Chapter 10
Aspiration

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Name and Synonyms

Aspiration; Aspiration Pneumonia; Aspiration Pneumonitis; Chemical Pneumonitis

Incidence/Epidemiology

- About half of all healthy adults aspirate to some degree during sleep, but this is usually not clinically significant. Healthy people have physiologic defenses (such as cough and glottic closure) against aspiration that helps to limit the damage that can be caused.
- Aspiration becomes clinically significant when the patient has some underlying condition that compromises the usual defenses.
- Up to 15 % of cases of typical community-acquired pneumonia (CAP) are due to aspiration of pathogenic bacteria from the oro-pharyngeal cavity and the stomach. The incidence increases with age, and up to 20 % of CAP in the elderly is from aspiration.

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- It is felt that the majority of hospital- and nursing home-acquired pneumonias are due to aspiration.
- Factors that can increase the risk of aspiration include: decreased level of consciousness; neurologic disorders that affect swallowing; mechanical disruption of the oro-pharynx, epiglottis, trachea, and esophagus, such as endotracheal intubation; nasogastric feeding tubes; tracheostomy, etc.

Differential Diagnosis

- Aspiration, especially aspiration of gastric contents causing aspiration pneumonitis, can present as acute shortness of breath with both tachypnea and hypoxia. As such, the differential is broad, and contains all the usual causes of acute dyspnea and respiratory compromise, such as ACS, pulmonary embolism, and pulmonary edema/CHF, among others.
- Aspiration pneumonia may present as typical CAP or HAP, with fever and cough with purulent sputum, but can also present sub-acutely when caused predominately by anaerobes.

Pathophysiology and Etiology

- Aspiration results in three broad clinical syndromes, often presenting with overlapping features:
  - Aspiration pneumonitis (chemical pneumonitis)
  - Bacterial Infection causing pneumonia, empyema, and/or pulmonary abscess
  - Airway obstruction from larger, solid matter
- The pathophysiology starts similarly in all syndromes. They are caused by the abnormal entry of endogenous secretions, fluids, and/or particulate matter into the lower airway.
- Aspiration/Chemical Pneumonitis. In this syndrome, there is aspiration of materials that have a direct, toxic effect on the lower airways and lung tissue. The best-known and studied substance is gastric acid, and serves as the pathophysiologic model for all other substances.
  - The airways and lungs are relatively resistant to injury. For clinically significant issues to result, there needs to be a large amount of aspirate (generally more than 25 ml in an adult), and the pH must be below 2.5.
  - When this condition is met, rapid physiologic changes occur (within 3 minutes), including atelectasis, peribronchial hemorrhage, pulmonary edema, and rapid death of bronchial epithelial cells.
  - After 4 hours, the alveolar spaces will become filled with an inflammatory exudate composed of inflammatory cells, fibrin, and desquamated tissue.

  - Within 2 days there will be hyaline membrane formation, and the lungs will be edematous and hemorrhagic with consolidation of the alveolar spaces.
  - Lungs that have been injured by acid or other directly toxic materials are more susceptible to subsequent bacterial infection.

- Bacterial Infection/Aspiration Pneumonia. The bacteria that cause aspiration pneumonia generally originate in the upper airways or stomach.
  - Classically, oral anaerobes (*Peptostreptococcus*, *Fusobacterium nucleatum*, *Prevotells*, and *Bacteroides* spp.) and streptococci caused aspiration pneumonia.
  - More recently, hospital- and healthcare-acquired aspiration pneumonia has been associated with more virulent organisms, such as Staphylococcus aureus, Pseudomonas aeruginosa, and gram-negative bacilli.

- Airway obstruction. Airway obstruction may result from either fluids or solid material aspiration.
  - The ingestion of fluids that are not directly toxic to lung tissue (saline, barium, etc.) can initiate a reflex airway closure, such as in drowning.
  - Solid objects cause differing levels of obstruction based upon their size relative to the airways.
  - Most foreign body aspirations occur in children between the ages of one and three.
  - Large objects can obstruct at the larynx, proximal trachea, tracheal bifurcation, or main stem bronchus. They cause nearly immediate respiratory distress, inability to talk, and cyanosis. Unless removed quickly, they can rapidly lead to death.
  - Smaller objects cause local atelectasis, and the patient will have a cough or focal wheezing.

Presentation

Typical/"Classic"

- Aspiration/Chemical Pneumonitis:
  - Acute onset of symptoms with profound dyspnea, and associated hypoxemia.
  - Often seen in the setting of known risk-factors for aspiration.

- Bacterial Infection. Presentation is variable, and depends upon the causative organisms and the overall health status of the affected patient.
  - Most patients present somewhat acutely with the typical symptoms of pneumonia, fever, productive cough, and dyspnea, especially when the infection is due to organisms other than anaerobes (such as Staph, Strep, Pseudomonas, etc.).

- Infections from anaerobic organisms often present more slowly, over days and weeks. There is often necrotic-smelling sputum, and a notable lack of rigors. Most patients with anaerobic aspiration pneumonia will have an easily recognized risk factor for aspiration, and poor dental health.

- Airway Obstruction.
  - Large particle airway obstruction causes acute respiratory compromise and failure, with severe dyspnea, inability to talk, hypoxia/cyanosis, and rapid cardiovascular collapse if not removed.
  - Small particle airway obstruction can present in a more subtle fashion, with an indolent, irritative cough, associated with dyspnea that is sometimes present only with exertion.

Atypical

- There is a wide-spectrum of clinical presentations and syndromes for aspiration. As above, aspiration syndromes typically present acutely, but depending upon many factors, may be sub-acute or indolent. Also, as noted above, atypical presentations occur especially with aspiration pneumonia caused by anaerobic organisms, airway obstruction caused by small particles, or aspiration pneumonitis caused by small volume, higher pH substances.

Primary Differential Considerations

- Differential considerations for aspiration include:
  - Respiratory Distress Syndrome
  - Other respiratory failure
  - Status asthmaticus
  - Circulatory shock
  - RSV infection in children

History and Physical Exam

Findings That Confirm Diagnosis

- A witnessed aspiration event, followed by the typical clinical syndrome of aspiration pneumonitis, confirms the diagnosis.

Factors That Suggest Diagnosis

- A patient who presents with community- or hospital-acquired pneumonia, has risk factors for aspiration, and/or has infiltrates in the dependent lung zones (lower lobes if aspiration occurred in the upright position, or superior segments of the lower lobes and/or posterior segment of the upper lobes if aspiration occurred in the supine position) should be further evaluated for aspiration and swallowing difficulties.

Factors That Exclude Diagnosis

- Finding another cause for the dyspnea/respiratory distress makes aspiration unlikely.

Ancillary Studies

Laboratory

- Laboratory abnormalities in aspiration pneumonitis are usually non-specific. There may be a moderately elevated white blood cell count. Patients may be hypoxic with a respiratory acidosis on blood gas analysis, especially in the acute setting when they are tachypneic.
- Patients with bacterial pneumonia caused by aspiration will usually have laboratory findings of acute infection with a leukocytosis with bandemia and/or a leftward shift. These patients may also be hypoxic.
    - Sputum culture has a limited role in aspiration pneumonia. Most infections are polymicrobial, and many of the causative organisms are difficult to culture. Coughed sputum samples are not useful for culture, as the normal flora of the mouth and upper airway contaminates them.
- Laboratory studies are not helpful in the diagnosis of airway obstruction from particulate matter.

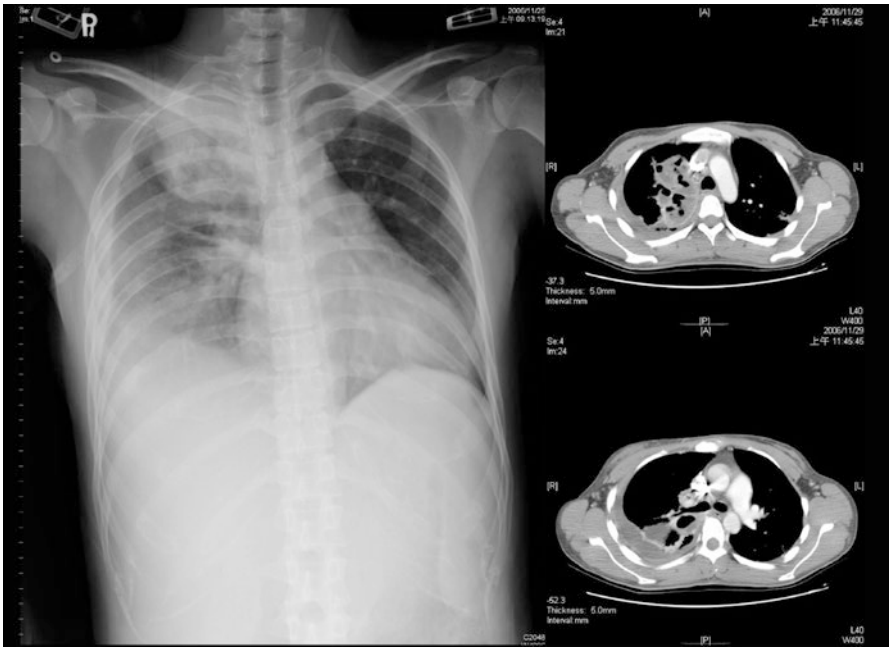
Imaging

- CXR findings in aspiration pneumonitis typically appear about 2 hours after an aspiration event. Typically, there are infiltrates in the dependent lung zones. These are the lower lobes when the patient was in an upright position during the aspiration event, and the superior segments of the lower lobes and posterior segments of the upper lobes if the patient was in the supine position during the aspiration event. Over time, if the disease progresses, the CXR may show evidence of ARDS with diffuse, fluffy infiltrates.

Aspiration pneumonia with infection: image progression. **a** Several hours after aspiration of gastric content, there are patchy infiltrates at both lung bases medially. **b** Three days after aspiration, the consolidation has increased in density and extent. At this phase, aspiration pneumonitis should be improving. This suggests secondary infection. **c** Four days after aspiration, computed tomography reveals dense consolidation in the posterior and lateral basal segments of both lower lobes. This degree of consolidation is more than one usually sees with uncomplicated aspiration pneumonitis. [Goodman LR. Imaging the Intensive Care Patient. In: Hodler J, von Schulthess GK, Zollikofer CL, editors. Diseases of the Heart and Chest, Including Breast 2011–2014 [Internet]. Milano: Springer Milan; 2011 [cited 2015 May 22]. p. 66–9. Available from: http://link.springer.com/10.1007/978-88-470-1938-6_10] *Caption adapted from original*

- The CXR in aspiration pneumonia caused by bacteria will also typically reveal an infiltrate in one or more of the dependent lung zones.
- Patients with pneumonia caused by anaerobic bacteria can have more indolent presentation and may develop either lung abscess or empyema that can be revealed on the CXR.

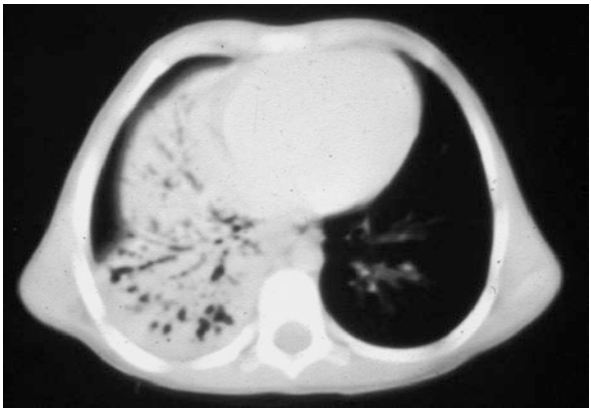
The chest radiograph and computed tomography scan showed pleural empyema without lung abscess. [From article: Lung abscess predicts the surgical outcome in patients with pleural empyema. Journal of Cardiothoracic Surgery. 2010;5(1):88. https://doi.org/10.1186/1749-8090-5-88, at http://link.springer.com/article/10.1186%2F1749-8090-5-88; by Hung-Che Huang, Heng-Chung Chen, Hsin-Yuan Fang, Yi-Chieh Lin, Chin-Yen Wu, Ching-Yuan Cheng, © Huang et al; licensee BioMed Central Ltd. 2010; licensed under Creative Commons Attribution License BY 2.0 http://creativecommons.org/licenses/by/2.0] *Caption from original*



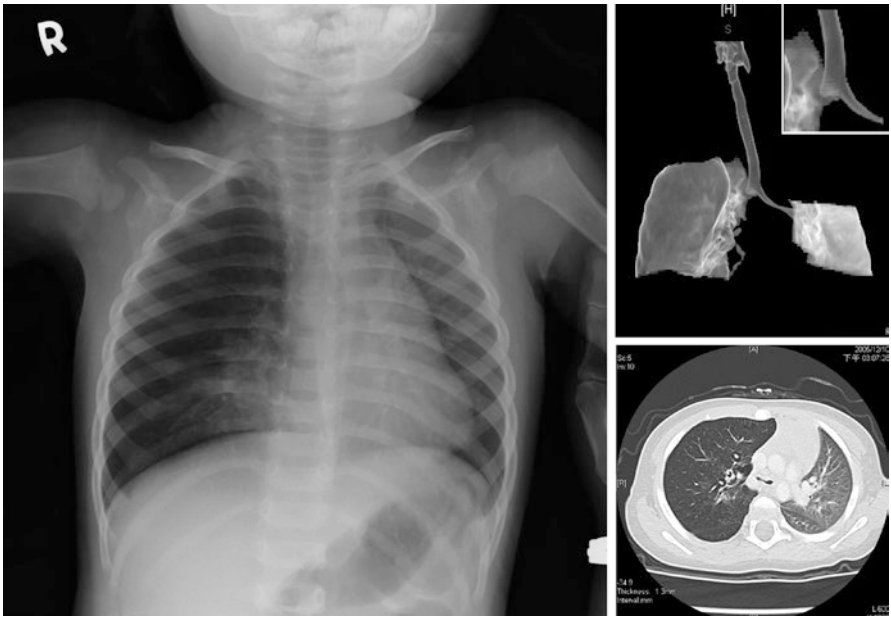
The chest radiograph and computed tomography showed pleural empyema with lung abscess. [From article: Lung abscess predicts the surgical outcome in patients with pleural empyema. Journal of Cardiothoracic Surgery. 2010;5(1):88. https://doi.org/10.1186/1749-8090-5-88, at http://link.springer.com/article/10.1186%2F1749-8090-5-88; by Hung-Che Huang, Heng-Chung Chen, Hsin-Yuan Fang, Yi-Chieh Lin, Chin-Yen Wu, Ching-Yuan Cheng, © Huang et al; licensee BioMed Central Ltd. 2010; licensed under Creative Commons Attribution License BY 2.0 http://creativecommons.org/licenses/by/2.0] *Caption from original*

- Airway obstruction from aspirated, large objects must be diagnosed prior to CXR, as the patients are in extremis and need rapid treatment. When the object is smaller, and the presentation not as severe or obvious, a CXR may be helpful. Many objects that are aspirated are biologic and radiolucent (peanuts, vegetables, other food objects), and some are radiodense (teeth, buttons, batteries, etc.). If the object itself is not visualized on the x-ray, there may be atelectasis with an elevated hemidiaphragm, and other signs of lung-volume loss.

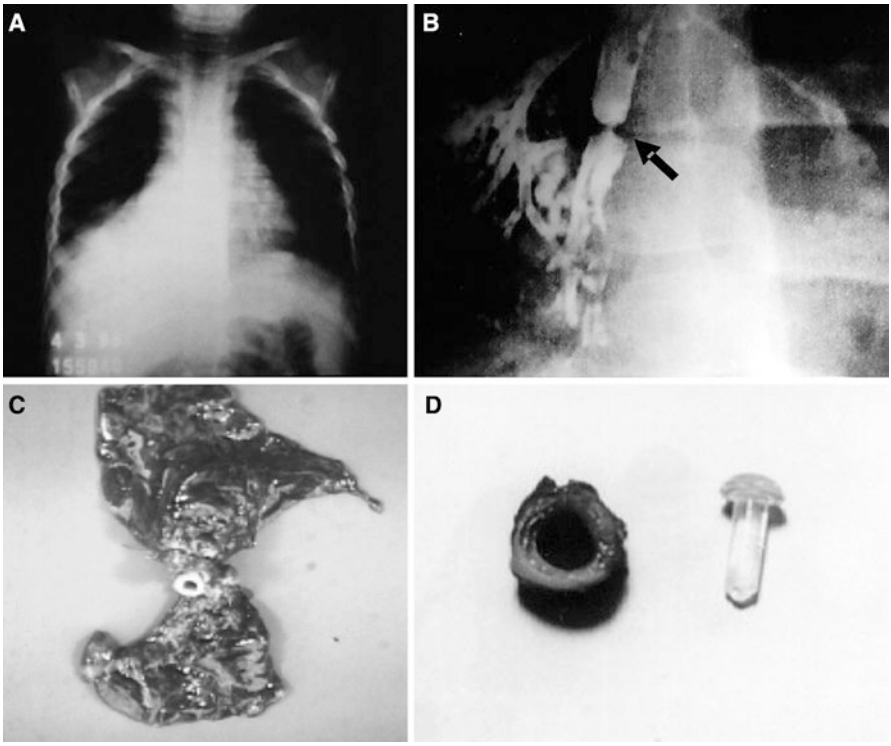
Frontal chest radiograph of a child with foreign body aspiration. The left lung is large and hyperlucent with less vessels due to air trapping caused by partial obstruction of the left main bronchus. Note the mediastinal shift to the right. [Soto G, Moënne K. Classic Chest Radiology Findings, Pearls and Pitfalls. In: Garcia-Peña P, Guillerman RP, editors. Pediatric Chest Imaging [Internet]. Berlin, Heidelberg: Springer Berlin Heidelberg; 2013 [cited 2015 May 22]. p. 13–30. Available from: http://link.springer.com/10.1007/174_2013_905] *Caption from original*



Axial CT of the lower chest in a case of chronic foreign body aspiration into the right intermediate bronchus, causing collapse and bronchiectasis in the right middle lobe and right lower lobe. [Koplewitz BZ, Bar-Ziv J. Foreign Body Aspiration: Imaging Aspects. In: Garcia-Peña P, Guillerman RP, editors. Pediatric Chest Imaging [Internet]. Berlin, Heidelberg: Springer Berlin Heidelberg; 2014 [cited 2015 May 22]. p. 305–26. Available from: http://link.springer.com/10.1007/174_2013_952] *Caption from original*



Plain chest radiograph showing a nearly left total opacity with ipsilateral mediastinal shift caused by foreign body aspiration. Three-dimensional chest computed tomography showing a nearly total occlusion in the right main bronchus [Huang H-J, Fang H-Y, Chen H-C, Wu C-Y, Cheng C-Y, Chang C-L. Three-dimensional computed tomography for detection of tracheobronchial foreign body aspiration in children. Pediatric Surgery International. 2008 Feb;24(2):157–60.] *Caption from original*



a Thorax X-ray showing atelectasis of the inferior and middle lobe of the right lung in a child with recurrent pneumonia for 2 years. b Bronchography showing stenosis of the intermediate segment, the foreign body cannot be seen. c Removed inferior and middle destroyed lobes. d Foreign body and blocked bronchus. When saw the foreign body, the mother said that it was part of a toy that had disappeared 2 years earlier [Cataneo AJM, Cataneo DC, Ruiz RL. Management of tracheobronchial foreign body in children. Pediatric Surgery International. 2008 Feb;24(2):151–6.] *Caption from original*

Special Populations

Age

- Aspiration pneumonitis is more common in the elderly, especially those with neurologic and other swallowing difficulties.
- Aspiration of objects is more common among children between the ages of one and three.
- Gastroesophogeal reflux (GER) is common in infancy, resulting in vomiting, albeit without complications.

- The diagnosis of gastroesophogeal reflux disease (GERD) applies when reflux events are associated with pathologic outcomes or debilitating symptoms.
- Concomitant aspiration events are rarely seen in infants with GERD, except in patients with swallowing disorders, e.g., neurological impairment scenarios.

Co-morbidities

- There are multiple co-morbidities that increase the risk of all types of aspiration. These include:
  - Reduced consciousness, which depresses the gag and glottic closure reflexes and can be brought on by causes such as alcohol and drug intoxication, and hepatic failure.
  - Prior stroke or neuromuscular disorder that impairs the ability to swallow.
  - Other neurologic conditions such as stroke, head injury, and dementia.
  - Mechanical instrumentation of the upper airway, such as endotracheal intubation, tracheostomy, nasogastric tube feedings, and upper endoscopy.
  - Periodontal disease.
  - General anesthesia and procedural sedation.
  - Gastroesophageal reflux, esophageal dysmotility.

Pitfalls in Diagnosis

Critical Steps Not to Miss

- Consideration of the diagnosis is the first critical step. Patients presenting with respiratory compromise need all appropriate supportive care until a diagnosis can be established.
- CXR should be performed early, but findings may be delayed by several hours.
- Patients who are felt to have a syndrome-consistent aspiration should have their swallowing function evaluated.

Mimics

- Many conditions can cause acute dyspnea and respiratory compromise, including ACS, pulmonary embolism, pneumothorax, pulmonary edema/CHF, among others.

Time-Dependent Interventions

- Airway obstruction with a large object causing complete airway obstruction is a medical emergency and can be fatal within minutes if not recognized and treated appropriately.
- Aspiration pneumonia from bacterial infection can present with acute respiratory compromise, so the rapid support of ventilatory function and administration of empiric antibiotics for likely pathogens is necessary.
- A witnessed aspiration event should be treated urgently with airway suctioning to remove as much fluid and solid matter as possible, and ventilatory and respiratory function should be supported.

Overall Principles of Treatment

- Aspiration pneumonitis.
  - As noted above, a patient with a witnessed or presumed acute aspiration event should have tracheal suctioning, administration of supplemental oxygen, and all respiratory and ventilator necessary.
  - The use of glucocorticoids is controversial. There are no good data supporting their use in aspiration pneumonitis.
  - Empiric or prophylactic antibiotics are commonly given in aspiration pneumonitis. Chemically injured lungs are at an increased risk for developing bacterial superinfection in the coming days, but there is no good evidence that prophylactic antibiotics administration prevents these infections. It is appropriate to administer antibiotics if the diagnosis is in doubt and bacterial pneumonia remains on the differential.
- Bacterial Aspiration Pneumonia.
  - Antibiotics are necessary in the treatment of aspiration pneumonia due to bacteria.
  - Most of these infections are polymicrobial, and include anaerobes. As such, most patients will be treated (at least initially), with a combination of antibiotics.
  - Clindamycin is the antibiotic of choice to cover anaerobes. Metronidazole should not be used alone, as it has a failure rate of up to 50% when used as monotherapy.
  - Clindamycin can be combined with either amoxicillin or penicillin.
  - When the patient has a hospital- or healthcare-acquired aspiration pneumonia, it is important to consider both gram positive organisms, such as Staph and strep, and the aerobic gram negative bacilli as causes. These patients should be broadly covered with an antibiotic or combination of antibiotics, to cover the gram-positives and negatives. This usually includes vancomycin

with either a carbapenem or piperacillin/tazobactam. These regimens will also cover most pathogenic anaerobes.

- Airway obstruction from large objects needs to be relieved immediately. The preferred method is the Heimlich maneuver. If unsuccessful, a surgical airway may need to be secured.
  - Smaller objects can often be removed by bronchoscopy.

Disease Course

- Aspiration pneumonitis. The course varies considerably based upon the patient's underlying medical condition and the cause of the aspiration. The majority of patients will recover rapidly. A small percentage will go on to develop ARDS and/or bacterial superinfection. There is a significant mortality associated with both of these complications.
- Patients with bacterial aspiration pneumonia often recover fully, but when the predominant pathogens are anaerobic bacteria, a small percentage can go on to develop pulmonary abscess or empyema as complications of the primary infection. The incidence of these complications has been decreasing.
- All patients who suffer from aspiration need to be evaluated for the primary cause of their aspiration, or they remain at risk for further episodes.
- Most patients who have an airway obstruction recover uneventfully if the obstruction is relieved in a timely manner.

Related Evidence

Paper of particular interest have been highlighted as:
*** Of key importance*

Practice Guideline

Australian and New Zealand Society for Geriatric Medicine. Australian and New Zealand Society for Geriatric Medicine. Position statement - dysphagia and aspiration in older people. Australas J Ageing. 2011 Jun;30(2):98-103. https://doi.org/10.1111/j.1741-6612.2011.00537.x. PMID: 21672120. http://www.ncbi.nlm.nih.gov/pubmed/21672120 **

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Use PubMed Clinical Queries to find the most recent evidence. Use this search strategy:

"Respiratory Aspiration"[Mesh] OR "Pneumonia, Aspiration"[Mesh] OR "Aspiration"