The Obese Trauma Patient

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COUNTIES MANUKAU HEALTH

Healthy Together INTEGRATED CARE

Why should we consider the obese differently?

- Increasing obesity rates
- Frequent comorbidities
- Differing patterns of injury
- Different baseline physiology
- Different pharmacokinetics
- Difficulty and frustrations in management

Definitions

Body mass index = BMI =weight kg/height m^2

The WHO definition is:

- Overweight = BMI 25 - 30
- Obesity = BMI >30

- Morbidly obese BMI >40

New Zealand

- 30% aged 15 + were obese
- A further 35% of adults were overweight but not obese.

- 46% of Māori adults were obese
- 67% of Pacific adults were obese
- Middlemore ED 72% overweight or obese,
- 12% morbidly obese

Obesity rates

- The adult obesity rate increased from 27% to 30% last 10 years
- Increasing pediatric obesity rate

- Adults living in the most deprived areas were 1.8 times as likely to be obese

Are obese persons at increased risk of injury?

Are the obese prone to different injury patterns?

Are there different trauma outcomes?

Comorbidities with obesity

- OSA
- Obesity hypoventilation syndrome
- T2DM +/- renal complications
- HTN
- Gout
- Fatty liver
- Obesity related cardiomyopathy

Sleep apnoea – a major and under-recognised public health concern

- 3-7x higher rate RTCs if obese
- NZ study BMI >28.7 = 2x rate traffic accident
- Long haul truck drivers particularly at risk
- Risk normalises with CPAP

Journal of Thoracic Disease 2015; 7(8): 1269-1272
Anaesthesiology Clinics 25 (2007) 91-98

Obstructive Sleep Apnoea and Risk of Motor Vehicle Crash: Systematic Review and Meta-Analysis

- Mean crash rate with OSA RR 2.42, CI 1.21 to 4.89 (P=0.013)
- OSA 5% general population,
  up to 50% of commercial drivers
- Predictors of crash with OSA include BMI, apnea plus hypoxia index, oxygen saturation and possibly daytime sleepiness
- Without OSA - BMI>30, 2 x higher crash rate

Stephen Tregear, James Reston, Karen Schoelles, Barabara Phillips
Journal of Clinical Sleep Medicine 2009 (5)6; 573-581

Crash rate of people with OSA by BMI

BMI	Crashes/ 10000 miles
<25	0.031
25-28	0.041
28-30	0.079
32+	0.101

The Cushion Effect

- Single centre review, 189 pts >13years injured MVC with at least one AIS score >2, 45 pts obese, 62 overweight
- Overweight av. adj AIS of < 5.5 underweight.
- Lower abdominal AIS scores in overweight
- Higher lower extremity scores in overweight
- Mortality lean 11.3%, Obese 20%

AIS score	Severity
0	Nil
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurviveable

Arabi et al
The Journal of Trauma 2003 June; 54(6): 1090-3

Obesity and Risk of Death due to Motor Vehicle Crashes

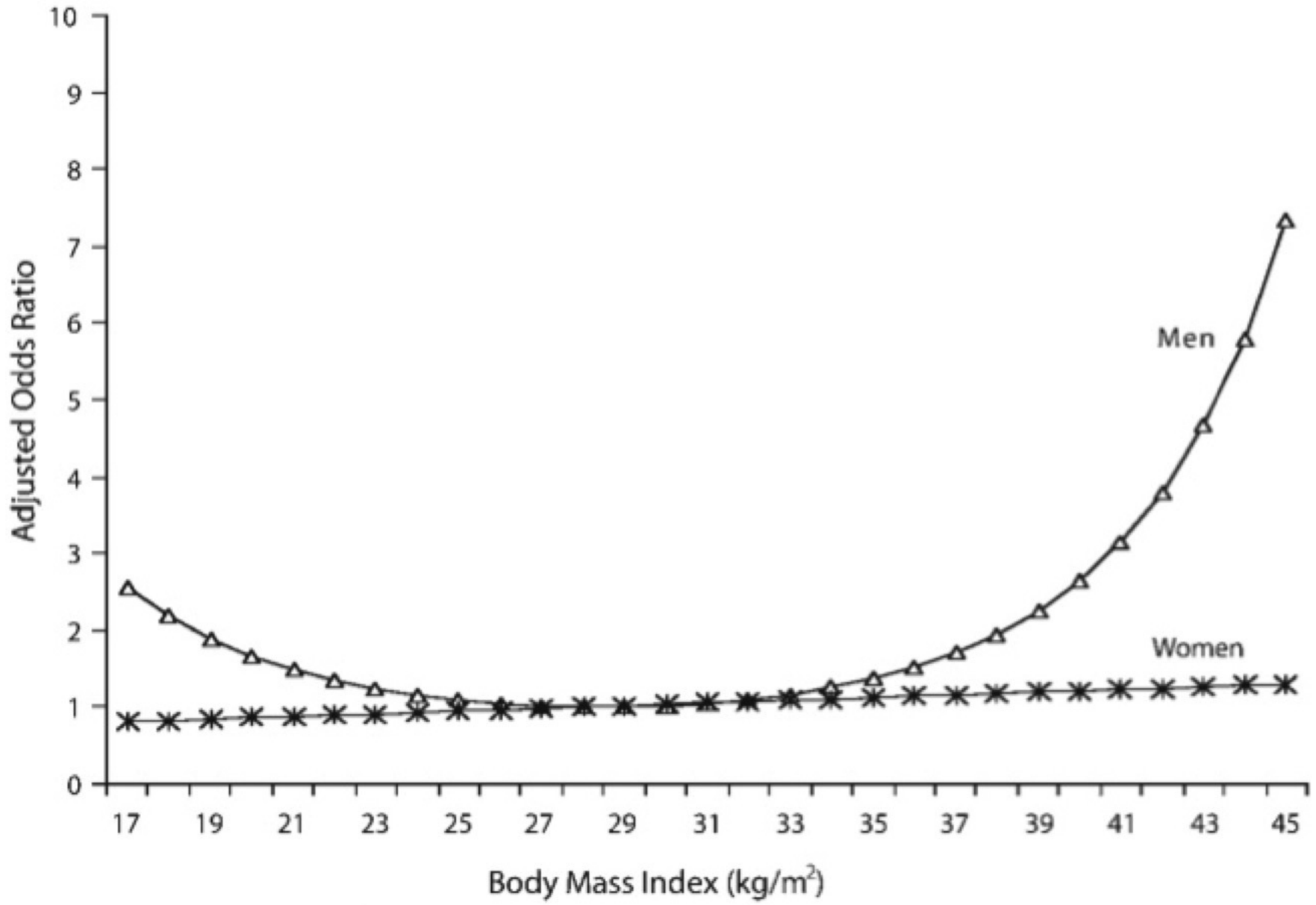
- Review 30667 crashes from 16 million drivers
- Risk of death increased for men at both ends of the BMI continuum among men (not women) ($P<0.05$)

