BTS clinical statement on aspiration pneumonia

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BACKGROUND, DEFINITIONS, AIMS AND SCOPE OF THE CLINICAL STATEMENT

This BTS Clinical Statement seeks to provide practical clinical guidance on aspiration pneumonia (AP), through sections covering the relevant epidemiology, pathogenesis, prevention, diagnosis and management (including palliative care considerations where appropriate). Key clinical practice points appear at the end of each of these sections and are brought together in the highlighted summary below. Areas requiring important research to fill key knowledge gaps are highlighted in a separate section.

The Statement arose because AP is disproportionately represented in people with a learning disability, in whom it is a major cause of death.[1] The management of patients with community-acquired pneumonia (CAP) and learning disability is, therefore, the focus of a comprehensive parallel BTS Clinical Statement, in which learning disability is carefully defined.[2] Despite this, however, most AP still occurs in people who do not have a learning disability. The existing literature on AP is of insufficient depth and quality to construct formal, comprehensive *guidelines*. For these reasons, the BTS proposed a Clinical Statement devoted to AP as a stand-alone document, but which specifically cross-references the sister Clinical Statement.[2] All of the general preventive, diagnostic and management principles described in this document can be applied to people with a learning disability, and the reader is directed to the relevant page of the statement on community-acquired pneumonia in people with learning disability.[2]

Importantly, this Clinical Statement seeks to complement the BTS Guidelines on CAP in adults[3] and in children[4] *by giving an AP-specific context*. However, readers should appreciate that the evidence base in the Guidelines has far stronger foundations than the evidence base for AP. As AP predominantly occurs in older adults, this Clinical Statement principally refers to practice in adults. However, we were eager to provide context specific to children, and subsections considering special considerations in children are added throughout the document.

AP refers to the microaspiration of bacteria-rich oropharyngeal or gastrointestinal (GI) secretions into the lungs in sufficient amounts to cause alveolar and systemic inflammation. Microaspiration sufficient to cause pneumonia is usually associated with abnormal swallowing. To avoid any potential confusion, the terms swallowing impairment, abnormal swallowing or swallowing difficulties are used instead of the term dysphagia, throughout.

AP is a common condition predominantly affecting older patients, and as the world's population continues to expand and age, AP will become an increasing concern for healthcare systems globally. Impaired swallowing can lead to malnutrition, dehydration, choking, reduced quality of life and death.[5–7] Because so many people are at risk of developing AP, a significant emphasis of this Statement is on prevention.

AP has been the subject of excellent reviews and commentaries.[8–13] However, two broad factors make it harder to generalise findings across studies on AP. First, it is often hard to diagnose AP with certainty, as microaspiration may be clinically 'silent' and unwitnessed. Second, microaspiration due to abnormal swallowing results from a wide range of pathologies, and so heterogeneous patient groups are included in published studies on AP.

The Statement focuses on the common clinical setting in which bacteria-rich oropharyngeal secretions are microaspirated into the lung. The following are not considered here: aspiration pneumonitis/"gross aspiration" (in which a large volume of vomitus of low pH suddenly enters the lungs, initially causing a chemical insult rather than infection); lipoid pneumonia; inhalation of foreign bodies; and meconium aspiration in the newborn. Similarly, microaspiration of infected secretions can cause disease of the airways (eg, bronchospasm, bronchiectasis and forms of bronchiolitis). We have focused on AP, but the interested reader is referred to articles describing aspiration-related airway disease.[9 10 14]

METHODOLOGY

The clinical statement group (CSG) was chaired by AJS, with membership drawn from experts in respiratory medicine (adult and paediatric), neurology, palliative care, nursing, gastroenterology, speech and language therapy, physiotherapy, microbiology and geriatrics . Lay/patient input was provided by representatives from NHS England's LeDeR programme and additional clinical advice was also sought on matters relating to critical and primary care. The CSG identified key areas requiring Clinical Practice Points and the overall content was developed to reflect the scope approved by the BTS Standards of Care Committee (SOCC). Following discussions of broad statement content, individual sections were drafted by group members. A final edited draft was reviewed by the BTS SOCC before

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Summary of clinical practice points

The following key points represent an executive summary for clinicians drawn from the sections that follow, in which greater detail is provided.

