General Principles in the Care of the Obese Trauma Patient
In this lecture, we will be discussing the
• Prevalence of obesity and trauma
• Challenges to performing a thorough initial assessment
• Management of blunt and penetrating injuries
Note that we are indeed the most obese nation in the world.

US Most Obese Country in World

1. United States
2. Kuwait
3. Croatia
4. Qatar
5. Egypt
6. United Arab Emirates
7. Trinidad and Tobago
8. Argentina
9. Greece
10. Bahrain
Obesity is defined as a body mass index of >30%

In 2010, according to the Centers for Disease Control (CDC), 33.8% of the US adult population is obese ... a 45% increase since 1988 (22.9%).

17% of children and adolescents are obese (1-19 years of age).

Comorbidities in the obese population include:

• Hypertension
• Diabetes
• History of stroke
• Increase risk of cancer
• Respiratory problems
This is the NIH definition
In the hospital setting, cost of care increases due to
- Higher infection rates (2 fold)
- Increased ventilator days (+8 days)
- Increased CVP days
- Increased ICU LOS
- Increased hospital days
- Higher mortality rate (6.2% higher)

The obese patient is at a higher risk for long term disabilities due to impaired mobility and limited access to healthcare.
Trauma is the 5th leading cause of death for all ages. 
#1 killer for children and young adults (1-44 years of age)

Head, chest, and abdominal trauma are the 3 leading causes of traumatic death. Mortality rate among the obese population from trauma is 8 times higher than that of the normal weight population.

MVC is the leading mechanism of injury.

Overall, unintentional injuries cost approximately $478.3 billion. MVC account for $200.3 billion.

These costs include loss of wages losses, medical expenses, insurance costs, property damages, and property damages.

**Image is of obese young man with multiple injuries after a MVC rollover.**
Quality trauma care and improved outcomes depends on the use of basic assessment skills and procedures. Obesity challenges:

- skill of the providers
- transport
- processes for ensuring highest quality of care and safety of the patient

Obesity challenges skill, equipment, and resources due to:

- Size
- Missing landmarks
- Chronic underlying health conditions

Transport from the scene to the hospital may require larger stretchers and ambulance. Additional personnel may be needed to move the patient or roll the patient. Verifying weight limits for gurneys and beds to ensure patient safety. Basic equipment may not accommodate the obese patient. Use of air transport may not be an option due to weight limits. Considerations must be made in evaluating and understanding patterns of injury. Lack of landmarks can hamper physical assessment. Medication dosing may need to be altered due to the patient’s weight.
Regardless of the patient’s weight, the core trauma assessments remain the same:
• Primary assessment and interventions
• Secondary assessment and interventions
• Adjuncts
• Tertiary survey
• Coordination of care necessary to facilitate the best and safest care.

How these assessments and procedures are performed will require some alterations.
Simultaneous airway management and c-spine protection can be challenging.
Challenges to assessing and managing the airway while protecting the c-spine in an obese patient may include:

• Short thick necks may negate the use of the traditional c-collar
• Poor neck extension
• Loss of landmarks needed for interventions such as airway adjunct measurements, cricoid pressure, endotracheal intubation
• Pharyngeal fat deposits predispose patient to pharyngeal wall collapse during intubation
• Supine position causes the weight of the abdomen to press on the diaphragm increasing the risk for aspiration.
• Backboard weight limits
• Increased body mass leads to decreased functional reserve capacity which rapidly contributes to hypoxia
Considerations to be taken would include:

- Elevating the head of the bed slightly to assist with manual opening of the airway
- Use of sandbags on either side of the head and tape to immobilize the c-spine if the use of a c-collar is not an option
- Facilitate early gastric tube placement to prevent aspiration
- Use of advanced intubation equipment
- Advocating early surgical cricothyrotomy for cuffed endotracheal or tracheotomy tube placement when normal intubation maneuvers are unsuccessful
- Surgical cricothyrotomy for cuffed endotracheal or tracheotomy placement may be difficult as well due to loss of landmarks and excessive adipose tissue
- If the patient has a known history of gastric banding, band deflation via access port may be needed to prevent aspiration.
Challenges to assessing and managing breathing effectiveness may include:

