Project: Ghana Emergency Medicine Collaborative

Document Title: Abdominal Compartment Syndrome

Author(s): Alison Haddock (University of Michigan), MD 2012

License: Unless otherwise noted, this material is made available under the terms of the Creative Commons Attribution Share Alike-3.0 License: http://creativecommons.org/licenses/by-sa/3.0/

We have reviewed this material in accordance with U.S. Copyright Law and have tried to maximize your ability to use, share, and adapt it. These lectures have been modified in the process of making a publicly shareable version. The citation key on the following slide provides information about how you may share and adapt this material.

Copyright holders of content included in this material should contact open.michigan@umich.edu with any questions, corrections, or clarification regarding the use of content.

For more information about how to cite these materials visit http://open.umich.edu/privacy-and-terms-use.

Any medical information in this material is intended to inform and educate and is not a tool for self-diagnosis or a replacement for medical evaluation, advice, diagnosis or treatment by a healthcare professional. Please speak to your physician if you have questions about your medical condition.

Viewer discretion is advised: Some medical content is graphic and may not be suitable for all viewers.
Use + Share + Adapt

{ Content the copyright holder, author, or law permits you to use, share and adapt. }

- **Public Domain – Government**: Works that are produced by the U.S. Government. (17 USC § 105)
- **Public Domain – Expired**: Works that are no longer protected due to an expired copyright term.
- **Public Domain – Self Dedicated**: Works that a copyright holder has dedicated to the public domain.
- **Creative Commons – Zero Waiver**
- **Creative Commons – Attribution License**
- **Creative Commons – Attribution Share Alike License**
- **Creative Commons – Attribution Noncommercial License**
- **Creative Commons – Attribution Noncommercial Share Alike License**
- **GNU – Free Documentation License**

Make Your Own Assessment

{ Content Open.Michigan believes can be used, shared, and adapted because it is ineligible for copyright. }

- **Public Domain – Ineligible**: Works that are ineligible for copyright protection in the U.S. (17 USC § 102(b)) *laws in your jurisdiction may differ

{ Content Open.Michigan has used under a Fair Use determination. }

- **Fair Use**: Use of works that is determined to be Fair consistent with the U.S. Copyright Act. (17 USC § 107) *laws in your jurisdiction may differ
  
  Our determination **DOES NOT** mean that all uses of this 3rd-party content are Fair Uses and we **DO NOT** guarantee that your use of the content is Fair.

  To use this content you should **do your own independent analysis** to determine whether or not your use will be Fair.
OBJECTIVES

- Discuss two critical care cases
- Challenges in management and diagnosis
- Review emergent management of a common ED presentation
- Focused exploration of a less common disease process
- Discussion of how the health care system can contribute to individual patient morbidity and mortality
CRITICAL PATIENT IN RESUS BRAVO

- Obese elderly Asian female
- Pale, breathing heavily
- Accompanied by son
ABCs

- A
  - Speaking single words

- B
  - RR 30
  - SpO2 unable to obtain

- C
  - HR 50
  - BP unable to obtain
PULSES AND BPs

- Old ATLS teaching
  - SBP > 80 mmHg if palpable radial
  - SBP > 70 mmHg if palpable femoral
  - SBP > 60 mmHg if palpable carotid

- Not scientifically validated

- Did confirm that loss of pulses occurs in order...
  - radial
  - femoral
  - carotid

NEXT STEPS

- IV
  - Multiple techs attempting

- O2
  - Supplemental O2 via NRB

- Monitor
  - Slow HR
  - No BP
NEXT STEPS
**Next Steps**

- **IV**
  - 16 gauge in R EJ

- **O2**
  - Supplemental O2 via NRB

- **Monitor**
  - Slow HR (ranging 40s-50s)
  - No BP (estimate 60-70 SBP)
What now?

Brief History

Brief Exam

Further Interventions

More Clinical Data
**Brief History**

- POD #10 from lap-to-open cholecystectomy
- Prolonged post-operative hospitalization due to “heart problems”
- Discharged home three days ago
- Increasingly weak today
- C/O severe fatigue, “chills”
- Denies measured temps, denies pain
- Taking all medications including Coumadin and blood pressure pills
**Brief Exam**

- Pale, increased WOB
- PERRL, dry MM
- Shallow clear breath sounds
- Slow irregular heartbeat
- Obese/distended and firm abdomen
  - No focal tenderness
- Cool extremities
  - No palpable radial pulse
  - Thready femoral pulse
FURTHER INTERVENTION

- IVF bolus
  - 1L wide open
  - Attempting to obtain additional access
- Pacer pads
What clinical data?