General

⇒ Aspiration pneumonia (AP), and risk factors for AP, are common. AP is particularly common in people with a learning disability, in older people and in patients with neurological or upper gastrointestinal conditions.
⇒ Prevention, identification and treatment of AP requires a multidisciplinary team approach.
⇒ Every hospital and care home should have at least one oral health 'champion' promoting good oral healthcare.

Pathogenesis of AP

⇒ AP is usually characterised by microaspiration of bacteria-rich secretions from the oropharynx into the lungs and is very frequently accompanied by swallowing difficulties.
⇒ Swallowing impairment may be 'silent' (not apparent to an observer) in patients with reduced laryngopharyngeal sensation or reduced conscious level, and in such patients a high index of suspicion for aspiration is needed.
⇒ Abnormal swallowing commonly improves/recovers spontaneously or with treatment, particularly after a stroke.
⇒ AP is also commonly caused by reflux of material from the gastrointestinal tract.

Prevention of AP

⇒ Good oral hygiene appears to reduce the rate of AP.
⇒ For patients in hospital or care homes, oral hygiene should include brushing of the teeth, tongue and palate with a soft toothbrush, using non-foaming toothpaste, at least two times per day.
⇒ Oral examination should be performed in all hospitalised patients at risk of AP or with suspected AP, and at least weekly in care home residents, checking for infection (eg, candidiasis), quality of dentition, food residue and cleanliness of mucosal surfaces. Any abnormalities should be treated.
⇒ People with swallowing difficulties should be referred to a speech and language therapist (SLT).
⇒ Whenever feasible, patients with mild swallowing problems who are not considered at high risk of AP after a bedside swallow assessment should be fed orally and observed carefully.
⇒ When consuming food and liquid as normal is felt to present a high risk of AP, cold carbonated drinks may be trialled; alternatively, thickened fluids or feeds may be trialled.
⇒ In patients approaching the end of life and/or with moderate–severe dementia, a best interests discussion should take place prior to a 'nil by mouth' instruction.
⇒ When an SLT considers a patient's swallow presents a high and imminent risk of AP and a 'nil by mouth' instruction is issued, a plan should be formulated (a) seeking to restore effective swallow and (b) arranging further assessment of swallow. A 'nil by mouth' instruction should be considered temporary, and steps taken to minimise duration where possible.
⇒ In patients with a newly diagnosed abnormality of swallowing that presents a high risk of AP, who are not felt to be approaching the end of life, early nasogastric feeding

Continued

Summary of clinical practice points Continued

(within 3 days of presentation with swallowing difficulties) improves nutritional status and outcomes. Attempts to improve swallow, with a view to restoring eating and discontinuing nasogastric feeding, must be continued.
⇒ Percutaneous endoscopic gastrostomy (PEG) should be considered when abnormal swallow presents a continuing high risk of AP and when nasogastric tubes are either poorly tolerated or fail to provide adequate nutrition.
⇒ PEG tubes should not always be considered permanent. If safe swallow returns PEG tubes can be removed.
⇒ In Chinese and Japanese patients at risk of AP after stroke, and in the absence of contraindications, angiotensin-converting enzyme (ACE) inhibitors should be prescribed to reduce the risk of AP. Insufficient evidence currently exists to support this practice in other ethnic groups.

Diagnosis of AP

⇒ A careful history is key to increasing the likelihood of an accurate diagnosis of AP. In patients presenting with suspected community-acquired pneumonia (CAP), risk factors and features of the history suggestive of aspiration, should be covered.
⇒ Chest X-ray fails to detect AP in up to 25% of cases, when compared with thoracic CT scans.
⇒ Older patients may have a blunted systemic inflammatory response compared with younger patients.

Management of AP

⇒ For patients being managed for AP in a hospital the antibiotic regimen should be informed by Medical Microbiology guidance on local epidemiology, taking into account recent antibiotic exposure, recent microbiology results when available, and where the patient was when the pneumonia began.
⇒ A 5-day course of antibiotics is considered adequate for AP unless there is failure to improve, in which case alternative sources of illness, complications of AP and/or an alternative antibiotic regimen should be sought.
⇒ Patients being managed for AP should receive thromboprophylaxis (unless contraindicated), adequate hydration and (if required) supplemental oxygen.
⇒ Patients hospitalised with AP should have early access to physiotherapy (to reduce the risk of sputum retention or atelectasis), with early referral for general, respiratory or neurorehabilitation as appropriate.

