Assessment and Management of Major Trauma Abdominal Trauma

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General principles

Antibiotics

Routine antibiotic administration is not warranted in most injured patients. In particular, the presence of a penetrating injury (e.g. gunshot wound, stab wound) does not indicate the need for antibiotic coverage in the absence of local signs of infection.

Prophylactic intravenous antibiotics should be given to all patients who require trauma laparotomy. Antibiotic prophylaxis should be as specific as possible and directed at the site of injury. If upper and lower tract injuries are suspected, or the site and severity are unknown, broad-spectrum coverage is appropriate.

For patients who require abdominal exploration, a single dose of prophylactic antibiotics given within one hour of incision is appropriate. In the face of hollow viscus injury, antibiotics can be continued, and provided there has been no delay in identification and surgical management, no more than 24 hours should be needed.

VTE prophylaxis

When possible, all hospitalized patients with traumatic injuries should receive at least one mode of prophylaxis. We generally use a combination of pneumatic compression devices and low molecular weight heparin. Patients at risk who do not have a contraindication to antithrombotic therapy should receive pharmacologic prophylaxis irrespective of their mobility.

Tetanus

Patients not known to have immunity against Tetanus should receive prophylaxis if they sustain a tetanus prone wound. Tetanus prone wound is defined as:

- wounds or burns that require surgical intervention that is delayed for more than six hours
- wounds or burns that show a significant degree of devitalised tissue or a puncture-type injury, particularly where there has been contact with soil or manure
- wounds containing foreign bodies
- compound fractures
- wounds or burns in patients who have systemic sepsis

Massive Transfusion

According to the current North Bristol Trust guidelines the definition of a Massive haemorrhage is one in which 1-1.5 patient blood volumes need to be transfused acutely/ within the next 24 hours.

In this situation treatment includes;

- Resuscitation – use ABCDE approach
- Identify and arrest bleeding (e.g. direct pressure, surgery, embolisation etc.)
- Permissive hypotension to allow end organ perfusion and promote clotformation (caution in head injury and older patients)

Assess response to treatment clinically and with hourly blood tests

- If trauma and/or shock and/or coagulopathy continue in a 1:1 ratio of RBC's : FFP
- If severely traumatised patient use 4:4:1 ratio of RBC's : FFP : platelets

Aim

- Haemoglobin above 10g/dl
- PT, APTT within reference range
- Fibrinogen above 1g/l. If not give 2 pooled units of cryoprecipitate
- Platelet count above 75 X 109/l. If not –

- -give 1 unit of platelets if count 30 – 74 X 109/l
- -give 2 units platelets if count < 30 X 109/l

Please see North Bristol Trust guidelines on Massive haemorrhage for detailed instructions (guidelines currently under review).

Operative vs Non Operative management of Abdominal Trauma Patients

All patients who are haemodynamically unstable or who have diffuse peritonitis, evisceration or impalement after abdominal trauma should be taken urgently for laparotomy.
In the presence of a pelvic fracture, a binder or external fixator should be in place before laparotomy is performed
Patient should be exposed from nipples to knees so groins are exposed if needed for vascular surgery. A laparotomy, thoracotomy and major vascular set should be available at start of procedure

Penetrating Abdominal Trauma

A routine laparotomy is not indicated in hemodynamically stable patients with abdominal stab wounds without signs of peritonitis or diffuse abdominal tenderness (away from the wounding site) in centres with surgical expertise. A routine laparotomy is not indicated in hemodynamically stable patients with abdominal gunshot wounds if the wounds are tangential and is no peritonism.

Blunt Abdominal Trauma

A routine laparotomy is not indicated in the hemodynamically stable patient without peritonitis presenting with an isolated blunt hepatic or splenic injury or abdominal free fluid without evidence of solid organ injury.

Solid Organ Injuries

1. In the hemodynamically stable blunt abdominal trauma patient without peritonitis, an abdominal CT scan with intravenous contrast should be performed to identify and assess the severity of injury to the liver and spleen.
The initial management of patients with blunt hepatic or splenic trauma should be mandated by their haemodynamic status rather than their grade of hepatic injury.
2. The severity of hepatic injury or splenic injury (as suggested by CT grade or degree of hemoperitoneum), neurologic status, age of more than 55 years, and/or the presence of associated injuries are not absolute contraindications to a trial of non-operative management in a hemodynamically stable patient.
Nonoperative management of hepatic or 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.

