LUNG: Effects of Aging, Pregnancy & Exercise

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DM Seminar

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Effects of Age

- Life expectancy is increasing
- US 47yrs(1900) to 71yrs (2001)
- India 63.7 yrs
- Decreased reserve
- Management and outcome of LRTI,HF

Structural Changes

- DECREASE IN:
- Chest wall compliance
- Static elastic recoil of lung
- Strength of resp muscles

Chest Wall

- Upper thorax/Rib cage
- Calcification
- Osteoporosis (wedge/crush # 34% 75-79)
- Kyphosis (25% severe 43% moderate 23% N)
- Lower thorax/Diaphragm abdo compartment

Resp muscle function

- Rib cage shape
- Decreased compliance
- Increased FRC (elastic recoil decreased)
- Flatter diaphragm(AP, Kyphosis)
- MIP, MEP decrease
- Increase in energy expenditure 20% (60y vs 20y)

Muscle strength

- Under nourishment (Diaphragm mass)
- Skeletal muscle strength (handgrip,sarcopenia,number,NM jn,muscle proteins, mito. Oxidative capacity)
- CHF, Parkinson’s,CVA,Myaesthenia

Lung parenchyma & Airways

- Pollution??
- Normal aging vs env exposure (tob/part)
- Animal models eg SAM
- Alveolar duct size
- No cellular infiltrate
- Lung wt:body wt constant
- Loss of recoil
- Compare to emphysema

PFT

- Quality
- Mood
- Fatigue
- Co-operation
- Cognitive impairment(dementia 22% at 80)
- Alternative methods

Lung Volumes

- Elastic recoil of chest wall & parenchyma
- Loss of recoil:
  - Increase in RV (50% 20-70 yrs)
  - Decreased VC (75% of best value)
  - TLC remains constant
- Closing volume increases
  - Decrease in PaO2
  - Increase in alv art difference

Spirometry

- FEV increases till 18, no change till 25
- Declines after 25
- More rapid in men.
- Airway reactivity hastens decline
- 30 ml/yr (31 ml/yr vs. 27 ml/ yr)
- FEV1/FVC < 70% overdiag COPD
- (males 82, females 92yrs)

Flow volumes curves & PEF

- Loss of elastic recoil & supporting tissue
- Obstructive pattern (even non smokers)
- PEF rates- decline with age
  - Highly variable; prediction equations not reliable
- No change in resistance

Resp muscle testing

- weakness
- shortness of breath
- decreased exercise tolerance
- alveolar hypoventilation
- resp failure
- MIP MEP SNIP
- handgrip

Gas Exchange

- Increase in units with dead space/shunt
- May explain decline in paO2
- Increased alv-art gap
- Relatively well preserved

Summary

- Compliance decreases
- Increased air trapping (RV,FRC,WOB)
- Resp muscle function declines
- Gas exchange well preserved
- Decreased sensitivity to hypoxia/hypercapnia
- Blunted response/delay in diagnosis

Lung in Pregnancy

The critically ill pregnant patient

Critically ill pregnant patient

- Primary care for the mother
- Effects on foetus of interventions

General changes

- Hyperaemia & oedema of mucosa (prog)
- Nasal congestion; small ng tube
- Diaphragm ascends 4cm
- Q waves in inf leads
- Chest wall widens 5-7 cm
- Chest tube placement

Respiratory changes

- Spirometry normal
- FEV1 normal
- Asthma variable changes
- Flow vol loops and peak flow unchanged
- TLC decreases 4-5% (diaphragm)
- FRC decreases 20%
- Minute vent increases 50% TV >>rate

Respiratory changes

- 60 % experience dyspnoea of pregnancy
- Progesterone on resp centre
- Direct resp stimulation
- Increased response to changes in Pa CO_2

ABG

- Mild chronic resp alkalosis
- Compensatory metabolic acidosis
- pH 7.40-7.47
- $PaCO_2$ 30-32
- PaO_2 N/slightly increased
- HCO_3 18-21 meq/L

