Superior Health Council Expert Meeting
"Severe bleeding: from basics to practice"
Brussels, 28/11/2013

Severe Hemorrhage :

Damage Control Surgery

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Disclosure

- DY does not have any relevant disclosures for the topic of this Expert Meeting
- The presentation of DY is not sponsored by any company nor are any specific products or companies identified

Overview: Damage Control Surgery

- Principles
- Lethal triad - Metabolic failure
- Practice :
  - Damage control surgery
  - Organ-specific techniques
  - Critical care
  - Reoperation
- Conclusion

Severe hemorrhage

- Exsanguinating haemorrhage accounts for 33-40% of all trauma-associated deaths.
  - About half occur before the patient reaches the hospital.
- All **civilian** and **military** trauma systems face the challenge of ensuring that bleeding patients receive timely and effective haemorrhage control.

Damage control

only initial interventions necessary

- → to control hemorrhage and contamination
- → to focus on reestablishing a survivable physiologic status.
- → then continued resuscitation and aggressive correction of their coagulopathy, hypothermia, and acidosis in the ICU
- → before returning to the OR for the definitive repair of their injuries.

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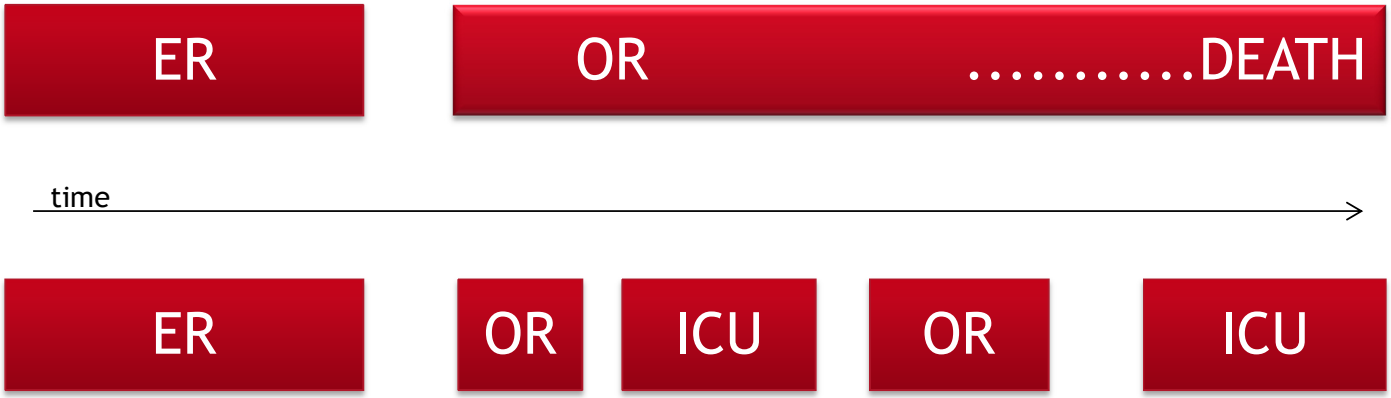
Damage Control Surgery (DCR)



DCR = rapid initial control of hemorrhage and contamination
with packing and temporary closure,
followed by resuscitation in the ICU,
and subsequent reexploration and definitive repair
once normal physiology has been restored.