- Motor Vehicle safety standards are designed for the the mid sized male BMI 24.3

Shankuan Zhu, Peter Layde, Clare Guse, Purushotttam Laud, Frank Pintar, Raminder Nirula Stephen Hargerten

American Journal of Public Health April 2006 96 (4) 734-739

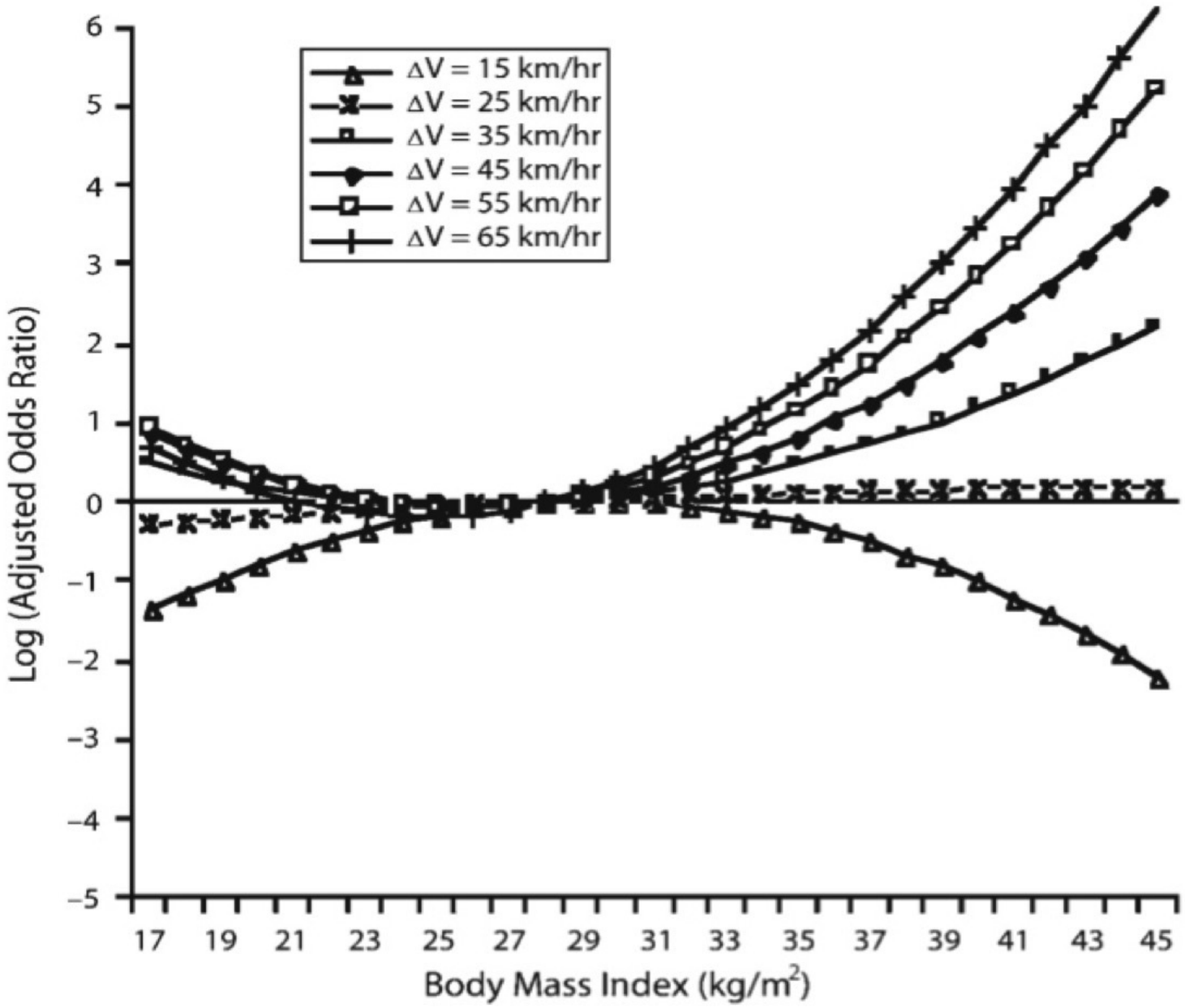
Fatality rate by BMI



Note. Reference body mass index = 28 kg/m^2.

FIGURE 1—Adjusted odds ratio for motor vehicle crash fatality by drivers' body mass index and gender, all subjects model (n = 20 745).

Fatality rate by BMI and velocity



Note. Reference body mass index = 28 kg/m^2.

FIGURE 2—Logarithmic-scaled adjusted odds ratios of motor vehicle crash fatality by body mass index and change in velocity among male drivers involved in front-end collisions, change in velocity model (n = 4164).

Why the differences?