Oxygen consumption

- Increased by 20%
- Uterine and fetal requirements
- Increase in cardiac & resp work
- O2 reserve is less (FRC, inc in consump)
- Rapid desaturation in intubation

Cardiac changes

- Cardiac output 40%
- Blood volume 2l
- RBC mass 20-30%
- Loss of 0.6l/1l well tolerated
- CVP/pulm cap wedge unchanged
- Colloid oncotic pressure decreased

CVS cont

- Comp of IVC on lying down (20wks)
- Decrease in EF by 20-30%
- Lateral repositioning
- Diastolic BP lower
- Ejection murmur
- S3
- ECHO: inc in dimensions, LV wall,small effusion,mild TR/PR,mild MR

Renal & GI

- GFR increases by 50%
- Creatinine clearance increases
- Normal creatinine lower 0.8mg%
- Reflux and aspiration
- Decrease in albumin (n 3.1 g%)
- S alk phos 2-4x normal
- Appendicitis/cholecystitis common

Foetus and placenta

- Gas exchange/nutrition/waste elimination
- Concurrent exchange mechanism
- O2 delivery:UA flow(600 ml/min),O2 content,Hb concentration and saturation
- Hypotension,contractions,vasoconst compromise flow.
- Ephedrine vasopressor of choice

Foetus:high O2 extraction

- Hb 15-16g%
- Sat 80-90% at PaO2 of 30-35 mmHg
- Ductus arteriosus
- 42 ml reserve
- 20 ml/min
- 2 min, actually 10 min
- Perimortem LSCS 24 wks 750g within 5 min of maternal arrest.

ICU Admissions

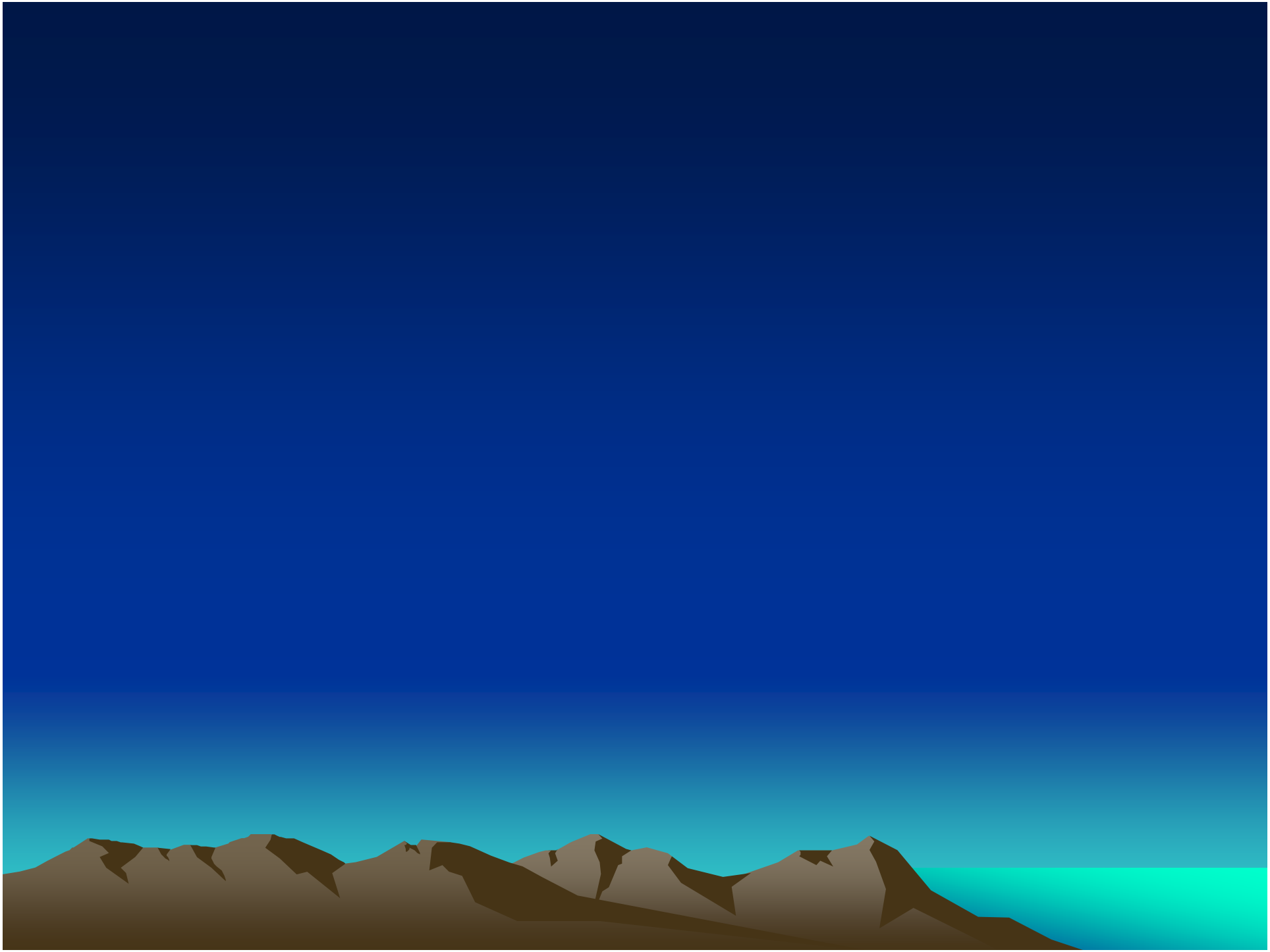
- Pre-eclampsia
- Amniotic fluid embolism
- Tocolytic pulm oedema
- Gest trophoblastic disease
- Peripartum cardiomyopathy (ACEI)
- Septic shock
- PTE (Warfarin, IVC filter)
- ARDS (better prognosis)
- Asthma (no change)
- Cardiac disease

