

Emergency Laparotomy

Open vs Closed Abdomen



Disclosure

Dr. McLean is a site primary investigator for XenMatrix AB Tissue Insert for Ventral Hernia repair. Sponsor: Bard Davol

Learning Objectives:

1. The learner will list factors which will contribute to decision to leave abdomen open after trauma or emergency surgical laparotomy.
2. the learner will list problems which occur as sequelae to the open abdomen
3. The learner will list items to monitor in patients with abdominal hypertension
4. The learner will list parameters to monitor in patients after abdominal closure
5. The learner will identify factors which are improved with enteral nutrition in the open abdomen

What is the open abdomen?

An Open abdomen occurs when the fascial layers are left open either as an emergency surgery in the ICU or after a trauma or emergency surgical laparotomy ¹.

Terms in the literature include: Damage control laparotomy, temporary abdominal closure...when there is a device.

Although termed “open” usually there is some kind of artificial covering

A case



A 25 Year old trauma patient was brought into the ED after GSW to the right side.

ED findings included right hemothorax, for which flight crew had inserted a chest tube

No exit wounds.

Case

Findings included the hemothorax, as well as distended abdomen.

Blood pressure was low, 70/50.

Massive transfusion was started.

Fast ultrasound was positive, so patient was taken to OR.



Operative and early course

Patient had a diaphragmatic laceration on the right and a large hepatic laceration.

The liver laceration was packed, including hemostatic agents, wrapped with a BOLSA technique, and the diaphragmatic laceration was repaired.²

Because patient was coagulopathic, cold, he was sent to ICU and then angiography.



ICU

The patient returned to the OR in 48 hours for unpacking and attempt at closure

It took several trips to OR prior to decrease in visceral edema.

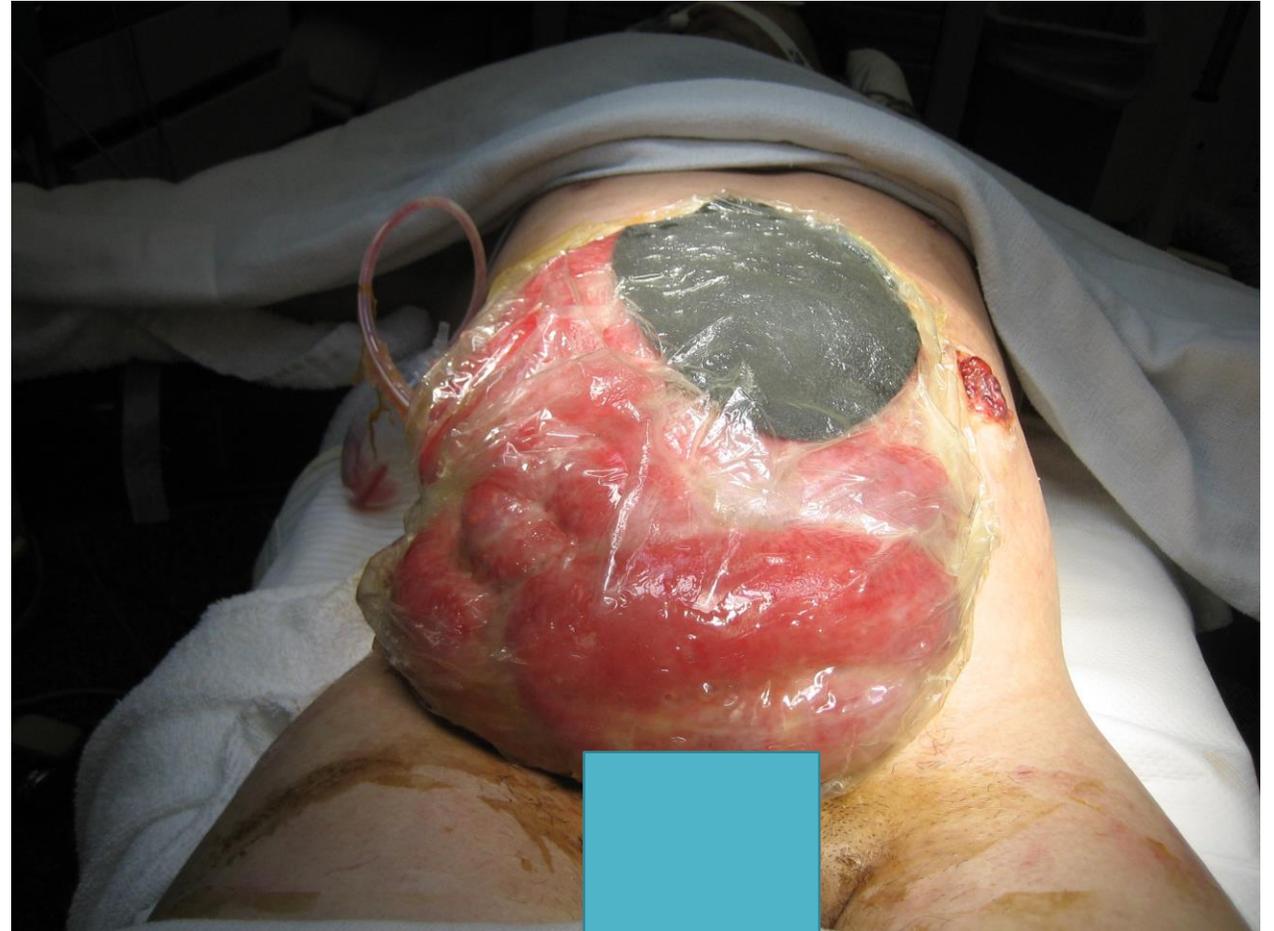


Overview of open abdomen

An open abdomen is when the fascia are not closed, leaving the viscera potentially exposed.

Almost all of these patients are in an ICU and have multiple problems.

The open abdomen itself can be a source of intensive ICU management.



Reasons to leave abdomen open

1. “Damage Control Surgery: ongoing physiologic derangements not amenable to surgical correction—Abdomen left open, ICU correction
2. Patient had abdominal compartment syndrome abdomen left open
3. Surgeon wants to have “second look” at some aspect of the laparotomy.
4. Prevention of abdominal compartment syndrome ^{1., 3., 4., 5.}

Planned Open Abdomen: Physiology: Damage Control

Physiologic reasons to leave abdomen open: 3., 4.,

1. greater than 6 units transfusion
2. lactate greater than 6
3. Base deficit
4. coagulopathy
5. viscera too edematous to close
6. Hypothermia, especially in presence of bleeding (source recent, damage control and CAT
7. Literature over 20 years show that there is improved survival if surgery stops, physiology is corrected

