Vesalius SCALpel™: Chest

Chest wall

chondrosarcoma most common primary tumor of chest wall

Mediastinum

compartments
- anterior: thymoma, teratoma, germ cell, lymphoma
- middle/visceral: cyst, foregut cyst/duplication (bronchogenic, esophagus), lymphoma
- posterior/paravertebral: neurilemmoma/Schwannoma, neurofibroma, ganglioneuroma, ganglioneuroblastoma, chemodectoma, paraganglioma
- other: thyroid, cystic hygroma, diaphragmatic (hiatal) hernia, aortic & ventricular aneurysm

mediastinal cyst
15-20% of mediastinal masses
- unilocular, smooth, round
- bronchogenic (60%)(near carina), esophageal duplication
- epithelial lined, small risk malignant transformation
- usually asymptomatic, small
- may or may not communicate with esophagus or trachea
- surgery recommended because of chance of infection, rupture, malignancy
- more difficult surgery

pleuro-pericardial cyst
- near cardiophrenic angle, 70% R
- no infection or malignancy risk
- aspirate

adult tumors
- thymoma > lymphoma > germ cell
  - 20-40yo 50% malignant
  - > 40 >40%
  - 1/3 symptomatic

pediatric
- neurogenic > thymic > lymphoma
  - 1/3 malignant < 20yo
  - 2/3 symptomatic: Horner's, SVC syndrome, hoarseness

thymoma
- thymic epithelial cell origin worse prognosis
- 50% of anterior mediastinal masses
- stage based on operative findings not histology
- myasthenia: autoimmune complement mediated antibody damage to Ach receptors
  - 30-50% of thymomas associated with myasthenia
  - 10-15% of pts with myasthenia have thymoma
  - 35% complete remission, 75% improvement with thymectomy
- shorter interval onset to surgery better result
- young more likely complete remission

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myasthenia has no effect on survival with thymoma, only stage and completeness of resection

lymphoma
multiple discrete nodules v single mass germ cell and thymoma
most common mediastinal malignancy, most anterior
nodular sclerosing Hodgkins most common
symptomatic have slightly worse prognosis

germ cell
seminoma: very radiosensitive; residual mass after RT probably scar, no AFP
non-seminomatous: chorio, embryonal, endodermal sinus (yolk sac)
teratoma most common (66%) mediastinal germ cell tumor
smooth, lobulated, at least 2 of 3 germ layers
benign are marker negative
very elevated betaHCG, AFP at Dx; Bx for Dx, then chemo
chemotherapy: cisplatin, bleomycin
restage w tumor markers, if still elevated more chemo
if normalized and residual mass resect (may represent teratomatous component)

neurogenic
neuroblastoma: child, malignant, metastasize early
ganglioneuroma: most common benign neurogenic tumor in child
ganglioneuroblastoma: intermediate differentiation
neurilemmoma/benign Schwannoma
malignant schwannoma
childhood neurogenic paravertebral tumors 75% benign
adult neurogenic paravertebral tumors 95% benign
schwannoma, neurofibroma most common
sympathetic chain or intercostals nerve ramus
exceptions to benignity: neurofibroma (5% chance of malignancy) and hx of radiation
neurofibroma 10% intraspinal component (dumbell tumor)

Heart

PDA: physiological in preemia, indomethacin
in term baby = structural, surgery
double aortic arch most common ring anomaly
respiratory, dysphagia symptoms
VSD: many small ones close spontaneously
aortic stenosis (AS) w significant gradient risk for sudden death: operate
PAT: > 90% focus in pulmonary vein
Maze procedure 90% successful
CABG: recurrence of angina > 5y = progressive atherosclerosis in native coronary arteries
extracorporeal circulation: maximum 6-8h
post-pericardiectomy syndrome (Dressler’s)
@ 2-4w, treat with anti-inflammatories
**Pericardium**

pericarditis
- most idiopathic
- causes: infection, neoplasm, post MI, post-op, uremic, drug, autoimmune
- chest pain, malaise, fever, friction rub
- treat underlying cause, NSAIDs

chronic constrictive pericarditis
- 90% idiopathic, 10% prior acute pericarditis
- fatigue, CHF, edema, ascites, pulsus paradoxus
  - Kussmaul’s sign (paradoxical increase JVD with inspiration)
- cardiac cath to differentiate from restrictive cardiomyopathy
- surgical pericardiotomy

tamponade
- Beck’s triad: hypotension, neck vein distention, muffled heart sounds
  - present in 30%
  - neck veins may not be distended with hemothorax
- US (FAST exam) 99% accurate
  - pericardiocentesis, window temporize, sternotomy to correct cause

pericardial malignancy:
- most metastatic: breast > lung > lymphoma
- mesothelioma most common primary malignancy
- palliative Rx: drain malignant effusion

