Intra-Abdominal Hypertension (IAH)

The ARDS of the gut!

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Disclosure

Tim Wolfe, MD
- Associate Professor, University of Utah SOM
  - Department Surgery, Division Emergency Medicine
- Clinical Practice in the community
- Conflict of interest:
  - Founder, Vice President, Medical Director: Wolfe Tory Medical
  - Manufacturer of the AbViser Intraabdominal pressure monitoring kit
- This lecture is about IAH and ACS, not the AbViser
• Have you ever seen a critically ill patient become progressively more swollen and edematous after fluid resuscitation?

• Have any of your ICU patients developed renal failure requiring dialysis?

• Have you ever seen a patient develop multiple organ failure and die?

What was their intra-abdominal pressure?
Case: Septic child

5 y.o. female presenting with septic syndrome

- Treatment: Fluids, antibiotics, vasopressors
- 24 hours into therapy develops worsening hypotension, oliguria, hypoxemia, hypercarbia. PIP rises from 20 to 40 cm
- IAP = 26 mm Hg → decompressive laparotomy
- Immediate resolution of renal, pulmonary and hemodynamic compromise
- 7 days later abdomen closed. Alive and well now.

DeCou, J Ped Surg 2000

Case: Aspiration patient

77 y.o. male with sepsis. Transferred to ICU where he required intubation, developed hypotension

- 10 liters IVF overnight, Norepi 1.0 mcg/kg/min.
- Anuric (35 ml urine in 8 hours). Lactate = 4.6
- IAP = 31 mm Hg. KUB – massively distend small and large bowel. US shows no free ascitic fluid.
- Surgeon consulted for possible decompressive surgery
- Rx: NGT, Rectal Tube, oral cathartics, neuromuscular blockade
- 1 hour later: IAP 12 mm Hg, UOP 210 ml, norepinephrine discontinued.

Cheatham, WSACS 2006
Case: Dyspnea in ER

67 y.o. female with dyspnea and agitation
• Hypotensive, agitated, H&P suggest liver dz
• IVF resuscitation, intubation, sedation
• Worsened over next 4-6 hours - Difficult to ventilate, hypoxic/hypercarbic, hypotension, no UOP.
• IAP = 45 mm Hg, abdominal ultrasound showed tense ascites paracentesis of 4500 cc fluid (IAP = 14)
• Immediate resolution of renal, pulmonary and hemodynamic compromise.
• Pathology shows malignant effusion – pancreatic CA.
• Care withdrawn at later time and allowed to expire.

Etzion, Am J EM 2004

Case Points

• Trauma is not required for ACS to develop:
  – Intra-abdominal hypertension and ACS occur in many settings (PICU, MICU, SICU, CVICU, NCC, OR, ER).
• IAP measurements are clinically useful: Help to determine if IAH is contributing to organ dysfunction (i.e. useful if normal or abnormal)
• “Spot” IAP check results in delayed diagnosis:
  – Waiting for clinically obvious ACS to develop before checking IAP changes urgent problem to emergent one.
• Medical interventions are often all that is needed
• IAP monitoring will allow early detection and early intervention for IAH before ACS develops.
Outline / Objectives

- Definition – what is it?
- Causes
- Physiologic Manifestations
- Incidence
- Impact on Outcome / Impact of intervention
- Detection:
  - Bladder pressure monitoring
  - Common Questions about monitoring
- Management / Treatment – MEDICAL vs surgical
- Cost Analysis
- Conclusion – early detection saves lives/money

Definitions

WCACS, Antwerp Belgium 2007

- **Intra-abdominal Pressure (IAP):** Intrinsic pressure within the abdominal cavity
- **Intra-abdominal Hypertension (IAH):** A sustained IAP > 12 mm Hg (often causing occult ischemia) without obvious organ failure
- **Abdominal Compartment Syndrome (ACS):** IAH > 20 mm Hg with at least one organ dysfunction or failure
Physiologic Insult/Critical Illness

- Ischemia ↔ Inflammatory (SIRS) response
- Fluid resuscitation
- Capillary leak
- Tissue Edema (Including bowel wall and mesentery)
- Intra-abdominal hypertension

Who is at risk for IAH - Fluids!