Abdominal compartment syndrome

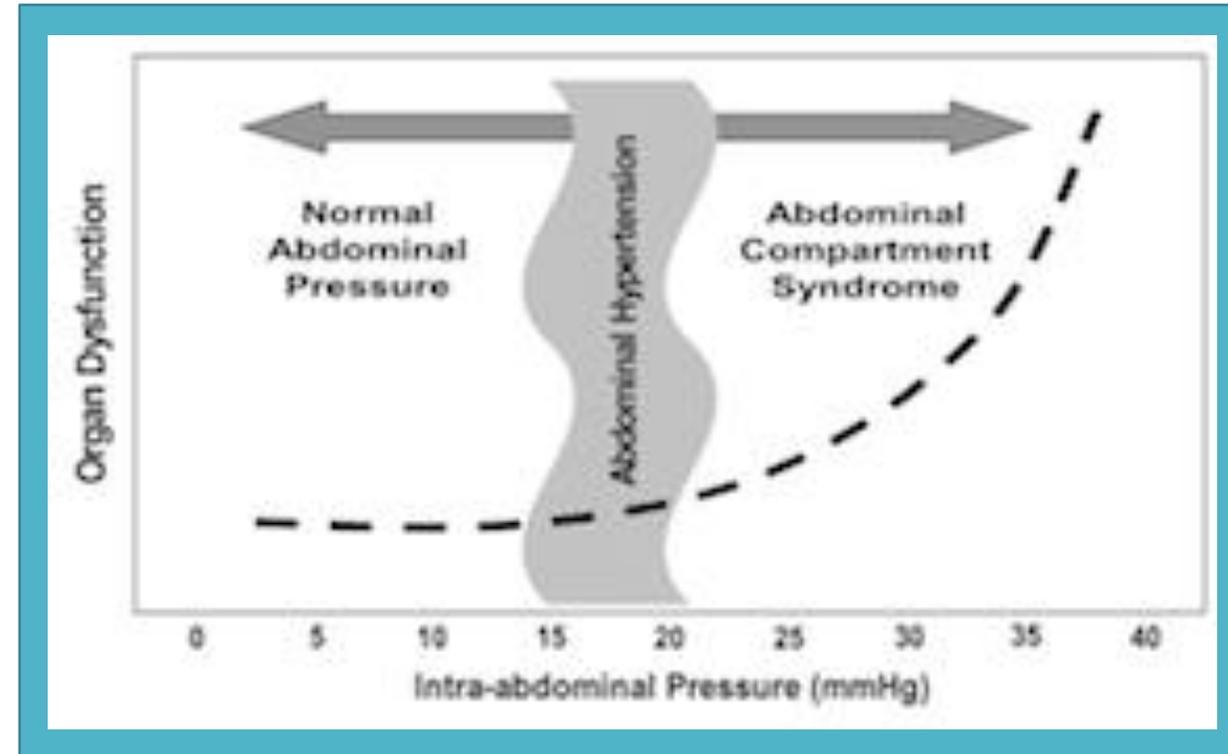
Abdominal compartment syndrome (ACS) occurs when intra-abdominal pressure rises above physiologic levels

Starts as Intraabdominal Hypertension (IAH)

IAH is defined by a sustained or repeated IAP ≥ 12 mmHg (pathologic).

ACS is a sustained IAP > 20 mmHG (\pm APP < 60 mmHG) associated with new organ dysfunction or failure. ⁵.

(APP= MAP-IAP)



Abdominal Compartment Syndrome

Primary IAH or ACS is associated with injury or disease in the early surgical or interventional radiology course

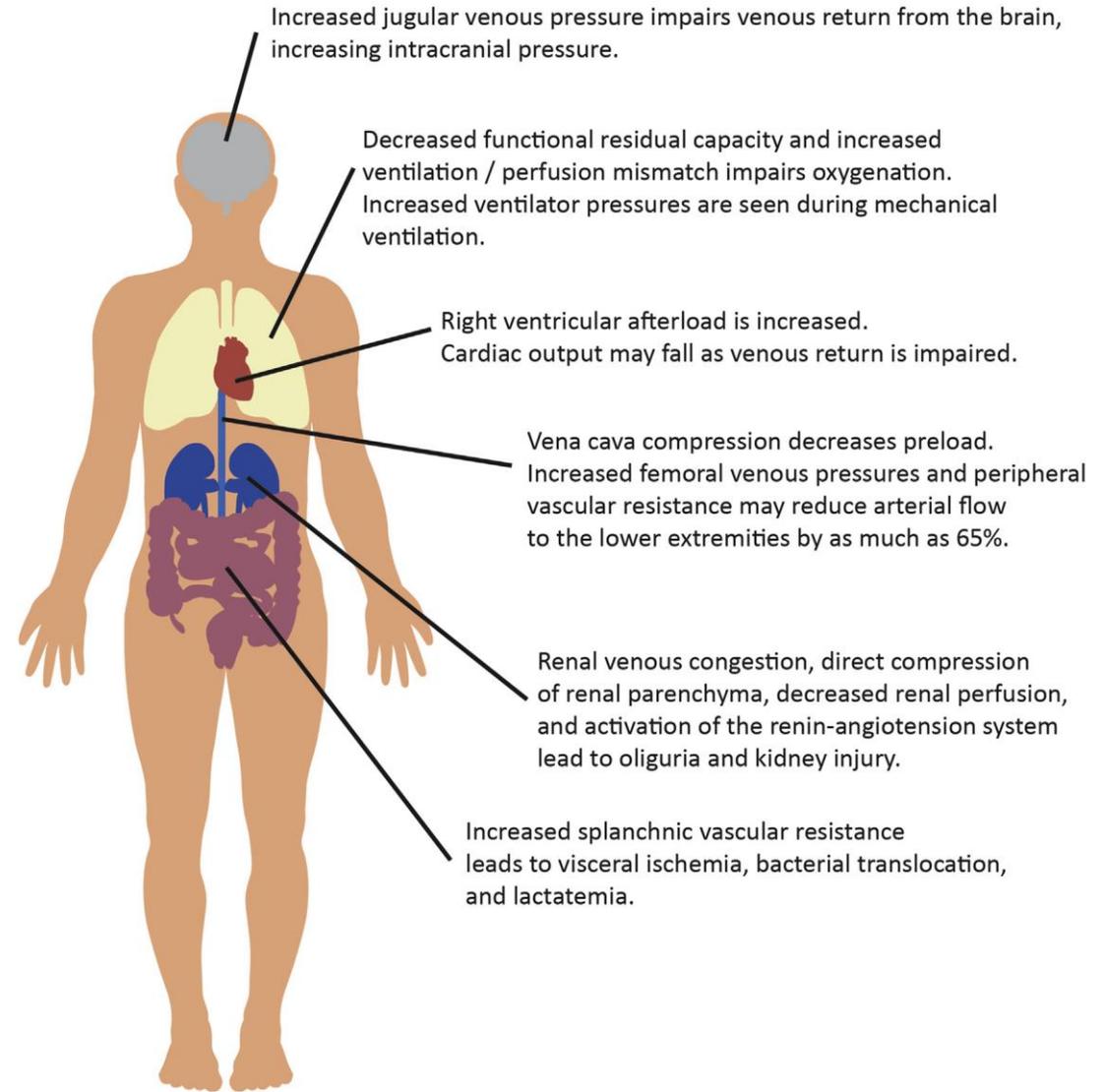
Secondary IAH or ACS is defined as ACS which occurs without primary injury or intervention in the abdomen itself. ⁵.