**Trachea**

segmental arterial supply
- benign: lipoma, fibroma, chondroma, GIST, hamartoma
  - hamartoma: resect (endobronchial if < 50% of diameter)
  - > 50% sleeve resection or lobectomy (if distal lung diseased from obstruction)
- malignant: squamous, adenoid cystic
- Rx: excision with primary anastomosis
  - 1/2 length of trachea can be removed, anastomosis with release maneuver
- post-op radiotherapy may be beneficial

**Benign lung**

sequestration: no airway communication
- most LLL
- intralobar:
  - intralobar sequestration most common (70%), blood supply thoracic aorta
  - anomalous systemic artery enters via inferior pulmonary ligament
  - posterior basilar
  - venous drainage into pulmonary vein
- extralobar: surrounded by separate visceral pleura
  - systemic venous drainage to azygous or portal

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extra associated with other anomalies: diaphragmatic hernia, congen ht dis
resect for repeated infections
congenital cystic adenomatoid malformation: abnormal bronchi and vasculature, resect
reported malignancy, especially rhabdomyosarcoma
congenital lobar emphysema: newborn, compromises good lung, resect
first few days of life, LUL hyperinflation common, mediastinal shift
cystic fibrosis: epithelial exocrine glands
pneumothorax most common surgical problem
pulmonary most common cause of death
bilateral transplant end stage
hamartoma: popcorn calcifications on CXR
spontaneous pneumothorax
young, tall, male, smoker typical
50% chance of 1st recurrence, 60% chance of 2nd
rupture of small blebs most common cause
most blebs apical, easily resectable by video-assisted thoracoscopic (VATS), less than
10% recurrence after resection
catamenial: menstruating woman, 90% R, 15% recurrence
pleurodesis for recurrent, high risk: pilot, scuba diver
chemical: doxycycline, talc
mechanical: VATS
pleural effusion
exudate: high LDH, protein, low glucose, low pH
malignant, infectious, collagen vascular
malignant effusion: thoracoscopic instillation bleomycin, talc
50% relief of shortness of breath
pleuroperitoneal shunt if VATS fails
transudate: CHF, cirrhosis, nephrotic syndrome
empyema
strep previously most common organism, now combination pneumococcus, staph,
strep, Gm negatives
parapneumonic most common cause, 20% mortality, worse elderly
3 stages:
exudative: few WBCs, low LDH (<1,000), high pH
fibrinopurulent: hi WBC & LDH, low pH
organizing: variable
early empyema: chest tube (thoracentesis, pigtail cath not effective), fibrinolytic,
antibiotics
late empyema (complicated, loculated, organized peel): surgical drainage, decorticate
open Thoracotomy, decortication if primary Rx fails
treat secondary lung compression, restriction
correct bronchopleural fistula
obliterate dead space (transposition flap)
pulmonary embolus
risk: post-op, cancer, elderly, inflammation, trauma
D-dimers elevated in most cases
helical CT 99% accurate (equivalent to angio)
sensitive for segmental and subsegmental
IV contrast contraindicated in renal failure
circulatory collapse, R heart strain catheter directed thrombolysis
thrombolysis decreases mortality v heparin alone
angio suction thrombectomy in critical
can remove 30-80% of clot burden (esp. saddle embolus)
operative embolectomy rarely done
US detects lower extremity clot in 50% of patients with PE
IVC filter indicated if clot detected to prevent further emboli