The unifying feature of IAH:
- FLUIDS! Shock requiring aggressive resuscitation with crystalloid fluids

Crystalloid based, preload driven, goal oriented shock resuscitation is the standard of care in North America:
- Sepsis – Surviving sepsis guidelines
- Trauma – ACLS guidelines
- Burn - Parkland formula
- Major abdominal surgery - Pre-operative loading
- Hypotension-any cause – Fluid loading at core of Rx
Fluids!

Where does 5+ liters go in the human body?

- The brain?
- The lung?
- The skin/soft tissue?
- The gut/mesentery…….

The fluid goes Right Here!!
Intra-abdominal Hypertension & Abdominal Compartment Syndrome

Physiologic Sequelae

Cardiovascular:
- Increased intra-abdominal pressures causes:
  - Compression of the vena cava with reduction in venous return to the heart
  - Elevated ITP with multiple negative cardiac effects
- The result:
  - Decreased cardiac output \(\rightarrow\) increased SVR
  - Increased cardiac workload
  - Decreased tissue perfusion, decreased ScvO2
  - Misleading elevations of CVP and PAWP
  - Cardiac insufficiency \(\rightarrow\) Cardiac arrest
IAH and the cardiovascular system

Hemodynamic pressure measurements changes:
- ↑ CVP and PCWP
- Elevations occur due to pressure transmission across diaphragm, not necessarily related to fluid status

Physiologic Sequelae

Pulmonary:
- Increased intra-abdominal pressures causes:
  - Elevation of the diaphragms with reduction in lung volumes, stiffening of thoracic cage, reduced alveolar inflation, increased interstitial fluid (lymph obstruction)
- The result:
  - Elevated intrathoracic pressure, stiffer chest wall
  - Increased peak pressures, Reduced tidal volumes
    - Intertitial edema, Atelectasis, hypoxia, hypercarbia
  - Ventilator Induced lung injury/Barotrauma
    - Cytokine release – pro-inflammatory response
    - Non-pulmonary ARDS
Physiologic Sequelae

Gastrointestinal:
• Increased intra-abdominal pressures causes:
  – Compression / Congestion of mesenteric veins and capillaries (capillary flow 25 mm arterial down to 15 mm venous)
  – Reduced cardiac output to the gut
The result:
  – Decreased gut perfusion, increased gut edema and leak
  – Ischemia, necrosis, cytokine release, neutrophil priming
  – Bacterial translocation
  – Development and perpetuation of SIRS
  – Further increases in intra-abdominal pressure

Physiologic Sequelae

Renal:
• Elevated intra-abdominal pressure causes:
  – Reduced cardiac output/perfusion pressure to kidneys
  – Increased proximal tubular pressure (resists filtration)
  – Compression of renal veins, parenchyma
The Result:
  – Reduced blood flow to kidney
  – Decreased glomerular filtration rate (GFR)
  – Renal congestion and edema
  – Renal failure, oliguria/anuria
Physiologic Sequelae

Neuro:
• Elevated intra-abdominal pressure causes:
  – Increases in intrathoracic pressure
  – Increases in superior vena cava (SVC) pressure with reduction in drainage of SVC into the thorax

The Result:
– Increased central venous pressure and IJ pressure
– Increased intracranial pressure
– Decreased cerebral perfusion pressure
– Cerebral edema, brain anoxia, brain injury
  • Maryland Shock Trauma unit often decompresses abdomens in patients with intractable intra-cranial hypertension

Physiologic Sequelae

Direct impact of IAP on common pressure measurements:
• IAP elevation causes immediate increases in ICP, IJP and CVP (also in PAOP)

15 liter bag placed on abdomen (Citerio 2001)
Circling the Drain

- Intra-abdominal Pressure
- Capillary leak
- Mucosal Breakdown
- Decreased O2 delivery
- Free radical formation
- Anaerobic metabolism
- Bacterial translocation
- Cellular Apoptosis
- Necrosis
- Acidosis

How common is this syndrome?

<table>
<thead>
<tr>
<th>Disease process</th>
<th>IAH incidence</th>
<th>Authors</th>
</tr>
</thead>
</table>
How common is this syndrome?

