis and need for blood transfusions should be taken into account, but they are not absolute contraindications for NOM. [WSES 2017: 2B] • Patients with hemodynamic stability and absence of other abdominal organ injuries requiring surgery should undergo an initial attempt of NOM irrespective of injury grade. [WSES 2017: 2A] 	<p>Consolidated the external recommendations into a single statement (A) regarding the absence of absolute contraindications to a trial of NOM in the hemodynamically stable or stabilized patient.</p>

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE	
<p>Other considerations: Monitoring and OR availability</p> <ul style="list-style-type: none"> • Nonoperative management of splenic injuries should only be considered in an environment that provides capabilities for monitoring, serial clinical evaluations, and an operating room available for urgent laparotomy. [EAST 2012: Level 2] • NOM of moderate or severe spleen injuries should be considered only in an environment that provides capability for patient intensive monitoring, AG/AE, an immediately available OR and immediate access to blood and blood product or alternatively in the presence of a rapid centralization system and only in patients with stable or stabilized hemodynamic and absence of other internal injuries requiring surgery. [WSES 2017: 2A] • Strong evidence exists that age above 55 years old, high ISS, and moderate to severe splenic injuries are prognostic factors for NOM failure. These patients require more intensive monitoring and higher index of suspicion. [WSES 2017: 2B] 	<p>Incorporated concepts from EAST and WSES statements. The concept of negligible risk of ongoing or delayed hemorrhage was introduced to indicate the types of splenic injuries that can be safely managed in a rural/remote facility with consult with a HLOC centre (B).</p> <p>Adopted WSES statement regarding NOM of moderate to severe splenic injuries and added site-specific requirements, such as access to radiology, interventional radiology and surgical capabilities. Provincial communication pathways for trauma were outlined and emphasized. (C)</p>	
<p>PEDIATRIC</p>	<p>Pediatric patients</p> <ul style="list-style-type: none"> • In the pediatric patient, hemodynamic stability, not grade of injury should dictate candidacy for NOM. [ATOMAC: 1A] • In the pediatric patient, hemodynamic status at presentation and/or high risk injuries (Grade 3–5) may be used as a determinant for pediatric ICU admission. [ATOMAC: 2B] • In the pediatric patient, length of stay should be determined by presentation, evolution in-hospital as well as grade of injury. [APSA: Grade C] 	<p>Incorporated into recommendations.</p>

ADDITIONAL LITERATURE SUPPORT

What is the success rate of non-operative management of blunt splenic injuries?

Overall reported success rate of observational management (without angiography) is 92–96%. ⁸⁻¹¹

Success rate of observational management of blunt splenic injury by injury grade

SOURCE (lead author, year)	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5*
Brillantino 2016 ¹⁰	100 %	95.4 %	95 %	90.9 %	83.3 %
Brault-Noble 2012 ⁸	100 %	98 %	84 %	79 %	78 %
Bhullar 2012 ¹²	99 %	98 %	94 %	77 %	37 %
McCray 2008 ⁹	100 %	99 %	94 %	84 %	100 %

* Grade 5 blunt splenic injuries are rare, resulting in a greater variability in success rate reported in studies

Recent success rate of non-operative management (NOM) (i.e. observational management only + NOM with angioembolization) has been reported in the range of 93–100%. ^{9,13}

What are the complications of non-operative management of blunt splenic injury?

Complications in NOM in blunt splenic injury include progression to splenectomy, hemodynamic instability and/or evidence of ongoing bleeding, and delayed laparotomy for missed associated injury, resulting in re-admission or emergency laparotomy.

Overall reported failure rate of NOM is 4 to 15% (according to a 2017 review of studies published 2000 onwards²), with higher rates reported for high grade injuries:

Failure rate of non-operative management of splenic trauma by injury grade

SOURCE (lead author, year)	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5*
Scarborough 2016 ¹⁴	–	–	–	17.8 %	29 %
Miller 2014 ¹⁵	–	–	3 %	7 %	50 %
Skattum 2013 ¹⁶	6 %	0 %	5 %	2 %	25 %
Bhullar 2012 ¹²	1 %	2 %	5 %	11 %	26 %
Velmahos 2010 ¹⁷	–	–	–	34.5 %	60 %
Requarth 2011 ¹⁸ (meta-analysis of studies published 1996–2000)	4.3 %	9.1 %	19.9 %	43.7 %	83.1 %
Peitzman 2000 ¹⁹	5 %	10 %	20 %	33 %	75 %

* Grade 5 blunt splenic injuries are rare, resulting in a greater variability in success rate reported in studies

What is the risk (probability) of delayed hemorrhage following non-operative management of splenic injuries?