Lung cancer

leading cause of death men and women (30% of all cancer deaths)
second in incidence after prostate and breast
asymptomatic solitary pulmonary nodule by age: < 50: 5% Ca, > 50: 50%, > 80: 100%
small cell and non-small cell types
small cell:
20% of lung cancers
2/3 metastatic @ Dx
bone, liver, brain, extrathoracic LNs
no surgery for metastatic
paraneoplastic syndromes:
SIADH most common 15%
vasopressin or atrial naturietic hormone -> hyponatremia
ACTH: Cushings syndrome, myasthenia, retinopathy, encephalomyelitis
chemotherapy primary treatment
cisplatin, cyclophosphamide, doxorubicin, vincristin (CAV)
with limited disease 80% response, 25% 5y survival
adding RT may improve
prophylactic brain RT may decrease mets 45%, but no long term survival benefit
non-small cell: squamous, adeno most common; large cell, carcinoid
squamous
most common (40-50%) lung Ca
central location more common than peripheral, cavitation, smoking
endobronchial, lymphatic spread
new lung lesion after squamous = new primary
adenocarcinoma
increasing frequency
peripheral location more common
early hematogenous spread
prognosis
stage I: 65% 5y, II: 55%, III: 35%
paraneoplastic syndromes:
Cushings, hypercalcemia, SIADH
resolve with resection
Dx/w/u
bronchoscopy, sputum cytology
criteria for surgery: FEV1 >1L, FRC >800cc
refine with quantitative V/Q (ventilation-perfusion scan)
determine which parts functional
treatment
surgery
stage I & II lung parenchyma: resect and mediastinal LN dissection
IIIa: ipsilateral mediastinal nodes: pre-op chemoradiation
IIIb, IV: chemoradiation, non-operative
lobectomy better 5y survival than wedge
superior sulcus (Pancost) tumor
pain, Horner’s
pre-op radiation: 3-5,000 cGy, restage
resect lobe, ribs
good results when complete resection

Metastatic disease to lung

liver mets to lung no resection, incurable (v colon)
melanoma, sarcoma, breast, colon common

Asbestos

lung mesothelioma, esophagus, stomach Ca

Thoracic outlet

multiple anatomic causes of constriction
vascular and neurologic components
first rib resection usual treatment

Thoracic trauma

cause of 25% of trauma mortality
rib fx elderly: 2X risk morbidity and mortality; 19% increase for each rib
most elderly not candidates for epidural
hemorthorax: initial output > 1,500cc to OR
innominate artery most common vascular injury in blunt trauma: median sternotomy
tension pneumo: kink superior and inferior vena cava, circulatory collapse
aorta
90% of blunt thoracic aortic rupture die at scene
if cross clamp necessary limit to 30m to avoid spinal cord ischemia
10-15% paraplegia
cardiac contusion: echocardiogram, enzymes
more common than valvular damage
troponin I specific for cardiac injury

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rises by 4-10 hours, 50% sensitivity within 4h, 100% @12 confirmatory, too late for emergency screening peaks 4-8d peak correlates with subsequent cardiac events conservative Rx severe can go into CHF, need aortic balloon pump thoracotomy R anterolateral rarely used double lumen tube prevent blood and secretions compromising non-involved side penetrating, tamponade, usually R ventricular injury clinical or FAST Dx needle pericardiocentesis temporizing only, not necessary for diagnosis sternotomy for definitive repair of injury flail chest: primary problem is pulmonary contusion pain control: intercostal block, epidural mechanical ventilation if necessary diaphragmatic rupture blunt 3X incidence of penetrating, usually (70%) L 80% present with dyspnea X-ray NG tube above diaphragm acute: explore through abdomen for associated abdominal injuries (85%), most spleen chronic/late: repair through thorax because of adhesions

Mechanical ventilation
FEV1 < 800 risk post op pulmonary compromise
physics/definitions minute ventilation = tidal volume X respiratory rate hypoventilation: PaCO₂ > 40 hypoxemia: PaO₂ < 60, SaO₂ < 90 O₂ delivery (DO): cardiac output X O₂ content CO = stroke volume X heart rate O₂ content = [Hb] X SaO₂ X 13.4 therefore: DO = CO X [Hb] X SaO₂ X 13.4 Dalton’s law of partial pressure: each gas in a mixture acts independently P (air) = pO₂ + p CO₂ + pH₂O + pN₂ pO₂ = FO₂ X P F = fraction, P = atmospheric pressure eg: atm press 760, FO₂ = .21, then pO₂ = 160 alveolar pO₂ modified by H₂O and CO₂ 760-47 (water), -40 (CO₂) X .21 = 110mmHg pAO₂ (partial pressure of alveolar O₂) arterial pO₂ does not equal alveolar pO₂ oxyhemoglobin dissociation curve rapid increase saturation up to 60mm, ~85% saturation; 97% @ 100mm acidosis (decrease ATP, 2,3DPG, increase CO₂) shift curve to right