<table>
<thead>
<tr>
<th>Disease process</th>
<th>IAH incidence</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decompensated CHF</td>
<td>60% (IAP ≥ 8 mmHg)</td>
<td>Mullens 2008</td>
</tr>
<tr>
<td>MICU and Mixed ICU population</td>
<td>35%-64%</td>
<td>Malbrain 2004, Malbrain 2005, Vidal 2005</td>
</tr>
</tbody>
</table>

How common – Shock with fluid resuscitation

  - 83% incidence of IAP > 12 mm Hg in septic shock
  - 51% incidence of IAP > 20 mm Hg in septic shock

- Daugherty, 2007: Abdominal compartment syndrome is common in medical intensive care unit patients receiving large volume resuscitation.
  - 85% of patients with 5 liters positive fluid balance had IAH
  - 30% had IAP > 20 with organ failure (abdominal compartment syndrome)
Does IAH / ACS affect patient outcome?

Mixed Med-Surg population

- IAH predicted mortality
  - IAH > 12 mortality 38.8%
  - No IAH - mortality: 22.2%

Malbrain, Crit Care Med, 2005

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Does IAH intervention affect patient outcome?

<table>
<thead>
<tr>
<th>Author</th>
<th>Population</th>
<th>Control Arm mortality</th>
<th>Study Arm mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ivatury 1998</td>
<td>Trauma</td>
<td>39%</td>
<td>11%</td>
</tr>
<tr>
<td>Oda 2005</td>
<td>Pancreatitis</td>
<td>30%</td>
<td>6%</td>
</tr>
<tr>
<td>Sun 2006</td>
<td>Pancreatitis</td>
<td>21%</td>
<td>10% (LOS 13 d)</td>
</tr>
<tr>
<td>Cheatham 2007</td>
<td>SICU</td>
<td>49%</td>
<td>28% (LOS 10 d)</td>
</tr>
<tr>
<td>Ennis 2008</td>
<td>Burns</td>
<td>31%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Does IAH/ACS protocol driven intervention affect patient outcome?
Cheatham 2007 – Is the evolving management of IAH/ACS improving survival? *Acta Clinica Belgica*

- **Mortality**
  - ↓ 21% (almost half)
- **Open Abdomens**
  - ↓ 28% to 15% (almost half)
  - ↓ time open 15 days
- **Hospital LOS**
  - ↓ 10 days

Does IAP/IAH protocol driven monitoring affect patient outcome?
Kimball 2009 – Data on 600 high risk monitored cases (not all had IAH or ACS)

- **Mortality**
  - ↓ 17% to 14% (NS)
- **Open Abdomens**
  - ↓ Half
- **Hospital LOS**
  - ↓ 4 days
How good is clinical judgment for detecting elevated IAP?

Prospective, blinded trial - Staff physician judgment

Results: < 50% of the time was the clinician able to determine when IAP was elevated.

“…findings suggest that more routine measurements of bladder pressure…”

Kirkpatrick, Can J Surg 2000

Does IAH / ACS affect patient outcome?

Points:
• IAH / ACS is common in the ICU environment (including yours).
• IAH and ACS increase morbidity, mortality & ICU length of stay.
• Early, protocol driven interventions improve survival & reduce organ failure without increasing cost of care (shorter ICU and hospital LOS)

However:
• Clinical signs of IAH are unreliable and only show up late in the clinical course …..SO
• Early monitoring (TRENDING) & detection of IAH with early intervention is needed to obtain optimal outcomes.
Intra-Abdominal Pressure Monitoring

“The reference standard for intermittent IAP measurement is via the bladder with a maximal instillation volume of 25 ml sterile saline.”

WSACS.org
“Home Made” Pressure Transducer Technique

Home-made assembly:
- Transducer
- 2 stopcocks
- 1 60 ml syringe,
- 1 tubing with saline bag spike / luer connector
- 1 tubing with luer both ends
- 1 needle / angiocath
- Clamp for Foley
Assembled steriley, used in proper fashion!

PROBLEMS:
- Home-made:
  - No standardization - confidence problem with data
  - Sterility issues
- Time consuming* – therefor its use is late and infrequent due to the hassle factor (i.e. not monitoring - waiting for ACS)
- Data reproducibility errors* - what are the costs / morbidity of inaccurate or delayed information?
- Other: Needle stick, Recurrent penetration of sterile system, Leaks, re-zeroing problems, failure to trend
Reproducibility Study

Inter-observer Scatterplot ($r = 0.95, p < 0.001$)

- Nursing driven study with 89 different nurses participating.
- Excellent intra- and inter-observer reproducibility
- Nurses became PRO-Active – measuring

Kimball, Int Care Med 2007

Common Questions: How much fluid should be infused into bladder?