Secondary ACS is often associated with large volume fluid resuscitation

Abdominal Compartment Syndrome

End-organ effects of Intra-Abdominal Hypertension

- * High peak airway pressures
- * Hypotension
- * Oliguria ^{5.}
- * Increased intracranial pressure ^{5. 6. 7.}

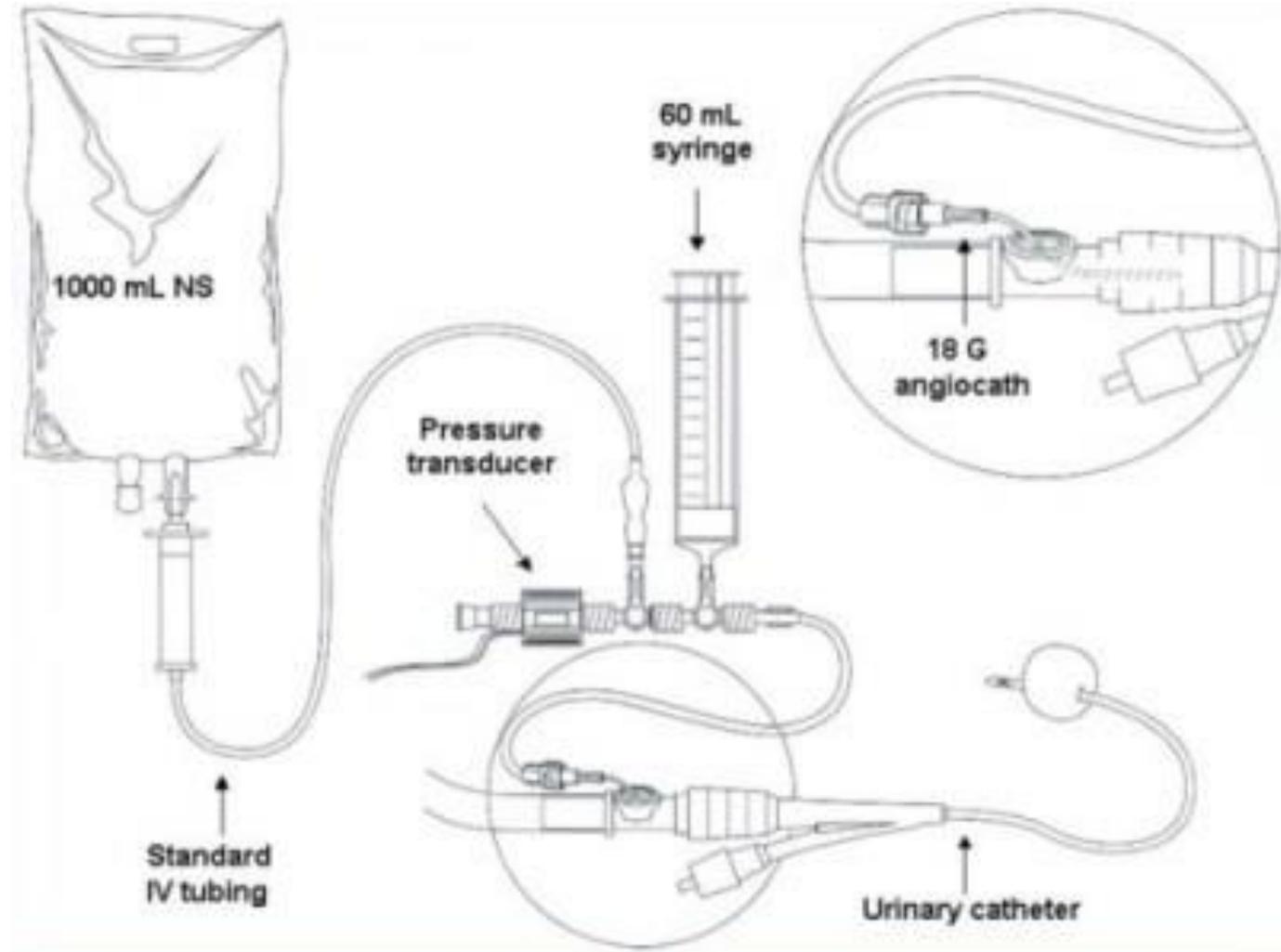


Diagnosis of compartment syndrome

Measuring of bladder pressure

Can use clamps, or special devices

Use draw port on foley catheter to connect pressure tubing to monitor, if not using specialized devices^{5, 6}.



INTRA-ABDOMINAL HYPERTENSION ASSESSMENT ALGORITHM

Patient meets **ONE** of the following criteria and has at least **TWO** risk factors for IAH:
 1. New intensive care unit admission
 2. Evidence of clinical deterioration

Measure patient's IAP to establish baseline pressure

IAP measurements should be:

1. Expressed in mmHg (1 mmHg = 1.36 cm H₂O)
2. Measured at end-expiration
3. Performed in the supine position
4. Zeroed at the level of the mid-axillary line
5. Performed with an instillation volume of no greater than 25 mL of saline (for bladder technique)
6. Measured 30-60 seconds after instillation to allow bladder detrusor muscle relaxation (for bladder technique)

Sustained IAP \geq 12 mmHg?

YES

Patient has IAH

**Notify patient's doctor of elevated IAP.
Proceed to IAH / ACS management algorithm**

NO

Patient does not have IAH

Observe patient.
Recheck IAP if patient deteriorates clinically.

Risk Factors for IAH / ACS

1. Diminished abdominal wall compliance
 - Acute respiratory failure, especially with elevated intrathoracic pressure
 - Abdominal surgery with primary fascial closure
 - Major trauma / burns
 - Prone positioning
2. Increased intra-luminal contents
 - Gastroparesis
 - Ileus
 - Colonic pseudo-obstruction
3. Increased abdominal contents
 - Hemoperitoneum / pneumoperitoneum
 - Ascites / liver dysfunction
4. Capillary leak / fluid resuscitation
 - Acidosis (pH < 7.2)
 - Hypotension
 - Hypothermia (core temperature < 33°C)
 - Polytransfusion (>10 units of blood / 24 hours)
 - Coagulopathy (platelets < 55000 / mm³ OR activated partial thromboplastin time (APTT) > 2 times normal OR prothrombin time (PTT) < 50% OR international standardised ratio (INR) > 1.5)
 - Massive fluid resuscitation (> 5 L / 24 hours)
 - Oliguria
 - Sepsis
 - Major trauma / burns
 - Damage control laparotomy

Abbreviations

IAH - intra-abdominal hypertension
 ACS - abdominal compartment syndrome
 IAP - intra-abdominal pressure

Abdominal Compartment Syndrome-- Importance

ACS is associated with multiple organ failure. ^{5, 14.}

Treatment of ACS

Medical treatment of ACS includes:

1. Neuromuscular blockade¹⁰

2. Sedation¹¹

2. Diuresis^{5,9, 12. 13.}

3. Removal of fluid^{5, 11. 13.}

Surgical Treatment includes: 5. 9.

Open Abdomen!

Planned Open Abdomen: Other

1. Ongoing sepsis and need for debridement, especially with pancreatitis ^{6,8}.
2. Second look at ischemic bowel ⁸.

Examples of temporary openings:



Methods of Open abdomen

1. Vac-Pack, first introduced by Barker, et al. ¹⁵.

A makeshift temporary closure with towels and laparotomy sponges.