- Gendered different disposition of excess body weight
- Males around chest, shoulders – increased momentum effects, increased injuries
- Females around hips, sl. better restrained

- Comorbidity and difficulties with emergency care and post-operative care may contribute to differences in fatalities

The Effect of Obesity on the Restraint of Automobile Occupants

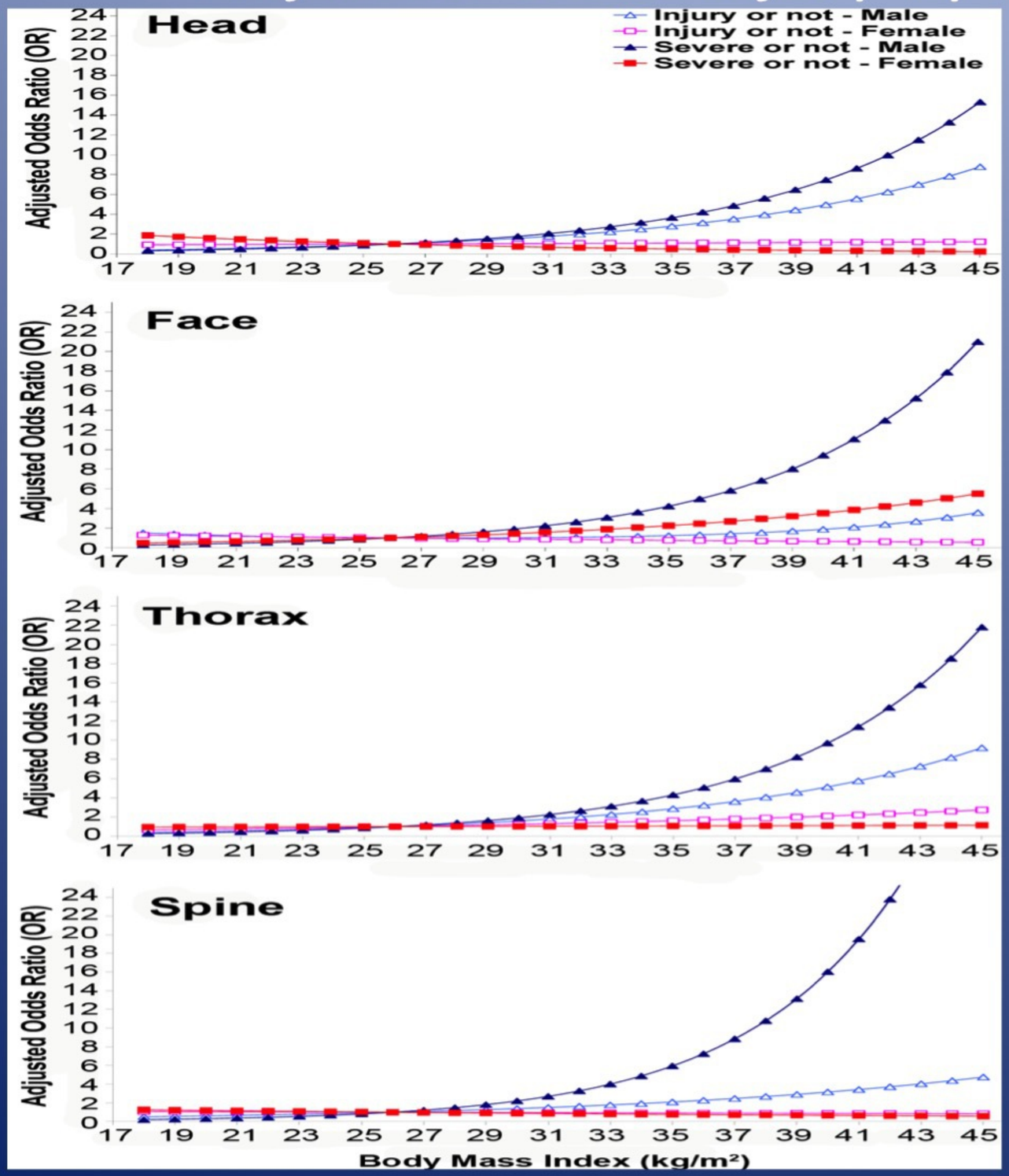
- Crash tests using obese vs normal weight cadavers (no mention of gender)
- Obese – signif. greater forward motion of the head +16cm, shoulder +25cm, pelvis +30cm
- Pelvises were poorly restrained as lap belt unable to engage pelvis.
- Obese subjects freq. fell off the front of the seat.

Jason Foreman, Francisco Lopez-Vades, David Lesley, Matthew Kindig, Richard Kent
Annals of Advances in Automotive Medicine Vol 53 Oct 2009 25-40

The Effect of Obesity on the Restraint of Automobile Occupants

- More belt payout in obese pre crash – reduced amount in spindle reducing spindle torque – 33% less peak upper shoulder belt force.
- Chest compressed by 44% obese vs 29%
- Similar number of rib #s and AIS scores but obese younger 53 vs 69 years

10,941 drivers involved in frontal collision crashes
Adjusted OR of injury by body region by BMI /Sex



Shankuan Zhu, Jong-Eun Kim, Xiaoguang Ma, Alan Shih, Purushottam W. Laud, Frank Pintar, Wei Shen, Steven B. Heymsfield, David B. Allison Plos Med 7(3): e1000250