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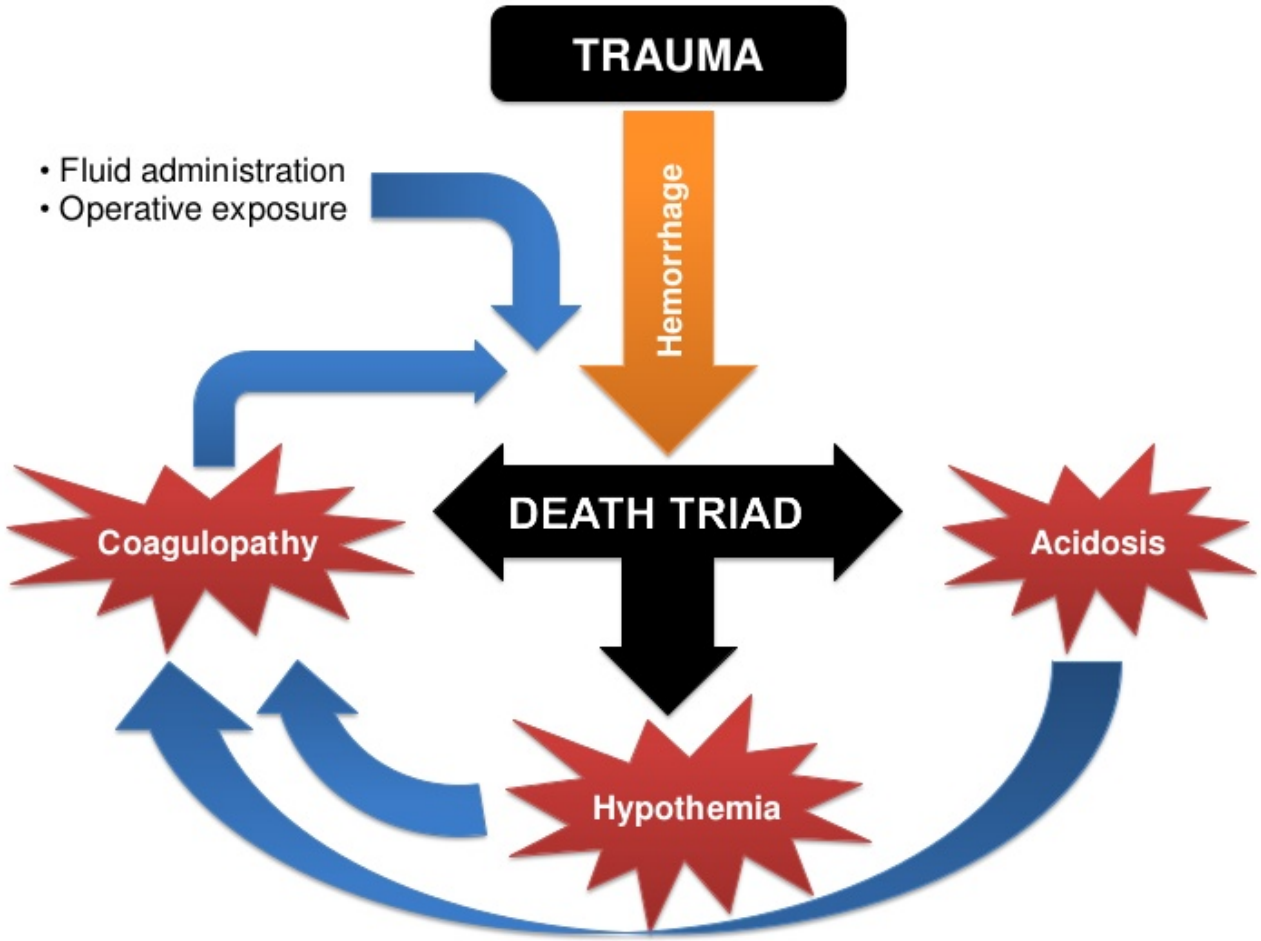

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Damage Control Resuscitation

= treatment strategy that targets the conditions that exacerbate hemorrhage in trauma patients

- Damage Control Surgery (DCS)
- Targetting the destructive forces of
  - hypothermia
  - acidosis
  - coagulopathy
- (Evidence based)Transfusion ratios / hypertonic fluid solutions
- Permissive hypotension
- (rFVIIa / tranexamic acid / cryoprecipitate)

Damage Control Resuscitation

- Permissive hypotension
- Haemostatic resuscitation
- Damage Control Surgery

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DCR

Three Phases of Damage Control Surgery

1. A B C D Resuscitation

   & Initial operation with hemostasis and packing

   1bis Transport to interventional radiology suite for embolization of arterial hemorrhage that could not be controlled during the open procedure, such as pelvic fracture or liver trauma involving the arterial circulation.

2. Transport to the ICU to correct the conditions of hypothermia,

   acidosis, and coagulopathy

3. Return to the OR for definitive repair of all temporized injuries

Initial A B C D Resuscitation Breathing & Ventilation (1)

Severe life threatening condition

- Tension pneumothorax
- Massive hemothorax
- Open pneumothorax
- Flail chest

→ Need emergency care

Initial A B C D Resuscitation Breathing & Ventilation (2)

1. Tension pneumothorax

   – Temporary : needle (no.14-16) at second intercostal space ,midclavicular

   - ICD : fifth intercostal space ,midaxillary line

2. Massive hemothorax – ICD : fifth intercostal space ,midaxillary line

   Indication for surgery – Bleed > 1500 cc on first ICD attempted

   – Continuous bleed > 200 cc/hr in 3-4 hrs

   - hemodynamic unstable (caked hemothorax)

Initial A B C D Resuscitation Shock (1)

Initial step in managing shock in the injured patient :

Recognize its presence and clinical presence of inadequate tissue perfusion and oxygenation.