Pros: fast and economical

Cons: leaks, difficult to account for fluid losses, may not keep heat in as well as more modern devices

2. Bogota Bag: Reported from Bogota. An empty sterile irrigation bag, cut to fit open area.

Pros: can see viscera

Cons: hard to control effluent, so no accounting for fluid losses



Wittman Patch

A temporary abdominal closure using a hook and burr method. ^{16.}

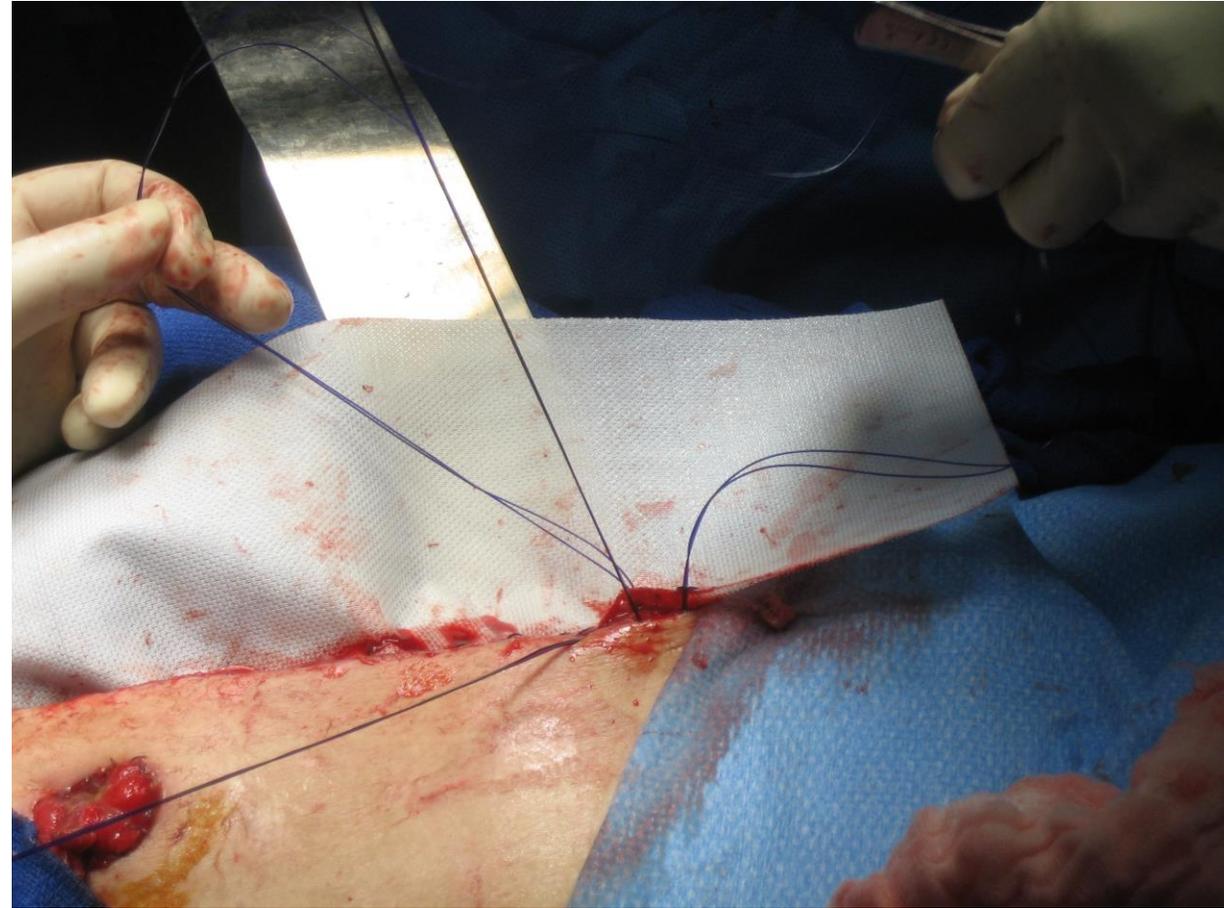
Pros: medial traction on fascia may aid closure

Can accommodate widely open abdomen

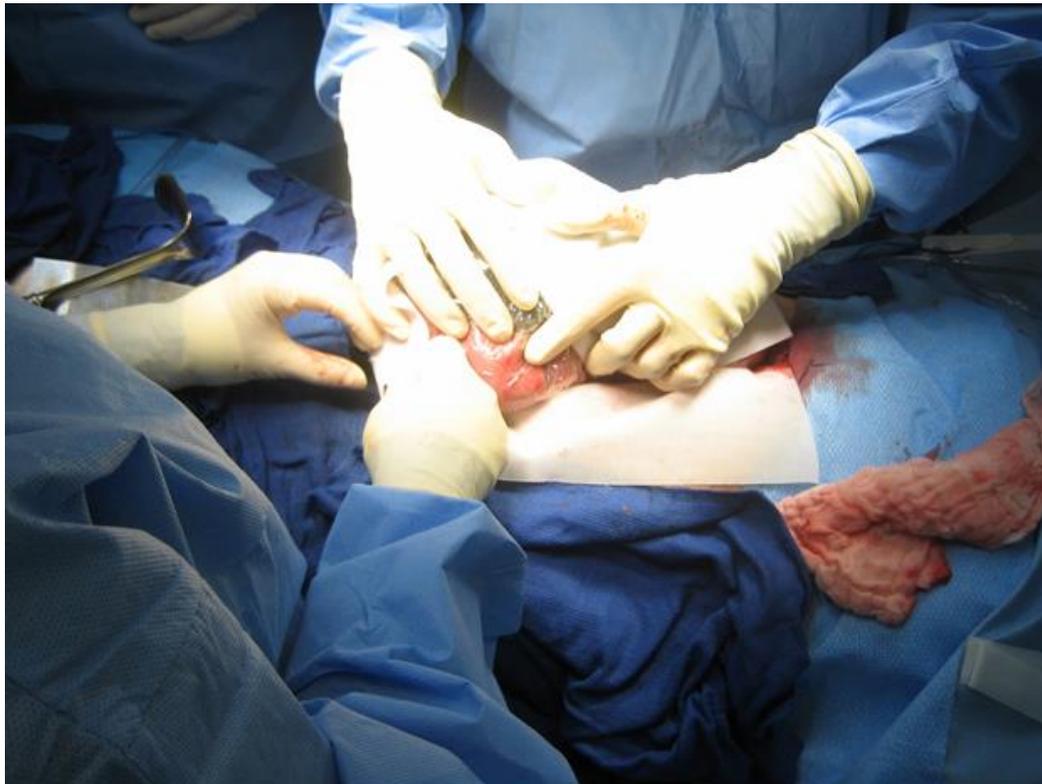
Cons: some damage to fascia

By itself, no accounting for fluid losses

Wittman Patch



Wittman Patch



Negative pressure wound therapy



This type of temporary closure has a sponge insert and protective plastic sheets to use inside abdomen.

Pros: some negative pressure

Easy to account for fluid losses

Cons: A little more costly than homemade versions

Needs changing every 48 hours ¹.

Wittman patch plus NPWT

Retrospective Review done at
TTUHSC El Paso ¹⁷.