Palliative care

⇒ The palliative care needs of patients who may be approaching the end of life, and their families should be addressed, including advance care planning and referral to specialist palliative care services as appropriate.

posting for public consultation and peer review on the BTS website June-July 2022. The revised document was re-approved by the BTS SOCC in September 2022 before final publication.

EPIDEMIOLOGY

Microaspiration, swallowing difficulties and AP are all common, although high-quality, validated estimates of prevalence at population level are lacking.

Rough estimates have suggested that as many as 1 in 20 people in the USA may have some degree of swallowing impairment,[15] and 0.4% of all hospital admissions in the USA may be due to AP.[16] Abnormal swallowing is caused by a variety of neurological, muscular or GI disorders and is unequivocally associated with increased risk of AP.[17–19] The proportion of people with risk factors for AP is increasing.[20–23]

AP is consistently associated with older age.[20 24–27] Up to a quarter of care home residents are at risk for AP at any given time.[28 29] Older people generally have reduced pharyngeal sensation.[30 31] Clinically 'silent' microaspiration is common in old age and it is likely that abnormal swallowing is greatly underestimated.

AP associated with stroke and chronic neurological conditions

Estimates vary according to clinical conditions, but anywhere between 3% and 50% of patients with stroke may develop AP,[32–36] also known as stroke-associated pneumonia (SAP). Approximately 11% of patients hospitalised with Parkinson's disease or dementia develop AP over a 3-month period,[37] and dementia with Lewy bodies carries a particularly high risk of AP.[18] AP also commonly complicates multiple sclerosis, motor neuron disease, Huntington's disease, Down syndrome and cerebral palsy.

Cancers of the head and neck, oesophagus and stomach and their treatment

Head and neck cancers are associated with a high risk of aspiration, augmented by treatments such as surgery, chemotherapy and radiotherapy, approaching 70% in treated patients in some series.[38 39] The risk accumulates with time in survivors, with around 50% of patients having late AP,[39–41] and around 60% describing impaired swallow at 3 years.[42] Oesophageal cancer is associated with AP in around 20% of cases,[19] and gastric cancer in around 3.5%.[43] Major cardiovascular surgery is complicated by AP in 20%–45% of cases,[44–46] and AP may arise after around 10% of thoracotomies.[47]

Intubation of the trachea

Intubation of the vocal cords using an endotracheal tube to allow mechanical ventilation creates an ideal environment for microaspiration. Ventilator-associated pneumonia (VAP) is, therefore, a form of AP, developing in approximately 20%–35% of patients intubated and mechanically ventilated for more than 3 days.[48–50] Trial data suggest that approximately 5% of patients who survive an out-of-hospital cardiac arrest develop pneumonia early in the course of hospital admission.[51]

Intubation of the GI tract

Enteral feeding (via nasogastric tubes, postpyloric feeding tubes or gastrostomy (eg, percutaneous endoscopic gastrostomy (PEG) tubes) is often used to feed patients with swallowing difficulties at high imminent risk of developing AP, but paradoxically increases the likelihood of AP, via cephalad movement of feed and aspiration into the lungs.

The overlap between AP and CAP/hospital-acquired pneumonia/VAP

The most common classification of pneumonia is based on where the patient was when the pneumonia began. Clearly, however, the process of micro-aspiration may occur regardless of a patient's location. As such, micro-aspiration contributes to CAP. The relative contribution of AP to CAP or hospital-acquired pneumonia (HAP)/VAP is often difficult to determine clinically. In general, where there is a clear contribution of AP to a case of CAP, the implication is that the potential range of causative pathogens may be broader than in a case of CAP that is not complicated by AP (see the Microbiology section and the Antibiotics section). A contribution from AP is less likely to broaden the range of likely causative pathogens in cases of HAP/VAP.

Between 5% and 15% of all CAP is thought to be AP,[24 52] though estimates in Japan have been as high as 60%.[53 54] The incidence of admission with community-acquired AP in those over 65 years has been estimated at 31 per 10 000 persons and (for age over 75 years) 35 per 10 000 in different healthcare systems.[25 26] Among patients admitted to hospital with pneumonia, 55% have impaired swallow,[55] though selected studies report abnormal swallow in up to 80% of patients with CAP.[56] Recurrent pneumonia is more common in patients with a history of AP.