Probability of delayed hemorrhage after NOM ranges from 0 to 15%^{9,20,21}, with a higher probability in higher grade injuries.²

It is difficult to distinguish between delayed hemorrhage and hemorrhage that was missed on the initial CT. This is particularly the case with older studies that used older CT technology. For this reason, more recent studies that clearly indicate delayed hemorrhage have been consulted.

What is the rate of spontaneous resolution of active hemorrhage detected as contrast blush on initial CT scan?

Probability of blush detected on CT leading to absence of extravasation on angiography ranges from 2.3 to 47%.²²⁻²⁴

One retrospective study showed 100% (3/3) patients with contrast blush on initial CT had no blush on post-transfer repeat CT.²²

Conservatively estimated, NOM of splenic injury results in a success rate of >98% for Grade 1 to 2 injuries, >90% for Grade 3 injuries, and >75% for Grade 4 to 5 injuries. Angiography is variably used to achieve these rates.

PEDIATRIC

What is the success rate of observational management of blunt splenic injury by grade in children?

SOURCE (lead author, year)	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5*
Linnaus 2017 ²⁵	92.9 %	93.4 %	96.2 %	92 %	65 %
Fakhry 2016 ²⁶	100 %	100 %	80 %	57 %	50 %

What is the risk (probability) of delayed hemorrhage following non-operative management of splenic injuries in children?

The most recent study from the ATOMAC group reported a 0.2% incidence of delayed splenic bleeding in a multi-institutional, prospective study examining 509 patients.²⁷

IV. ANGIOGRAPHY / ANGIOEMBOLIZATION

KMQ-4. What are the indications for angiography/angioembolization (AG/AE) in blunt splenic injuries?

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<p>Indications</p> <ul style="list-style-type: none"> • Angiography should be considered for patients with American Association for the Surgery of Trauma (AAST) grade of greater than III injuries, presence of a contrast blush, moderate hemoperitoneum, or evidence of ongoing splenic bleeding. [EAST 2012: Level 2] • AG/AE may be considered the first-line intervention in patients with hemodynamic stability and arterial blush on CT scan irrespective from injury grade. [WSES 2017: 2B] • AG/AE may be performed in hemodynamically stable and rapid responder patients with moderate and severe lesions and in those with vascular injuries at CT scan (contrast blush, pseudo-aneurysms and arterio-venous fistula). [WSES 2017: 2A] • AG/AE should be considered in all hemodynamically stable patients with WSES grade III lesions, regardless with the presence of CT blush. [WSES 2017: 1B] • AG/AE could be considered in patients undergoing to NOM, hemodynamically stable with signs of persistent hemorrhage regardless of the presence of CT blush once excluded extrasplenic source of bleeding. [WSES 2017: 1C] • The panel suggests splenic artery angioembolization (SAE) as the first-line intervention in patients with hemodynamic stability and arterial blush on CT scan, irrespective of injury grade, where the expertise and resources required to carry out the procedure are readily available. [WSES 2022: Conditional recommendation, Moderate quality of evidence] • A low threshold for SAE is suggested for patients with AAST Grade 3 blunt splenic injury without contrast extravasation in the presence of risk factors for NOM failure (i.e., age above 55 years old, high injury severity score, the need for red cell transfusions in ED or during the first 24 h, patients on anticoagulant therapy, HIV disease, cirrhosis, and drug addiction). [WSES 2022: Conditional recommendation, Low quality of evidence] 	<p>Accepted hemodynamic stability (including after resuscitation and not likely to abate) and diagnostic imaging abnormalities (i.e. active vascular extravasation, pseudoaneurysm, and arterio-venous fistula) as indicators for IR consult for AG/AE (A, B, C).</p> <p>Contrast blush on CT emphasized as an elevated risk for NOM failure.</p> <p>Emphasized interdisciplinary collaboration between consulting surgeon and interventional radiologist (D).</p>