30 patients, Average age 34.1 years

Case types 16 trauma, the rest
other

Most for visceral edema in 17, 5 had
hepatic packing, 3 patients with
fistulas

56% final primary fascial closure



Wittman Patch



Patient gets to ICU, Now what?

ICU care issues with open abdomen ^{18., 19. 20.}

1. Increased fluid losses from open peritoneum

2. Important to try to control outputs...this helps skin integrity as well as accounting for input and output

3. Assessment of ongoing bleeding—if abtherra fills up repeatedly, patient may need to go back to OR. ^{21.}

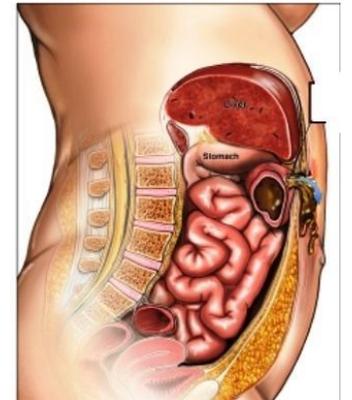
3. Hypothermia: open abdomen can have heat loss...need to have external warming, or even internal warming, as in the warming catheters ^{19.}

4. Metabolic problems: acidosis: must be followed closely, can use ventilator to help. ^{19.}

5. Judicious use of fluids vs blood: most centers have massive transfusion protocol or TEG or ROTEM guided resuscitation to aid resuscitation...this will decrease EC fistula. ^{12. 19.}

Multidisciplinary care for open abdomen

1. Fluid losses
2. Possible loss of abdominal domain—unable to close ^{18.}
3. Gastrointestinal tract fistulas 12.,^{18.}
4. Difficulty in early mobilization
5. Ventilator management: have to watch for increase PIP from Abdominal compartment syndrome ^{19. 20.}
6. Possible difficulty in weaning from vent after closure ^{20.}
7. Skin care around wound and prevention of breakdown
8. Warming patient—open abdomen is a source of heat loss

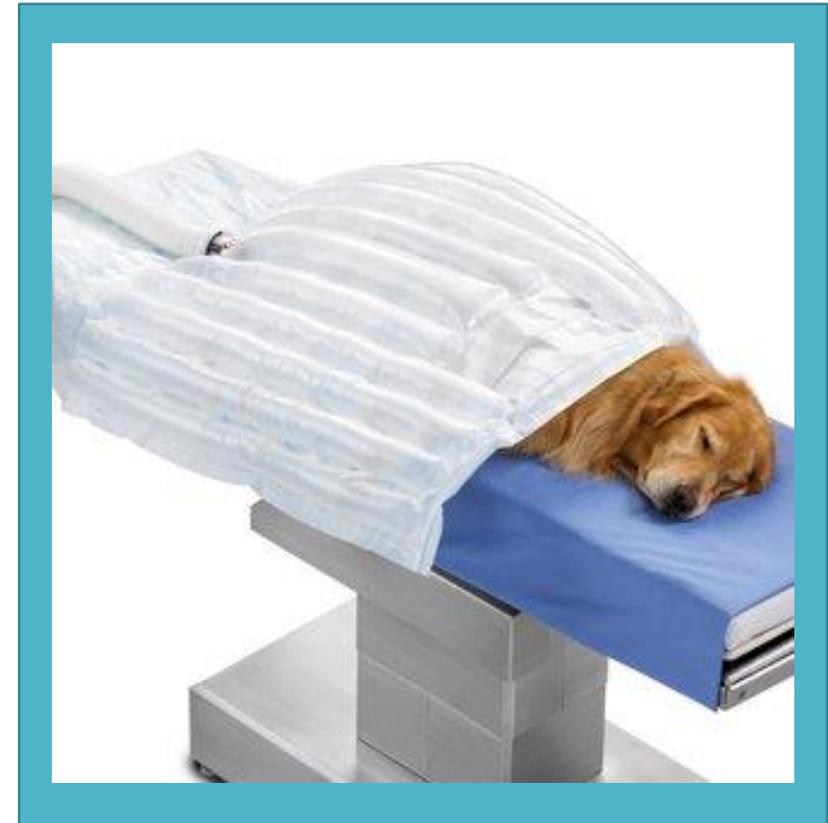


Special Issues with Open Abdomen

Warming:

Many of these patients have been left open because they were cold and coagulopathic 19

Can use active external or active internal warming



Fluid Losses

Fluid losses are increased and must be measured.



Fluid Resuscitation

Fluid resuscitation should be aimed at organ perfusion

Withholding fluids will not help ACS nor patients with an open abdomen.^{5.}

The entire patient must be evaluated without regard to visceral edema

However excessive fluid resuscitation should be avoided as this is a predictor of IAH and ACS as well as a cause of secondary ACS^{5. 14. 19.}



Coagulopathy

Since many of these patients will have had an open abdomen chosen because of the lethal triad of coagulopathy, hypothermia and acidosis, coagulopathy must be corrected

A TEG or ROTEM guided transfusion or a Massive Transfusion Protocol is helpful.



Decreasing Visceral Edema/Resuscitation Strategies

Currently Massive Transfusion Protocols are in place in most trauma centers to aid resuscitation and treat coagulopathy at the same time. ^{18, 21.}

CAT or critical administrative thresholds have been shown to be helpful...usually reach CAT at 3 units/hour. ²¹

CAT has been shown to be predictive of mortality if time is taken to close abdomen. ^{21.}

At Texas Tech—El Paso, we switched to a hemostatic MTP in 201.

Reviewing 258 laparotomies since switch, 118 had AL (damage control). 55(47%) had of AI had hemostatic MTP. 53.4% did not. Of those closed 1st case, only 9 (6.7%) had MTP compared to those closed after 2 or more takebacks. (p=.000) ^{22.}

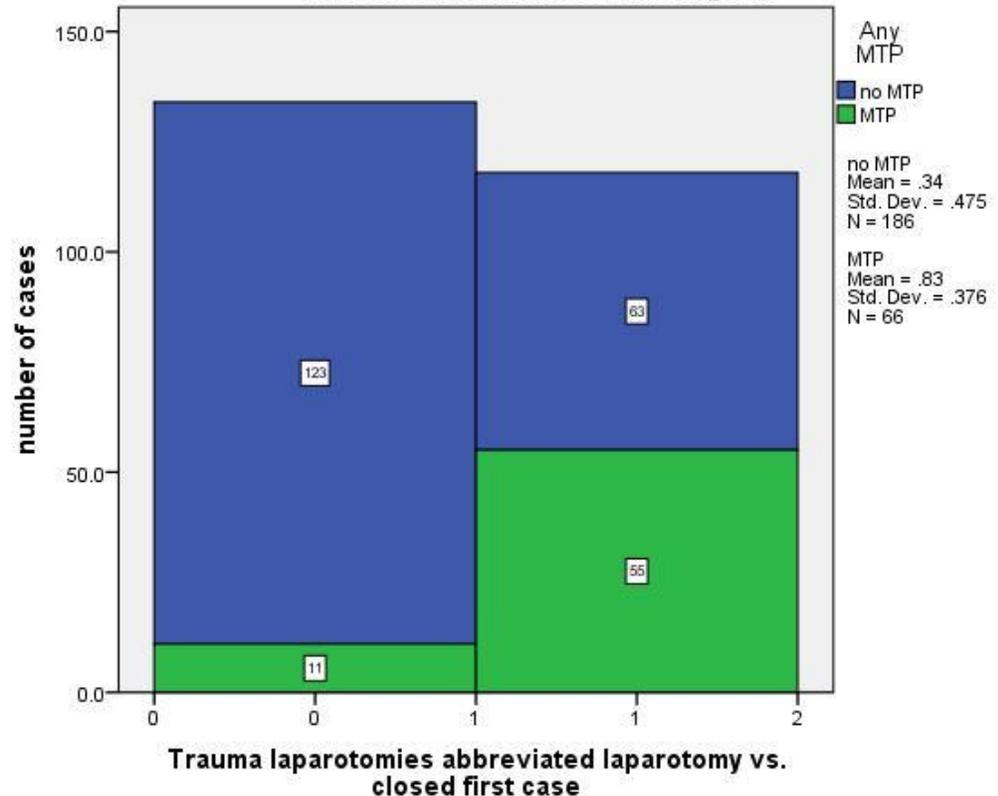
Decreasing visceral edema/Resuscitation strategies