In summary, evidence suggests that a contribution from abnormal swallowing and microaspiration is important in a significant proportion of CAP. Microaspiration is considered a greater contributing factor for HAP, and to be responsible for all cases of VAP.

Mortality

Mortality in patients treated for AP in hospital is approximately 10%–15%,[57 58] rising with advancing risk factors for swallowing abnormalities[59] and with age.[60] VAP carries a mortality of around 33%.[48 49 61] AP accounts for about 20% of deaths in head and neck cancer.[42]

PATHOGENESIS

Microaspiration is known to occur in healthy individuals,[62–64] and it follows that microaspiration does not always lead to AP. Increasing evidence points to microaspiration from the oropharynx being the source of the normal bacterial communities in healthy lungs.[65 66] The assumption remains that the lungs competently deal with microbial loads up to a certain size or bacterial composition, beyond which pneumonia emerges.

AP, therefore, arises when sufficient bacteria-rich secretions from the oropharynx or upper GI tract reach the alveolar regions of the lung to drive lung consolidation and an inflammatory immune response. In health, efficient swallow and cough prevent secretions from reaching the lung in sufficient quantities to produce pneumonia. The infective burden of microaspirates is determined by the degree of impairment of usual oral, pharyngeal and upper GI clearance mechanisms. Consequently, factors associated with an increased risk of AP generally relate to disrupted neurology, consciousness, muscle function, oropharyngeal integrity, upper GI function or immune function (table 1).

An inability to swallow oropharyngeal secretions efficiently is central to the pathogenesis of AP, and the physiology of a normal swallow is discussed in some detail below to give context to the processes that can become abnormal and predispose to AP.

Normal and abnormal swallowing

Swallowing is divided into oral, pharyngeal and oesophageal phases (figure 1). When awake, swallowing is a combination of automatic involuntary and voluntary swallows and, when unconscious, a swallow is an upper airway protective reflex.

Sensory receptors and pathways involved in the initiation of effective swallow are complex but have received attention because they may represent therapeutic targets. For example,

Table 1 Factors associated with increased risk of AP

General	Age >60 years Resident in long-term healthcare facility (permanently or in the last 90 days) **Smoking** **Underweight/malnourished** **Overweight** **Prolonged supine position** **Hurried/inattentive feeding by carers**
Reduced conscious level	Cardiac arrest Traumatic brain injury **Opiate and non-opiate-based analgesia, anti-psychotic medication, sedatives, benzodiazepines, anti-seizure medications, antihistamines, anti-spasmodics for example, baclofen** **Alcohol excess**
Neurological disease	Stroke Dementia Learning disability Parkinson's disease Motor neuron disease Multiple sclerosis Cerebral palsy **Delirium**
Muscle disease	Sarcopenia Muscular dystrophies and myopathies **Myasthenia gravis**
Upper GI disease	Oesophagogastric cancer Achalasia Eosinophilic oesophagitis **Recurrent vomiting** **Benign oesophageal stricture** **Gastro-oesophageal reflux (GOR)** **Hiatus hernia** **Gastroparesis (eg, via autonomic dysfunction or overuse of opiates)**
Laryngopharyngeal disease	Pharyngeal or laryngeal cancer Vocal cord paralysis
Oral and dental disease	Oral cancer **Dry mouth** **Sialorrhoea** **Dental caries** **Dental plaque** **Dental abscess or decay** **Candidiasis** **Retained food products** **Unclean tongue**
General increased risk of infection	Diabetes mellitus Use of antibiotics in the last 90 days Immunosuppression
Instrumentation of the airways and digestive tract	Upper GI endoscopy **Nasogastric or nasojejunal tube** **Percutaneous endoscopic gastrostomy (PEG) or percutatneous endoscopic jejunostomy (PEJ) tubes** **Endotracheal tube** **Laryngeal mask airway** **Nasotracheal tube**

Modifiable risk factors are in bold text. Specific risk factors for pneumonia in learning disability are considered in the BTS Clinical Statement on Community Acquired Pneumonia in People with Learning Disability Statement, which is published concurrently with this statement, see comment beside Table 1.[2]

