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 w 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: Horners, 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

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
- aoartic 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
  - Kussmal'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

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
congentital 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)
opertive 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, vinctistin (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
adeno
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

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

hemothorax: 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

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
mechanincal 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: $PaCO_2 > 40$
hypoxemia: $PaO_2 < 60$, $SaO_2 < 90$
O_2 delivery (DO): cardiac output X O_2 content
CO = stroke volume X heart rate
O_2 content = [Hb] X SaO_2 X 13.4
therefore: DO = CO X [Hb] X SaO_2 X 13.4
Dalton's law of partial pressure: each gas in a mixture acts independently
P (air) = pO_2 + p CO_2 + pH_2O + pN_2
$pO_2 = FO_2$ X P
F = fraction, P = atmospheric pressure
eg: atm press 760, FO_2 = .21, then pO_2 = 160
alveolar pO_2 modified by H_2O and CO_2
760-47 (water), -40 (CO2) X .21 = 110mmHg pAO_2 (partial pressure of alveolar O_2)
arterial pO_2 does not equal alveolar pO_2
oxyhemoglobin dissociation curve
rapid increase saturation up to 60mm, ~85% saturation; 97% @ 100mm
acidosis (decrease ATP, 2,3DPG, increase CO_2) shift curve to right

easier unloading of O_2 (normal p50 = 27mm, acidosis p50 = > 27)
organs compensate for decreased blood flow by extracting more O_2
body normally consumes 25% of O_2, mixed venous O_2 is normally 75% saturated (pO_2 40mm)
mixed venous O_2 (SvO_2) increases in septic shock, L-R shunt
normal work of breathing consumes 2% of O_2; post op as high as 50%
need for ventilator support: R > 35, $PaCO_2$ > 60, A-a O_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 manditory 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
O2, 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 O_2)

weaning paramerers
FiO_2 < .50
PEEP < 10
negative inspiratory force (NIF) > 20-30cm, H_2O
T-tube trial: R < 24, TV > 5-8cc/Kg, minute vol > 10L/m, pCO_2 < 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
PaO_2/FiO_2 > 200
shunt fraction < 15

weaning strategies
SIMV + PS + PEEP + O_2
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/CO_2 embolus
abrupt drop end tidal CO_2, 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% O_2
> 30% intubate

References:

Feins, R. What's new in general thoracic surgery. JACS, 199(2), Aug. '04: 265-272.