TTUHSC-EP study 2012-2015:
patients with damage control had increased association with MTP.

In AL patients, only 6.3% of no-MTP and 23.6% of hemostatic MTP had primary fascial closure. OR 0.71 for H-MTP patients to achieve primary fascial closure.

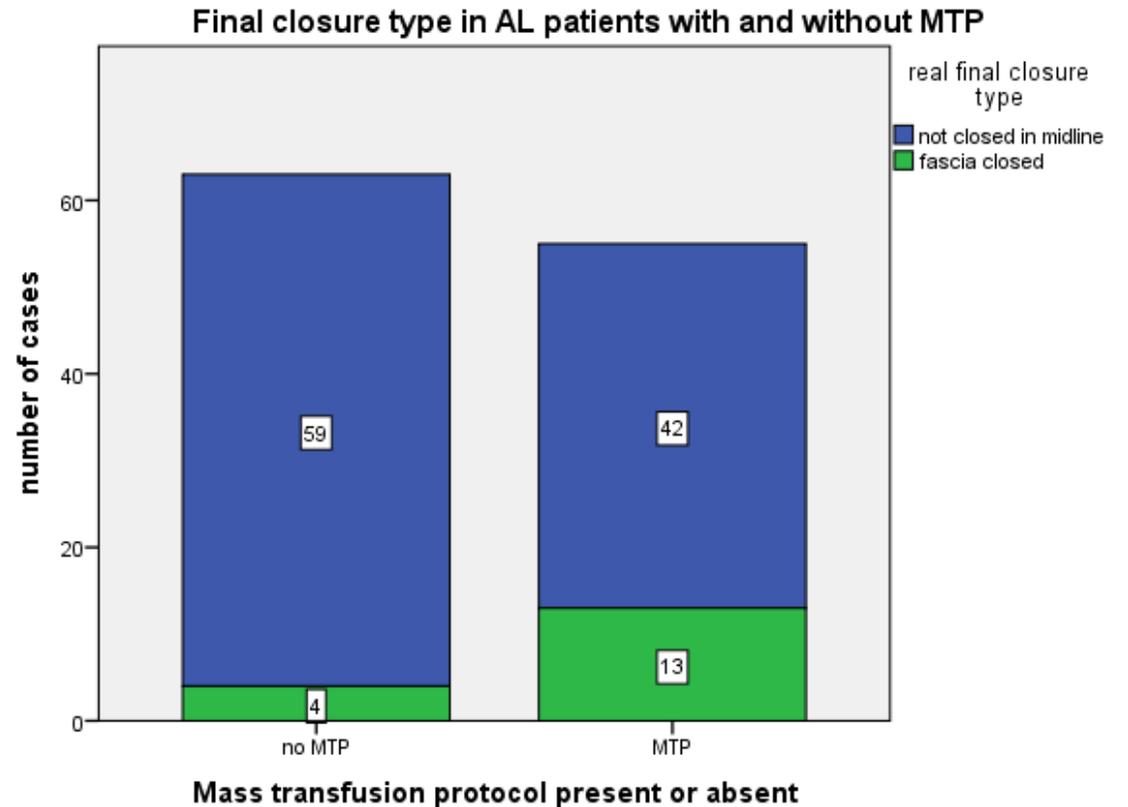
Theory is that they had decreased visceral edema from more blood, less crystalloid. ²².

Trauma laparotomies which had abbreviated laparotomy (damage control) had increased incidence of having MTP



Decreasing visceral edema

Study found that if patients did have Abbreviated Laparotomy or Damage control Laparotomy, if that patient had the new Massive Transfusion Protocol designed to aid coagulation, More were able to achieve primary fascial closure: 6.3 % of those resuscitated without MTP vs 23.6% of those resuscitated with MTP had primary fascial closure (p=.009)



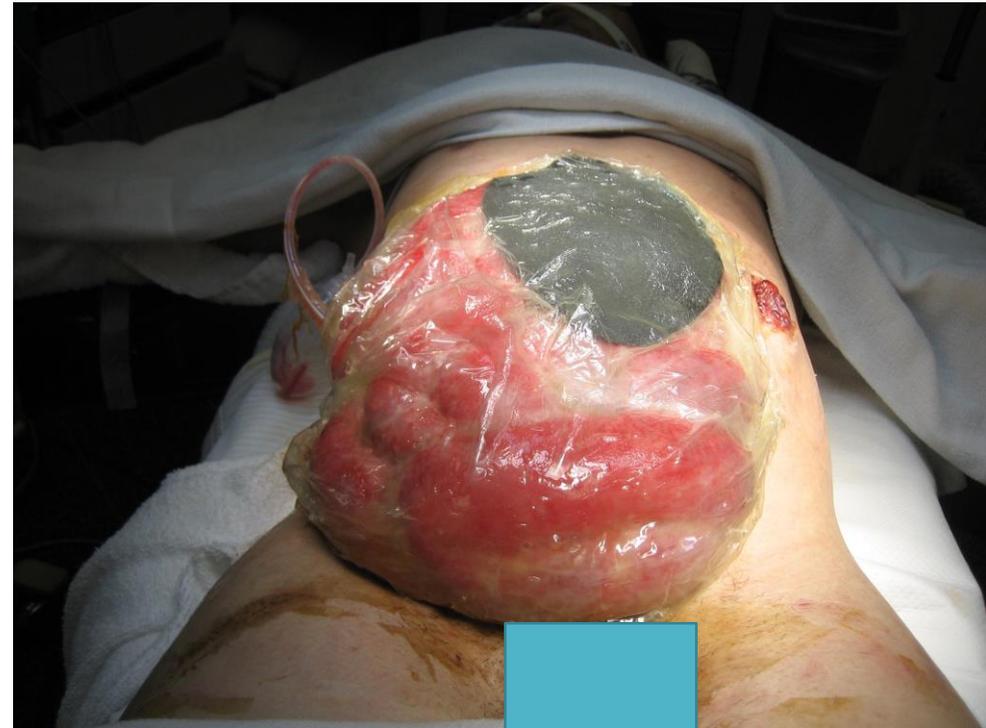
Primary fascial closure was achieved in 55% of H-MTC patients vs. 88% of no-MTC patients. In AL patients only, 4/63 (6.3%) of no MTP and 13/55 (23.6%) of those with MTP had fascial closed in midline. P=.009, OR =0.71 for MTP patients in AL to have a bridged closure compared to those without MTC.