Hemorrhage is the most common cause of shock in the injured patient.

Second step : Identify the probable cause of the shock state.

External hemorrhage control : – Manual compression / Splint / Elastic bandage

Internal hemorrhage: Identify major sources of occult blood loss :

- Thoracic
- Abdominal cavities
- Soft tissue surrounding major long bone fracture
- Retroperitoneal space from pelvic fracture

Combination

Initial A B C D Resuscitation Shock (2)

Shock in traumatic patients DD non-hemorrhagic shock !!

- Cardiogenic shock
- Tension pneumothorax
- Neurogenic shock
- Hypovolemic shock
- Septic Shock

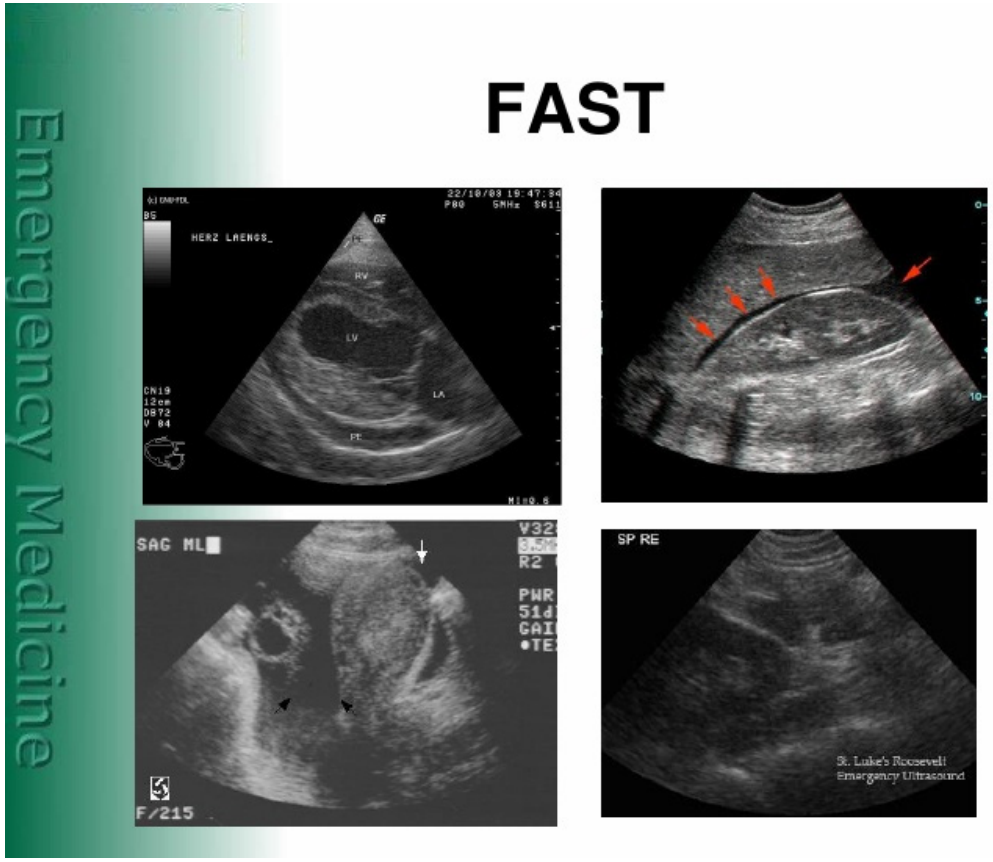
Assessment of hemorrhagic shock

If unidentified source of bleeding:

- Clinical assessment of torso
- **Pelvic ring stability !!!**
  - association with intra-abdominal injury (75%)
  - in polytrauma: 25 % incidence of pelvic fractures
- **FAST** and/or CT in shock room

→ FAST positive + hemodynamic instability = DCS

Focused Assessment with Sonography for Trauma (FAST)



Rapid
Noninvasive
Accurate
Inexpensive
Can be repeated
Indications same as DPL

Utility comprised by:
- obesity
- subcutaneous air
- previous surgery

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DCS :Principles

First 'damage control' procedure :

- control of hemorrhage
- prevention of contamination
- protection from further injury
- temporary closure

Cross talk Surgeon – Emergency Specialist (1)

Permissive hypotension

- Keep the blood pressure low enough to avoid exsanguination while maintaining perfusion of end organs.
  → If the pressure is raised before the surgeon is ready to check bleeding, blood that is sorely needed may be lost.