- Fat deposits in the diaphragm and intercostal muscles which decrease effective gas exchange
- Elevated diaphragm due to enlarged abdomen which affects landmarks
- Increase body mass decreases the functional reserve capacity leading to hypoxia. Recovery takes much longer.
- Skin folds make auscultation difficult
- Increased work of breathing especially in the supine position
- Excessive soft tissue makes BMV ventilations more difficult
- Sleep apnea which requires consideration of non-invasive positive pressure ventilation
- Impaired lung compliance
- Effectiveness of adjunct devices is user dependent.
- Lack of landmarks and increased adipose tissue complicate needle decompression and chest tube insertion
Considerations to be taken would include:

• Use of non-invasive positive pressure ventilations vs. NRB
• Early intubation
• Reverse trendelenburg to facilitate lung expansion
• Moving all skin folds to facilitate a flat surface for the stethoscope diaphragm
• 2-person bag-mask ventilation to ensure secure fit and to accommodate the increase intrathoracic pressure created due to the weight of the chest wall and intrabdominal pressure on the diaphragm
• Needle decompression landmarks and size needle would be different (needle insertion in the traditional MCL 2nd intercostal space)
• Facilitation of “awake” intubation may not be the best option considering the need for patient cooperation and c-spine protection.
• Close monitoring of oxygen saturation by monitoring level of consciousness, capnography, BiPap, mental status changes, and restlessness
• Breathing may take 2-4 times more effort so tidal volume at 10mL/kg of ideal weight and titer
• Anesthesia will make respiratory capability worse due to decreased lung and chest wall compliance

• Image is intubation of large patient with a glide scope.
Intubation should be considered early in the assessment to avoid hypoxemia.

Indications for intubation include:
- Neck circumference greater than 43 cm
- Mallampati classification of III or IV  Details on next slide
- Limited neck ROM
- Prolonged supine positioning increased the risk of hypoxemia due to the increased effort to breath from chest weight and intra-abdominal pressure on the chest cavity limiting movement of the diaphragm.

Positioning for intubation may require significant elevation of the torso to accommodate the horizontal alignment of the external auditory meatus and sternal notch.

Effective pre-oxygenation may be difficult or impossible if performed by one-person. Obtaining a sufficient seal for BVM ventilations may be impossible due to excessive fatty tissue.

Medications may need to be adjusted based on ideal body weight, true body weight, and lean body weight.
- Induction agents – LBW
- Rocuronium – IBW
- Succinylcholine - TBW

Variations in ventilator settings need to be considered to meet the physiological...
needs of the patient.
   • Tidal volume based on IBW then titer based on inflation pressures and
     ABGs
   • PEEP 10cm/H2O
Challenges to alternatives to endotracheal intubation may be challenging as well. Lack of landmarks and excessive adipose tissue must be considered.
   Surgical cricothyrotomy
   Tracheostomy
   “Awake” intubation

“Awake” intubation may not be an alternative due to patient cooperation and 10 spine protection.
A clinical instrument used to assess the ease of obtaining an airway
Class I Visualization of the soft palate, fauces, uvula, and both anterior and posterior pillars
Class II Visualization of the soft palate, fauces, and uvula
Class III Visualization of the soft palate and the base of the uvula
Class IV (difficult) The soft palate is not visible at all
Evaluation of the Circulatory system for effectiveness can be a challenge.
Challenges to the assessment and interventions may include:

- Excessive adipose tissue which hampers the ability to palpate pulses
- Lack of landmarks for carotid and femoral pulses
- Obese non-hypertensive individual:
  - Normal heart rate
  - Increased blood volume
  - Increased stroke volume
  - Increased cardiac output
  - Increased left ventricular volume
  - Decreased systemic vascular resistance
  **hypertension augments the above resulting in CHF….thus rapid volume replacement is poorly tolerated (similar to geriatric trauma patients)**
- Normotensive blood pressure may be indicative of hypotension given the history of hypertension
- Identification and treatment of pericardial tamponade may be challenging due to lost landmarks and thickness of fat tissues
Considerations may include:

**IV access**
- Use of 2" peripheral IV needles for IVF infusions and
- 6" spinal needles for Pericardiocentesis
- Early central line insertion due to failure to secure peripheral access
- Cutdowns
- IO
- Ultrasound assistance with line placement
- Increased awareness of the need for sterile line insertion because of skin folds

**Monitoring**
- Early hemodynamic monitoring for cardiac response to volume resuscitation (a-line, CVP)
- Close monitoring of rapid volume resuscitation
- Non-aggressive volume challenges