- Labs?
- XR?
- CT Scan?
- US?
- Phone-a-friend?
Resus Shortcuts

VBG
EKG
CXR
7.23/44/164

Na 137  Glu 147
K  4.9   Lac 8.2
Ca 1.04 Hct 28
Diagnosis?

Shock.
Types of Shock

- Hypovolemic
- Obstructive
- Distributive
- Cardiogenic
Differential Diagnosis

- Hypovolemic
  - Hemorrhagic
- Obstructive
  - No apparent evidence of PE, PTX or tamponade...
- Distributive
  - Sepsis from recent hospitalization/surgery
- Cardiogenic
  - Hx of recent cardiac problems
  - Medication toxicity?
REASSESSMENT

- Ongoing bradycardia 40s-50s
- Treatment?
  - For HR <50bpm with evidence of hypoperfusion
  - Or if high risk of progression to complete block
  - Options: atropine vs. pacing
- Atropine
  - 0.5 – 1mg IVP adult dose
  - Anticholinergic positive chronotropic effect
  - Pt has increased HR to 50s-60s without BP improvement
**REASSESSMENT**

- Respirations increasingly labored
- Abdomen still distended
- Now poorly responsive to son’s questioning

- Back to the ABCs!
REASSESSMENT

- Airway now secure
- Still unable to obtain BP

- Access: single EJ
- Additional 14g placed by EDT in R AC

- Second L warmed NS started
- Pt started on pressors
PRESSORS (over) SIMPLIFIED

<table>
<thead>
<tr>
<th></th>
<th>α</th>
<th>α = β</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>norepinephrine</td>
<td>epinephrine</td>
<td>dobutamine</td>
</tr>
<tr>
<td>Lower</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dose</td>
<td>= more β</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>= more α</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REASSESSMENT

- How can we distinguish between types of shock?
RAPID ULTRASOUND IN SHOCK (RUSH)

PUMP
- cardiac contractility
- tamponade
- PTX
- RV strain
RAPID ULTRASOUND IN SHOCK (RUSH)

TANK
- IVC – size & resp change
- FAST
Rapid Ultrasound in Shock (RUSH)

PIPES
- Aorta
- DVT
Ultrasound
REASSESSMENT

- Abdomen increasingly distended and firm
- Surgery contacted

- Treatment initiated for hemorrhagic shock
- O+ pRBCs placed on rapid transfuser
  - Massive transfusion anticipated
  - Given calcium chloride
REVERSAL OF ANTICOAGULATION: FIRST STEPS

- **FFP**
  - Typical adult pt requires 3-4 unites to reverse
  - Contains all vitamin K dependent factors
  - Does not fully reverse
    - Ex: factor IX does not rise >20% of normal post FFP (not reflected in INR)
  - Requires thawing
  - Risks volume overload

- **Vitamin K**
  - 10mg slow IV
  - Starts to work in 4hrs
**Reversal of Anticoagulation: Next Steps**

- **Recombinant Activated Factor VII**
  - Expensive, limited literature
  - UofM: “serious bleed associated with prolonged INR after significant clotting factor replacement”
  - 1200mcg x one dose

- **Prothrombin Complex Concentrate**
  - Plasma-derived product, no matching required
  - Virally inactivated and 20x less volume than FFP
  - Contains II, IX, and X (+ VII in UK)
  - Currently infrequently used in US
  - Expensive
  - Potentially thrombogenic
**Reassessment**

- Rapid transfusion of 3U FFP, 4U pRBCs
- Surgery at bedside
- Still no BP on max dose dopamine (20mcg/kg/min)
- Pulse check = no carotid or femoral
- PEA
  - Compressions initiated
  - Single dose of 1mg epinephrine
  - Return of strong pulse
REASSESSMENT

- ABCs
  - Airway secured with ETT
  - Ongoing hypotension despite pressors

- Volume
  - Cordis inserted into R groin + 14G PIV + 16G PIV
  - Femoral arterial line
  - Rapid infuser for pRBCs, FFP

- Pressors
  - Max dose dopamine
  - Epinephrine and norepinephrine initiated post-arrest
Labs

Hematology:

CBCP:

10.1

26.2 >------< 375

31.3

Diff (Automatic):

<table>
<thead>
<tr>
<th>NEUT</th>
<th>LYMPH</th>
<th>MONO</th>
<th>EOS</th>
<th>BASO</th>
</tr>
</thead>
<tbody>
<tr>
<td>%: 83.7</td>
<td>8.3</td>
<td>8.0</td>
<td>.0</td>
<td>.0</td>
</tr>
<tr>
<td>#: 21.9</td>
<td>2.2</td>
<td>2.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Cardiac Enzymes (18:00):

Troponin: 0.11; CPK: 102; CKMB: 2.3;

Liver Panel:

Prot: 5.7; Alb: 3.1;

AST: 54; ALT: 23;