Management

- Trauma call out
- A
- B
- C
- D
- E

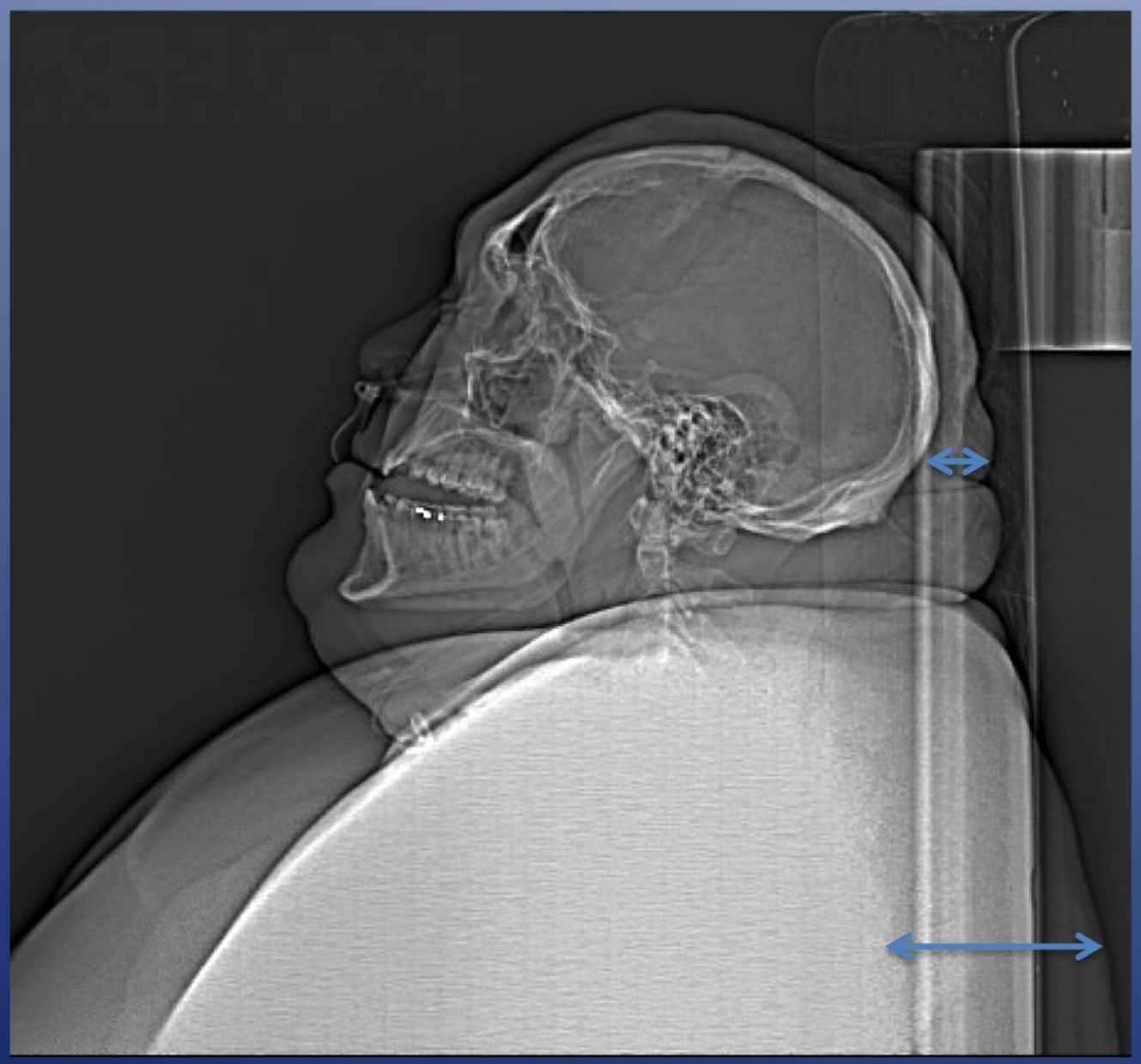
Bariatric trauma call

- Encourage early notification by paramedics of bariatric patient transfer
- Have bariatric bed available
- Hover mattress or hoists
- Additional staff / orderlies for transfers

Airway

- Adipose limiting neck movement and mouth opening
- Pre-existing OSA, obstruction normal
- Lying flat poorly tolerated
- May normally have low O_2sats or raised PCO_2
- Relatively poor tidal volumes due to high position of diaphragm from oversized abdomen, quick desaturation

Airway



- Don’t fit or tolerate C-spine collars
- Relative excess of back adipose tissue so supine position is not neutral for C-spine
- Ear to sternal notch best for airway, pillow may help neutralise C-spine

Airway

- Treat as difficult - most experienced intubator
- Reverse Trendelenberg (head up tilt) 15-30^{O}
- Pre-oxygenation
- Apnoeic High flow NP O_2 + $ETCO_2$ monitoring
- Mac 4 blade standard
- Video laryngoscopy, bougie

The impact of obesity on the outcomes of emergency intubation in trauma patients

- 9980 trauma patients intubated at level 1 trauma centre over 4 year period, stratified for BMI
- BMI not an independent risk factor for failed intubations in the field or the ED
- All trauma intubations at this centre treated as a difficult intubation and only for experienced staff

Sifri ZC, Kim H, Lavery R, Mohr A Livingston DH
J Trauma 2008 Aug 65(2): 396-400

Airway backup plan

- LMA – may be difficult
- Cricothyroid assessment prior to intubation, same position, may be very difficult to be confident of landmarks
- If cric needed vertical midline incision to allow extension if not at level of membrane

Timing of Tracheotomy in Mechanically Ventilated Critically Ill Morbidly Obese Patients

- **Tracheostomy at or before 9 days best outcomes**
- Retrospective chart review 102 patients, medical and trauma
- Time to liberation from mechanical ventilation shorter in in early versus late group (P=0.002)
- Mean days of respiratory support 15.1 early vs 27.2 late (P<0.001)
- Total ICU and hospital length of stay longer in the late group(P<0.001)
- Nosocomial penumonia higher in the late group (P=0.004)
- Several had cric rather than trache

Alhajhusain A, et al
Critical Care Research and Practice 2014 Article ID 840638

Obesity Hypoventilation syndrome

- Chronic respiratory impairment, hypoxia and hypercapnia
- Only in a minority of the morbidly obese
- Diminished central respiratory drive and a bunted respiratory response to hypercapnia
- Thought to be due to leptin resistance

Obesity Hypoventilation Syndrome

Further compromise of ventilation with

- Spinal immobilisation
- Supine positioning
- Chest trauma
- Sedatives
- Analgesics / opioids