- Endpoint of resuscitation before definitive hemorrhage control was a systolic pressure of 70 to 80 mmHg

- Trauma patients without definitive hemorrhage control should have a limited increase in blood pressure until definitive surgical control of bleeding can be achieved.

Technology

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Cross talk Surgeon – Emergency Specialist (2)

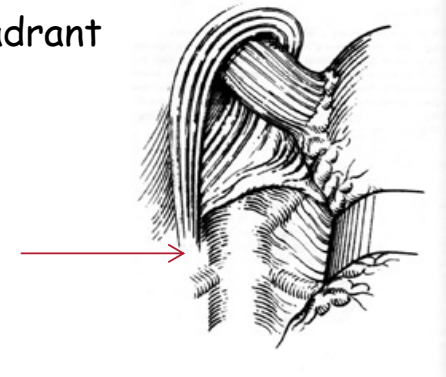
Hypothermia in severe hemorrhagic shock

- Large, well conducted retrospective studies have shown that a core temperature of less than 35°C on admission is an independent predictor of mortality after major trauma
- Prevention of hypothermia is easier than reversal. Limit casualties' exposure
- Warm all blood products and intravenous fluids before administration
- Use forced air warming devices, which are useful before and after surgery but are less effective when the need for operative exposure restricts application to the limbs
- Employ carbon polymer heating mattresses, which are highly effective and do not restrict surgical access
- (above normal) heating of the shock room and operating theatre


Medtronic

Damage Control Laparotomy (1)

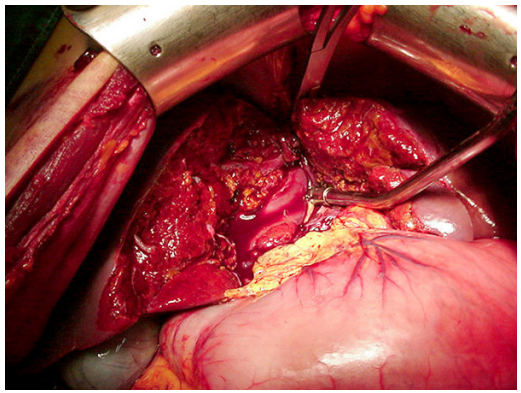
- rapidly prepped from neck to knees with large abdominal packs soaked in antiseptic skin preparation solution
- incision should be made from the xiphisternum to the pubis
  → may require extension into the right chest or as a median sternotomy
- immediate control is initially achieved with four quadrant packing with multiple large abdominal packs.
- eventually aortic control at this stage, at the diaphragmatic hiatus
  → clamp without isolation of aorta



- next step is to identify the main source of bleeding: careful inspection of the four quadrants of the abdomen is necessary
- bleeding from the liver, spleen or kidney can generally be achieved by applying pressure with several large abdominal packs

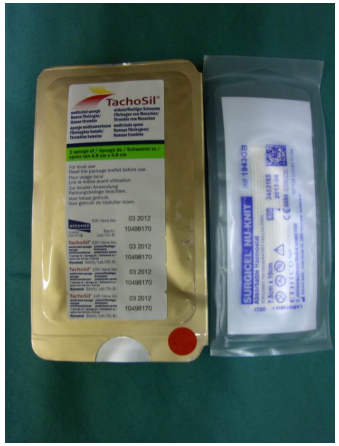
Damage Control Laparotomy (2)

- controlling surgical bleeding: ligation, balloon catheter tamponade, or packing.
- splenic and renal injuries are treated with rapid resections
- non-bleeding pancreatic injuries are simply drained
- liver injuries are packed



- use of topical hemostatical agents
- hollow viscus perforations : prevention of contamination
  - either a simple suture closure or rapid resection of the involved segment
  - no anastomoses are performed, and ostomies are not matured
  - bowel ends stapled