**Cardiovascular Assessment**
- Mark locations of pulses for future reference
- Heart sounds can be best heard at:
  - the left lateral chest wall with the patient turned on their left side OR
  - over the aortic or pulmonic areas of the left or right sternal border at the second intercostal space

**Other**
- DPL replaced with exploratory laparotomy
Neurological assessment can be difficult.
Challenges to determining an obese trauma patient’s neurological status may be due to underlying:

- Sleep apnea → somnolence
- Difficult to determine GCS
- Lack of mobility
- Airway problems with less neurological impairment

Mobility limitations on the supine position may make determining the “best” motor response a bit difficult. Literature suggests assessment of symmetry may be more valuable. Asymmetry would warrant future investigation.

Ongoing monitoring of neurological status is essential to maintaining airway patency and breathing effectiveness. A small increase in neurological impairment may lead to a rapid loss of airway and breathing.
Neurological disability assessment and management considerations would include:

- Close monitoring of GCS
- Early discharge planning
- Establish baseline

What is the weight limit on your CT scanner, your MRI?

Discharge planning

Documenting ADL and ability to ambulate

- What is the level of activity that he is normally involved in?
- Is he able to stand?
- Is he able to walk?
- When was the last time that he walked around his home?
- What aids to ambulation does the person use?
Exposure and environmental controls are essential to an accurate assessment.
Removing clothing may cause skin sheering due to the weight of the body and pulling associated with clothing removal. Obese patients are prone to skin tears and breakdown.

With the increased surface area, the obese trauma patient is at risk for hypothermia. Hypothermia should be avoided as early as possible to prevent anti-coagulation processes.

Exposure to the environment may be a consideration due to longer extrication times due to the size and habitus of the patient’s body and difficulty in safely removing the patient.

Skin folds need to be examined for retained objects, fungal infections, wounds, and skin breakdown.

Large pannus may complicate the assessment and palpation of the abdomen and/or pulses. It is also a site for potential uncontrolled internal bleeding.
Special equipment and clothing may be needed to safely move the patient while minimizing exposure.

Use of additional personnel may also be needed to safely move and/or transport the patient.

**Where do you get supplies and equipment? Do you have on site? Do you have to call a vendor?**
Routine exams and diagnostic studies are essential. However, they may be more difficult and may be limited due to patient size and weight.

Excess adipose tissue will require deeper penetration of x-rays to get an adequate CXR.

Weight and size limits may prohibit use of the CT scanner or MRI. **Image is of CT scanner at zoo.** (Due to rapidly growing epidemic of obesity, ED facilities and Trauma Centers rely on local zoos and/or veterinarian facilities to obtain CT images of patients with BMI greater than 40 kg/m2)

Safe transport of the obese patient must be considered. Additional staff and use of moving boards may be required to transport and transfer the patient for diagnostic studies.

Diagnostic peritoneal lavage and FAST may be difficult to perform due to the loss of anatomic landmarks needed.
Patient size creates challenges and may alter the accuracy of vital signs.

Blood pressure cuffs may not be large enough resulting in inaccurate readings.

Landmarks for cardiac monitor pads may alter the accuracy of the cardiac strips.

The increase thickness of the finger pads can alter the reading of pulse oximeters.

The weight of the abdominal skin places the patient at increased risk for aspiration when in a supine position and cause urinary incontinences. Early insertion of gastric tube and urinary catheter need to be considered.
Considerations when caring for the obese patient:

- Normotension may be “hypotension” for the obese patient
- Marking the location of cardiac probes will assist to ensure probes are placed in consistent areas
- Pulse oximetry probes may need to be placed on the earlobe for a more accurate reading
- Early gastric tube to prevent aspiration
- Early insertion of urinary catheter to ensure accurate readings of output and prevent incontinence
- Use of size-appropriate cuffs and lines. Transferring the patient with size-appropriate equipment
- Increased awareness of potential sources of nosocomial infections to reduce morbidity.
- Use of doppler to identify pulses.
The size of the patient may require larger splints be used to stabilize fracture sites.

Placement of splints may require additional staff.

Checking and marking pulses are critical to proper splint placement and can be difficult with the obese patient.

In situations where appropriate sized equipment may not be available and/or additional staff is needed to apply splints, the compromising position the patient is placed in can effect their ability to adjust to the situation.