Diagnostic Laparoscopy

Diagnostic laparoscopy is most useful for inspecting the diaphragm in thoracoabdominal wounds, although some studies suggest it may be useful in evaluating the depth of wound tracts and identifying visceral injury in patients with equivocal peritoneal penetration. In addition, some diaphragmatic and visceral injuries may be amenable to repair using DL, avoiding the need for exploratory laparotomy and thereby decreasing length of stay, morbidity, and cost. However, laparoscopy is inadequate for identifying hollow viscus and retroperitoneal injury.

Damage Control Surgery

Damage control surgery has been shown to reduce mortality in severely and multiply injured patients. Damage control surgery, involves immediate operative control of haemorrhage and gastrointestinal contamination followed by transfer to the intensive care unit for ongoing resuscitation. Intraperitoneal packing and temporary abdominal closure are followed by fluid resuscitation, patient warming and correction of coagulation deficits in the intensive care unit.

The aim is to complete the laparotomy within an hour and for the patient to be transferred to ICU.

Upon arrival to the intensive care unit the lethal triad of acidosis, hypothermia, and coagulopathy is corrected with ongoing fluid resuscitation and component transfusion therapy. Once the patient is stabilized, definitive treatment of the patient's injuries can be undertaken.

Hemodynamically unstable patients and those with multiple injuries should be explored though a generous midline abdominal incision. Trauma laparotomy should be performed in a standard fashion by packing the four quadrants and evaluating the intra-abdominal organs in a systematic fashion, and when indicated, exploring the retroperitoneum.

Injuries to the gastrointestinal tract should be evaluated and repaired in a systematic manner. Control of intra-abdominal haemorrhage should be the first priority to minimize the need for transfusion and minimize fluid requirements, followed by control of gastrointestinal contamination.

Please refer to NBT Damage Control Laparotomy protocol for detailed guidance.

- A focused team brief occurs at the start of surgery lead by the TTL.
- Situation reports occur every 10 minutes to ascertain haemodynamic state of patient and surgical progress.
- At an hour if haemodynamic stability has not been achieved, a second opinion is sought to ascertain whether continuing surgical intervention is appropriate.

Management of Organ Specific Injuries

Liver Injuries

The initial management of patients with blunt hepatic trauma should be mandated by their hemodynamic status rather than their grade of hepatic injury.

The AAST grading system is most useful for predicting the likelihood of success with nonoperative management, which is higher for low-grade injuries (Grade I, II, III) compared with high-grade injuries (Grade IV, V). Patients with Grade VI injuries are universally hemodynamically unstable, mandating surgical intervention.

If high-grade liver injuries are present on CT please contact the on-call hepatobiliary surgeon at University Hospitals Bristol. Haemodynamically unstable patients require urgent, damage control laparotomy.

Control of hepatic haemorrhage is approached in a step-wise fashion initially using simple measures and progressing to more aggressive techniques, as needed. Initial control of bleeding is performed with manual compression, portal clamping or perihepatic packing. Ongoing mild-to-moderate bleeding from the parenchyma can be controlled using topical haemostatic agents, electrosurgical techniques, and ligation of the parenchymal vessels. For more severe injuries, liver suturing techniques or hepatic artery ligation may be needed. If these techniques fail, the segment of liver may need to be resected. If there is difficulty in controlling bleeding please contact the hepatobiliary surgeon on call at University Hospital Bristol.

Nonoperative management is the treatment of choice for hemodynamically stable patients with hepatic injury. It consists of observation and supportive care with the adjunctive use of arteriography and hepatic embolization.

Patients who are hemodynamically stable but demonstrate extravasation from the liver on computed tomography (CT) of the abdomen have higher failure rates with nonoperative management, and these patients should undergo arteriography and possible liver embolization followed by continued observation and serial haemoglobin determination. Angiography with embolization should be considered in a hemodynamically stable patient with hepatic injuries with evidence of active extravasation (a contrast blush) on abdominal CT scan.

