The Open Surgical Abdomen—
a management challenge for the surgical
and non-surgical intensivist

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Open Sesame: opening the cavity

The Management of the Open Abdomen in Trauma and Emergency General Surgery: Part 1—Damage Control

Jose J. Diaz, Jr., MD, Daniel C. Cullinane, MD, William D. Dutton, MD, Rebecca Jerome, MS, Richard Bagdonas, MD, Jaroslav O. Bilaniuk, MD, Bryan R. Collier, DO, John J. Como, MD, John Cumming, MD, Maggie Griffen, MD, Oliver L. Gunter, MD, John Kirby, MD, Larry Lottenburg, MD, Nathan Mowery, MD, William P. Riordan, Jr., MD, Niels Martin, MD, Jon Platz, MD, Nicole Stassen, MD, and Eleanor S. Winston, MD

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Management Open Abdomen: Part 1—Damage Control
• **Indications for opening “the can of worms”:**

**ACS:**

• Abdominal compartment syndrome: IAP > 20 mmHg with signs of organ dysfunction (Level 1)
• IAP > 25 mmHg (Level II)
• After DCS for non-abdominopelvic trauma, secondary ACS (Level II)
• After DC with an open abdomen as preventative measure to prevent ACS, especially if: > 10 U packed cells, > 15L of crystalloids (Level III)
• **Damage control:** consider OA technique if
• Acidosis (pH < 7.2)
• Hypothermia (temp < 35 °C)
• Coagulopathy
• > 10 U packed cells
• (Level III)

• **General surgery:**
• Intra-abdominal infection/peritonitis/necrotizing pancreatitis

• **Vascular surgery:**
• rAAA with significant visceral oedema where closure would result in ACS (Level II)
• IAH > 21 mmHg in post-op rAAA (Level III)
Figure 1. The management of the open abdomen in trauma, emergency general, and vascular surgery flow diagram. OA, open abdomen; PIP, peak inspiratory pressure.
Critical Care Issues in Managing Complex Open Abdominal Wound

William D. Dutton, MD¹, Jose J. Diaz Jr, MD, CNS, FACS, FCCM¹, and Richard S. Miller, MD, FACS¹
More concise & nice

Damage Control Surgery—The Intensivist's Role
Scott G. Sagraves, Eric A. Toschlog and Michael F. Rotondo
The open abdomen technique: setting the stage

- **STAGE 1:**
  - Pre-ICU Critical Care
  - ACS
  - Trauma
  - Pancreatitis and peritonitis
  - Vascular emergency
  - Temporary abdominal closure (TAC)
Pre-ICU Critical Care

• Damage control resuscitation should start in the ER

• Aggressive management of coagulopathy has been shown to decrease mortality and need for excessive crystalloid administration

• EGDT (hemorrhagic shock) and appropriate transfusion protocol important to limit morbidity and mortality

• Decision for extent of DCL made intra-op based on patient’s pre-op status and physiological reserve and pathological findings

• Avoid progression to Hypothermia, Acidosis and Coagulopathy intra-operative
Abdominal compartment syndrome

- Decompressive laparotomy is definitive treatment

- Leads to improvement in lung compliance, CI, tidal volume & urine output and leads to decrease in:
  - CVP, PAP, HR, Paw

- (See lecture on Perfusion Pressures)
Trauma

• DC according to triggers (Acidosis, temp and coagulopathy) leads to:

  • Decreased operative time & need for transfusions
  • Reduced length of stay
  • Infectious complications and visceral oedema
**Pancreatitis and peritonitis**

- Descriptive studies have shown salvage rates as high as 80% if managed with OA, serial debridement and packing.

- No significant difference in death rates between step-up approach vs. open necrosectomy.

- Serial washouts for different infectious etiologies for peritonitis shown to decrease mortality and morbidity.
Vascular emergency

• Improved outcomes in rAAA & ACS if detected early and managed with OA technique

• Longer intra-op cross-clamp time/ Blood loss results in greater risk for IAH & colonic ischaemia

• If IAP > 21mmHg, decreased mortality with decompression
Temporary abdominal closure (TAC)

• Bogota Bag - simple & inexpensive technique
  - sewn to fascia to make fascial bridge
  - potential for fascial trauma
  - used for trauma and abdominal sepsis
  - closure rate of 28-40%

• Ready-to-use transparent “bowel bag”
• Mesh
• Velcro –type Wittmann sheath – low complication rates
• **STAGE 2:**
• Initial post-operative resuscitation
• Ventilatory support
• Sedation, anxiolytics and paralysis
• Bedside laparotomy
• Antibiotics
• Nutritional support of the open abdomen
Initial post-operative resuscitation