TBILI: 1.7;

ALK: 156;

Chemistry:

142c | 102 | 24 Cal: 9.32c AnGap: 17

-------------------< 190 BUN/Cr: 16

4.6 | 22 | 1.5 CalcOsm: 301

Coags:

INR: 1.8 (PT: 18.1); PTT: 24.8;
REASSESSMENT

- Mismatch between BPs
  - Femoral arterial line = SBPs in 60s
  - Cuff pressure = SBPs in 100s

- Overall poor responsiveness to pressors and fluids

- Additional diagnosis made:
ABDOMINAL COMPARTMENT SYNDROME

Patrick Fitzgerald, Atlanta, GA, [Wikimedia Commons](https://commons.wikimedia.org)
**Abdominal Compartment Syndrome**

- **Definition**
  - Sustained intra-abdominal pressure of >20 mmHg associated with new organ dysfunction or failure

- **Measurement of IAP**
  - Challenging clinical diagnosis
  - Direct peritoneal cannulation, rectal, gastric, IVC
  - Most popular = bladder
  - Routinely tracked in MICU/SICU/TBICU settings

- **Relatively high incidence**
  - One study found ACS in 14% of high-risk trauma pts
  - Another found 50% of ICU pts had IAH (>12 mmHg)
ABDOMINAL COMPARTMENT SYNDROME

- Primary ACS: injury/disease in abdomen
  - Abdominal trauma
  - Abdominal hemorrhage
  - Bowel obstruction
  - Intra-peritoneal sepsis
  - Ruptured AAA
  - Acute pancreatitis
  - Less acute: morbid obesity, pregnancy, massive ascites

- Secondary ACS: third-spacing in abdomen
  - Severe sepsis, burns
  - Any shock requiring massive fluid resuscitation
Box 1: Emergency department patients at risk of developing intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS)

Patients who should be considered at higher risk of developing IAH and ACS:

- Patients with open or blunt abdominal trauma
- Patients requiring large volume fluid resuscitation (especially in the context of an underlying capillary leak problem)—for example:
  - pancreatitis
  - septic shock
  - trauma
  - severe burns
- Patients with increased intra-luminal contents
  - gastroparesis
  - ileus
- Patients with increased abdominal contents
  - haemoperitoneum or pneumoperitoneum
  - ascites or liver dysfunction

<table>
<thead>
<tr>
<th>Condition</th>
<th>Increased</th>
<th>Decreased</th>
<th>No change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean blood pressure</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>Heart rate</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Peak airway pressure</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Thoracic/pleural pressure</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Central venous pressure</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Pulmonary capillary wedge pressure</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Inferior vena cava pressure</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Renal vein pressure</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Systemic vascular resistance</td>
<td>x</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cardiac output</td>
<td>-</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Venous return</td>
<td>-</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Visceral blood flow</td>
<td>-</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Gastric mucosal pH</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Renal blood flow</td>
<td>-</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Glomerular filtration rate</td>
<td>-</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Cerebrospinal fluid pressure</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Abdominal wall compliance</td>
<td>-</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>
Intra-Abdominal Pressure Monitoring Algorithm

IAP monitoring Q 1-2 hours for first 24-36 hours

IAP consistently <12 mm Hg
- Begin simple medical management
  - Sedation / Pain control
  - Avoid proning
  - Reposition bed – unflex hips
  - Remove constrictive bandages
  - Optimize fluids
    - Use goal directed resuscitation
    - Avoid boluses
    - Concentrate drips
    - Aim for neutral fluid balance
  - Decompress GI tract
    - NGT / Rectal tube
    - Prokinetics – EES, metoclopramide
    - Enemas

Reduce frequency of IAP measurements to Q 4-6 hours for additional 24 hours

IAP 12-15 mm Hg
- Add more advanced medical management of IAH
  - Ultrasound or CT to find fluid collections, abscess, etc
  - Paracentesis / Percutaneous drain fluid
  - Slow down tube feeding to trophic levels
  - Diuresis / Dialysis / Ultrafiltration (post-resuscitation, replace volume with colloids to maintain intravascular volume)
  - Colloids plus diuretics if appropriate

IAP 15-20 mm Hg
- If pressure progresses to > 20 mm Hg
  - Neuromuscular blockage trial
  - Colonoscopy to decompress distended colon if present
  - Stop enteral nutrition
  - Inform surgical consultant

IAP >20 mm Hg with evidence of organ dysfunction / ischemia and comorbidity
- Surgical Consult: Consider surgical decompression
  - Through abdominal wall if this is initial decompression
  - Through abdominal dressing if recurrent decompression

"Additional Insult" - Patient develops new indications for IAP monitoring
- IAP pressures remain <12 mm Hg
  - Discontinue IAP monitoring