NEW

NEW

PEDIATRIC

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<p>Contraindications</p> <ul style="list-style-type: none"> • Contrast blush on CT scan alone is not an absolute indication for an operation or angiographic intervention. Factors such as patient age, grade of injury, and presence of hypotension need to be considered in the clinical management of these patients. [EAST 2012: Level 3] • Hemodynamically stable patients with WSES grade II lesions without blush should not undergo routine AG/AE but may be considered for prophylactic proximal embolization in presence of risk factors for NOM failure. [WSES 2017: 2B] 	<p>Emphasized interdisciplinary collaboration between consulting surgeon and interventional radiologist in the clinical decision-making (D).</p>
<p>Management pathway</p> <ul style="list-style-type: none"> • In patients with bleeding vascular injuries and in those with intraperitoneal blush, AG/AE should be performed as part of NOM only in centers where AG/AE is rapidly available. In other centers and in case of rapid hemodynamic deterioration, OM should be considered. [WSES 2017: 2B] • The panel suggests angiography and eventual SAE in all hemodynamically stable adult patients with AAST Grades 4-5 splenic injuries, even in the absence of CT blush, in centers with adequate experience and where SAE is rapidly available, especially when concomitant surgery that requires change of position and that may cause dislodgement of clots and rebleeding (i.e., spinal surgery in the prone position) is needed. [WSES 2022: Conditional recommendation, Moderate quality of evidence] • The panel suggests preferring proximal SAE over distal SAE when splenic artery angioembolization is needed. [WSES 2022: Conditional recommendation, Low quality of evidence] 	<p>Outlined transfer requirements to HLOC and emphasized inter-facility communication. (E)</p>
<p>Pediatric patients</p> <ul style="list-style-type: none"> • In the pediatric patient, contrast extravasation on CT scan does not mandate AG/AE. [ATOMAC: 2C] • In the pediatric patient, AG/AE may be considered as an alternative to splenectomy (ATOMAC 2C) if hemodynamics allow. 	<p>The majority of patients with contrast extravasation will be successfully managed conservatively. However, in these patients with contrast extravasation there is a greater risk for failure of NOM, and the appropriate services should be made aware of the potential need for angioembolization or splenectomy.</p> <p>AG/AE may be considered as an alternative to splenectomy if hemodynamics allow.</p>

ADDITIONAL LITERATURE SUPPORT

What is the success rate of angiography/angioembolization (AG/AE) in blunt splenic injuries?

Success rate of AG/AE range from 73 to 100%.²⁸

In severe injuries (Grades 4 to 5), difference in success rate between NOM with and without angioembolization can be as great as 78.4%.⁹ Failure rate of NOM without AG/AE can be as high as 26% in these injuries.²⁹ These findings are supported by a 2017 systematic review and meta-analysis comparing NOM with and without AE, which showed that there is no difference in NOM failure rate, mortality, hospital length of stay, or blood transfusion requirements but that morbidity was significantly higher in splenic AE vs. NOM, with AE significantly reducing the failure of NOM in Grades 4 to 5 injuries.³⁰

Conflicting evidence exists for the benefits of angioembolization in preventing splenectomy.^{31, 32}

What are the complications of angiography/angioembolizations in blunt splenic injuries in adults?

Major complications of AE include: delayed bleeding, total or subtotal splenic infarction, splenic abscesses, acute renal insufficiency, pseudocysts, and puncture-related complications. Rate of major complications range from 3.7 to 28.5%.^{1, 2}

Minor complications include fever, pleural effusion, coil migration, and partial splenic infarction. Rate of minor complications range from 23 to 61%.^{1, 2}

No randomized control trials exist comparing morbidity related to AG/AE and NOM without AG/AE.

A large prospective study found AG/AE-related morbidity of 47% compared to morbidity of 10% in NOM without AG/AE.¹¹

A large study of post-discharge complications in patients who received NOM found higher rate of thirty-day readmission among patients who received NOM with AE than patients who did not receive AE (12.8% vs. 7.4%, $p=0.002$).³³

NEW

An RCT comparing one-month splenic salvage rate between prophylactic splenic AE (with surveillance) and splenic AE if necessary found no significant difference in overall complications.³⁴

PEDIATRIC

What evidence is available regarding angiography/angioembolization in children with blunt splenic injury?

Several investigations have documented the safety of not performing AG/AE in the context of contrast extravasation on CT scan in the pediatric patient. Approximately 80% of patients may still be successfully managed without intervention.^{5, 35, 36} However, in patients with contrast extravasation the risk for failed NOM is greater than those without evidence of extravasation.^{25, 37, 38} Angioembolization should be considered a safe alternative to splenectomy for select pediatric patients and in some cases the first line therapy with the added benefit of decreased length of stay.^{5, 37-39} Adolescents cared for at adult sites were more likely to have AG than matched patients with similar injuries at pediatric centres.³⁷

KMQ-5. With regard to selective versus non-selective angioembolization, what is the preferred approach to angioembolization in splenic injuries?

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<ul style="list-style-type: none"> In the presence of a single vascular abnormality (contrast blush, pseudo-aneurysms, and artero-venous fistula) in minor and moderate injuries, the currently available literature is inconclusive regarding whether proximal or distal embolization should be used. In the presence of multiple splenic vascular abnormalities or in the presence of a severe lesion, proximal or combined AG/AE should be used, after confirming the presence of a permissive pancreatic vascular anatomy. [WSES 2017: 1C] 	<p>Adopted first sentence. Replaced second sentence with preference for selective (i.e., proximal) angioembolization due to fewer minor complications reported in retrospective cohort studies (see below).</p>

ADDITIONAL LITERATURE SUPPORT

**What is the effectiveness of selective versus non-selective angioembolization?
What are the complications?**

No prospective studies or randomized controlled trials available on the subject.