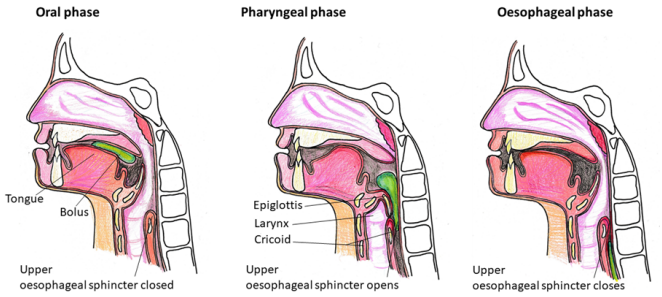

Figure 1 Normal swallowing. In the oral phase, food is prepared by the lips, tongue and teeth to form a bolus which is propelled backwards by the tongue. Only the oral phase of swallowing is completely under voluntary control. Anticipation of food and mastication stimulates saliva production, which helps effective swallowing. Healthy adults produce around 1.5 L of saliva daily.[267] In the pharyngeal phase, the tongue base retracts to push the formed bolus into the pharynx. The anterior upper oesophageal sphincter, the main muscle of which is cricopharyngeus, sits behind the larynx. The upper oesophageal sphincter is a 2–4 cm section under high pressure, which normally stops air entering the oesophagus. The external laryngeal muscles move the anterior cricopharynx and the larynx upwards and forwards, opening the upper oesophageal sphincter. Simultaneously, the epiglottis curves posteriorly and downwards over the larynx to meet the arytenoid cartilage, effectively sealing the larynx and preventing airway penetration. Closure is at the level of the true vocal cords, the false cords, the arytenoids and the epiglottis. The motion of the hyoid bone and epiglottis also reduces cricopharyngeal pressure, contributing to opening of the upper oesophageal sphincter. The pharynx contracts and moves the food bolus into the oesophagus, closing behind the bolus. As the bolus enters the upper oesophagus apposition of the tongue base and posterior pharyngeal wall propels the tail of the bolus. Successful swallowing also depends on the simultaneous arrest of respiration (deglutition apnoea). This is centrally generated and synchronous with, but not dependent on, laryngeal closure. Typically, exhalation precedes and follows the swallow, to prevent bolus inhalation. During the oesophageal phase of swallowing, the bolus moves towards the stomach by peristalsis, which is regulated entirely by the autonomic nervous system.

interest has surrounded thermal and tactile stimuli promoting effective swallowing. Increasing attention has focused on cough regulation by transient receptor potential vanilloid subtype 1, which is the receptor for the neuropeptide substance P, which in turn can mediate cough. Angiotensin-converting enzyme (ACE) 1 degrades substance P. Local substance P is reduced in patients with swallowing difficulties and AP[67] and restoration of substance P levels, for example by ACE inhibition, has become a therapeutic goal.

The multiple interacting mechanisms involved in healthy swallowing can be disrupted by a range of different pathological processes, which are significantly over-represented in conditions associated with a learning disability. These are discussed in more detail in online supplemental appendix 1.

Mechanisms involved in abnormal swallowing are exaggerated in older people. Older people have reduced pharyngeal sensory perception for swallowing and cough.[30 68] In addition, the most common pattern of breathing in a normal swallow is exhalation–exhalation, but in some older patients inhalation during swallowing may occur, which may predispose to aspiration.[69] Ageing is also associated with loss of muscle mass, decreased saliva production, ineffective dentition, reduced sense of smell and/or taste and delayed laryngeal closure.[27] The upper oesophageal sphincter may decrease in cross-sectional area with age, probably driven by weakness in the suprahyoid muscles. This results in smaller boluses being conveyed to the upper oesophagus, leaving larger amounts of pharyngeal residue,[70] which in turn can be aspirated.[71] Furthermore, pulmonary and systemic immunity

become impaired with increasing age, increasing susceptibility to infection.[72]