Topical Haemostatical Agents



Factor concentrators	
Mineral zeolite	Granules (QuikClot); mesh bags (QuikClot Sport Advanced Clotting Sponge); gauze (QuikClot Combat Gauze)
Mucoadhesives	
Oxidised cellulose	Gauze (Surgicel Fibrillar, Surgicel Nu-Knit)
Gelatin	Foam (Sugifoam, Gelfoam, Gelfilm)
Procoagulant supplementors	
Human-derived factors	equine collagen patch with fibrinogen and thrombin (TachoSil) Liquid or aerosol: fibrin sealants (Tisseel, Evicel, Crosseal); gelatin–thrombin suspension (Floseal)
Bovine-derived factors	Gauze (FastAct); glue (BioGlue); sponge (TachoComb)

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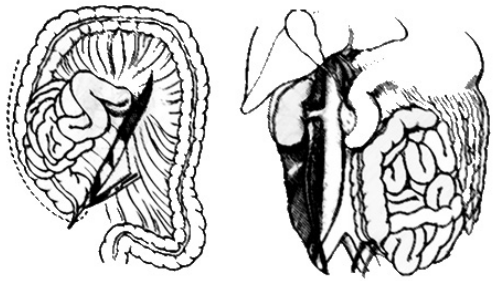
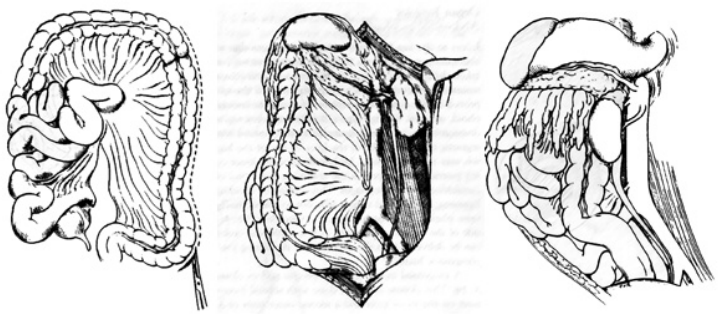
Damage Control Laparotomy (3)

- where necessary, mobilization and delivery of retroperitoneal structures using several medial visceral rotation manoeuvers
- all intraabdominal and most retroperitoneal haematomas require exploration and evacuation.

R 

L 

- non-expanding perirenal haematomas, retrohepatic haematomas or blunt pelvic haematomas should not be explored and may be treated with abdominal packing --> subsequent angiographic embolization may be required

Damage Control Laparotomy (4)

Scheduled reoperation

- removal of clots and abdominal packs
- complete inspection of the abdomen to detect missed injuries
- haemostasis
- restoration of intestinal integrity
- abdominal wound closure

Damage Control Laparotomy (5)

Completion of the procedure :

- temporarily closed using an improvised plastic bag ("Bogota bag")
- ev. commercially available topical negative pressure dressing
- facilitates observation of volume and nature of drainage

Evidence ?

- No randomised trial has ever evaluated the concept of DCS
- Retrospective reviews indicate improval of survival, especially in penetrating injuries *(Rotondo 1993, Carillo 1998,....)*
- DCS nevertheless generally accepted, but only as part of DCR

Task Force for Advanced Bleeding Care in Trauma

Recommendations for DCS :

1. Time elapsed between injury and operation should be minimized for patiens in need of urgent surgical bleeding control (1A)
2. Early FAST for detection of fluid with suspected torso trauma (1B)
3. Patients with positive FAST and hemodynamic instability should undergo urgent surgery (1C)
4. Patients with pelvic ring disruption in hemorrhagic shock should undergo immediate pelvic ring closure and stabilisation (1B)
5. Patients with ongoing hemodynamic instability despite adequate pelvic ring stabilisation receive early angiographic embolisation or surgical bleeding control, including packing (1B)