No significant difference observed in overall failure rate between distal and proximal embolization.

No significant difference has been observed between proximal and distal embolization for incidence of major infarctions, infections, or re-bleeding.

Higher rate of minor complications has been reported in distal than in proximal embolization (see table below). Proximal embolization is also protective in high grade injuries.⁴⁰

Complications in proximal vs. distal splenic embolization

COMPLICATION	PROXIMAL EMBOLIZATION	DISTAL EMBOLIZATION
Minor infarction	0.0 to 8.4 % ⁴¹	14.3 to 19.8 % ³²
Re-bleeding	2.2 to 2.8 % ³²	1.6 to 4.5 % ³²

V. TRANSFER TO HIGHER LEVEL OF CARE (HLOC)

KMQ-6. What are the indications for transfer of patients with blunt splenic injuries to a higher-level trauma center?

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
None	Recommendations regarding transfer to higher level of care were drafted, based on provincial realities and the expert opinion of the SAG.

VI. ACUTE HOSPITAL CARE

KMQ-7. What type and duration of monitoring are necessary for patients with blunt splenic injuries?

KNOWLEDGE SYNTHESIS

NEW

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<ul style="list-style-type: none"> • Clinical and laboratory observation associated [with] bed rest in moderate and severe lesions is the cornerstone in the first 48–72 hour follow-up. [WSES 2017: 1C] • The panel suggests 1 day (for low-grade splenic injuries AAST Grades 1–2) to 3 days (for high-grade splenic injuries AAST Grades 3–5) of hospital admission, with the duration of stay based on hemodynamic status, hemoglobin and hematocrit stability, and results of the follow-up CEUS/CT scan at 48–72 h for adult patients. [WSES 2022: Conditional recommendation, Moderate quality of evidence] • Admission to a monitored setting (high dependency unit or intensive care unit) is suggested for adult patient with high-grade splenic injuries treated with NOM. [WSES 2022: Conditional recommendation, Low quality evidence] • The panel suggests that early discharge after NOM for blunt splenic injury, especially those with AAST Grade ≥ 3, could be at least accompanied by an explicit patient and caregiver education regarding the risk of outpatient rupture and, in every case, an outpatient clinical follow-up, telephone, GP-follow-up, or community nurse follow-up after 5–7 days is recommended. [WSES 2022: Conditional recommendation, Moderate quality of evidence] • There is not enough evidence to recommend specific hemodynamic monitoring in patients with splenic injuries treated with NOM. The panel suggests that all patients treated with NOM for high-grade splenic injuries (AAST Grade ≥ 3) might receive continuous hemodynamic monitoring of vital parameters (pulse pressure, cardiac frequency, and peripheral O₂ saturation) and frequent serum hemoglobin and hematocrit levels evaluation (every 8 h). [WSES 2022: Conditional recommendation, Very low quality of evidence] • In patients with low-grade splenic injuries and stable hemodynamic status (AAST Grades 1–2) treated with NOM, the panel suggests close medical and nursing monitoring with evaluations of hemoglobin and hematocrit levels every 12–24 h if no complication occurs. [WSES 2022: Conditional recommendation, Very low quality of evidence] 	<p>The only external recommendation for monitoring pertains to the first 48 to 72 hours. Created new recommendations outlining monitoring requirements based on expert opinion.</p>

	EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
PEDIATRIC	<p>Pediatric patients</p> <ul style="list-style-type: none"> In the pediatric patient, high risk injuries or initial hemodynamic instability should be monitored in a pediatric ICU. [APSA LOE 4: Grade C; ATOMAC: 2B] In the pediatric patient, length of stay can be based on grade of injury, but may be safely reduced from prior APSA recommendations of grade +1 day [APSA: Grade C] 	<p>Hemodynamically unstable pediatric patient can be managed locally in an ICU. Second statement was adopted (E).</p>

KMQ-8. When is supplementary imaging required in the hospitalized patient?

