1. (Deya) Describe the anatomy of the cervical fascia.
2. (Deya) Name the deep neck spaces. Be prepared to draw pictures to help us understand.

Spatial compartments within the neck are defined by fascial planes. These are important to know when dealing infection & its likely routes of spread in the neck. Commonly affected spatial compartments are the retropharyngeal, parapharyngeal, & submandibular spaces.

Fascia of the neck: divided into superficial & deep layers
Deep layer of cervical fascia further divided into: superficial, middle, & deep.
- **Superficial:** envelops SCM & trapezius muscles. Extends superiorly to hyoid bone where it surrounds the submandibular gland & the mandible. Inferiorly, attaches to clavicle & medially, it forms floor of submandibular space as it covers the muscles of the FOM.
- **Middle (aka visceral or pretracheal fascia):** surrounds infrahyoid strap muscles, thyroid, larynx, trachea, & esophagus. Below hyoid, this layer continues inferiorly to fuse with pericardium. Above hyoid, this layer continues on the posterior pharyngeal wall as the bucopharyngeal fascia.
- **Deep (aka prevertebral fascia):** surrounds prevertebral muscle. Anteriorly, it divides to form a thin alar layer & a thicker prevertebral layer. Between these two layers is the "danger space," extending from the skull base to diaphragm.
- **Retropharyngeal space:** Between middle & deep layers of deep cervical fascia
- **Parapharyngeal space:** limited by the lateral wall of the pharynx, the cervical vertebrae, & the medial pterygoid muscle.
- **Submandibular space**
  - Boundaries: 1- anteriorly by the mandible, 2- superiorly by the mucosa of the FOM, 3- inferiorly by the superficial layer of the deep cervical fascia, & 4- posteriorly by the parapharyngeal space.
  - Mylohyoid further divides this space into submaxillary space (below the mylohyoid muscle) & sublingual space (above the mylohyoid muscle).
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3. (Deya) Where is the “Lincoln Highway” & what is the importance?
   Carotid Sheath aka “Lincoln Highway”
   - Contains common carotid artery, its major divisions, internal jugular vein, cranial nerves IX to XII, sympathetic plexus & lymph nodes.
   - Named “Lincoln’s Highway” by Mosher in 1929 because it is formed by all three layers of deep fascia but anatomically separate from all layers. This was indicative of the importance of the creation of the first transcontinental paved highway in the US that was conceived 16 years earlier.
   - Travels through pharyngomaxillary space & extends from skull base to thorax. Lies posterior to parapharyngeal space, lateral to retropharyngeal space, anterolateral to prevertebral spaces & medial to parotid space & styloid process. Infection most commonly secondary to spread of infection from adjacent fascial spaces.
   - Complications of infection in this space include upper airway obstruction, pneumothorax, pneumomediastinum, vocal cord paralysis, Horner’s syndrome, internal jugular thrombophlebitis. Spread of infection to mediastinum via the Lincoln highway is a cause of significant morbidity & mortality.

4. (Dara) Microbiology of deep neck infections.
   The microbiology of deep neck infections usually reveals mixed aerobic and anaerobic organisms, often with a predominance of oral flora. Most common are gram positive cocci: Group A beta-hemolytic streptococcal species (Streptococcus pyogenes) is most common. Alpha-hemolytic streptococcal species (Streptococcus viridans, Streptococcus pneumoniae), Staphylococcus aureus are also common. Fusobacterium nucleatum, Bacteroides melaninogenicus, Bacteroides oralis, and Spirochaeta, Peptostreptococcus, Klebsiella and Neisseria species often are found together in various combinations. Pseudomonas species, Escherichia coli, and Haemophilus influenzae are occasionally encountered.
   A study by Asmar of retropharyngeal abscess microbiology demonstrated polymicrobial culture results in almost 90% of patients. Aerobes were found in all cultures, and anaerobes were found in more than 50% of patients, although the estimation of anaerobic infections may be low because of the difficulty in growing these organisms.

5. (Dara) Most common etiology of deep neck infections. Name some others.
   Before widespread use of antibiotics, 70% of deep neck space infections were caused by spread from tonsillar and pharyngeal infections. Today, tonsillitis remains the most common etiology in children, followed by odontogenic sources. In addition to surgical infections, poor dental hygiene and IV drug use are increasingly common sources of infection in adults. Other causes of deep neck infections include:
   - Tonsillar and pharyngeal infections
   - Dental infections or abscesses
   - Oral surgical procedures or removal of suspension wires
   - Salivary gland infection or obstruction
   - Trauma to the oral cavity and pharynx (e.g., gun shot wounds, pharynx injury caused by falls onto pencils or Popsicle sticks, esophageal lacerations from ingestion of fish bones or other sharp objects)
   - Instrumentation, particularly from esophagoscopy or bronchoscopy
   - Foreign body aspiration
   - Cervical lymphadenitis
   - Branchial cleft anomalies
   - Thyroglossal duct cysts
   - Thyroiditis
   - Mastoiditis with petrous apicitis and Bezold abscess
   - Laryngopyocele
   - IV drug use
   - Necrosis and suppuration of a malignant cervical lymph node or mass
   As many as 20-50% of deep neck infections have no identifiable source.