Difficulty in mobilizing/Positioning

Because of connections may have difficulty mobilizing.;

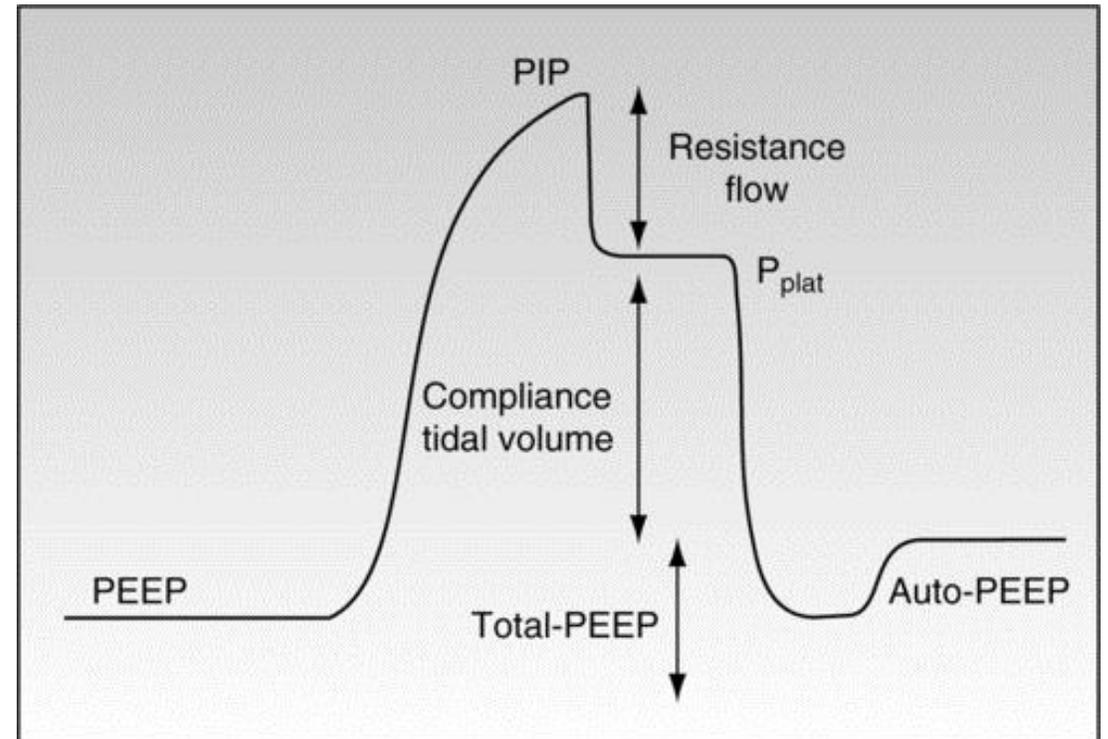
Note that HOB elevation even as much as 20 degrees can elevate intraabdominal pressure, although pressure measured supine. (1 study) ⁵.

Prone positioning also elevates IAP. ⁵.



Ventilator management

- * Although opening the abdomen should decrease problems with ventilator management, there are issues with open abdomen as well as when it is closed.
- * Patients who had early EN noted to have increased length of time on ventilator
- * Obese patients had more time on ventilator with open abdomen with BMI ≥ 40 ²⁰.
- * Elevation of PIP noted with increased abdominal hypertension—this is a great number to know preoperatively so that postop changes can be measured. ⁵.



Nutrition and OA : Can we Feed?

Two issues:

- *Are nutritional needs different in patients with an open abdomen?
- *Can enteral feeds be given safely?
- *Delicate Balance between providing nutrition and perhaps causing increased abdominal volume



Nutritional needs

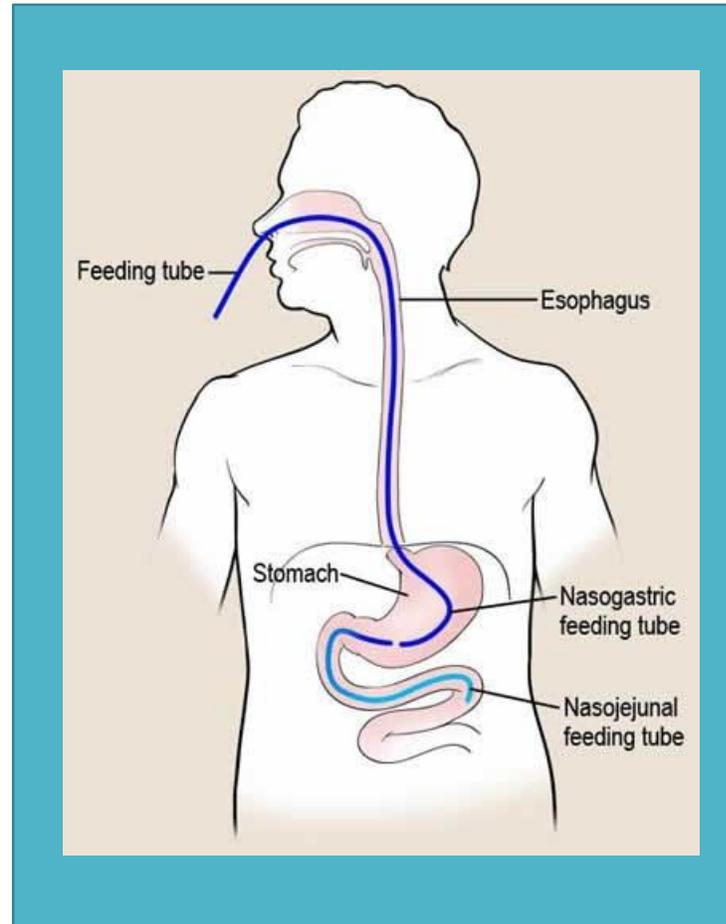
Nutritional needs are increased with an open abdomen

- * Cheatham ML et al.: Studied nitrogen balance by collecting fluid from open abdomen as well as urinary nitrogen loss.²³
- * Findings were that in patients with an open abdomen, should account that 2 grams nitrogen per liter of fluid were lost per day.
- * May have increased caloric demands due to heat loss: if indirect calorimetry is available, suggest using it.

Enteral feeds

Enteral Feeds can be given with open abdomen:

Several studies have shown improvements in outcomes with early enteral feeding, which has been defined for OA patients at different time intervals. ²⁴.