KNOWLEDGE SYNTHESIS

	EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
NEW	<ul style="list-style-type: none"> • After blunt splenic injury, clinical factors such as a persistent systemic inflammatory response, increasing/persistent abdominal pain, or an otherwise unexplained drop in hemoglobin should dictate the frequency of and need for follow-up imaging for a patient with blunt splenic injury. [EAST 2012: Level 3] • CT scan repetition during the admission should be considered in patients with moderate and severe lesions or in decreasing hematocrit, in presence of vascular anomalies or underlying splenic pathology or coagulopathy, and in neurologically impaired patients. [WSES 2017: 2A] • The panel suggests radiological follow-up to be based on clinical findings in AAST Grades 1–2 splenic trauma treated with NOM and suggests against routine imaging follow-up in these patients. [WSES 2022: Conditional recommendation, Low quality of evidence] • The panel suggests repeating imaging with contrast-enhanced ultrasound (CEUS)/CT scan in 48 h to 72 h post-admission and, eventually, at 5–7 days of trauma (only if remarkable changes in CT scan at 72 h are detected, or new signs/symptoms related to the trauma occur) in adult patients with AAST Grade 3 splenic injuries or higher treated with NOM, regardless of whether SAE has been performed or not. [WSES 2022: Conditional recommendation, Low quality of evidence] • The panel suggests, in expert hands and dedicated institutions, using CEUS as an alternative imaging modality in the follow-up of conservatively managed splenic trauma to reduce the number of CT examinations, especially in children [WSES 2022: Conditional recommendation, Very low quality of evidence] 	<p>Developed umbrella phrase “any changes in clinical status” as potential indicator of repeat imaging or other investigations. Accepted WSES indication for repeat CT in higher grade injuries and added time frame within which to obtain the repeat scan based on evidence of delayed splenic pseudoaneurysm formation as early as 48 hours (see below) and on logistical realities of provincial trauma centres.</p>
PEDIATRIC	<p>Pediatric patients</p> <ul style="list-style-type: none"> • Routine follow-up imaging for asymptomatic, uncomplicated, low grade injuries in children with solid organ injuries is not indicated. The risk of complications in high grade spleen, liver or kidney injuries is low but may require interventions. Limited data are available to support the need for follow-up imaging for high grade injuries. Imaging should be reserved for symptomatic patients at follow up. [APSA: Level IV evidence, Grade C recommendation] 	<p>There is no relevant literature about early repeat imaging specific to pediatric patients with splenic injury; obviating unnecessary radiation appears justified.</p>

ADDITIONAL LITERATURE SUPPORT

**What is the incidence of delayed splenic pseudoaneurysm formation by injury grade?
Timing of formation?**

Overall rate of incidence of delayed splenic pseudoaneurysm formation ranges from 3.0 to 15.4%^{19, 31, 32, 42-44} to as high as 74%.⁴⁵

A retrospective multicenter study¹¹ found incidence of delayed splenic pseudoaneurysm formation in 17.7% of patients treated with initial observation and 11.9% of patients treated with early angioembolization.

Probability of delayed splenic pseudoaneurysm formation is greater in patients with high grade splenic injuries² – as high as 50% in Grade 4 to 5 injuries versus 24% in Grade ≤3 injuries.³³

Delayed splenic pseudoaneurysm formation by injury grade

SOURCE (lead author, year)	GRADE 1	GRADE 2	GRADE 3	GRADE 4	GRADE 5
Muroya 2013 (n=16)	0 %	30.4 %	18.4 %	0 %	–
Leeper 2014 (n=25)	4 %	16 %	24 %	56 %	–

Timing of splenic pseudoaneurysm formation varies, from 48 hours²¹ to 1 to 8 hospital days after injury.¹¹ A large prospective study found the 180-day risk of splenectomy after NOM was 3.5%, with higher risk for higher grade injuries (6.9% for Grades 3 to 5 injuries).³⁴

What is the risk of pseudoaneurysm bleeding?

Major risk of splenic pseudoaneurysm is hemorrhage leading to splenic rupture:

- Risk of hemorrhage from splenic pseudoaneurysm: 37%⁴⁶
- Risk of splenic rupture due to undetected splenic pseudoaneurysm: 3 to 10%⁴²
- Risk of mortality after splenic rupture: 10 to 25%,⁴⁷ and as high as 90% if left untreated⁴¹

KMQ-9. What activity restrictions should be imposed on patients with blunt splenic injuries, in hospital and post-discharge?

KNOWLEDGE SYNTHESIS

	EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
NEW	<ul style="list-style-type: none"> Activity restriction may be suggested for 4–6 weeks in minor injuries and up to 2-4 months in moderate and severe injuries. [WSES 2017: 2C] Allow early mobilization within 24 h in low-grade (Grades 1-2) splenic injuries treated with NOM. Patients with AAST Grade 3 injuries can be mobilized after 2 days from trauma if no other contraindications exist. [WSES 2022: Conditional recommendation, low quality evidence] In high-grade splenic injuries (Grades 4-5), if no other contraindications to early mobilization exist, the patient can be mobilized safely after 2 days from trauma when three successive hemoglobins 8 h apart after the first are within 10% of each other, and if clinical parameters remain stable. [WSES 2022: Conditional recommendation, low quality evidence] 	<p>New recommendation has been created, based on recent evidence (see below) and expert opinion of the SAG.</p>
PEDIATRIC	<p>Pediatric patients</p> <ul style="list-style-type: none"> In the pediatric patient, bed rest should be limited to 1 day for low risk injuries (Grade 1-2), 2 days for high risk injuries (grade 3-5) [APSA: Grade C] In the pediatric population, patients should avoid physical activity as per APSA recommendations for a total duration of grade + two weeks. [APSA: Grade C] 	<p>Both statements adopted.</p>

ADDITIONAL LITERATURE SUPPORT

What is the risk of delayed hemorrhage in blunt splenic patients without activity restrictions?