<table>
<thead>
<tr>
<th>Table 2. ICU management of the open abdomen patient</th>
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<tbody>
<tr>
<td>Sedation, anxiolytics and systemic neuromuscular blockade (NMB)</td>
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<tr>
<td>RASS -4, paralytics with BIS monitor</td>
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<tr>
<td>Resuscitation: normalization of acidosis</td>
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<tr>
<td>pH &gt; 7.2</td>
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<tr>
<td>Correction of coagulopathy: blood product resuscitation</td>
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<tr>
<td>INR ≤ 1.5</td>
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<tr>
<td>Correction of hypothermia: passive vs active re-warming</td>
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<tr>
<td>Ideal &gt;37°C</td>
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<tr>
<td>Monitoring for abdominal compartment syndrome (ACS): primary, secondary and tertiary</td>
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<tr>
<td>IAH ≥12 mm Hg, ACS &gt;20 mm Hg with evidence of organ dysfunction/failure</td>
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<tr>
<td>Ventilator management</td>
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<tr>
<td>Low volume 5–6 mL/kg body weight</td>
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<tr>
<td>Management of the open abdomen:</td>
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<tr>
<td>Vac-pack dressing</td>
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<tr>
<td>Nutrition support of the open abdomen</td>
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<tr>
<td>Supplement protein 2 g/kg</td>
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</tbody>
</table>
Ventilatory support

- Ventilate according to ARDS protocol
- Watch out for TRALI, ALI
- Neuromuscular blockade might be considered
- Use pressure control or pressure supported techniques to limit tidal volumes
- PIP to look out for $2^\circ$ ACS
Sedation, anxiolytics and paralysis

- Fentanyl and midasolam
- Richmond agitation sedation scale (RASS)
- Can add on propofol or replace midasolam
- BIS (bispectral index monitor) to evaluate adequacy of sedation especially in paralyzed patients
**Bedside laparotomy**

- Patient with OA should be evaluated daily for the possibility of fascial closure

- In cases of severe Intra-abdominal sepsis or pancreatitis daily saline wash outs can be performed at the bedside in patient that is CV unstable
1. The ICU Attending and the Operating Surgeon will be present for the entire surgical procedure.
2. Obtain Informed Consent (if possible).
3. Pre-procedure Checklist to be reviewed by the bedside nurse.
4. The bedside nurse and a respiratory therapist will monitor the patient and record the procedure (Conscious Sedation Sheet)
   a. Monitors: ECG, BP (A-Line), Pulse Oximetry, ICP (if indicated), and ventilatory settings
5. Indication to proceed to the Operating Room
   a. Surgical Bleeding
   b. Dead Bowel
   c. Need to open another Body Cavity
   d. Surgeon Preference
6. For Bedside Laparotomies,
   a. A sterile perimeter will be set up in the patient’s room. All individuals must wear a surgical head covering and mask.
   b. The ICU Attending will oversee the anesthetic management of the patient.
      i. General Anesthesia  Propofol, Ativan, Vecuronium, and set-up of the ventilator
   c. A sterile hand wash should be performed by the operating team.
   d. Pro-operative antibiotics are indicated only if a new surgical wound is to be made. (Ancef 1 gm IV)
   e. A Betadine / Chlorhexidine abdominal prep will be used.
   f. A standard Bovie will be set up (when indicated).
   g. Wall Suction canisters set-up.
   h. (4) L warm NS Irrigation
   i. A standard bedside celiotomy tray will be set up including suture on a sterile field.
# Antibiotics

<table>
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<th>Table 3. Antibiotic indications</th>
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<tr>
<td><strong>Trauma</strong></td>
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<td>(1) No hollow viscous injury—prophylactic (&lt;24 hours) antibiotic coverage for skin flora.</td>
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<tr>
<td>(2) Bowel injury with spillage—prophylactic (&lt;24 hours) coverage for both gram negative enteric and anaerobic organisms.</td>
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<tr>
<td><strong>Emergency general surgery</strong></td>
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<tr>
<td>(1) Peritonitis—continued antibiotics covering both gram-negative enteric and anaerobic bacteria until source control achieved.</td>
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<tr>
<td>(2) Pancreatitis—same</td>
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<tr>
<td><strong>Vascular surgery</strong></td>
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<tr>
<td>(1) Vascular graft—prophylactic (&lt;24 hours) coverage for skin flora.</td>
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Nutritional support of the open abdomen

Although direct measurement of abdominal fluid protein loss may be optimal, an estimate of 2 g of nitrogen per liter of abdominal fluid output should be included in the nitrogen balance calculations of any patient with an open abdomen (level II).

Enteral access and feeding of the patient with an open abdomen with an intact GI tract should be instituted as early as possible, as this may improve the rate of early primary bowel wall closure, fistula formation, and hospital charges (level III).
Trying to catch the boat

- **STAGE 3:**
  - Re-laparotomy
  - To take place < 36 hrs
  - Aim to control and reduce intra-abdominal sepsis
  - Debridement of devitalized or contaminated tissue
- Staged abdominal reconstruction
The Boat has sailed: attempts at abdominal closure

- **STAGE 4:**
  - Attempting fascial closure
  - Accepting: planned ventral hernia
Will the boat ever come back / we are now stranded

- **STAGE 5:**
- Delayed abdominal reconstruction (6-12 months)
Overview of the open abdomen technique.
Review of Abdominal Damage Control and Open Abdomens: Focus on Gastrointestinal Complications