- **Non-compliant bladder**: Measured pressure increases as volumes exceed 50 ml of infusion
- **Compliant bladder**: Measured pressure changes very little with higher volumes of fluid infusion

WSACS: Max volume 25 ml, 1 ml/kg in children.
Common Question: How do I recognize appropriate IAP transduction onto my monitor?

Proper transduction clues:
- Respiratory variation noted (subtle at low pressures)
- Oscillation test positive
- Reproducible over several measurements

Common Questions: Do patients with “open abdomens” need to be monitored?

YES!
- There is no such thing as an “open abdomen” outside the O.R. – just expanded abdomen
- By the very fact they are “open” suggests they have a very high capillary permeability problem
- Gracias 2002 found 25% incidence of recurrent ACS in open abdomens
- You have already committed a fortune in resources and time to this patient – take the added step to monitor their IAP

6 hours post op:
- IAP = 24
- Lactate = 6.5

Post dressing release:
- IAP = ?

24 hours later:
- IAP = 12
- Lactate = 1.9
Common Questions: What is the risk of UTI from transvesicular IAP monitoring?

- **Concern** – UTI can cause sepsis. CAUTI is not reimbursable
  - Infection control statements – “Closed system is required to reduce UTI risk. Bladder pressure monitoring violates closed system concept”
- **Contrary concern** – Everything is medicine is based on risk benefit analysis
  - What is the risk of UTI versus the risk of missing IAH/ACS?

How do we resolve this - What is the actual data?

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Common Questions: What is the risk of UTI from transvesicular IAP monitoring?

**Actual Data**

The Basis for the “closed system” recommendation

- **Kunin NEJM 1966:**
  - Observational trial of drain tube and bag (attached after Foley placed, disconnected for appropriate clinical indications)
  - Results – Fewer CAUTI compared to historical method of allowing Foley to drain into open jar

- **Wong, CDC guidelines 1980**
  - Expert opinion piece – used Kunin 1966 as literature support
  - Never updated despite 29 years of additional research
Common Questions: What is the risk of UTI from transvesicular IAP monitoring?

**Subsequent Research Data:** “Closed sealed systems” versus “breaking the seal” demonstrate no difference in CAUTI risk. (This is different from an open jar)

- Six prospective randomized controlled trials (level 1 evidence), one non-randomized trial
  - Over 4000 patients randomized (two trials with 1500 each)
  - All studies compared open (not connected) vs closed (pre-connected, tamper seal) drain system
  - All studies had many patients who had tubing disconnected (one mandated every 3 day drain tube/bag replacement)
  - Results: **NO DIFFERENCE** in CAUTI

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**Maki, Engineering out the risk of infection with urinary catheters, Emerg Inf Control 2001**

“Infections in which biofilm does not play a role are probably caused by mass transport of intraluminal contents into the bladder by retrograde reflux of microbe laden urine when a collection system is manipulated.”

<table>
<thead>
<tr>
<th>Factor</th>
<th>Relative risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolonged catheterization &gt;6 days</td>
<td>5.1-6.8</td>
</tr>
<tr>
<td>Female gender</td>
<td>2.3-5.7</td>
</tr>
<tr>
<td>Catheter insertion outside operating room</td>
<td>2.0-5.3</td>
</tr>
<tr>
<td>Urology service</td>
<td>2.0-4.0</td>
</tr>
<tr>
<td>Other active sites of infection</td>
<td>2.3-2.4</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2.2-2.3</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>2.4</td>
</tr>
<tr>
<td>Anemia (creatinine &gt;2.0 mg/dL)</td>
<td>3.1-2.6</td>
</tr>
<tr>
<td>Ureteral stent</td>
<td>3.5</td>
</tr>
<tr>
<td>Monitoring of urine output</td>
<td>2.0</td>
</tr>
<tr>
<td>Drainage tube below level of bladder and above collection bag</td>
<td>1.9</td>
</tr>
<tr>
<td>Antimicrobial-drug therapy</td>
<td>0.1-0.4</td>
</tr>
</tbody>
</table>
Common Questions: What is the risk of UTI from transvesicular IAP monitoring?