Obesity Hypoventilation Syndrome

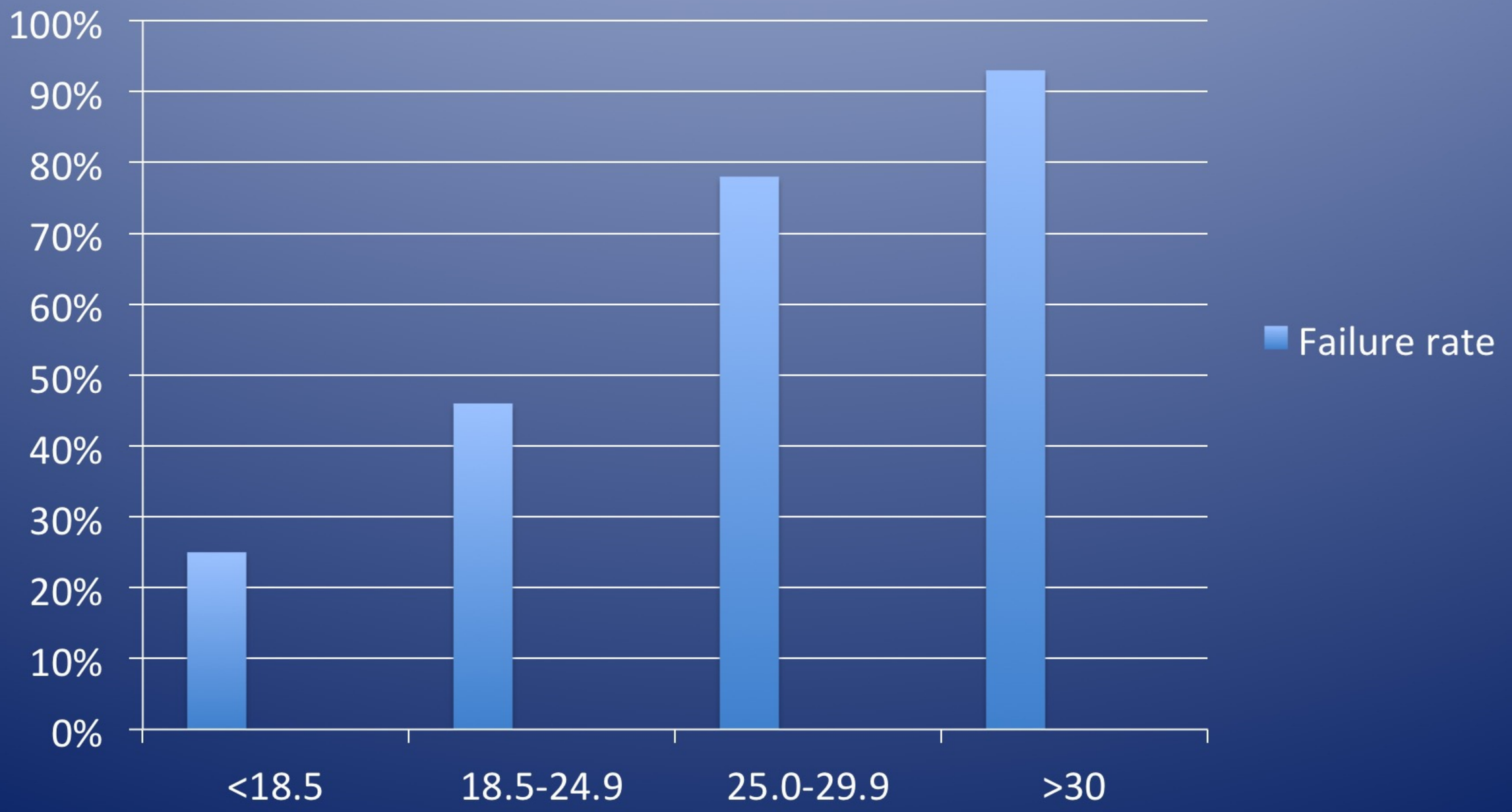
Management with

- Early recognition, Blood gas – hypercapnia
- Careful use of opioids
- BiPAP
- Intubation and ventilation

Breathing

- High flow O_2 – watch $ETCO_2$ may be a retainer
- CPAP, BiPAP early especially if this is their normal treatment
- Adequate analgesia, low dose ketamine, PCA, epidural
- Upright as early as safe
- Ventilation – slightly higher tidal volume and pressure than for ideal body weight

Calculated failure rate needle decompression 2nd ICS (5cm needle) and increasing BMI



Chest drain insertion

- Anticipate difficult ICD insertion
- Position well, assistant on arm +/- retracting breast.
- Bed head up to lower diaphragm
- Good procedural analgesia, bolus fentanyl +/- ketamine

Chest drain insertion

- Adequate incision (hand sized not finger)+/- long “sounding” needle
- Self retaining retractor, +/- scrub assistant
- Local into pleural space once at space +/- suture to mark infiltrated space, or bougie for temporisation
- Sterile opsite to join tube to tubing as this may be within incision.

Circulation

- Large cuff for better accuracy, beware hypotension
- Anticipate difficult IV access
- Long IV needles, tips can displace with movement if only a small portion in vein
- Ultrasound guidance
- Assistant to retract apron for femoral artery or vein access
- IO may need cut down to locate bone

Baseline abnormal physiology in morbidly obese

- Vascular dysfunction due to abnormal levels of insulin, aldosterone, cortisol and insulin
- LV syst. and diast. dysfunction and RV diast. dysfunction + cardiomyopathy syndrome
- ↑ abdominal pressure ➡ ↑ intrathoracic volume
  ↑ thoracic pressure ➡ ↑ CVP measurements
- Difference in citric acid cycle gene expression, increasing availability of inorganic acids contributing to metabolic acidosis in trauma

Traditional Resuscitative Practices Fail to Resolve Metabolic Acidosis in Morbidly Obese Patients Following Severe Blunt Trauma
Winfield et al
J Trauma 2010 Feb; 68(2) 317-330

Circulation

- Blood volume best approximated by ideal weight
- May need additional fluids / bloods to drive right heart.
- Can be underfilled despite peripheral oedema
- Heart sounds frequently muffled by subcutaneous adipose tissue

Response to resuscitation in the morbidly obese

- Higher heart rates,
- Poorer O_2 saturation, oxygen delivery and tissue oxygenation
- Prolonged metabolic acidosis
- Higher incidence of multi-organ failure