6. (Amy) Potential complications of deep neck infections and how their management.
   Deep neck infections have many potential life-threatening complications. Those infections that are untreated or inadequately treated, occur in older patients, extend to other deep neck spaces, or occur in patients with systemic disease such as HIV or diabetes are at particular risk for complications. Airway obstruction from compression of the trachea can occur with any deep neck infection, but it is usually associated with Ludwig’s angina. Timely evaluation of the airway is important, and some patients may require tracheotomy. Mediastinitis is a rare but serious complication that occurs when infection spreads inferiorly along fascial spaces into the mediastinum. Symptoms include respiratory distress, tachycardia, chest pain, back pain, erythema/edema of the neck and chest, crepitus, and shock. Plain chest films often do not show changes until late in the course of the disease. CT of the neck and chest is
preferred and may demonstrate esophageal thickening, air fluid levels, pleural effusions, and obliteration of normal fat planes. Treatment includes IV antibiotics and surgical drainage; a thoracic surgery consultation is often warranted. Aspiration can occur spontaneously or during intubation if a retropharyngeal abscess ruptures and drains into the airway, resulting in severe pneumonia, lung abscess, or empyema. Vascular complications include internal jugular vein thrombosis and carotid artery rupture, which occurs when infection involves the carotid sheath and results in weakening of the arterial wall. Impending carotid artery rupture and hemorrhage may be heralded by recurrent small bleeds from the ear/nose/mouth, local hematoma, shock, or an unexplained cranial neuropathy. Treatment is surgical and involves obtaining proximal and distal control, followed by ligation of the vessel. Repair is not always possible due to the infected tissues. Other complications include sepsis, osteomyelitis of the spine/mandible/skull base, upper GI bleeding, and neurologic deficits (Horner’s syndrome, vocal cord palsy).

7. (DR) You order a lateral neck film to rule out a retropharyngeal abscess. What are the radiographic criteria for widening of this space?

Measuring at the level of C2, the distance from the anterior surface of the vertebrae to the posterior border of the airway should be 7 mm or less, regardless of the patient’s age. At C6, this distance should be 14 mm or less in children younger than 15 years. A distance of 22 mm is considered normal in an adult. A simpler, but less precise, rule is that the soft tissue plane should be less than one half the width of the corresponding vertebral body.

Bear in mind that lateral plain films are neither sensitive nor specific -- the false negative rate is as high as 33% and poor neck extension or film shot during expiration can result in a false positive.

8. (Josh) Indications for surgical management of deep neck infection. Superficial infections such as cellulitis and sometimes even abscesses can be managed with antibiotic therapy alone. However surgical intervention is indicated for most deep abscesses, especially if there is airway compromise, sepsis syndrome, or no response to antibiotics within 48 hours. Fluid resuscitation should precede surgery if possible because patients will be dehydrated from not eating and fever related water loss. Complications such as septic emboli, septic shock, and pulmonary aspiration should be expected in the recuperative period after surgery. More aggressive surgery may be required for complicated deep neck space infections. For example, a thrombosed IJV should be ligated and resected. Infection extending into the mediastinum may require thoracic surgery. Although cervical drainage alone is usually sufficient for infections above the carina and the fourth thoracic vertebral body, an abscess below the level of the carina should be drained transsthoracically. In mediastinal infections not requiring thoracic drainage, blunt dissection along the carotid sheath and the paratracheal space facilitates evacuation and a drain should be placed in the anterior mediastinum.

9. (Kathy) What is Ludwig's angina?

Ludwig’s angina is a rapidly spreading, firmly indurated cellulitis that originates intraorally and involves submandibular and sublingual spaces bilaterally, but without abscess or lymphadenopathy. It is the most common type of necrotizing cervical fasciitis. Signs of sepsis are usually present. There is erythema and tender, firm edema of the anterior neck without fluctuance. Tissue fluid is not frankly purulent, but serosanguinous and malodorous. There is non-pitting firm induration of the entire floor of mouth, elevating the tongue, impairing chewing and swallowing, and producing the classic “hot potato” voice. If edema extends to the base of tongue, it can obstruct the airway.

Treatment is IV antibiotics, close airway monitoring, and often includes intubation of tracheotomy if upper airway becomes obstructed. Surgery is an option if needed for debridement of necrotic tissue or for decompression of a compartment.

10. (Kathy) Necrotizing cervical fasciitis….how does this differ in presentation and management from other deep neck infections?

Necrotizing cervical fasciitis is a fulminant infection with necrosis of connective tissue spread along fascial planes and high mortality. It is usually polymicrobial and odontogenic and occurs more frequently in immunocompromised and postoperative patients. The patient is usually acutely and severely ill with a high fever. The overlying skin may be exquisitely tender, edematous, and erythematous. The erythema associated with necrotizing fasciitis is flat and transition to adjacent normal skin is indistinct. These findings combined with soft-tissue crepitation from gas producing bacteria are diagnostic. As necrosis progresses, the skin becomes pale and anesthetic, and then dusky. Blisters or bullae form, and sloughing can occur within 48 hours of initial symptoms.

Necrotizing cervical fasciitis is life threatening, and all patients with this infection should be monitored in an intensive care setting. Respiratory failure, mediastinitis, pericardial tamponade, disseminated intravascular coagulopathy, neuropathy, and delirium are all potential complications. Patients with mediastinitis have a fourfold greater mortality rate than those with only cervical involvement (64% vs 15%). Death often results from sepsis with multiorgan failure and hemodynamic collapse.

Early surgery is mandated for necrotizing fasciitis. Empirc broad-spectrum IV antibiotic therapy, such as a combination of third-generation cephalosporin (ceftriaxone) plus either clindamycin or metronidazole, should be initiated as soon as possible.
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Relatively benign superficial findings often belie extensive underlying soft tissue necrosis. Subcutaneous tissues are pale and edematous, with fat liquefaction and “dishwater” drainage. All soft tissue and skin that are no longer viable must be excised. The surgical wound should be left open for continued wound care and packed with antimicrobial-soaked gauze. Daily debridement is indicated until wound stabilizes. Airway control with tracheotomy is almost always indicated at the time of initial debridement.

11. (Tali) Your friend wants to get a cat, but is worried about possible infections. What can you tell her?

Cat Scratch Disease (CSD) is most common cause of chronic benign adenopathy in children and young adults. ~0.77-0.86 case per 100,000 population with an estimated 24,000 cases recognized in US/yr. Organism: Vast majority caused by *Bartonella henselae* but also by *B. quintana*. Most common sites of regional LAD: upper extremities (46%) and head and neck (26%).

**Clinical Presentation of CSD:** Initial formation of a small erythematous papule at inoculation site persisting several weeks to months. Later, lymph nodes draining the site of infection become enlarged and tender. Patients may also have low grade fevers, malaise and, less commonly, rash, lytic bone lesions, granulomatous conjunctivitis, pneumonitis and CNS involvement. This illness is usually benign and self-limited, lasting 6-12 weeks. Demographics: Males> Females. Age <20 (80%).

**Atypical Presentation:** Bacillary Angiomatosis (BA) is an uncommon vascular proliferative manifestation of infection with *B. henselae* that occurs in patients that are immunosuppressed, 90% in HIV+ males. Manifestations include friable dermal lesions which can be cutaneous papules, subcutaneous nodules or indurated hyperpigmented plaques. Other areas of involvement include the mucous membranes of the mouth, nose, larynx, bronchi and conjunctiva; lung and pleura, bone, and CNS. Visceral involvement is termed peliosis hepatica.

**HPI:** Contact with cats, usually kittens, is found in 90% of patients and antecedent cat scratch in 60%. Risk factors include having a cat in the household less than 12 months of age, especially one with fleas.

**Diagnosis:** Based on history, serology, and histologic findings. Culture very difficult. *Serologic methods:* Most commonly the indirect fluorescent antibody assay, which has a sensitivity of 88% and a specificity of 97% for antibodies. PCR also used.

**Histology of lymph node aspirates:** small, pleomorphic, gram-negative, argyrophilic bacilli on Warthin-Starry staining.

**Treatment:** CSD is considered a self-limited illness and usually no treatment is required. However, at least one study has suggested that the use of azithromycin for 5 days reduces lymph node size more rapidly than placebo. If the lymphadenopathy is massive (>5 cm), chronic adenopathy may persist for 1-2 years. Aspiration of a suppurated lymph node should be considered to relieve pain and hasten recovery. **Formal incision and drainage should not be performed as a draining sinus tract may develop that takes several months to resolve.** BA requires treatment. Erythromycin orally is the treatment of choice; the duration depends on the extent of bone involvement. Extensive or fulminant disease may require intravenous erythromycin. Complete resolute can usually be expected in 3-4 weeks. An alternative antibiotic is doxycycline.

12. (CY) Scrofula vs. non-tuberculosis infections of the neck.

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<thead>
<tr>
<th>Scrofula</th>
<th>NTM (nontuberculosis mycobacterium)</th>
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<tr>
<td><strong>Epidemiology</strong></td>
<td>Lymphadenitis is the primary manifestation of TB in 5% of the immunocompetent population, with the cervical lymph nodes providing the site of infection in 2/3 of cases. 95% of mycobacterial cervical infections in adults</td>
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<td>In children, app. 92% of cervical infections caused by NTM, person to person transmission does not occur. NTM species are ubiquitous in nature, OC is common portal of entry, usually occurs in immunocompetent pts.</td>
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<td><strong>History</strong></td>
<td>Painless enlarging or persistent mass, systemic sx include F/C, weight loss or malaise in 43% of pts</td>
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<td>Chronic cervicofacial mass, no constitutional symptoms, poor response to conventional abx, no hx of TB exposure</td>
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<td><strong>PE</strong></td>
<td>Any cervical node (anterior chain more common), firm and rubbery → matted, mult. masses in 2/3 of pts, bilat in 1/3 of pts</td>
</tr>
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<td></td>
<td>Nontender, slightly fluctuant mass with overlying skin with violaceous hue, “cold abscess”</td>
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<tr>
<td><strong>Imaging, labs</strong></td>
<td>CT nonspecific, PPD + in app. 83% pts.</td>
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<td>CT nonspecific, PPD can have X-reactivity</td>
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<td><strong>Diagnosis</strong></td>
<td>FNA is with a sensitivity of 77%, specificity of 93%, PPV ~ 100% Most reliable criteria is the presence of acid-fast bacilli and Cx (takes 4-6 wks, can use PCR). Granuloma formation is highly suggestive Excisional or incisional bx potentially due to possible spread of disease and sinus formation</td>
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<td>FNA definitive diagnosis based on identification of the organism by culture. Excisional or incisional biopsy can be can be diagnostic as well as therapeutic</td>
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<tr>
<td><strong>Treatment</strong></td>
<td>Medical treatment alone is the standard treatment for scrofula Surgical – plagued by a high rate of recurrence and fistulizations</td>
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<td>Complete surgical excision. Removing all regional LNs not necessary because satellite nodes do not appear to be associated with recurrent disease. Reports of aspiration alone or curettage without recurrence documented</td>
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13. (Scott) A patient presents with a slow growing, painless submandibular mass. Biopsies reveal gram-positive anaerobic bacillus with sulfur granules. What is the diagnosis and how should it be treated?

Actinomycosis is relatively rare, M/F = 2/1.

*Actinomyces* species are nonsporulating strict or facultative anaerobes with a variable cellular morphology that ranges from diphtheroidal forms to coccoid filaments. They are normal constituents of the oral, gastrointestinal, and genital flora. Cultures should be observed for at least 14 to 21 days to allow adequate detection. Human actinomycosis is primarily caused by *A. israelii*. Actinomycosis is a chronic disease characterized by abscess formation, draining sinus tracts, fistulas, and tissue fibrosis. It can mimic a malignancy or granulomatous disease.

Tendency to spread without regard for anatomic barriers, including the fascial planes or the lymphatics. Pain is uncommon. Another characteristic is the presence of sulfur granules within infected tissue. The granules are 100 to 1,000 B5m in diameter and are hard in consistency.

Predisposing factors: dental caries and extractions, gingivitis and gingival trauma, diabetes mellitus, immunosuppression, malnutrition, and local tissue damage caused by neoplastic disease or irradiation.

**Cervicofacial actinomycosis:** Characteristic lesions usually develop slowly, over weeks to months, with adherence to overlying skin giving it a bluish or reddish appearance. Often mistaken for cellulitis but, in fact, more likely represents venous congestion. Over time, sinus tracts invariably form on the skin surface or oral mucosae, eventually erupting to express a thick yellow or serous exudate, which yields the characteristic sulfur granules. A characteristic inflammatory, cicatricial scarring eventually results.

Cervicofacial involvement is the most common manifestation, accounting for 50% of all cases; thoracic, abdominal, pelvic, and disseminated infections occur less frequently.

**Medical Care:**

In patients whose actinomycosis is not critical, the option to treat medically along with prolonged courses of antibiotics is an acceptable alternative.

A combined medical-surgery approach frequently is needed for complicated disease, especially when thoracic, abdominal, or CNS disease is present.

The duration of therapy is prolonged and should be extended well beyond resolution of symptoms to decrease the likelihood of recurrence.

For most complicated cases, 4-6 wk of IV penicillin G followed by 6-12 months of oral penicillin V is indicated. For patients with penicillin allergy, clindamycin, ceftriaxone, chloramphenicol, and tetracyclines are good alternatives.

**Surgical Care:**

Surgery is indicated for resection of necrotic tissue, debulking of large masses, sinus tract excision, incision and drainage of empyemas, and abscesses and bone curettage. Surgery alone is not curative, and the use of prolonged courses of antibiotics is always required.