Normal and abnormal cough

An effective cough requires three components to be intact. First, the individual needs to be able to inspire up to 85%–90% of total lung capacity. Second, intact bulbar function is required to ensure rapid closure of the glottis for approximately 0.2 s, with subsequent contraction of abdominal and intercostal (expiratory) muscles to generate intrapleural pressures of >190 cm H_20.[73] Third, on glottic opening, explosive decompression is required to generate transient high peak cough flow (PCF).[74] In patients with swallowing difficulties, those with respiratory inflammation due to aspiration have lower PCF.[75] PCF is simple to perform as a clinical test.[76] Normal ranges vary with age,[77] but values below 270 L/min should generally lead to a more detailed assessment of cough and consideration of teaching cough augmentation techniques. Assessment of lung function in learning disability is considered in the Learning Disability Statement, see comment beside Table 1.[2]

Ineffective cough can arise from reduced consciousness, brainstem lesions, antitussive drugs (eg, opiates), peripheral nerve lesions (eg, left recurrent laryngeal nerve palsy), vocal cord pathology (eg, candidiasis), impaired pharyngolaryngeal sensation and respiratory muscle weakness.

Microbiology

The healthy oral cavity has a relatively stable population of bacterial communities.[63 78] Among patients in residential care, hospital wards or intensive care units (ICUs), the oropharynx becomes colonised with organisms such as *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*.[79 80] When swallowing is disrupted, oral secretions have a higher chance of being aspirated past the vocal cords and into the lungs.

Poor oral hygiene and reduced salivary flow contribute significantly to altered bacterial species in the mouth.[81 82] Several studies have postulated that the development of AP is promoted by gingivitis,[83] dental plaque[84–86] or dental caries.[41 87] However, results have been inconsistent. One large database study found no association between CAP and chronic periodontitis,[88] while another suggested that dental caries predicts pneumonia.[89]

A further source of infected, microaspirated secretions is the upper GI tract. Gastro-oesophageal reflux (GOR) is common in patients at risk of AP and increased in the presence of hiatus hernia and enteral feeding.[90] Proton pump inhibitors are widely used in older patients. As they increase gastric pH, they may reduce bacterial killing in the upper GI tract and their use is associated with pneumonia in outpatients and hospitalised patients.[91 92]

The organisms responsible for causing AP have been a source of continued debate. Bronchoscopic studies yielding bronchoalveolar lavage fluid are scarce. The principal controversy has been around the role of anaerobes in the pathogenesis of AP.[93] The emerging consensus is that AP is commonly polymicrobial, and that while aerobic Gram-negative bacilli are over-represented, Gram-positive organisms are also commonly isolated.[61 94 95] Anaerobes seem unlikely to make a major difference to outcome except in the most severely ill. The range of bacteria isolated in VAP seems broadly similar to that in AP, but with a greater number of potential pathogens.[48 96–98]

Box 1 Conditions predisposing to large-volume aspiration in children.

Structural abnormalities
- ⇒ Laryngeal cleft.
- ⇒ Vocal cord palsy (congenital or acquired).
- ⇒ H-type tracheo-oesophageal fistula.
- ⇒ Choanal stenosis.
- ⇒ Cleft palate (and Pierre Robin syndrome).
- ⇒ Craniofacial disorders with upper airways obstruction.
- ⇒ Vascular ring.

Abnormal coordination or weakness of pharyngeal or laryngeal muscles
- ⇒ Cerebral palsy.
- ⇒ Neuromuscular weakness (eg, spinal muscular atrophy, myotonic dystrophy, Duchenne's muscular dystrophy).
- ⇒ Bulbar palsy (progressive or acquired).

Absence of protective reflexes
- ⇒ Delayed maturation of swallowing reflexes.
- ⇒ Cerebral palsy.
- ⇒ Sedation, sedative anticonvulsants.

Airway adjuncts
- ⇒ Tracheostomy.
- ⇒ Nasopharyngeal airway.
- ⇒ Endotracheal tube.
- ⇒ Non-invasive respiratory support such as continuous positive airway pressure or bilevel positive airway pressure.