Follow-up care

There are few data to guide the routine care and follow-up of patients with hepatic injury who have been managed nonoperatively. No definitive recommendations have been established regarding the need or timing of follow-up imaging, the need for or duration of bed rest, the timing of return to daily activities and/or exercise, or the timing to initiate prophylactic or therapeutic anticoagulation. A length of stay between 3-5 days depending on grade of injury would be appropriate for patients with isolated hepatic trauma. It is a common recommendation that patients avoid strenuous activities for six weeks. For patients with higher grade injuries, strenuous physical activity is restricted for a longer period of time up to three months

Splenic Injuries

The initial management of patients with splenic trauma should be mandated by their hemodynamic status rather than their grade of injury.
Haemodynamically unstable patients with splenic injury require urgent laparotomy.
The decision to perform splenectomy versus splenic salvage (ie, splenorrhaphy, partial splenectomy) is made based upon the grade of injury, presence of associated injuries, patient's overall condition, and experience of the surgeon. The small future risk of overwhelming postsplenectomy sepsis needs to be balanced against the more significant risk of recurrent haemorrhage.

When considering splenic salvage, the surgeon must determine whether the patient can tolerate rebleeding and reoperation for the small, but real, risk of recurrent haemorrhage. Splenectomy is

often a more appropriate choice for patients with multiple injuries or comorbidities who may not tolerate a significant or recurrent episode of hypotension or a second surgical procedure.

Splenectomy is also more appropriate for patients requiring urgent surgical management of other significant injuries that preclude taking the extra time needed for splenic salvage. In the setting of damage control, delayed splenic salvage can be considered (within 24 to 48 hours) for low-grade splenic injuries, provided that the bleeding is controlled with packing. Splenectomy is the safest option, given that most patients who require damage-control surgery are on the brink of physiological collapse, are hypothermic, acidotic, coagulopathic, and will likely only poorly tolerate recurrent haemorrhage.

Non Operative Management and Embolization.

Hemodynamically stable patients with low-grade (I to III) blunt or penetrating splenic injuries may be initially observed safely. In general, patients who meet the criteria for observation but who require intervention to manage extra-abdominal injuries (eg, leg fracture stabilization) can also be safely observed.

The duration of observation should be individualized based upon the grade of splenic injury, nature and severity of other injuries, and the patient's clinical status.

In a survey of actively practicing trauma surgeons, there was agreement that higher-grade injury generally required longer observation periods. A common, but not evidence-based practice regarding the duration of observation following splenic injury is that the number of days of observation is equal to the injury grade plus one.

An observation period of five days identifies at least 95 percent of patients who would require some form of intervention. One multicentre trial found that 86 percent of patients who failed non-operative management did so within 96 hours of hospital admission, with 61 percent of failures occurring during the first 24 hours. Patients with higher-grade injuries may require more prolonged periods of observation.

Portal hypertension is a relative contraindication to non-operative management due to the increased venous pressures that may prevent clot formation and control of haemorrhage even after successful splenic embolization. Other relative contraindications include higher-grade splenic injury (>Grade III), active contrast extravasation, large volume haemoperitoneum (though difficult to accurately quantify), traumatic brain injury, refusal of blood transfusion in the setting of pre-existing anaemia, or altered neurologic status precluding adequate serial abdominal examination.

Splenic embolization requires specialized imaging facilities and a vascular interventionalist (ie, interventional radiology, vascular surgeon) experienced with celiac artery catheterization and embolization techniques. Where available, embolization is potentially most useful when employed selectively in hemodynamically stable patients who have CT findings that include active contrast extravasation, splenic pseudoaneurysm, or large volume hemoperitoneum.

Splenic embolization is associated with additional risks that include bleeding, pseudoaneurysm formation at the arterial puncture site, splenic infarction, splenic/subdiaphragmatic abscess, inadvertent embolization of other organs (eg, kidneys) or lower extremities, allergic reaction to contrast and contrast-induced nephropathy.

Patients who fail observation require either splenic embolization, or more commonly, operative management. Indications to pursue intervention include hemodynamic instability, the development of diffuse peritoneal signs, or decreasing haemoglobin attributed to splenic haemorrhage. Hypotension may be absolute or relative, or evidenced as persistent tachycardia in spite of adequate fluid resuscitation.

Post splenectomy vaccination

Immunization is recommended for asplenic patients, since splenectomy impairs opsonization of encapsulated organisms.