Nutrition AND Open Abdomen

Study	Early EN DEFINED	Early EN	Late EN	n	Comment
Collier et al 25.	≤ 4 days	<ol style="list-style-type: none"> 1. Increased rate of PFC 2. Lower EC fistula (9% v 26%) 3. Lower charges 	> 4 days	78: 43 Early EN, 35 late EN	4 days is longer than studies on all ICU patients
Dissianaikie 26.	< 36 hours	<ol style="list-style-type: none"> 1. Decreased VAP rate 44% v 75% 	>36 hours, X = 7 days	100: 35 on EN,	Used TPN in those not on EN, felt that calories the same

Nutrition and Open abdomen

Study	Early EN defined	Early EN	Late EN	n	Comments
Byrnes et al ²⁷ .	Before fascial closure	12 Longer time with open abdomen 7.1 vs 3.4 days	11 Mean Open abdomen 3.1 days	23	Small study. Higher rate of bowel injuries in EN group First study to incorporate OA and bowel injury
WTA multicenter ²⁸ .	Before fascial closure	Time to any feeds 3.6 days 62% of these low dose feeds 20cc/hour	After abdomen closed	597	Large study Time to abdomen closed longer in EN group: 9 vs 5 days; Closure rate was higher in EN group (75% vs 68%) NO significant difference between EN and Late N wrt complications

When the patient gets abdomen closed

What issues does the intensivist need to think about when the patient gets the abdomen closed?

What are methods to get an open abdomen closed and how do they impact the ICU course?

Tricks for closing

METHODS

1. Medial traction—using the Wittman patch
2. Medial traction in OR
3. Component separation
4. Serial closure in ICU

ICU ISSUES

1. Watch out for increase peak airway pressures
2. Pain control will be needed
3. Division of muscles may cause bleeding. Patient may later have core stability issues
4. This will necessitate serial days when patient given sedation, neuromuscular blockade. May increase LOS

Items for ICU Personnel to Monitor

1. Intra-abdominal Hypertension: can occur after closure. Monitor by routine measurement of bladder pressure. Cannot reliably use physical exam (WSACS reviews, 2007) ^{5, 18, 19}

Treat: can use neuromuscular blockade, diuresis if there is edema. May need to re-open.

2. Elevated Peak Airway and Plateau pressures on ventilator 5, 18

Treat: Lengthen inspiratory time. Could use NMB also. Check minute ventilation, possibly lower tidal volume and increase rate to equal minute ventilation.

3. Assessment of Wound for Dehiscence

Treat: if happens early, notify surgeon ASAP. If there is a small dehiscence, surgeon may treat with VAC

4. Bleeding if Extensive mobilization of flaps was needed

Treat: Transfusions as needed, check coagulation analysis, notify surgeon

Why be concerned for Open Abdomen?

There is a real incidence of ventral hernia:

Hofmann et al. (2017): 87 patients followed prospectively since 2007 for surgery with open abdomen after secondary peritonitis. Used dynamic fascial sutures to close. 39 patients alive at end of last study in 2013 included, one died, 38 total patients included. Overall 56.3% of patients had died. 21 patients (55.3% of latest cohort) answered questionnaire.

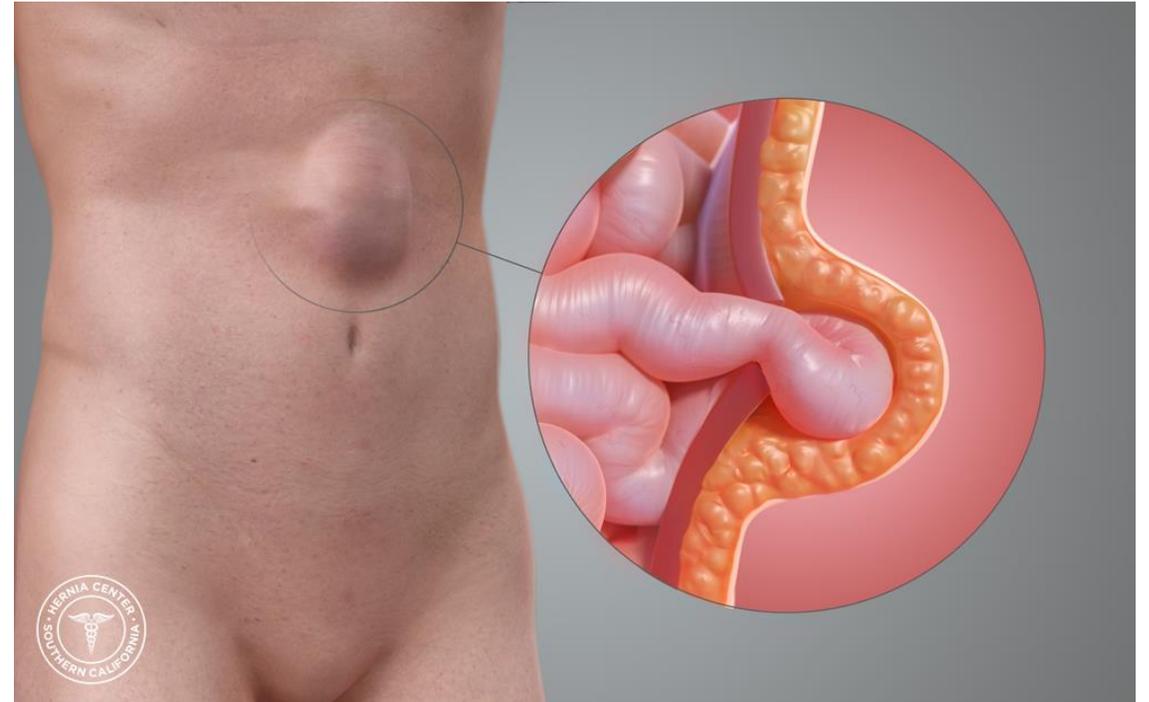
7 (33.3%) had incisional hernias.

6 had chronic pain. ³².

Willms et al. reported on 55 OA patients: ³³.

35% had incisional hernias.

Fascial closure rate was 74% initially.



Quality of Life after Open Abdomen

In a study of patients who had initial treatment with open abdomen and delayed abdominal wall reconstruction:

41 of 152 patients, Delayed AWR. A QOL assessment was done.

31 patients employed prior to AWR, 23% did not return to work by the study because of the DAWR.

65% screened positive for depression

23% screened positive for PTSD.

Physical Component Scores were lower compared with established norms.

This means that these patients have prolonged morbidity from an open abdomen.

Strategies to decrease number of OA's

1. Don't leave abdomen open, don't take damage control lightly ^{1,30,31} .

2. Judicious fluid replacement, considering coagulation control.

Harvin et al. reduced use of DCL from 39% to 23% after trauma in 2 years, no difference in mortality. ²⁹.

Higa et al. in Tucson, and others decreased the number of damage control laparotomies from 36.3% to 8.8 % at one institution over a three years. ³⁰.

The Tucson study noted a projected cost/charge savings of 2.2 million and 5.8 million.

Conclusions

The open abdomen is common in surgical and trauma ICU's

Conditions which may warrant an open abdomen are Abdominal Compartment Syndrome, Damage Control Surgery for Trauma or Emergency General Surgery, Need for repeat visualization of intra-abdominal contents

The ICU care of the Open abdomen patients is multi-disciplinary including respiratory care, physical therapy, the intensivist and nursing staff for ongoing fluid requirements, transfusion requirements and monitoring

Once the abdomen is closed, there are important parameters to monitor including intra-abdominal pressure, airway pressures, fluid balance and wound care.