Cheatham, Intravesicular pressure monitoring does not cause urinary tract infection. Int Care Med 2006
- Compared ICU patients getting IAP monitoring to those who did not get IAP monitoring
- CAUTI rate 7.9 versus 6.5 per 1000 cath days (P=N.S.) despite higher acuity and mortality in the IAP group.

- Compared ICU patients getting IAP monitoring to national baseline rates of CAUTI.
- CAUTI rate:
  - IAP monitoring: 0.2 per 1000 catheter days
  - National baseline: 5.5 per 1000 catheter days

Management of IAH and ACS
**Assessment Algorithm**

*2007*

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 or new organ failure

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. **Zerod at the iliac crest in the mid-axillary line**
5. **Performed with an instillation volume of no greater than 25 mL of saline (1 mL/kg for children up to 20 kg)** (for bladder technique)
6. **Measured 30-60 seconds after instillation to allow for bladder detrusor muscle relaxation (for bladder technique)**

**Risk Factors for IAH/ACS**

1. Diminished abdominal wall compliance
2. Acute respiratory failure, especially with elevated intrathoracic pressure
3. Abdominal surgery with primary fascial or skin closure
4. Major trauma / burns
5. Fracture, head of bed > 30 degrees
6. High body mass index (BMI), central obesity
7. Increased intra-abdominal contents
8. Peritoneal / peritoneum
9. Acute / acute dystrophy
10. Capillary leak / fluid resuscitation
11. Acute renal failure
12. Hyperkalemia
13. Hyperthermia (core temperature > 33°C)
14. Polytransfusion (>12 units of blood / 24 hrs)
15. Coagulopathy (platelets < 50,000 / mm³ OR partial thromboplastin time (PTT) > 2 times normal
16. Coagulopathy (PTT > 2 times normal OR international standardised ratio (INR) > 1.5)
17. Mesenteric fluid resuscitation (> 2 L / 24 hours)
18. Paracentesis
19. Cirrhosis
20. Septis
21. Major trauma / burns
22. Damage control laparotomy

**UUMC: Nurse is empowered to enter any patient fulfilling criteria**
IAH: Medical Management

**Improve Abdominal Wall Compliance**

- Ensure adequate sedation & analgesia
- Remove constrictive dressings, abdominal eschars
- Avoid prone position, head of bed > 20 degrees
- Consider reverse Trendelenberg position
- Consider neuromuscular blockade

**Improve Abdominal Wall Compliance**

Shifts pressure-volume curve to right, reducing IAP for the same volume.

Pressure volume curves of the abdomen in a patient with poor (closed squares) compared to a patient with normal (open circles) abdominal wall compliance.
IAH/ACS Management: Positioning

Vasquez, 2007

Stretch out

IAH: Medical Management

Evacuate intraluminal contents, intra-peritoneal fluid collections:
Reduces total volume in abdomen moving patient down the curve regardless of compliance.
Sun, 2006: Indwelling peritoneal catheter vs conservative measures in fulminant acute pancreatitis.

- 110 cases of severe fulminant pancreatitis - RCT
  - Control group: Routine ICU supportive care
  - Study group: Routine ICU supportive care PLUS
    - IAP monitoring (mean pressure 21 mm Hg on day 1)
    - Indwelling peritoneal drain catheter (drain 1800 cc on day 1)
  - Outcome:
    - Control - 20.7% mortality, 28 day hospital LOS
    - Study group - 10.0% mortality (p<0.01), 15 day LOS
IAH: Medical Management

Optimize fluid administration:
Reduces bowel and mesenteric edema.

- Avoid excessive fluid resuscitation
- Aim for zero to negative fluid balance by day 3
- Reuscitate using hypertonic fluids, colloids
- Fluid removal through judicious diuresis once stable
- Consider hemodialysis / ultrafiltration

Sepsis-induced capillary permeability
Bowel edema

IAH/ACS Management:
Consider hemodialysis


- 17 cases of severe pancreatitis and IAH
  - Treated with hemofiltration when IAP + 15 mm, PRIOR to developing renal insufficiency (maintained adequate serum oncotic pressure with albumin)
- Results:
  - Interleukin (IL-6) cytokine levels cut in half
    - Reduced vascular permeability and interstitial edema
  - Mean IAP value dropped from 15 mm to less than 10 mm
  - 16 of 17 patients discharged alive without complication
IAH/ACS Management: Consider Hemofiltration