Ideally, vaccines are administered either 14 days prior to or 14 days following splenectomy for maximal immunologic benefit. Delaying vaccinations for 14 days postoperatively increases the antibody response, but may not be feasible in all trauma patients given the historically sporadic follow-up in this patient population. Therefore all splenectomy patients should be immunised at the time of discharge, regardless of the postoperative day if they have not already received the appropriate vaccinations.

Asplenic patients should receive a booster dose of HiB/Men C vaccine and a single dose of pneumococcal polysaccharide vaccine. They also receive yearly influenza vaccinations.

Advice to patient

Upon discharge, patients are typically restricted from participation in high-risk activities such as skiing, mountain biking, skydiving, wrestling, contact sports and military combat, for a period of up to three months. While there are no clinical studies to support this duration, one assumes that repeat trauma to the fragile, healing spleen could lead to re-injury.

Bowel injury

CT of the abdomen is the test of choice for identifying specific intra-abdominal injuries in hemodynamically stable patients with blunt injury and is the most sensitive non-invasive imaging test for identifying gastrointestinal injury. However CT scan findings should always be evaluated in the context of the patient's clinical condition. The presence of intraperitoneal free air, vascular beading, abrupt vessel termination, or the presence of extra-luminal contrast, are highly suggestive of injury.

Patients with CT findings suggestive of bowel injury require urgent laparotomy.

Those patients who have sustained penetrating injury which has not breached the peritoneal cavity or blunt trauma with no CT findings suggestive of injury may be treated conservatively.

It is important to maintain a high index of suspicion for bowel injury as initial CT findings may not show free fluid or free air. It may be that a persistent lactic acidosis is the only indication for laparotomy.

Operative Management of Bowel Injuries.

Patients who are hemodynamically stable with limited other injuries can undergo definitive management of their bowel injuries at the time of the initial exploration.

In the setting of damage control, repair of gastrointestinal injury should be delayed until after hemodynamic stabilization, which is typically within 24 hours of the injury. Contamination is controlled with stapling off bowel ends and resecting damaged bowel. Formation of a defunctioning stoma is also delayed until definitive surgery. Repair should be undertaken no later than 48 to 72 hours after injury because bowel distention can extend the injury.

- The anterior and posterior surfaces of the stomach should be inspected for signs of contusion or laceration. The posterior surface can be examined after opening the lesser sac. Ligating a few of the short gastric arteries will facilitate exposure. Small gastric perforations can be identified by injecting air into the nasogastric tube to insufflate the stomach and then filling the abdomen with saline to cover the stomach while observing for air bubbles. Alternatively, methylene blue can be instilled into the stomach via the nasogastric tube and the stomach inspected for leakage.

- The entire bowel and mesentery, beginning from the ligament of Treitz, should be examined. All abnormalities should be thoroughly evaluated and tagged (eg, bowel clamp),

but definitive repair should not be undertaken until the entire length of bowel has been examined.

●Evaluation of duodenal injury requires mobilizing the duodenum from its retroperitoneal attachments, and the pancreas, which is commonly injured as well, should also be examined. *Duodenal and pancreatic injuries are discussed in detail separately.*

●If there is evidence of large bowel injury, the involved region of the colon should be fully mobilized to allow inspection of the colon circumferentially.

Mesenteric bleeding and mesenteric hematomas identified intraoperatively can be managed using straightforward techniques. Embolization may be appropriate for patients with a transient response to resuscitation. Active mesenteric arterial bleeding can usually be controlled with simple ligation.

Due to the rich collateral blood supply to most areas of the small intestine, limited ligation of mesenteric arterial vessels will not result in bowel compromise, but multiple ligations, proximal arterial branch ligation, or mesenteric resection may necessitate resection of the associated bowel. Once the injury to the mesentery has been managed, the viability of the bowel should be assessed.

A defunctioning stoma may be required in the presence of an open fracture to limit contamination

Operative management of Pancreatic and Duodenal injuries.

Damage control to manage duodenal injuries may involve rapid closure of the injured segment or resection of a full-thickness duodenal injury without reestablishing continuity. For suspected pancreatic duct injuries, wide drainage is used, but if the injury is distal, a quick distal pancreatectomy can be performed.

Bleeding from the pancreas distal to the head of the pancreas can usually be controlled with packing; however, high grade injuries to the head of the pancreas, which may also involve the duodenum, are often associated with bleeding that cannot be controlled by packing. In these cases resection without reconstruction may be needed.