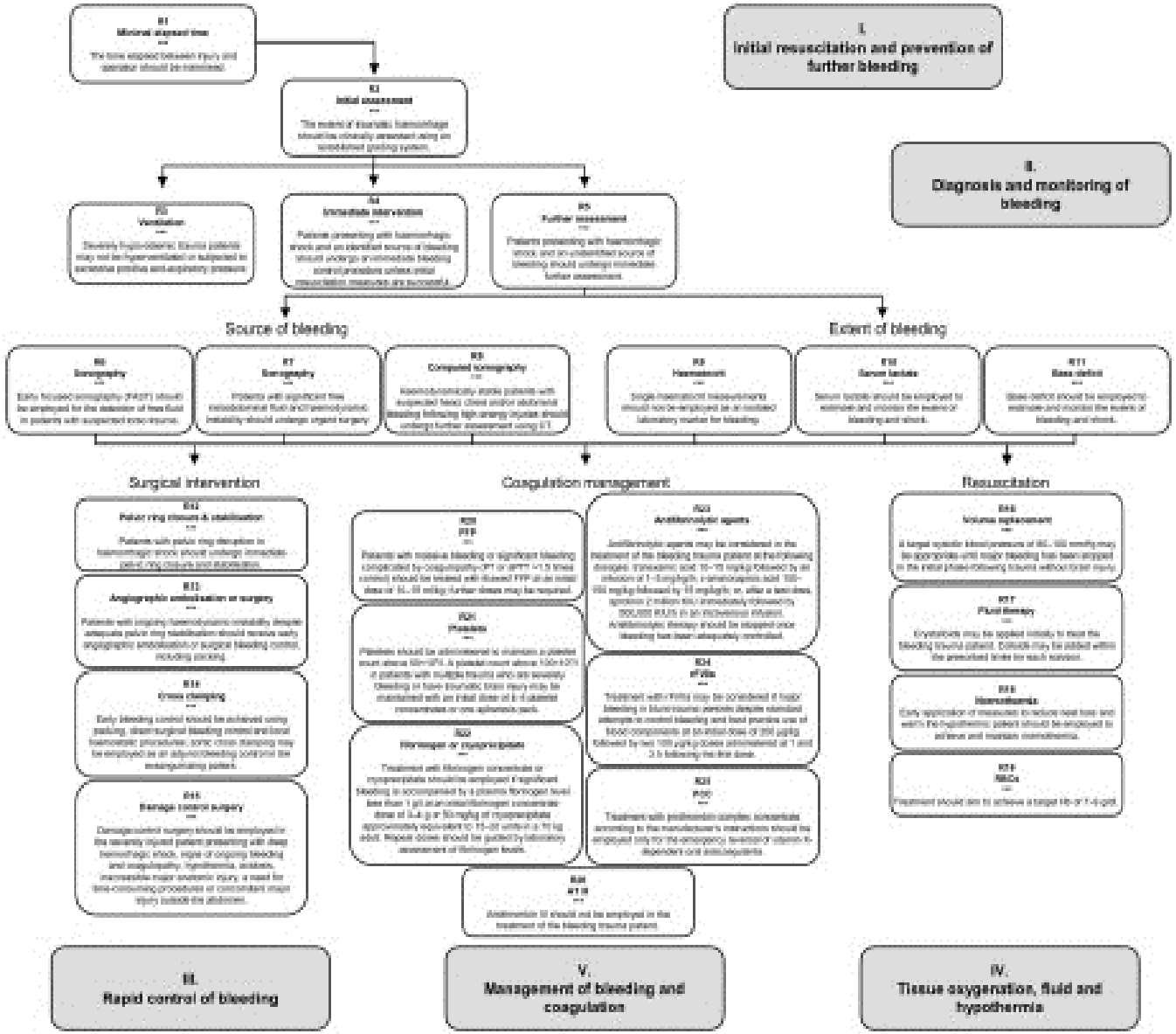
Spahn, Crit Care 2007 & 2013

Task Force for Advanced Bleeding Care in Trauma

Recommendations for DCS :

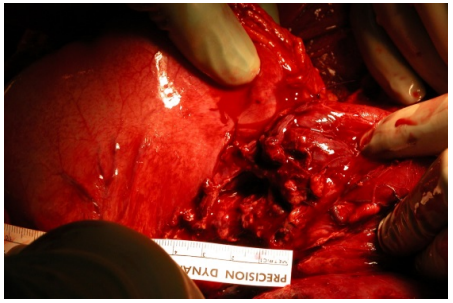
6. Early bleeding control must be acheived by packing, direct surgical bleeding control and the use of local hemostatic procedures. In the exssanguinating patient aortic cross-clamping may be employed as an adjunct to achieve bleeding control (1C)
7. Damage Controle Surgery should be employed in the severly injured patient presenting deep hemorrhagic shock, sign of ongoin bleeding ad coagulopathy (1C)