Fluid Overloaded  Post CVVH

Optimize systemic/regional perfusion:

- "Balanced resuscitation"
  - Enough fluid - but not too much
  - Vasoactive support to enhance perfusion

Cheatham, Malbrain 2007
Decompressive Laparotomy:

- Err on the side of early vs late intervention
  - Less bowel edema or cell damage, better chance of early closure and early recovery.
- Be aware that delaying care until this complication occurs is VERY expensive – more expensive the longer you wait:
  - Vanderbilt costs for open abdomen (Vogel 2007):
    - Same admission closure $150,000 (Cheatham data suggests > $200,000)
    - Failure to close on initial admission $250,000++ (estimate nearly as much over next year by time ventral hernia finally repaired).

IAH/ACS Management: Decompressive Laparotomy

Rigid Abdomen in ACS

Post decompressive laparotomy
Decompressive Laparotomy

- Delay in abdominal decompression may lead to intestinal ischemia
- Decompress Early!

Decompressive Laparotomy

Post-operative dressing

Several days post-op
### Surgical Management of Compartment Syndromes

<table>
<thead>
<tr>
<th>Compartment</th>
<th>Pathophysiology</th>
<th>Surgical Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranium</td>
<td>ICP elevation</td>
<td>Craniotomy, etc.</td>
</tr>
<tr>
<td>Chest</td>
<td>Tension pneumothorax</td>
<td>Chest tube</td>
</tr>
<tr>
<td>Pericardium</td>
<td>Cardiac tamponade</td>
<td>Pericardiocentesis</td>
</tr>
<tr>
<td>Limb</td>
<td>Extremity compartment</td>
<td>Fasciotomy</td>
</tr>
</tbody>
</table>

### Compartment Syndromes versus Hypertension

- Abdominal compartment syndrome = **Emergent Surgical Disease.**
- Intra-abdominal hypertension = **Urgent Medical Disease.**
Cost analysis

Is IAP monitoring and intervention cost effective?

Compartment syndrome risk comparison

- **The Cranium**: Fall, hit head, LOC, vomiting but alert
  - Is it worth the cost of a head CT? (Standard of Care)
    - Incidence is less than 5% positive
    - Less than 0.5% need ANY intervention

- **The Abdomen**: ICU patient with major fluid resuscitation (5 liters positive at 24 hours or less)
  - Is it worth the cost of measuring their IAP?
    - Incidence of IAH is 85%
    - 30+% will have ACS
Cost analysis
Prospective protocol driven interventional trial data: Kimball 2009
• **Design:** 600 patients prospectively monitored/treated with IAH protocol over 4 years compared to prior year
• **Results comparing prior year to last year data:**
  – **Length of Stay** – 4.1 fewer days in ICU per the 109 patients monitored
    • 447 fewer ICU days (@ 3000/day = $1.3 million)
  – **Abdominal decompression** - 12 fewer decompressions
    • 12 fewer decompressions/year (mean charges for these patients >$150,000 = $1.8 million)
• **Estimated total reduced charges = $3.1 million**
• **Actual total yearly cost for monitoring devices:** $9265

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Cost analysis: IAP monitoring impact on resource utilization.

Other more difficult to quantify costs
• **Opportunity costs** (think waitress with a table)
  – Longer ICU LOS leads to inability to admit another patient to that bed.
    • ICU charges are far higher during first few days of admission – so in terms of business, long ICU LOS leads to losses in terms of new patient billing.
• **Mortality costs**
  – Higher death rate without treatment leads to loss of that person from productive life in society. What is the economic value of a human life?

  What is a reasonable cost to save one life?
Final Thought

Do NOT wait for signs of ACS to be present before you decide to check IAP
  – By then the patient has one foot in the grave!
  – You have lost your opportunity for medical therapy
  – The costs of saving this patient are now HUGE

Monitor ALL high risk patients early and often:
  – TREN D IAP like a vital sign
  – Intervene early, before critical pressure develops

Questions?

IAH and ACS Educational Web sites:
  www.abdominal-compartment-syndrome.org
  WSACS.org

My email: twolfe@wolfetory.com

Via Ferrata Tridentina - Italy