To resect the proximal duodenum and pancreas, the pylorus, pancreatic neck, and proximal jejunum are stapled across and transected, the common bile duct is ligated, and the biliary tract is drained using tube cholecystostomy Closed suction drains are placed to control duodenal and pancreatic secretions. Following resuscitation and stabilization, definitive resection and reconstruction (Whipple) can be performed.

For high grade injuries to the upper GI tract please contact the Upper GI surgical team.

Renal Injury

Urine from patients with suspected renal injury should be examined for haematuria both visually and by dipstick, serum creatinine should also be noted to assess for existing renal injury or impairment.

Decision to image must be made based upon both clinical findings and the method of injury. Radiographic imaging is indicated in cases where there is gross haematuria, microscopic haematuria with hypertension or major associated injuries. Those with rapid deceleration injury, clinical indicators of renal trauma or associated injuries should be imaged immediately. Those with penetrating trauma to the torso or abdomen should be imaged for renal injury if there is suspicion based upon the entry or exit would, both in the presence and absence of haematuria.

The management of renal injuries may be influenced by the decision to explore or manage associated abdominal injuries. Irrespective of mode of injury, patients with renal haemorrhage resulting in haemodynamic instability despite aggressive fluid resuscitation require renal exploration. In addition, renal exploration is indicated in those with incidental finding of expanding or pulsatile perirenal haematoma. Grade 5 vascular injuries may be treated conservatively if haemodynamically stable at

presentation, the need for invasive management is based upon the requirement of continuous fluid and blood resuscitation. The overall aim of exploration after renal trauma is control of haemorrhage and renal tissue salvage. Intra-operatively, renal reconstruction should be attempted when haemorrhage is controlled and there is enough viable real parenchyma.

When there is no indication for open abdominal surgery, renal angiography with selective embolization is indicated. Angiography is indicated in those with haemodynamic stability who are found to be candidates of radiological control of haemorrhage on CT.

Indications for renal angiography on CT:

- Massive extravasation
- A large devascularised segment
- Identification of grade 4/5 lesions
- Arterial laceration or evulsion
- Global or segmental hypoperfusion of kidney
- Intimal tear or false aneurysm
- Segmental or subsegmental arterial bleeding
- Thrombosis
- Peri-renal haematoma compressing the kidney

Angio-embolisation should be undertaken with caution in those with grade 4/5 injuries as initial success rate is low and many will require additional intervention.

Non-operative management is the treatment of choice in most renal injuries. Haemodynamically stable patients with blunt renal trauma should be managed conservatively and closely observed until resolution of haematuria. Risk of complication with conservative management increases with grade of injury. Repeat imaging 2-4 days post trauma reduces the incidence of missed complications. CT scans should always be performed on patients with fever, unexplained decreasing haematocrit or significant flank pain. In those with grade 1-4 injuries who are clinically well, imaging can be safely omitted.

Urinary Tract Trauma

In patients with a low risk pelvic fracture and no evidence of urethral injury on physical examination, it is reasonable to make one attempt at passage of a Foley (ie, bladder or urinary) catheter.

Low risk fractures include single ramus fractures and ipsilateral rami fractures without posterior ring disruption. The risk of urethral injury approaches zero with isolated fractures of the acetabulum, ilium, and sacrum. If resistance is met during this single attempt, remove the catheter and obtain a retrograde urethrogram. If the urethra is intact, insert a Foley and inspect the initial output for evidence of haematuria.

If a urethral injury is suspected subsequent to successful placement of a Foley catheter, **do not remove** the catheter. A retrograde urethrogram may be obtained by inserting a small feeding tube alongside the catheter and proceeding as above. Please seek advice from urology for management of patients with an abnormal urethrogram or in cases of suspected urethral injury when an urethrogram cannot be performed. In females, suspected urethral injury mandates discussion with urology; urethrography is not indicated in the emergency department.

With bladder injuries, the primary goal is to keep the bladder completely decompressed, which facilitates healing by minimizing bladder wall tension. If urethral injury is excluded, place a Foley catheter and irrigate the bladder as needed to clear any clots and ensure adequate drainage. Because bladder injuries are frequently associated with intraabdominal trauma, a diligent search for additional injuries should be undertaken in all patients with an abnormal cystogram. When undertaking this search, keep in mind that ultrasound cannot distinguish between blood and urine.