Issues with depression, low self esteem, anger
Healthcare provider bias and comments hamper effective patient care. It is important the healthcare provider recognizes their bias and is able to control it when caring for the obese trauma patient.

Pain medication doses may need to be examined to determine if it is weight dependent and providing adequate effects. Pain medication always needs to be administered IV not subcutaneously or intramuscular due to absorption rate concerns.

Equipment and bedding need to be specifically examined to ensure patient safety.

Also healthcare providers must think about personal safety when moving obese patients.
Challenges will include:

- Need for additional staff to ensure patient safety
- Consideration of the bed/stretcher width to accommodate logrolling the patient.
- Moving skin folds to appropriately auscultate, palpate, and inspection the posterior surfaces.
The image denotes how hard and frustrating it can be to care for a morbidly obese patient.

Let’s look at some caveats to caring related to:

• Disposition
• Post-operative care
• Missed injuries
• Fractures
• Morbidity
• Mortality
• Pharmacology
• Consultations
Patient disposition needs to be determined as early as possible in order to facilitate quick transfer and definitive care.

Interfacility transfer of patients will require coordination with the transporting agency to accommodate the size of the patient. Special equipment and/or additional personnel may be required to safely move the injured patient.

Intrafacility transfer of patients may require coordination of care with the various support services and receiving department.

For the patient going to the OR, additional staff may be needed to properly position the patient. Access to special equipment will need to be secured and moved as quickly as possible. Intubation equipment may need to be gathered.

For the ICU and/or floors, equipment such as beds, lifting equipment, bedside commodes, etc. will need to be identified and secured. Additional staff will be needed to move the patient routinely.
Post operative care is centered around the understanding that wound healing will take longer which places the patient at a higher risk for infections and sepsis. Limited mobility and injuries increases the likelihood of decubitus ulcers. Length of stay and ventilator time must be anticipated.

- Wound dehiscence
- Inability to close abdomen
- Sepsis
- Decubitus ulcers
- Increased wound infection
  - Negative nitrogen balance
  - Decrease serum albumin
- Malnutrition
- Slow clearance of lactic acid
- Increased LOS
- Increased vent time
- Glucose monitoring
Injuries to the chest and abdomen are difficult to assess and diagnose due to increased adipose tissue, enlarged abdominal cavities, and poor ventilatory compliance. Most commonly missed injuries are:

- Sternal fractures
- Flail chest
- Pelvic fractures
- Rib fractures
- Pulmonary contusions

Note pulmonary contusion on left in the x-ray.
Treatment of fractures and post-operative care need to consider:
• Use of stronger rods for lower extremity and pelvis injuries
• Increase suspicion for compartment syndrome given the increase adipose tissue
• Recognition that casting of larger extremities can be more difficult and require additional staff and closer monitoring.
• TLSO usage may not be considered due to abdominal girth and increased limited mobility.
The patient’s health condition prior to the injury must be considered. Lack of primary care could be related to the patient’s inability to physically seek medical attention. As a result the patient may not be aware of co-morbidities.

Non-compliance may be a factor in cases of known health problems.

Mortality from traumatic injuries is higher in the obese patient as compared to the non-obese trauma patient. The rate is as high as 8%. Causes for death include:

- Multisystem organ failure
- Traumatic brain injury
- Cardiac failure
- Respiratory arrest
- Pulmonary embolism

<table>
<thead>
<tr>
<th>Morbidity</th>
<th>Mortality</th>
</tr>
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<tbody>
<tr>
<td>Lack of primary care</td>
<td>Multisystem organ failure</td>
</tr>
<tr>
<td>Isolation</td>
<td>Traumatic brain injury</td>
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<tr>
<td>Non-compliance</td>
<td>Cardiac failure</td>
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<td></td>
<td>Respiratory arrest</td>
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<td></td>
<td>Pulmonary embolism</td>
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The table above illustrates the additional risks associated with obesity in trauma patients.
An understanding of the impact obesity has on pharmacological principles is essential for the healthcare provider. Drug effect MAY be altered due to:

- Change in volume of distribution
- Renal clearance
- Hepatic metabolism
- Protein binding
- Underlying disease

Dosage may need to be weight-based:

- Dose weight (DW) = Ideal body weight (IBW) + 0.3 (total body weight – IBW)
Early nutrition consults are vital to facilitating wound healing. Primary care providers may be consulted to assist with identification and managing underlying co-morbidities. Discharge planning needs to begin upon arrival. Equipment and resources the obese patient will need at discharge may take time to identify and secure. Sleep apnea testing may be needed to ensure adequate ventilatory support once the patient leaves the hospital.
Overall, obese suffer more complications (including TBI) vs. non-obese in severe blunt trauma. **What are some potential pathophysiological causes of increased complications in the obese secondary to TBI?** Ask what these complications may be; DVT? PE? Pneumonia? Decubiti? Wound infection?