Brian P Smith¹, Raeanna C Adams²,³,⁷, Vijay A Doraiswamy³,⁷, Vivek Nagaraja³,⁷, Mark J Seamon⁴,⁷, Johathan Wisler⁵,⁷, James Cipolla⁶,⁷, Rohit Sharma⁷, Charles H Cook⁵,⁷, Oliver L Gunter²,⁷, Stanislaw PA Stawicki⁵,⁷
Complications related to the abdominal wall and cavity:

- Ventral hernia
- Infection
- Sterile abdominal collections
Ventral hernia: Chronic

- Incidence in patients undergoing DC/OA 13-80 %
- Wound /intra-abdominal infection following DC/OA surgery increases risk of wound dehiscence
- Absorbable mesh 80% rate of hernia
- After definite closure recurrence rate of 5-10%
Infection

• Surgical infection rates in DC/OA as high as 83%

• Depends on extent of traumatic bowel injury and pathology (contamination/perforation/ischaemic bowel)

• **Major contributing factors:**
  - Bile leak: 8-33%
  - Enterocutaneous fistulae: 2-25%
  - Intra-abdominal abscess amenable to percutaneous drainage
Sterile abdominal fluid collections:

- Difficult to differentiate between infected and non-infected fluid collections

- Incidence of localized fluid collections: 19% on day 4; 6% on day 8; 2.5% on day 12

- CT abdomen investigation of choice, loculated fluid needs drainage if accessible
II: **Complications related to bowel and feeding access:**

- Fistulæ
- Ileus and bowel obstruction
- Enteral feeding and access in DC/OA patients
Fistulae:

Fig 2. An example of a complex open abdominal wound featuring entero-atmospheric fistulae (arrows).
Enterocutaneous/atmospheric fistulae:

- Incidence as high as 19%
- Lack of vascularized tissue over exposed bowel precludes spontaneous healing
- Continuous efflux of enteric contents:
  - High catabolic activity, protein loss, risk of infection and very high mortality
- Sporadic cases of closure with fibrin glue and acellular dermal matrix has shown some success
- Adequate nutrition essential for wound healing and fistula closure
Ileus and bowel obstruction:

• Ileus has surgical and non-surgical causes
• High volumes of fluid during resus period leads to wall oedema
• ? Role of hypertonic saline in ameliorating resuscitation-induced intestinal oedema
• Bowel obstruction due to adhesions
• Adhesiolysis a challenge in “frozen abdomen”
Enteral feeding and access in DC/OD patients:

- Despite bowel oedema, enteral feeding is safe in DC/OA. Promotes healing, fewer infections and fistulization rates.

- Nasogastric/ nasoduodenal tubes appear suitable, jury out on PEG tube.

- No definite data on risk of breakdown of stoma with enteral feeds and risk of fistulization.
III: Hemorrhagic complications in damage control patients

- GIT bleeds: surgical or stress-ulcer related
- PPI’s advocated
IV: **Special topics related to DC/OA patients:**

- Mortality
- Post DC/OA disability and loss of productivity
- Management of the pancreas during damage control
- Damage control for non-trauma
- Damage control in pregnancy
- Retained surgical foreign bodies and DC
Mortality

• Mortality as high as 42%
• Mortality increased by MOF, infections, complications related to fistula’s
• Poor prognosticators contributing to mortality is:
  • Pre-existing malnutrition
  • Morbid obesity
  • Other co-morbid diseases
  • Advanced age
Post DC/OA disability and loss of productivity

- Prolonged ICU/hospital stay
- Increased ventilator days
- High risk for nosocomial infections, thromboembolic complications, prolonged inactivity with physical deconditioning
- Chronic ventral hernia leads to decreased QOL
Management of the pancreas during damage control

• DC/OA for pancreatitis carries mortality of 40%

• More “re-laparotomy”

• Fascial closure very unlikely

• Severe SIRS/ other complications related to pancreatitis
Damage control in pregnancy:

Management of a Pregnant Patient with an Open Abdomen
Sharline Z. Aboutanos, MD, Michel B. Aboutanos, MD, MPH, Ajai K. Malhotra, MD, Therese M. Duane, MD, Rao R. Ivatury, MD

Non-trauma indications in third trimester:
- Intra-abdominal pregnancy
- Spontaneous hepatic rupture
- PPH
Damage control in pregnancy

Penetrating Injury in Pregnant Patient

- Patient unstable or injury above fundus, to flank or back
  - Explore
  - Treat injuries
    - Acidosis, Coagulopathic, Hypothermic
      - (-) Close abdomen
      - (+) Damage control
    - Is fetus in distress or obstructing the field?
      - Yes Emergent C section
      - No Fetal conservative management & FHT
  - Is fetus viable?
    - Yes Treat mother
    - No Fetus dead, bullet in uterus, injury below fundus; stable mother
      - Conservative management

*Maternal care is priority!

Algorithm for penetrating injury in the pregnant patient.
Retained surgical foreign bodies and DC

- RSFB: reaction fibrinous/exudative
- **Exudative:**
  - Early
  - Sepsis
  - Foreign body migration
  - Abscess formation
  - Fistula formation
- **Fibrinous:**
  - Late
  - Granuloma formation
  - Abdominal pain
  - Bowel obstruction
“Whatever you do, do NOT pull that out!”