With upper tract injuries, identification and urologic consultation are the priorities of emergent management.

Patients with microscopic haematuria, but without apparent significant genitourinary injury, should be referred for routine outpatient urology follow-up within a few of weeks.

Major Blood Vessel Injuries

Damage to major blood vessels will require urgent referral to the on-call vascular surgeon.

Abdominal Wall Closure

Laparostomy

Following trauma surgery, a decision to close the abdomen with or without skin closure depends upon the ability to approximate the fascial edges, the amount of intra-abdominal contamination, the potential for anastomotic breakdown, and the need to perform a second-look operation.

In patients undergoing damage control surgery and in those with a planned second-look operation to assess bowel viability, the abdomen should be left open and a temporary abdominal closure used. Leaving the abdomen open may also be more prudent in patients who are at risk for abdominal compartment syndrome.

The preferred method of this at NBT is with a negative pressure system (Ab There trademark KCI). This system is kept in theatres on both level 2 and level 3. The plastic liner is placed over the abdominal contents into the paracolic gutters. 2 sponge layers are applied and the pressure is usually set at 125mmHg. It can be set lower if there is concern about bleeding. However, the intention is that packing should control the bleeding before application of the dressing

If re-look laparotomy does not occur to undertake definitive surgery, the dressing must be changed every 72 hours as a maximum but usually at 48 hours. In the absence of a requirement for further surgery, the presence of a laparostomy is to reduce oedema, prevent intra-abdominal hypertension and reduce contamination. If an abdomen is left open the aim is to close it within 10 days. After this it is unlikely that fascial closure will be achieved.

The preferred method of closure within this period is primary closure but sometimes a mesh is necessary to bridge the fascial gap. The choice of mesh in this situation is a vicryl mesh Management of the open abdomen should be consultant lead. The leads for the open abdomen at NBT, Miss Burt and Miss Pullyblank are also available for advice.

Long term management of the open abdomen

If fascial closure is not achieved then the dressing is changed to a conventional VAC dressing. Insertion of a vicryl mesh to bridge the fascial defect will aid changing to conventional Vac Rx. It is essential that the mesh and bowel are protected with Adaptic touch (trademark) or equivalent before applying the sponge foam. Once the wound has granulated then healing can be facilitated by a Skin graft

Longer term, the patient may require abdominal wall reconstruction as they will be left with a muscle defect and incisional hernia.

AAST Organ Injury Grades

Liver Injury Grading

The grades of hepatic injury are as follows:

- Grade I – Hematoma: subcapsular <10 percent surface area. Laceration: capsular tear <1 cm parenchymal depth
- Grade II – Hematoma: subcapsular 10 to 50 percent surface area, intraparenchymal <10 cm in diameter. Laceration: capsular tear 1 to 3 cm parenchymal depth, <10 cm in length
- Grade III – Hematoma: subcapsular >50 percent of surface area or ruptured subcapsular or parenchymal hematoma; intraparenchymal hematoma >10 cm or expanding. Laceration >3 cm in depth
- Grade IV – Laceration: parenchymal disruption involving 25 to 75 percent of a hepatic lobe or 1 to 3 Couinaud segments.
- Grade V – Laceration: parenchymal disruption of >75 percent of a hepatic lobe, >3 Couinaud segments within a single lobe. Vascular: juxtahepatic venous injuries (retrohepatic vena cava, central major hepatic veins).
- Grade VI – Hepatic avulsion

Traumatic Splenic Injury Grading

The American Association for the Surgery of Trauma (AAST) has published a spleen injury grading scale based upon the anatomic injury identified on CT scan [20]. The grade of injury and the degree of hemoperitoneum on CT scan relate to the success of nonoperative management, but do not consistently predict the need for initial operative.

The AAST criteria for hematoma and laceration for each splenic injury grade are as follows [20]:

- Grade I – Hematoma: subcapsular, <10 percent of surface area. Laceration: capsular tear <1 cm in depth into the parenchyma.
- Grade II – Hematoma: subcapsular, 10 to 50 percent of surface area. Laceration: capsular tear, 1 to 3 cm in depth, but not involving a trabecular vessel.
- Grade III – Hematoma: subcapsular, >50 percent of surface area OR expanding, ruptured subcapsular or parenchymal hematoma OR intraparenchymal hematoma >5 cm or expanding. Laceration: >3 cm in depth or involving a trabecular vessel.
- Grade IV – Laceration involving segmental or hilar vessels with major devascularisation (ie, >25 percent of spleen).
- Grade V – Hematoma: shattered spleen. Laceration: hilar vascular injury which devascularises spleen

Gastrointestinal Tract Injury Grading

Stomach:

- Grade I – Intramural hematoma <3 cm; partial-thickness laceration
- Grade II – Intramural hematoma ≥3 cm; full-thickness laceration <3 cm
- Grade III – Full-thickness laceration >3 cm
- Grade IV – Full-thickness laceration involving vessels on greater and/or lesser curvature
- Grade V – Extensive rupture >50 percent; devascularisation

Small intestine:

- Grade I – Contusion or hematoma without devascularisation; partial-thickness laceration
- Grade II – Full-thickness laceration <50 percent of circumference
- Grade III – Full-thickness laceration ≥50 percent of circumference
- Grade IV – Transection
- Grade V – Transection with segmental tissue loss; devascularised segment

Colon:

- ●Grade I – Contusion or hematoma; partial-thickness laceration
- ●Grade II – Full-thickness laceration <50 percent of circumference
- ●Grade III – Full-thickness laceration ≥50 percent of circumference
- ●Grade IV – Transection
- ●Grade V – Transection with tissue loss; devascularised segment

Rectum and rectosigmoid colon:

- ●Grade I – Contusion or hematoma; partial-thickness laceration
- ●Grade II – Full-thickness laceration <50 percent of circumference
- ●Grade III – Full-thickness laceration ≥50 percent of circumference
- ●Grade IV – Full-thickness laceration with perineal extension
- ●Grade V – Devascularised segment

Duodenal injury scale

- ●Grade I: Hematoma involving a single portion of duodenum or partial thickness laceration without perforation
- ●Grade II: Hematoma involving more than one portion or disruption <50 percent circumference or major laceration without duct injury or tissue loss
- ●Grade III: Laceration with disruption of 50 to 75 percent circumference of 2nd portion or disruption of 50 to 100 percent circumference of 1st, 3rd, 4th portion
- ●Grade IV: Laceration with disruption >75 percent circumference of 2nd portion or involving ampulla or distal common bile duct
- ●Grade V: Massive laceration with disruption of duodenopancreatic complex or devascularisation of duodenum

Pancreas injury scale

- ●Grade I: Minor contusion without duct injury or superficial laceration without duct injury
- ●Grade II: Major contusion without duct injury or tissue loss, or major laceration without duct injury or tissue loss
- ●Grade III: Distal transection or parenchymal/duct injury
- ●Grade IV: Proximal transection or parenchymal injury involving ampulla
- ●Grade V: Massive disruption of the pancreatic head

Kidney Injury Scale

- Grade I: Subcapsular, nonexpanding contusion/haematoma without parenchymal laceration
- Grade II: Nonexpanding perirenal haematoma confirmed to renal retroperitoneum or Laceration <1 cm of parenchymal depth of renal cortex without urinary extravagation.
- Grade III: Laceration <1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravagation
- Grade IV: Parenchymal laceration extending through renal cortex, medulla and collecting system or main renal artery or vein injury with contained haemorrhage.
- Grade V: Completely Shattered Kidney or Avulsion of renal hilum which devascularises kidney

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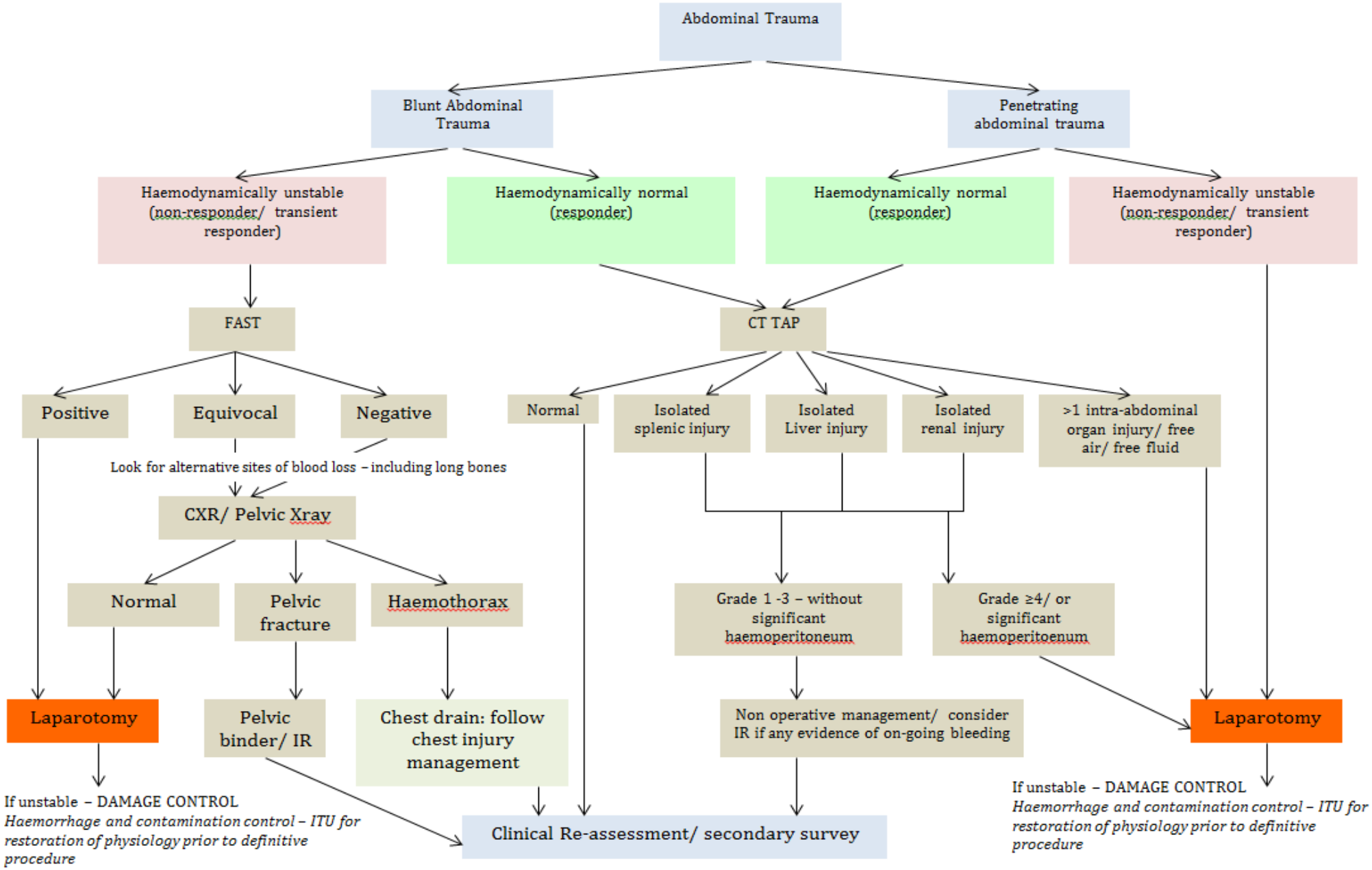
Abdominal Trauma
Blunt Abdominal Trauma
Penetrating abdominal trauma
Haemodynamically unstable (non-responder/ transient responder)
Haemodynamically normal (responder)
Haemodynamically normal (responder)
Haemodynamically unstable (non-responder/ transient responder)
FAST
CT TAP
Positive
Equivocal
Negative
Normal
Isolated splenic injury
Isolated Liver injury
Isolated renal injury
>1 intra-abdominal organ injury/ free air/ free fluid
Look for alternative sites of blood loss – including long bones
CXR/ Pelvic Xray
Normal
Pelvic fracture
Haemothorax
Grade 1 -3 – without significant haemoperitoneum
Grade ≥4/ or significant haemoperitoenum
Laparotomy
Pelvic binder/ IR
Chest drain: follow chest injury management
Non operative management/ consider IR if any evidence of on-going bleeding
Laparotomy
If unstable – DAMAGE CONTROL
Haemorrhage and contamination control – ITU for restoration of physiology prior to definitive procedure
Clinical Re-assessment/ secondary survey
If unstable – DAMAGE CONTROL
Haemorrhage and contamination control – ITU for restoration of physiology prior to definitive procedure