Wolfemantim, Wikimedia Commons
Abdominal Compartment Syndrome

- Definitive management: surgical decompression
### Box 2: Conservative measures for treatment of abdominal compartment syndrome

- **Paracentesis**\(^{59}\)
- Gastric and rectal suctioning
- Prokinetic agents (metoclopramide, domperidone, erythromycin, prostagethermine)
- Diuretic therapy
- Continuous veno-venous haemofiltration with aggressive ultrafiltration
- Sedation and paralysis\(^{60}\)
- **Body positioning**

---

Abdominal Compartment Syndrome

- Definitive management: surgical decompression

- In ED, pt difficult to ventilate
  - Given doses of versed and vecuronium
  - Anesthesia arrived to assist

- Covered with piperacillin/tazobactam
- OGT placed before transport to OR
OPERATIVE REPORT

INDICATIONS FOR THE PROCEDURE: Mrs. PG is an elderly woman who underwent a laparoscopic converted to open cholecystectomy 10 days ago. She presented to the ER with complaints of feeling weak and light-headed. Shortly after admission to the ER, she became hypotensive and had a PEA arrest. She was resuscitated and a FAST scan showed a large amount of fluid in her abdomen; her abdomen was also quite tense on examination. She is anti-coagulated with Coumadin and her INR at that time was 1.8. She was presumed to have an intra-abdominal bleed and was therefore taken emergently to the OR. She was requiring significant amounts of fluid resuscitation, including 4 units of PRBC's as well as pharmacologic pressure support. She was intubated in the ER.

PROCEDURE: Time out was performed, confirming correct patient. Anesthesia was induced with general endotracheal anesthesia. The patient was positioned in the supine position on the table and was prepped and draped in the usual aseptic fashion. Her abdomen was then entered through a midline incision extending from xiphoid to just above the pubis. Dissection was carried down through the subcutaneous tissues and the fascia was opened in the midline. Upon entering the peritoneal cavity, a large amount of blood and clot was encountered and evacuated. Approximately 1,500 cc's of clot and old blood was evacuated, the majority of the clot was encountered inferior to the liver. This was evacuated and there was obvious bleeding from the gallbladder fossa. This was controlled with a combination of electro cautery, fibrillar, and surgicel. The area was then widely irrigated with warm normal saline and topical thrombin spray was applied and packs were then placed. Five minutes elapsed and we re-examined the area and no further bleeding was appreciated. At this point, all packs were removed. There was no further evidence of bleeding. Since the patient had undergone massive fluid resuscitation and anesthesia was already having some difficulties with ventilation, we elected to leave her abdomen open and place an abdominal VAC. Sponge and needle counts were correct at the conclusion of the case. The patient was taken to the SICU in critical condition.

Upon entering the peritoneal cavity, a large amount of blood and clot was encountered and evacuated. Approximately 1,500 cc's of clot and old blood was evacuated, the majority of the clot was encountered inferior to the liver. This was evacuated and there was obvious bleeding from the gallbladder fossa.
Hospital Course

- Extensive ICU course
  - ARF with anuria, on CRRT
  - Resp failure requiring tracheostomy
  - Febrile with +BAL (stenotrophomonas), MDR UTI, infected rectus sheath hematoma (both E coli)
  - Intermittent A-fib with RVR
  - Multiple pulmonary emboli
- Transferred SICU to BICU to CCMU
- Discharged home two months later with PEA as primary diagnosis
**Speed Case**

- 52yo M with a hx of “liver and kidney problems”
- CC: SOB

- Arrives in Resus A in acute distress
- Gasping for breath, saying single words
- Pale, diaphoretic
- Bradycardic with palpable radial pulse
- Unable to measure BP or SpO2
- PIV placed by EDT
**Speed Case**

- Becomes unresponsive <60sec after arrival
- BVM applied
- Given atropine 1mg IV w/o change in status
- Loses pulses
- CPR initiated
  - 2 rounds epinephrine/atropine
  - Intubated w/o meds
SPEED CASE

- Empirically medicated given “kidney” history
  - Calcium gluconate
  - Sodium bicarbonate
- VBG returns with K of 8.0
  - Started insulin and glucose
  - Albuterol via ETT
- ROSC after <10 minutes (3 rounds)
- Spontaneous movements observed
**Speed Case**

- Gradual onset of hypotension after ROSC
- Started on dopamine
- Empiric sepsis coverage
  - Piperacillin/tazobactam
  - Vancomycin
- Accepted for admission by CCMU
- Sedated with propofol

- Cooling?
**Speed Case**

- 2 week admission to CCMU requiring dialysis
- Normal neurologic status post-extubation
- Discharged home with outpt dialysis, otherwise doing well
THANK YOU!