PED

Several recent studies have shown no association between early mobilization with minimal bed rest and delayed splenic hemorrhage both in adult^{19, 48-50} and pediatric^{5, 51, 52} patients with blunt splenic injuries managed via NOM.

VII. VENOUS THROMBOEMBOLISM PROPHYLAXIS

KMQ-10. What is the optimal timing for initiating deep vein thrombosis (DVT) prophylaxis in patients with blunt splenic injuries?

KNOWLEDGE SYNTHESIS

NEW

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<p>Chemical prophylaxis</p> <ul style="list-style-type: none"> Pharmacologic prophylaxis to prevent venous thromboembolism can be used for patients with isolated blunt splenic injuries without increasing the failure rate of non-operative management, although the optimal timing of safe initiation has not been determined. [EAST 2012: Level 3] Spleen trauma without ongoing bleeding is not an absolute contraindication to LMWH-based prophylactic anticoagulation. [WSES 2017: 2A] LMWH-based prophylactic anticoagulation should be started as soon as possible from trauma and may be safe in selected patients with blunt splenic injury undergoing NOM. [WSES 2017: 2B] In patients with oral anticoagulants the risk-benefit balance of reversal should be individualized. [WSES 2017: 2B] For patients with blunt splenic injuries treated with NOM with/without splenic artery angioembolization (SAE), in the absence of specific complications, the panel suggests that DVT and VTE prophylaxis with LMWH be started within 24 h from hospital admission for patients with AAST Grades 1–2 and within 48–72 h for those with AAST Grades 3–5 splenic injuries. [WSES 2022: Conditional recommendation, Moderate quality of evidence] 	<p>Consolidated external recommendations.</p> <p>Added timing of VTE prophylaxis (i.e. within 12 hours for every injury grade) based on the expert opinion of the SAG.</p>
<p>Mechanical prophylaxis</p> <ul style="list-style-type: none"> Mechanical prophylaxis is safe and should be considered in all patients without absolute contraindication to its use. [WSES 2017: 2A] 	<p>Added a contraindication for the use of mechanical prophylaxis: patients with lower extremity trauma.</p>

ADDITIONAL LITERATURE SUPPORT

What is the risk of developing thrombosis VTE prophylaxis after blunt splenic injuries?

A prospective study (n=147) found 5% risk of developing VTE after trauma-related splenectomy.⁵³

A large retrospective study (n=6,162) found 1.97 times greater risk of VTE in splenic injury than in control, with a rate of 10.08 per 10,000 person-years (8.46 no splenectomy, 11.81 splenectomy).⁵⁴

A large prospective study (n=675) found increased risk for VTE with splenectomy (AOR 2.6, 95%CI: 1.2 to 5.9).⁵⁵

What is the incidence of hemorrhage in splenic patients with/without VTE prophylaxis?

Several retrospective studies indicate low-molecular weight heparin (LMWH) administration does not increase the failure rate of NOM^{56,57} or increase the risk of bleeding events.⁵⁸

VIII. OVERWHELMING POST-SPLENECTOMY INFECTION PROPHYLAXIS

KMQ-11. Which vaccinations should be administered and when in patients with blunt splenic injuries?

KNOWLEDGE SYNTHESIS

NEW

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<p>Vaccination type</p> <ul style="list-style-type: none"> Patients should receive immunization against the encapsulated bacteria (<i>S. pneumoniae</i>, <i>H. influenzae</i>, and <i>N. meningitidis</i>). [WSES: 1A] 	<p>Adopted and added “post-splenectomy or post-proximal angioembolization” for clarity in clinical management.</p>
<p>Vaccination schedule/timing</p> <ul style="list-style-type: none"> Vaccination programs should be started no sooner than 14 days after splenectomy or spleen total vascular exclusion. [WSES: 2C] In patients discharged before 15 days after splenectomy or angioembolization, where the risk to miss vaccination is deemed high, the best choice is to vaccinate before discharge. [WSES: 1B] The panel suggests against routine vaccination for overwhelming post-splenectomy infection (OPSI) from encapsulated bacteria in patients treated with NOM for splenic injury with or without SAE. [WSES 2022: Conditional recommendation, Moderate quality of evidence] The panel suggests a tailored approach driven by the immunologic state of the patient before the splenic injury and taking into account possible effects of SAE in losing 50% or more of spleen mass. If 50% or more of the splenic mass is lost, and in every case of AAST Grade 5 injury, patients might be considered as asplenic and potentially more susceptible to OPSI; therefore, they could receive immunization against encapsulated organisms [WSES 2022: Conditional recommendation, Low quality of evidence] In adult trauma patients who have undergone splenic angioembolization, we conditionally recommend against routine post-splenectomy vaccinations. [EAST 2022: Level 3] 	<p>Adopted and combined the two statements into one recommendation.</p>

	EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<p>PEDIATRIC</p>	<p>Other vaccination indications</p> <ul style="list-style-type: none"> • Regarding infections prophylaxis in asplenic and hyposplenic adult and pediatric patients, immunization against seasonal flu is recommended for patients over 6 months of age. [WSES 2017: 1C] • Regarding infections prophylaxis in asplenic and hyposplenic adult and pediatric patients, Malaria prophylaxis is strongly recommended for travelers. [WSES 2017: 2C] • Regarding infections prophylaxis in asplenic and hyposplenic adult and pediatric patients, antibiotic therapy should be strongly considered in the event of any sudden onset of unexplained fever, malaise, chills or other constitutional symptoms, especially when medical review is not readily accessible. [WSES 2017: 2A] • Regarding infections prophylaxis in asplenic and hyposplenic adult and pediatric patients, primary care providers should be aware of the splenectomy/ angioembolization. [WSES 2017: 2C] 	<p>Deferred to the BC Centre for Disease Control guidelines for infections prophylaxis in asplenic and hyposplenic patients.</p>

NEW

ADDITIONAL LITERATURE SUPPORT

What is the risk of overwhelming post-splenectomy infection (OPSI) with splenectomy or splenic embolization after splenic injury?

Risk of overwhelming post-splenectomy infection (OPSI) with splenectomy or splenic embolization ranges from 0.05 to 23%,^{2,59} with the majority of infections occurring more than 2 years following the procedure.⁶⁰

NEW The Eastern Association for the Surgery of Trauma (EAST) conditionally recommends against routine post-splenectomy vaccination among adult trauma patients who have undergone splenic AE, based on a 2022 systematic review/meta-analysis (n=240) yielding level III evidence.³ The authors found no difference in immune function (measured by immune markers) between AE patients and controls, while splenectomy patients had increased complications, increased immune markers.

A large retrospective study (n= 4,360) of blunt splenic trauma patients in California reported short- and long-term infectious complications by procedure:⁶¹

PROCEDURE	ADMISSION	30 DAYS AFTER INJURY	1 YEAR AFTER INJURY
Splenic angioembolization	1.59 %	5.18 %	9.16 %
Splenectomy	1.76 %	4.85 %	8.85 %

In the same study, among patients with Grade 4 to 5 splenic injuries, 11.7% reported infectious complications in the angioembolization group and 23.1% in the splenectomy group.⁵⁹

Risk of mortality due to OPSI is 30 to 70%, most deaths occurring within first 24 hours.²

What is the optimal timing of vaccination?

All vaccines are best administered 2 weeks after surgery. If the patient is discharged earlier and there is concern that they might not return for follow-up, vaccines should be administered prior to discharge.⁶²

What is the effectiveness of vaccination? What is the effectiveness of repeat vaccination?

Effectiveness and administration schedule of vaccination in asplenic/hyposplenic adults

VACCINE	VACCINE EFFICACY (VE)	SCHEDULE (PHAC)
Pneumococcal	<p>PCV13 In healthy adults age ≥65 years: 75% (95%CI, 41.4 to 90.8)⁶³</p> <p>PPV23 In healthy older adults VE ranges from 45 to 73%.^{64, 65} Efficacy wanes over time.⁶⁶</p> <p>Repeat vaccination: PPV23 No evidence of hyporesponsiveness if administered 5 years or longer from initial dose.⁶⁷⁻⁶⁹</p>	<ol style="list-style-type: none"> 1 dose of PCV13 vaccine (at least 1 year after any previous dose of PPV23 vaccine) 1 dose of PPV23 vaccine at least 8 weeks after PCV13 vaccine 1 booster dose of PPV23 vaccine at least 5 years later⁷⁰
Meningococcal	<p>Men-C-ACYW Only data available is for Men-C-ACYW-135-DT (Menactra). Early estimates indicate 80 to 85% VE within 3–4 years of vaccination, efficacy waning over time.⁷¹</p> <p>Age 10 to 23 years: 78% (95%CI, 29 to 93%)^{72, 73}</p> <p>4CMenB (Bexsero) No data available.</p> <p>Repeat vaccination: Men-C-ACYW No evidence of hyporesponsiveness for conjugate meningococcal vaccines, including Men-A-ACYW.⁷⁴</p>	<p>Age ≥11 years:</p> <ol style="list-style-type: none"> 2 doses of Men-C-ACYW 8 weeks apart (see notes below) 2 doses of 4CMenB given at least 4 weeks apart (see notes below) Re-vaccination with Men-C-ACYW recommended every 5 years for those vaccinated at 7 years of age and older.⁷⁰
Haemophilus Influenzae Type B	<p>Hib Estimated 95 to 100% VE in children.⁷⁵</p>	<p>1 dose recommended regardless of Hib immunization history (at least one year after any previous dose)</p>

PHAC = Public Health Agency of Canada
 PCV13 = Pneumococcal 13-valent conjugate vaccine
 PPV23 = Pneumococcal polysaccharide 23-valent vaccine
 VE = Vaccine efficacy
 Men-ACYW = Quadrivalent conjugate meningococcal vaccines
 4CMenB = Multicomponent meningococcal vaccine
 Hib = Haemophilus Influenzae Type B

Notes: Men-C-ACYW vaccines are not authorized for use in adults 56 years of age and older and 4CMenB vaccine is not authorized for use in those 17 years of age and older. However, based on limited evidence and expert opinion its use is considered appropriate.⁶⁴

Although not recommended for routine immunization, 4CMenB vaccine should be considered for immunization of high-risk individuals (age ≥2 months) against invasive meningococcal disease caused by serogroup B strains expressing antigen covered by the vaccine.⁶⁴

IX. POST HOSPITAL CARE

KMQ-12. What is the optimal timing for repeat imaging after blunt splenic injury? Which imaging modality should be used to follow-up blunt splenic injury?

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG'S RATIONALE
<p>NEW</p> <ul style="list-style-type: none"> • Doppler US and contrast-enhanced US are useful to evaluate splenic vascularization and in follow-up. [WSES 2017: 1B] • The panel suggests selective imaging follow-up at 1, 3, and (unless imaging confirms healing at 3 months) 6 months after discharge for patients with blunt splenic injuries treated with NOM only in the presence of risk factors for long-term complications and depending on the level of activity (professional athletes, those practicing high-impact sports, heavy lifting). The choice to perform imaging follow-up after discharge includes several considerations, such as the presence of severe splenic injuries (AAST Grades 4–5); the association with other injuries that would warrant other specific follow-up; the age and expected activity level of the patient post-discharge; the type of NOM utilized (e.g., strictly observational or including interventional radiology); the duration of the hospital stay (with earlier discharge at risk of higher readmission rates). [WSES 2022: Conditional recommendation, Low quality of evidence] • The panel suggests performing contrast-enhanced imaging follow-up (CT/ CEUS) before returning to major physical activity (2–4 months in high-grade injuries) in adult patients with WSES Class II–III (AAST Grades III–V) splenic injuries treated with NOM. [WSES 2022: Conditional recommendation, Low quality of evidence] 	<p>SAG agreed with WSES recommendation to use Doppler ultrasound for follow-up imaging.</p> <p>Added further recommendation for follow-up more broadly, including timeline, imaging and return to work/sports evaluations, to offer guidance in clinical judgment based on the expert opinion of the SAG.</p>

ADDITIONAL LITERATURE SUPPORT

NEW A 2018 systematic review of 18 studies showed that most patients with delayed complications of NOM developed clinical signs and symptoms (e.g., increasing abdominal pain, decreasing hematocrit and hemoglobin levels, tachycardia, hypotension, and fever) and that follow-up CT findings did not correlate with the clinical course or influence clinical management.⁷⁶ The authors therefore recommend against routine imaging with follow-up CT in asymptomatic patients with lower grade blunt splenic injuries. Similar conclusions were drawn by the authors of a 2021 systematic review of 27 studies.⁷⁷

For risk of **delayed hemorrhage** after non-operative management of blunt splenic injury, see [page 24](#).

For the risk and timing of **pseudoaneurysm** formation after non-operative management of blunt splenic injury, see [page 34](#).

PEDIATRIC For routine repeat imaging in pediatric patients, see response to KMQ-8. In the pediatric population, routine re-imaging of patients with blunt splenic injury prior to discharge is not indicated. Imaging of symptomatic patient’s rarely results in intervention.¹⁹
 In the pediatric population, routine follow-up imaging after discharge is not indicated.

In a large cohort of patients who underwent NOM following blunt liver and spleen trauma, reimaging asymptomatic patients did not result in any intervention.¹⁹ The incidence of delayed splenic bleeding is exceedingly rare.²

KMQ-13. What is the preferred management of delayed pseudoaneurysm?

RECOMMENDATIONS

- A. If a new pseudoaneurysm is noted on follow-up imaging, discussion with general surgery is recommended to determine best management, e.g. serial imaging vs. embolization.

KNOWLEDGE SYNTHESIS

EXTERNAL RECOMMENDATIONS	SAG’S RATIONALE
None available	With lack of scientific evidence or external clinical guidance on the management of delayed splenic pseudoaneurysms, a new recommendation was developed based on the SAG’s expert opinion.