Management issues

- Vasopressors
  - Uterine flow,ephedrine,vol replacement,positioning
- CPR
  - Defib, lt lateral,LSCS
- Ventilation
  - NIV vomiting, aspiration
  - Airway: failed tube,rapid desat,aspiration

Mechanical ventilation

- Avoid hyerventilation
- Plateau 30-35
- PaCO2 60 acceptable
- Bicarb for acidosis
- Delivery may improve outcome.



Response to Exercise

- Normal healthy respiratory system adapts to extremes
- Aim: To maintain PaO_2 and $PaCO_2$ near normal

During Exercise

- O_2 of mixed venous blood reduced
- 4 fold increase in cardiac output (decreased pulm cap transit time)
- Increase cardiac output to lung (adapts to maintain low pressures)
- 20X increase in minute ventilation

Exercise Hyperventilation

- $PAO_2 = PIO_2 – VO_2/V_A$ .K
- $PACO_2 = VCO_2/V_A$ .K
- Alveolar ventilation increases out of proportion to VCO2
- $PaCO_2$ falls with exercise.
- Minimizes metabolic acidosis.
- Guards against hypoxaemia.

Minimize WOB

- 20 fold increase in ventilation
- O_2 cost of breathing 10% of VO_2
- Rate and VT increase(to 50% of VC)
- Lung stretch minimized
- Expiratory muscles activated:aid insp muscles
- Airway resistance N (10 fold increased flow)
  - Skeletal muscle/parasymp tone/tethering to lung

Maximizing gas exchange

- PAO2-PaO2 (5-10)
- 15-25
- VQ mismatch
- Extrapulm shunt
- Diffusion limitation
- Intrapulm shunt

Increased Cardiac Output

- Increased hydrostatic pressure
- ? Plasma exudation ?pulm oedema
- Pulm arterioles distensible: vasc res N
- Increased lymphatic drainage
- Osmotic pressure gradient