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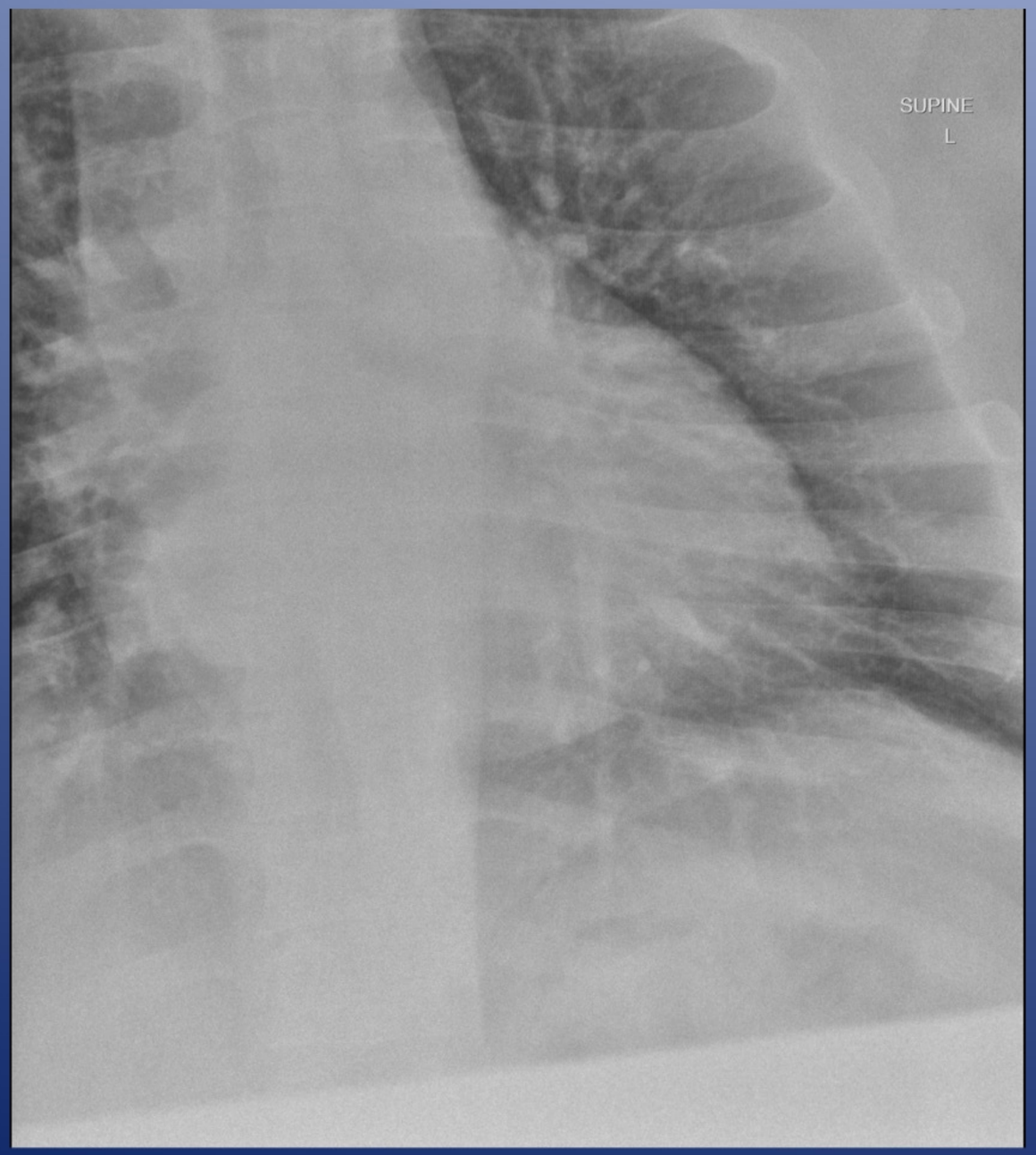
Circulation



- Plain views limited use, poor penetrance, poor positioning of plate, plates too small
- Occult blood loss through unrecognised haemorrhage into internal degloving injuries, examine carefully

E-FAST scan

- RUQ and LUQ may not be achievable
- Lifting apron may give adequate pelvic view
- Cardiac views through L 5th ICS at sternal edge
- Pulmonary views – use abdominal probe if linear too shallow (6-10cm)

Advanced Imaging

- Manufacturer specified weight limitations - table servos
- Aperture size limitation, CT and MRI may not be possible, open MRI units
- CT higher dosages needed to obtain adequate penetration and images often are of poorer quality

Disability

- Consider hypercapnia as cause of decreased GCS, especially post opioids
- Frequent co-existent T2DM, often run very high BSLs, symptomatic hypoglycaemia at lower end of normal glucose range

Equipment

- Longer needles
- Weight limitations of equipment, beds, CTs, hoists, commodes, wheelchairs, have bariatric equipment available
- Consider arm boards to extend effective table size
- 2 x operating theatre tables secured together (check brakes fully on!)
- Longer surgical instruments

Equipment – weight limits

- CT 150, 180, 250, 295kg limitations
- Equine scanner 700kg (Pukekohe vets)
- MRI 150 or 180kg + aperture size limitations, Open MRI units now available

- Crutches standard 115kg, Special 180kg, Obese 400kg
- Walking frames standard 127, large 225kg

Exposure

- Loss of objects i.e. glass in skin folds
- Caution – esp on log roll - use sides or large bed.
- More difficulties with heat loss rather than hypothermia

Exposure

- Have large gowns available
- Most big patients are acutely self conscious of their size, avoid prolonged exposure
- Low self esteem as an integral component of obesity in most
- Professional attitude, start of a long therapeutic relationship, patient cannot instantly lose 100kg
- Neutral language, weight, heavy, big acceptable
- Obesity as a societal disease with enormous hurdles to achieve weight loss for individuals

Spinal injury

- No difference in the overall incidence of spinal fractures between obese (7.4- 14%) and non-obese (6.3-16%)
- Gross inspection and palpation of injury are more difficult
- Greater importance on clinical suspicion by mechanism and imaging
- More vigilance in reviewing images

C-spine immobilisation

- May not fit standard hard collar or spinal boards and higher risk pressure areas
- Sandbags, taping and careful handling, additional staff until cleared / imaged

If fracture confirmed

- Philadelphia collar, mix and match with velcro extensions +/- tape
- Aspen no neck collar can be additionally contoured in the axial plane to accommodate tissue rolls.
- Involve Orthotics early to fit collars

Spinal imaging

- Large tissue envelope
  - requires higher penetration
  - poor quality plain radiographs
  - Magnification
  - Nearly impossible to view the cervicothoracic junction with plain films

Is Computed Tomography Reliable for the Evaluation of Cervical Spine Injury in Obese Patients?

4824 patients, single centre, 26% obese

NO stat. difference in incomplete or inadequate imaging between obese and non-obese

Young A, Wilson S, Wolfe L , Duane T
The American Surgeon Brief Reports June 2014 (80) 627-629

T and L Spine immobilisation

- Bracing - Very difficult to obtain rigid 3 or 4 point immobilisation of spine at any level in the obese
- Strong consideration should be given to surgical fixation of potentially unstable thoracolumbar injuries
  - Larger incision, more complications, longer equip

Evaluation and Treatment of Spinal injuries in the Obese Patient
Greenleaf R and Altman D
Orthop Clin N Am 42 (2011) 85-93

Musculoskeletal

- Higher BMI is associated with greater bone mineral density (but less than expected for total weight)
- Increased Osteoarthritis especially of knee
- RR need for TKJR BMI >40 = 32.7x, usually 10 years earlier
- Higher baseline rate rotator cuff injuries and meniscal tears
- Higher baseline rate carpal tunnel syndrome

Musculoskeletal

- Similar fracture risk with minor trauma
- Higher rate simple falls with #s particularly
  - humerus, lower leg and ankle
    - Consider ORIF humerus as freq cast failure
- Increased # risk with major trauma
  - severe tib/fib and femur #s
  - Increased ipsilateral NOF + femoral shaft #
- Higher non-union rate

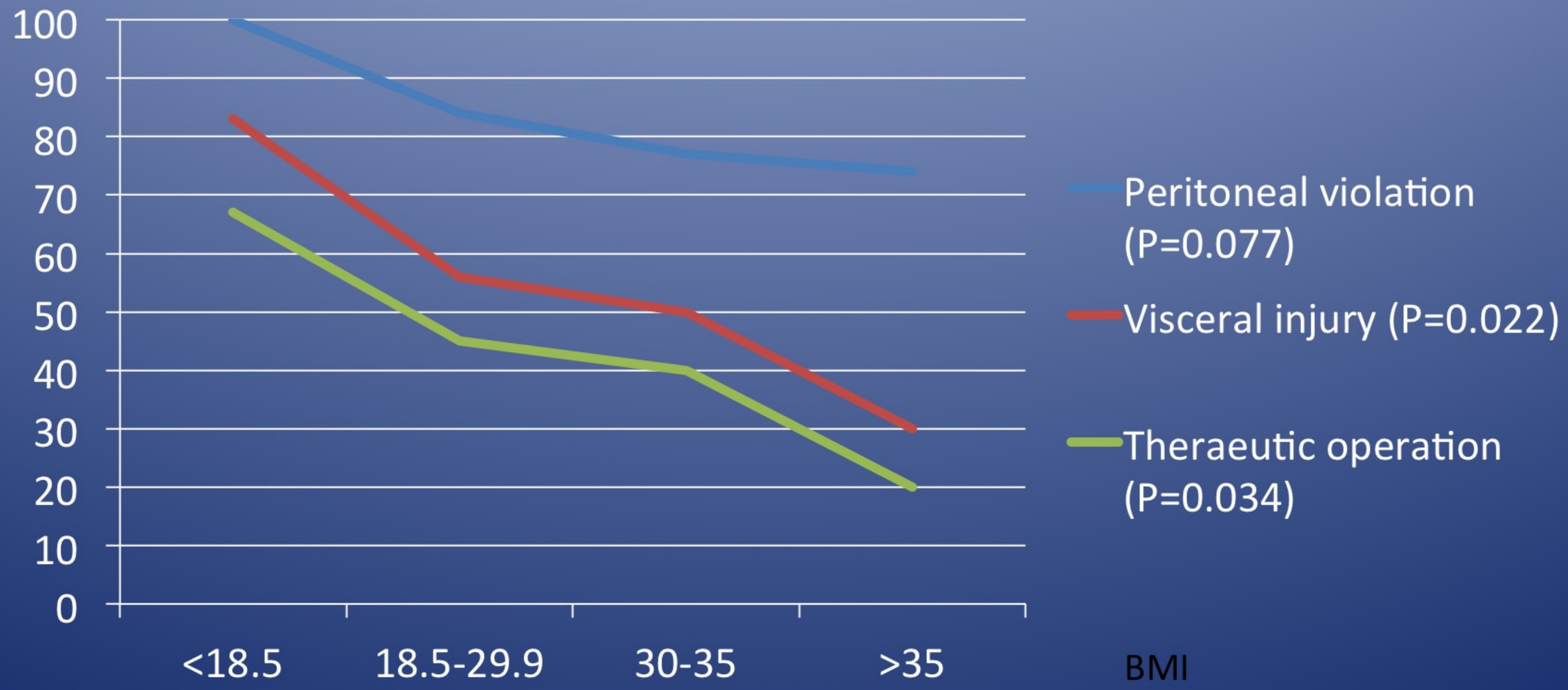
Musculoskeletal

- Freq. difficulty using crutches/ frames if NWB
- Prosthesis fitting more challenging if amputation required
- Functionally often end up chair dependent

Penetrating trauma

- Relative protection by adipose from penetrating trauma to trunk
- Can use vaginal speculum to help visualise base of stab wounds
- Heavier patients may be more suitable to observation and serial examination

Impact of body mass index on injury in abdominal stab wounds: implications for management.



Bloom MB et al J Surg Res 2016 Jul; 197 (1) 162-6

Obesity - Pharmacokinetics

- Proportion of body fat increased + larger lean body mass than normal healthy individuals of the same age, gender and height
- High incidence of nonalcoholic steatohepatitis - alteration of cytochrome P450 isoforms, especially CYP 2E1
- Renal function may be impaired (studies vary) esp. with chronic diabetes and HTN
- Plasma protein binding, albumin normal but increased concentrations of alpha1 acid glycoprotein
- Lipophilicity of drugs altering volume of distribution
- Monitor drug levels frequently if narrow therapeutic index

Other

Nutrition

- Despite size usually poorly nourished
- High protein diet as standard

Early Catheterisation

- bedpans difficult, large pans available
- slow to mobilise

DVT prophylaxis

Elevated BMI independently contributes to hypercoagulability after injury

- Increased risk for lower **and** upper limb DVT
- Ultrasound less reliable for diagnosis
- Enoxaparin 0.5mg TBW b.d. prophylaxis to max 120mg/dose
- Below knee TEDs if able
- Mechanical compression devices

Complications of trauma

Obesity increases

- Ventilation days
- ARDS
- ICU admission and LOS
- Decubitus ulcer
- Pneumonia
- Surgical site infection
- Sepsis
- UTI
- DVT / PE
- Acute kidney injury
- MOF
- Mortality

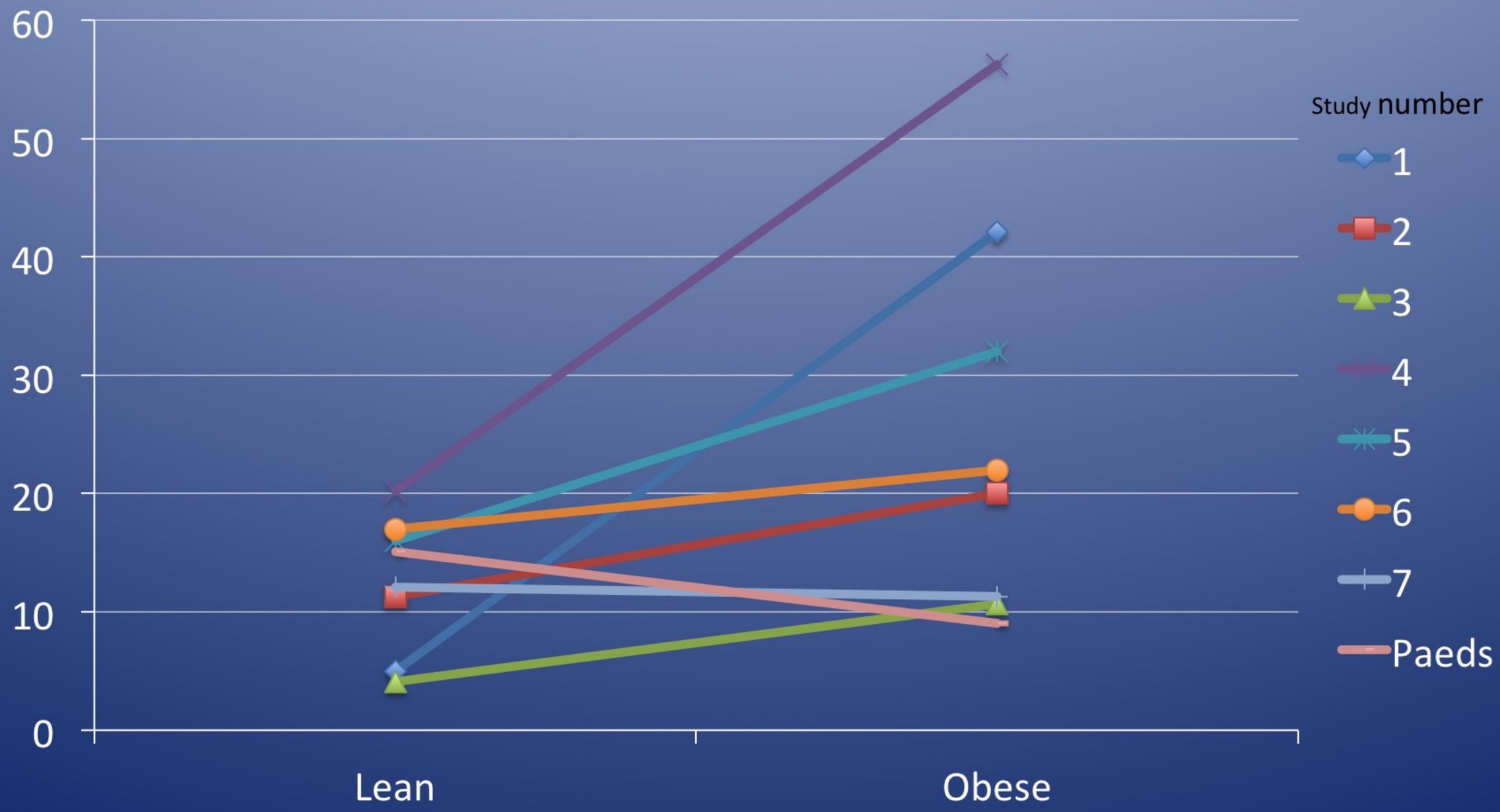
Most studies complicated by poor recording of height and weight data

Increased incidence of most complications in those that have looked

Reduced cytokine response to major trauma may be mechanism of increased nosocomial infections

Higher mortality rates in majority of studies

% Mortality rate by BMI in Trauma



Summary

- Different injury patterns seen in the obese patient, future need to address vehicle safety standards to mitigate for a heavier population
- Differences in baseline physiology
- Co-existent pathology common and affects response to treatment post trauma
- Higher trauma related morbidity and mortality
- Standard assessment techniques limited
- ABCDE approach still useful

Homework

Know weight limitations of your institutions

- Beds
- CT and MRI scanner – and alternative arrangements
- Theatre beds
- Where to find alternative equip e.g. needles for thoracocentesis
- Is your institution already recording height and weight data for major trauma patients?