Obese TBI Patient:
- Tend to be older >45 y/o
- Tend to have lower admission blood pressure 125 +/- 38
- Head injuries tend to occur less frequently in this demographic.
- Some research suggest the obese have higher propensity for head injuries vs. chest injuries in severe high-speed crashes secondary to the 'Cushion Effect'.

Higher mortality vs. lean patients **Ask why this may be so? Does it relate to the complications?**

Higher mortality associated with adverse effects not with obesity
No difference in need for craniotomy
Higher incidence of chest injuries

33% higher incidence of thoracic trauma [frontal impacts]
Higher incidence in male and older obese patients w/ thoracic injuries
Thoracic injury higher for unbelted obese vs. belted

Incidence of thoracotomy similar to lean counterparts

Obesity-related injuries: [not found in lean]
Major laceration thoracic aorta
Multiple cardiac lacerations
Bilateral flail chest
Ultrasonography – limited visualization due to SQ abdominal fat
Excessive subcutaneous gas in abdominal fat limits views

The image is of diagnostic laparoscopy

Damage Control Laparotomy (DCL) – extended time to definitive closure vs. lean counterparts

Laparoscopic Abdominal Repair – limited due to visualization and access secondary to increased abdominal fat
More likely repair open laparotomy

“Cushion Effect” – there is evidence that excess abdominal fat decreases maximal Abbreviated Injury Score (mAIS) in blunt trauma

More likely to require DPL due inability to obtain abdominal CT scanning with body weight > 450lbs
MVC-related obese have greater % lower extremity injuries
Slightly higher incidence of pelvic fracture
Lower incidence cervical, thoracic and lumbar fractures
Slightly higher incidence of upper extremity fractures
Overall overwhelming incidence of lower extremity fractures

Image is post op total hip patient.
Obese less likely to be ejected secondary to body habitus and inability to be ejected through windows.

Many pelvic repair operations are delayed in the obese secondary to limitations of OR due to size of the patient and lack of OR beds and equipment to accommodate obese patients.

**What are some reasons the obese may require return OR trips for pelvic repair?**
Thought to be result of “Cushion Effect”

- Increased abdominal fat may act as a cushion
- Less likely to be ejected vs. lean counterparts in MVC
- Therefore, lower propensity for column injuries
Complications

- Overall obese patient 42% higher complication rate vs. 32% lean population
- Require slightly higher total hospital LOS (24 vs. 19 days)
- Higher ICU LOS (13 vs. 10 days)
- Slightly higher ventilator days > 2 days vs. lean
- No difference in incidence of pulmonary complications
Management: Blunt Trauma

• Complications
  • NIH / WHO: Obese vs. Lean Severe Trauma
    • Increased ICU LOS
    • Increased propensity of:
      • Cardiac arrest
      • Acute Renal Failure
      • Multisystem Organ Failure
    • No difference in initial leukocyte inflammatory response
    • However, resolution of initial inflammatory response appears to be lengthened in the obese population
Management: Penetrating Trauma

• Current Clinical issues
  • Similar to blunt trauma management
  • Challenges related to body habitus similarly associated in blunt trauma
    • Prohibitory radiological imaging due to body habitus
    • Airway control in obese patient
    • Prohibitive diagnostic ability (i.e. ultrasound, radiological imaging, laparoscopic intervention) all due to body habitus
- Obese more likely to suffer a high-risk anatomic area (72% vs. 60%)
- LOS for burned obese patient significantly higher (9.3d vs. 7.1)
- Burn complications in Obese:
  - More frequent OR debridement
  - Higher rates of infection
  - Slower healing rates of affected areas
  - Greater permanent functional impairment
Summary

- Obesity is an increasing epidemic
- There are special physiological, social and emotional considerations in caring for critically injured patients that healthcare providers must understand
- Intervention measures specific to the management of critically injured patients is paramount to optimal outcomes