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easier unloading of O\textsubscript{2} (normal p50 = 27mm, acidosis p50 = > 27)
organs compensate for decreased blood flow by extracting more O\textsubscript{2}
body normally consumes 25\% of O\textsubscript{2}, mixed venous O\textsubscript{2} is normally 75\% saturated
(pO\textsubscript{2} 40mm)
mixed venous O\textsubscript{2} (SvO\textsubscript{2}) increases in septic shock, L-R shunt
normal work of breathing consumes 2\% of O\textsubscript{2}; post op as high as 50\%
need for ventilator support: R > 35, PaCO\textsubscript{2} > 60, A-a O\textsubscript{2} difference > 350, VD/VT > 0.6,
shunt fraction > 20\%

ventilation modes
volume ventilation (eg anesthesia machine in OR)
  flow is square wave
  tidal volume (TV) remains constant
  airway pressure depends on compliance
  machine delivered breaths evenly spaced
  awake patient may become asynchronous, uncomfortable
  no patient-initiated breaths allowed
assist control (AC)
  same as volume control, but separate patient initiated breaths permitted
  unevenly spaced, all same TV
  awake patient may hyperventilate
IMV (intermittent mandatory ventilation)
  intermittent mandatory breaths
  no assisted spontaneous breaths
  synchronized triggered mandatory breaths, more comfortable
  machine breaths are volume controlled
  good weaning mode
  spontaneous breaths increase the work of breathing
  pressure support eases the work of triggered breaths
SIMV (synchronized IMV) + PS (pressure support)
  machine breaths are volume controlled
  spontaneous breaths are pressure-supported
  guaranteed minimum minute ventilation, best of both
  improved safety as weaning mode
  graded unloading of work of breathing
  O\textsubscript{2}, ventilation, work of breathing independently controlled
SIMV alone without pressure support increases work of breathing
pressure controlled/non-spontaneous
  for severe lung disease in paralyzed patient
  pts with poor compliance
  limit airway pressure to protect lungs
PEEP (positive end expiratory pressure)
  recruits collapsed alveoli, increased FRC
  can be combined with any ventilator mode
  improves alveolar oxygenation
  reduces physiologic shunting
downside: increases mean intrathoracic pressure, barotrauma
autoPEEP: reverse I/E ratio ventilation, breath stacking
progressive PEEP trial for optimal O2 delivery
protection strategies against pressure/volume trauma, O2 toxicity
reduce FiO2 to < .50 as soon as possible
keep positive airway pressure (PAP) < 50cm
use PEEP early in ARDS, may decrease PAP, barotrauma
select at lower inflection point
smaller tidal volume: 3-6cc/Kg
permissive hypercapnea (with added O2)

weaning parameters
FiO2 < .50
PEEP < 10
negative inspiratory force (NIF) > 20-30cm, H2O
T-tube trial: R < 24, TV > 5-8cc/Kg, minute vol > 10L/m, pCO2 < 50
rapid shallow breathing index: rate/TV < 105 (higher than 105 = rapid shallow
breathing; fast shallow breaths not as effective as slow deep)
A-a gradient < 300-350mm
PaO2/FiO2 > 200
shunt fraction < 15

weaning strategies
SIMV + PS + PEEP + O2
each can be weaned independently
continuous v intermittent process
gradual v abrupt physiological changes
comfort level, lack of sedation
control work of breathing, exercise
may still need to provide rest, prevent fatigue

prone positioning: alveolar recruitment dorsal lung, improved drainage of secretions, increased FRC

air/CO2 embolus
abrupt drop end tidal CO2, drop BP due to venous return obstruction
R lateral decubitus, central venous catheter aspiration of gas from right atrium

CO poisoning
carboxyHb > 10% Rx 100% O2
> 30% intubate

References: