Aspiration-related Lung Disease: Evaluation & Management

Inaugural Paediatric Respiratory and Sleep Medicine Symposium

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Aspiration

- Aspiration – penetration of material below the subglottic area and into the lower airways
- Aspiration syndromes – results from a failure of airway protective mechanisms in preventing foreign material from entering the airways
  - acute large volume (macro-) aspiration
  - recurrent small volume (micro-) aspiration

- Chronic aspiration may be caused by
  - Aspiration of gastric contents / food
  - Aspiration of oropharyngeal secretions

If the amount that enters the airways is significant enough to overwhelm protective mechanisms, or if the material is irritant, aspiration can result in lung disease in children

Symptoms of aspiration

- Symptoms common to many other respiratory conditions
  - Chronic cough
  - Wheezing
  - Congestion
  - Choking or gagging with feeds
  - Failure to thrive
  - Apnoea
  - Intermitent fever spikes
  - Recurrent chest infections
  - “Wet vocal quality” or “wet breathing”

- Chronic aspiration patients present with complicated underlying medical conditions that either

  (1) interfere with the normal mechanisms of swallowing or

  (2) because of the presence of GOR

  - Feeding failure
  - GOR
  - Neurological problems
  - Chronic respiratory disease
  - Tracheostomy
  - Impaired laryngeal function
  - Airway lesions causing obstructed breathing
  - Abnormal connections between airway and GI tract
  - Congenital syndromes
  - Prematurity

Consequence of chronic pulmonary aspiration

- Significant hospitalization for recurrent pneumonias
- Progressive lung injury and bronchiectasis
  - Significant bronchiectasis may persist into adulthood
  - Respiratory failure
- Leading cause of death in neurologically impaired patients and congenital syndromes e.g. Cornelia de Lange and Cri Du Chat

Conditions associated with recurrent aspiration

Anatomical defects

- Macroglossia
- Cleft palate
- Laryngeal clefts
- Tracheo-oesophageal fistula
- Vascular rings
- Cricopharyngeal achalasia
- Foreign body in oesophagus

Neurological problems

- Decreased consciousness
- Encephalopathy
- Prematurity
- Cerebral palsy
- Hydrocephalus
- Vocal cord paralysis

Neuromuscular disorders

- Muscular dystrophy
- Spinal muscular atrophy
- Myasthenia gravis
- Guillain-Barré syndrome

Congenital syndromes

- CHARGE association
- Cri du Chat

Miscellaneous

- Tracheostomy
- Endotracheal tube
- Babies and young children who are fed with inappropriate techniques or foods

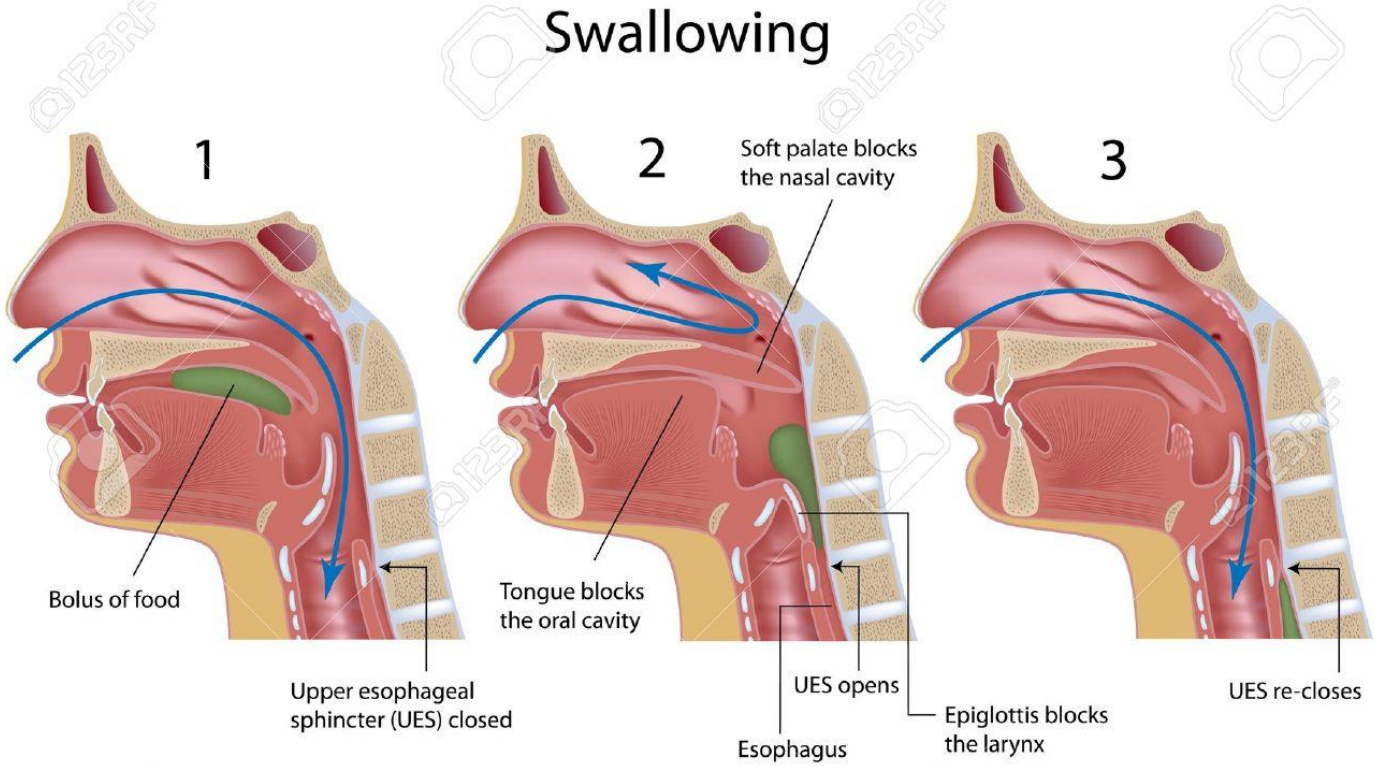
Swallowing dysfunction

- Infants who are tachypnoeic have dyscoordinated swallowing in relation to sucking and breathing
- Acute illness can exacerbate the swallowing dysfunction in any condition, as it can lead to fatigue more quickly
- Children with neurological impairment are also at risk of recurrent aspiration of saliva due to blunted cough reflex, dysfunctional swallowing, and depressed laryngeal sensation

Aspiration of saliva / oral secretions

- Least-commonly recognized form of chronic aspiration
- May not be diagnosed until significant lung injury has developed
- Oral cavity contains a high density of bacteria and yeast that can cause lung infections if aspirated in sufficient quantity
- Mostly neurologically impaired children
- Due to severe swallowing incoordination and absent laryngeal sensation rather than excessive production of saliva
- Other conditions associated
  - CHARGE association
  - Vocal cord paralysis

Aspiration caused by swallowing dysfunction



- Oral phase (voluntary) – sucking ,chewing, manipulating bolus, delivery to pharynx

- Pharyngeal phase (involuntary) – airway protection, cessation of respiration, vocal folds adduction, false vocal folds closure, retroversion of epiglottis, elevation of larynx, stretching and opening of cricopharyngeus, bolus propelled by pharyngeal constrictors through UOS

- Oesophageal phase (involuntary) - Transport of bolus to stomach by peristalsis + gravity, return of larynx to resting position

Conditions associated with dysfunctional swallowing

Oral /preparatory

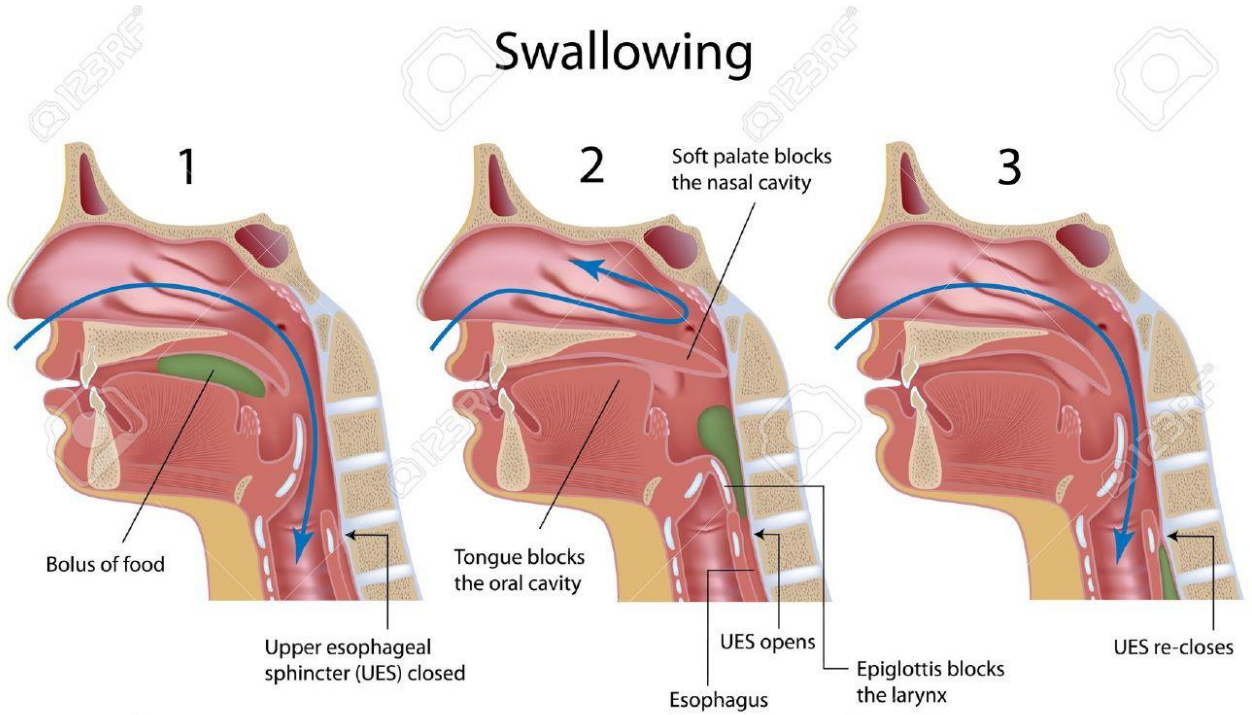
- Choanal atresia
- Cleft palate
- Macroglossia
- Micrognathia
- Oral sensory-motor dysfunction
- Cranial nerve paralysis

Pharyngeal

- Cricopharyngeal achalasia
- Arytenoid prolapse
- Laryngeal cleft
- Vocal cord paralysis
- Laryngo-pharyngitis

Esophageal

- Tracheo-oesophageal fistula
- Eosinophilic oesophagitis
- Vascular ring
- GORD
- Oesophageal dysmotility
- Achalasia
- Esophageal stricture



Differential diagnoses of chronic recurrent aspiration

- Respiratory conditions that result in chronic cough

  - Bronchopulmonary dysplasia
  - Tracheobronchomalacia
  - Primary ciliary dyskinesia
  - Bronchiectasis
  - Cystic fibrosis
  - Foreign body in the airways
  - Childhood interstitial lung disease

Evaluation – a multidisciplinary approach

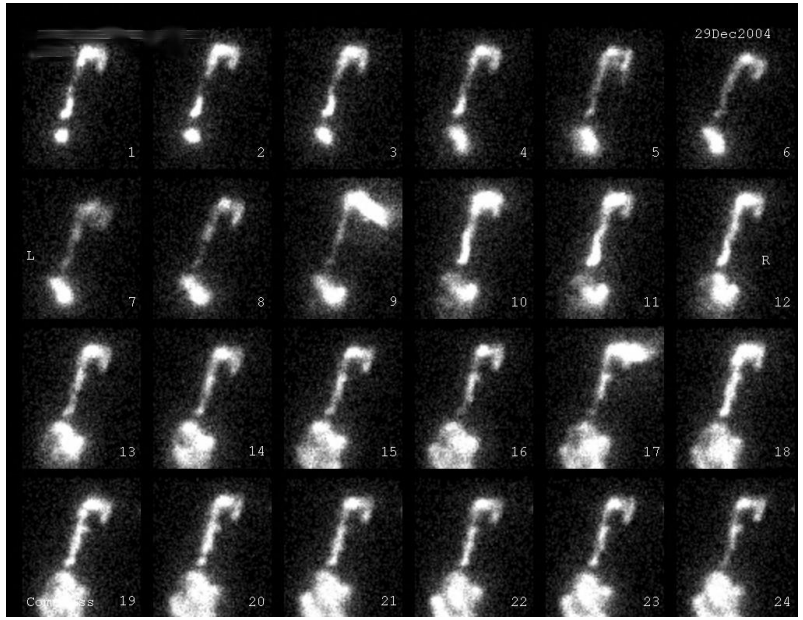
- ENT
- Gastroenterologists
- Pulmonologists
- Speech therapists (speech pathologists)
- Occupational therapists
- Dietitians
- Behavioural psychologists
- Social workers

Feeding evaluation – feeding clinic

- History – medical, developmental, dietary, respiratory status, aerodigestive interventions
- Clinical assessment of non-nutritive and nutritive oral motor skills
- Clinical assessment of oral motor / feeding skills, parent-child interaction
- Note gagging, coughing, choking, colour changes, increased noisiness with feeding, apnoea/bradycardia, difficulty in secretion management, suction needs, food/liquid in tracheostomy tube

Radionuclide salivagrams

- Small quantity of radiotracer in the buccal space
- Recording serial images until clearance from the mouth
- Presence of activity in the trachea or bronchi indicates aspiration of saliva



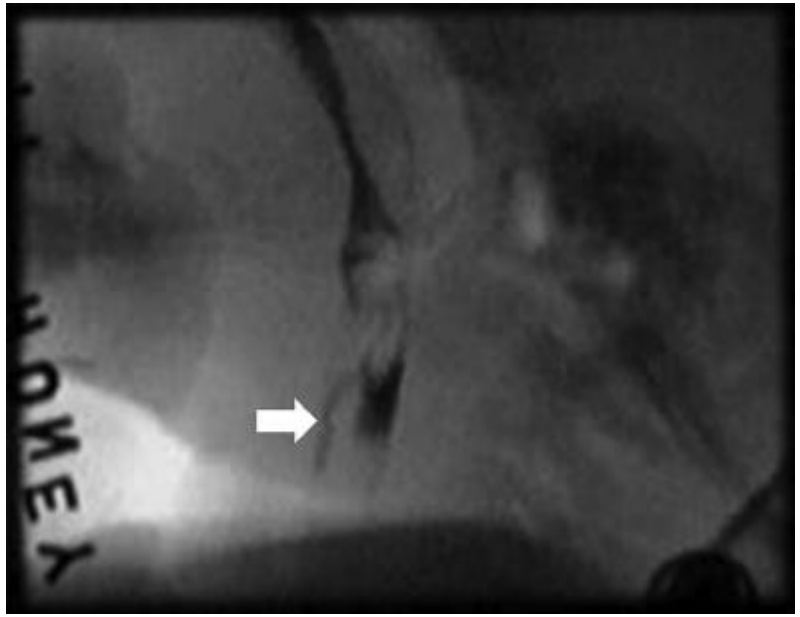
- Tests specific but infrequently positive in children highly suspected of aspiration
- Correlate poorly with other tests for aspiration

Videofluoroscopic swallow study "Modified barium swallows"

- Directly evaluates oral, pharyngeal, and oesophageal phases of swallowing
- Utilizes consistencies similar to what the child is accustomed to eating
- Can see aspiration and food penetration caused by premature spillage, delayed initiation of swallow, ineffective swallow, pooling in hypopharynx, achalasia, reflux
- Poor sensitivity for laryngeal cleft, H-type fistula
- Led by speech therapists and radiologists

Videofluoroscopic swallow study Limitations

- Snapshot
- Affected by patient cooperation, position, state of health, volume of food taken, number of swallows evaluated, being “rushed” by the evaluator



Fibreoptic endoscopic evaluation of swallowing (FEES)

- Small flexible nasopharyngoscope passed transnasally
- Positioned between the soft palate and epiglottis
- Multiple swallows visualized directly via video monitor
  - Green dye in mineral water
  - Liquid, then puree, then solids to chew
- Oral and pharyngeal phases assessed

Fibreoptic endoscopic evaluation of swallowing (FEES)

- Pros
  - Evaluates functional anatomy of swallowing
  - Children fed the same food they are accustomed to eating at home
  - Consistencies can be varied
  - Effectiveness of implemented compensatory and therapeutic swallowing techniques can be assessed
  - Direct feedback to audience – feeding recommendations made at time of study
  - No sedation or radiation exposure
  - Completely portable
  - Bedside investigation

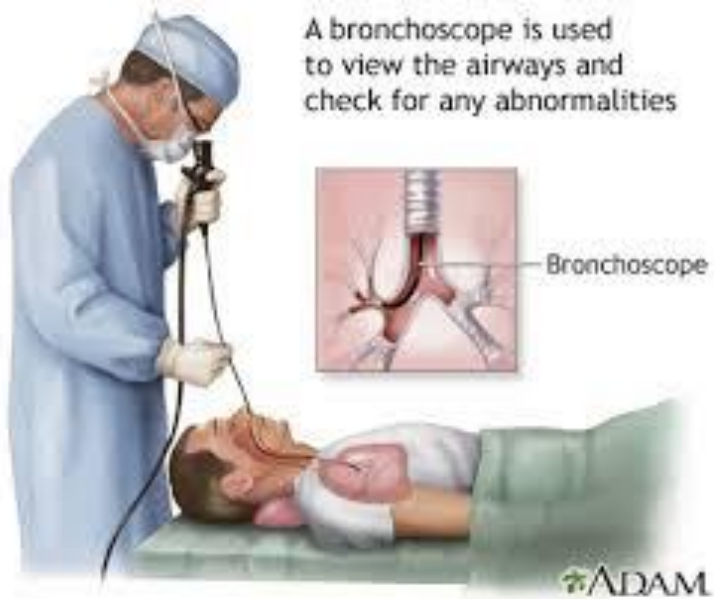
- Cons
  - Scope is blind to events occurring during pharyngeal contraction / actual swallow / oesophageal phase
  - Invasive

Bronchoscopy

- To identify structural defects such a laryngeal cleft and H-type tracheoesophageal fistula
- Can reveal inflamed mucosa around the larynx / large airways indicating acid contact

Flexible bronchoscopy

- Can assess upper and lower airways
- Identify pathology from nose to distal bronchi
- Good to identify dynamic airway lesions (e.g. malacia) which rigid bronchoscopy may obscure
- Can do broncho-alveolar lavage – inflammatory profile



Rigid bronchoscopy

- Far superior for identification of laryngeal clefts, H-type tracheoesophageal fistula, cricopharyngeal achalasia
- Direct approach to the posterior larynx, cricoid and proximal trachea with instruments to manipulate tissue makes this possible

Assessment of anatomy of the aerodigestive tract

- Combined bronchoscopy
- Allows complete evaluation of airways, discuss integrated care plan

Triple endoscopy

- Addition of evaluation by a gastroenterologist
- For evaluation for potential reflux aspiration, acid oesophagitis, eosinophilic oesophagitis, anatomic abnormalities of the upper gastrointestinal tract
- Poor wound healing and scarring more likely following airway surgery if upper GIT and larynx is inflamed

Radiology of chronic aspiration

- Hyperaeration
- Subsegmental or segmental infiltrates and peribronchial thickening
- Bronchiectasis eventually
- Dependent areas of the lower lobes as well as posterior upper lobe segments usually involved
- Chest X-rays are not sufficiently sensitive to detect subtle changes - a normal X-ray does not rule out aspiration

Feeding management strategies

- Approach individualised for each patient
- Direct rehabilitative manoeuvres / exercises
- Compensatory strategies – sensory stimulation, alterations in positioning for feeding, specialised feeding equipment, specific behavioural approaches to improve interaction or overcome aversion
- Supplemental feeding (NG tube, gastrostomy placement) to provide calories for growth while working on oral feeding

Treatment of salivary aspiration

- Oral anticholinergic medications
  - Adverse effects common - behavioral changes, constipation, dry mouth, urinary retention, flushing, nasal congestion, vomiting, diarrhoea
  - Thickening of tracheal and bronchial secretions could result in life-threatening mucus plugging of airways or tracheostomy tubes
- Injection of glands with botulinum toxin
  - Submandibular, parotid
  - Limited duration of effect
- Tracheostomy
- Ligation of salivary ducts
- Removal of salivary glands

Gastroesophageal reflux

- Movement of stomach contents back up into the oesophagus and sometimes into the oropharynx (laryngopharyngeal reflux disease)
- Common in young infants due to the immature gastro-oesophageal junction and their flat posture
- GORD = GOR associated with clinical effects
- GORD also commonly present in children with chronic diseases of the respiratory tract

Relationship between lung disease and gastro-oesophageal reflux disease

- Gastro-oesophageal reflux is the movement of stomach contents back up into the esophagus and sometimes into the oropharynx (laryngopharyngeal reflux disease)
- Causal relationship between GORD and chronic respiratory disease is often difficult to ascertain

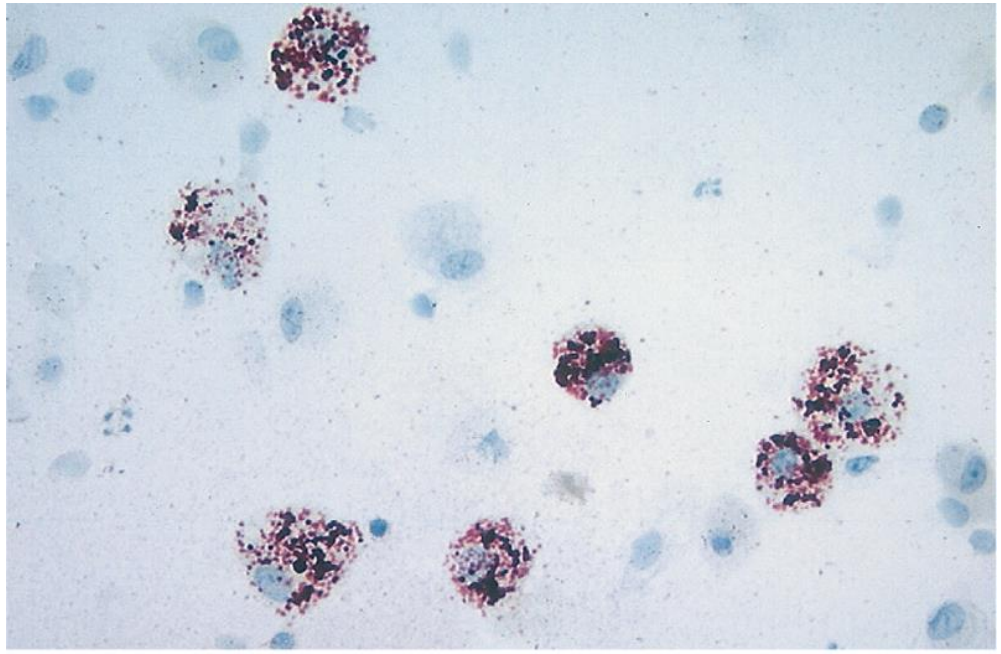
Relationship between lung disease and gastro-oesophageal reflux disease

- GORD can cause chronic respiratory diseases
  - Vagally-mediated reflex bronchospasm after oesophageal acidification
  - Recurrent microaspiration
  - Acid desquamation of mucosa, damage to alveolar lining cells and capillaries, and neutrophilic inflammation
  - Repeated aspiration of partially digested vegetable matter and saliva with neutral pH—foreign body reaction involving cell-mediated immunity – nodular granulomas, giant cells and bronchiolitis with alveolar organization

- Conversely, chronic respiratory diseases can predispose to GOR
  - Hyperinflation in chronic lung diseases causing diaphragmatic flattening and thereby decreasing the efficacy of lower oesophageal sphincter (LOS)
  - Higher negative pleural pressures in respiratory diseases increasing the incidence of GOR
  - Use of certain smooth muscle relaxants like salbutamol relaxing the LOS

Analysis of BAL samples from posterior basal lobes

Oil Red O and Sudan IV stains for lipid in BAL to diagnose aspiration of food



Lipid laden macrophages (Oil Red O) – lipid in phagosomes stained

Limitations:

The segment in which a BAL is performed may not be one affected by the aspiration

Aspiration is an intermittent phenomenon and can vary in amount and frequency
-timing of bronchoscopy may be significant

Lipid stains do not identify children who aspirate oral secretions but who are not being fed orally

Other investigations for the presence of gastro-oesophageal reflux

- *Contrast swallow*
- *Gastro-oesophageal scintigraphy* (milk scans)
- *24-hour oesophageal pH monitoring* (pH study)
- *Multichannel intraluminal impedance study*
- *Oesophagoscopy*

Treatment of reflux aspiration

- If GOR is present in infants, correct positioning, smaller, more frequent feeds, and feed thickeners can help
- Lifestyle modifications such as avoidance of certain foods and weight management
- Acid suppression
- Pro-kinetics
- Transpyloric feeding (G-J, jejunostomy tubes)
- Fundoplication

The aerodigestive team:
A very tight-knit inter-disciplinary team

- ENT
- Pulmonary medicine
- Gastroenterology
- Surgery
- Anaesthesia
- Nurse practitioners
- Nurses
- Intensivists
- Radiologists
- Geneticists
- Developmental paediatricians
- Speech and language therapists
- Feeding team
- Sleep team

Tests scheduled in coordinated fashion to minimise the burden on patients and their families (reduce unnecessary hospital visits and avoid repeated use of anaesthetics)

Prognosis

- Most patients will recover within a few weeks, if an aspiration event is adequately treated and managed without complications
- If recurrent aspiration untreated, it may lead to complications such as recurrent pneumonitis, lung damage, bronchiectasis, bronchiolitis obliterans and failure to thrive

- Sometimes, children with clinical evidence of recurrent aspiration will have negative test results for swallowing dysfunction or GORD
- A trial of no feeding by mouth and NG feeding could improve their respiratory symptoms
- These cases highlight the difficulties in establishing the diagnosis of CPA and the importance of clinical judgment in suspected cases

Thank you