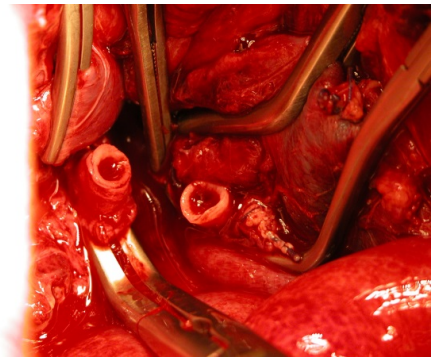
Spahn, Crit Care 2007 & 2013

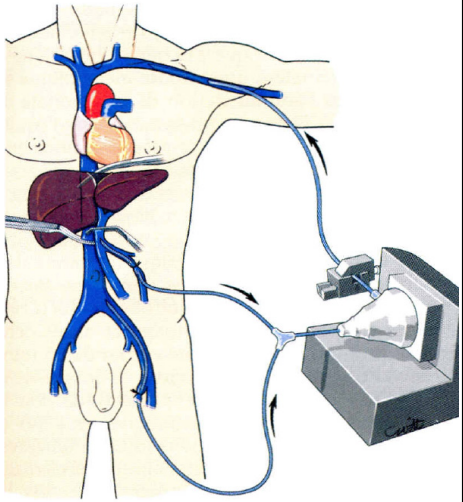

I.
Initial resuscitation and prevention of further bleeding
II.
Diagnosis and monitoring of bleeding
Source of bleeding
Extent of bleeding
Surgical intervention
Coagulation management
Resuscitation
III.
Rapid control of bleeding
V.
Management of bleeding and coagulation
IV.
Tissue oxygenation, fluid and hypothermia

Logistic of trauma care

- Emergency room with FAST & MSCT
- "Hybrid" operation theatre to allow damage control surgery and angiographic embolisation
- Level I – level II Trauma Centers

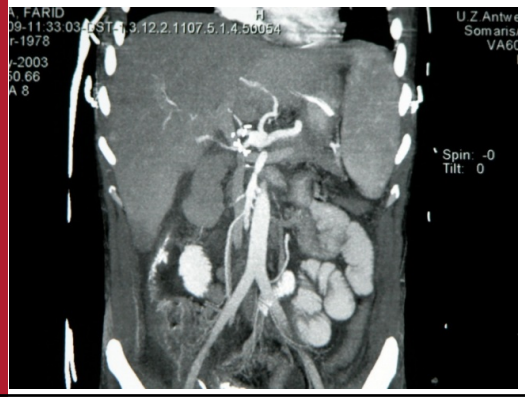


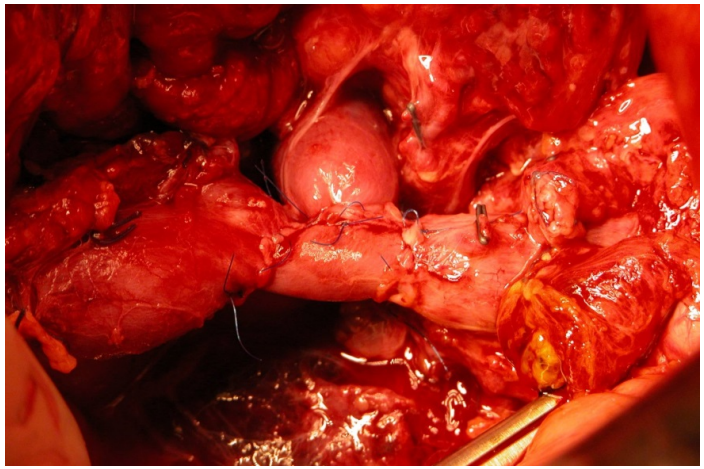




Case:

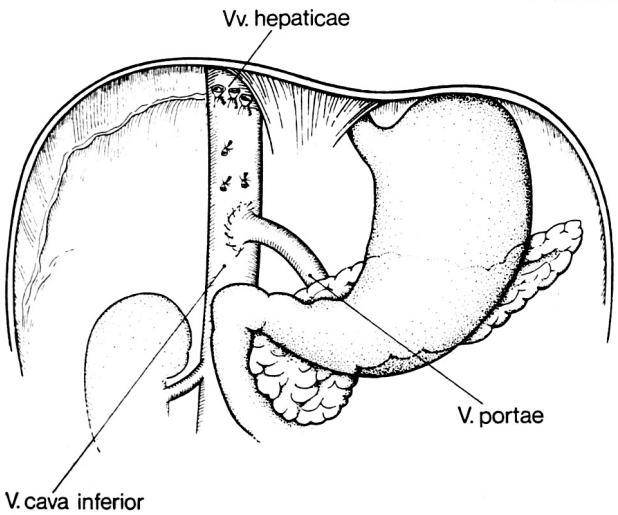
Male, young
Gunshot wound from epigastrium to right dorsal flank
Laceration SMA / Portal-SMV confluens / pancreatic head
and inferior caval vein
Trauma center 1: clamping SMA / PV-SMV / packing
Trauma center 2: veno-venous bypass / repair SMA /
jugular vein graft interposition PV / Whipple

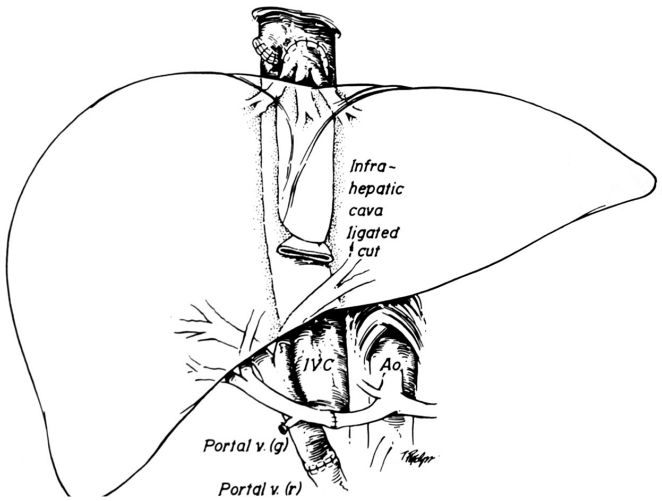


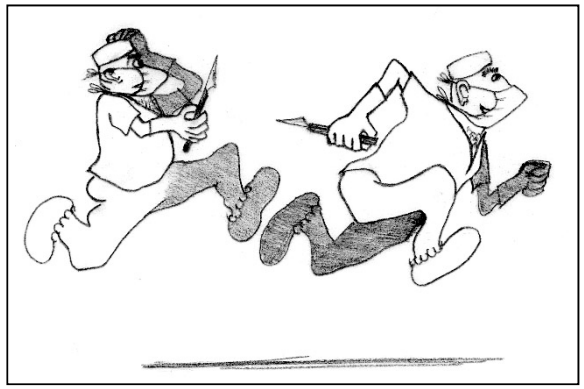


Case:

Female 22 y
Tennisball epigastrium
Shatterd liver
DCS + packing in trauma center 1
Transport trauma center 2
Hepatectomy and portocaval shunt
Liver transplantation within 24 u







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Unanswered questions in DCS

- Which patients would benefit the most from haemostatic resuscitation, and how should these patients be identified at the outset of resuscitation?
- Which patients will benefit from permissive hypotension?
- What are the precise indications for recombinant factor VIIa, tranexamic acid, and cryoprecipitate?
- Would better resuscitation reduce the need for damage control surgery and allow more patients to undergo primary definitive repair?

Summary (1)

- Damage control surgery is adopted for severely injured patients, in which the initial operation is abbreviated after control of bleeding and contamination to allow ongoing resuscitation in the ICU.
- Trauma resuscitation must address all three components of the "lethal triad" of hemorraghic shock: coagulopathy, metabolic acidosis and hypothermia
- Damage control resuscitation integrates permissive hypotension, haemostatic resuscitation, and damage control surgery

Summary (2)

- Damage control surgery is a surgical strategy aimed at restoring normal physiology rather than anatomical integrity; however, this component of damage control resuscitation should not be applied in isolation
- Damage control surgery starts in the ER, continues through the OR and ICU until resuscitation is complete
- Topical haemostatic agents and interventional radiology are nowadays useful adjuncts to surgical control of bleeding.

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