Microbiology specifically relevant to CAP in learning disability is considered in the Learning Disability Statement, see comment beside Table 1.[2]

Special considerations in children

In children abnormal swallowing can lead to failure to thrive, choking, AP and impaired neurodevelopment.[99–101] Co-ordinated safe swallowing is established during infancy. Primary aspiration into the airway and retrograde aspiration of refluxate following GOR are relatively common causes of lung disease in children. Healthy infants may aspirate sufficient volumes to cause AP, probably because of immature swallowing reflexes.[102 103]

Silent microaspiration is common in children with learning disability.[104] Chronic aspiration may be unrecognised, can result in progressive lung disease, and is a major cause of death in children with severe learning disability. Hypostatic pneumonia (the collection of fluid in the dorsal region of the lungs) occurs especially in those confined to a supine position for extended periods and is more common in children with learning disability.

Large-volume aspiration usually occurs because of an underlying predisposition, examples of which are shown in box 1. Upper airway obstruction increases the risk of aspiration in all infants.[105 106]

GOR is common under 6 months of age. Infants may posset frequently, and some may exhibit discomfort, but for many, there are no noticeable consequences. GOR is thought to occur due to immaturity of the gastro-oesophageal junction coupled with a liquid milk diet and the recumbent position of infancy. Acid in the distal oesophagus may trigger bronchospasm. For most children, GOR is self-limiting and resolves in the second year of life.

In infants, small amounts of liquid reaching the larynx can cause laryngospasm. In neonates and preterm infants reflux

Clinical practice points

⇒ AP is usually characterised by microaspiration of bacteria-rich secretions from the oropharynx into the lungs and is frequently accompanied by swallowing difficulties.
⇒ Swallowing impairment may be 'silent' (not apparent to an observer) in patients with reduced laryngopharyngeal sensation or reduced conscious level, and in such patients a high index of suspicion for aspiration is needed.
⇒ Abnormal swallowing commonly improves/recovers (particularly after a stroke), either spontaneously or with treatment.
⇒ AP is also commonly caused by reflux of material from the GI tract.

reaching the larynx can initiate life-threatening reflex apnoea and bradycardia.[106] Persistent significant GOR to the level of the larynx may modulate laryngeal sensation and hinder the development of a safe co-ordinated swallow in normal infants.[107]

Aspiration of oral secretions in the absence of food or refluxate can be a significant problem for children with learning disability and can contribute to progressive lung disease, even when feeding and GOR are safely managed. This risk may persist into adulthood.

PREVENTION

Factors associated with increased risk of AP were described in table 1. Preventive measures should be focused on individuals with these clinical factors. In practical terms, many patients will have their first contact with healthcare professionals after already developing risk factors (eg, stroke with swallowing difficulties) or after already having an episode of AP. To prevent new/further aspiration, clinical teams should aim to promote restoration of effective swallow and cough, to reduce bacterial load in secretions and to ensure adequate hydration and nutrition.

Effective prevention of AP relies on effective multidisciplinary team working and communication, involving speech and language therapist (SLTs), physiotherapists, oral hygienists/dentists, dietitians/nutritionists, nurses, pharmacists, radiologists and physicians. Further work is required to develop clinical tools to predict pneumonia in hospital, in order to focus prevention strategies on those most at risk, though promising examples have been described.[108]

Swallowing difficulties

Assessment

There is no validated screening tool for swallowing that covers all older hospitalised patients at present.[109] In the specific setting of stroke, a failed swallowing screen has been associated with greater development of AP,[110] and screening may lead to a reduction in AP.[111] Cough after eating/drinking, choking episodes witnessed by patients/families/healthcare staff or episodes of presumed AP are indications that an assessment of swallowing is required.

Swallowing is best assessed and managed by an SLT using a holistic approach,[112–114] as part of a wider, multidisciplinary clinical team. Abnormal swallowing can also impact on psychosocial well-being, including stress around mealtimes, reduced enjoyment of meals, avoidance of eating with others and reduced quality of life.[115] There may also be an adverse impact on carers and families.[112 113]

SLT assessment incorporates a detailed history,[116 117] with an oromotor and cranial nerve assessment, focusing on motor and sensory components of eating and drinking. Two or more impaired components of an oromotor examination correlate with a higher risk of aspiration.[118] Clinical suspicion of silent aspiration or recurrent pneumonia are indications for SLT assessment.

Specific preventive advice based on the assessment can be conveyed directly to patients. For people who have difficulties with comprehension or retention of information, 'compensatory techniques' can be used by carers.[119] These may include: changes in posture; physical support methods at mealtimes; changes in food textures; thickening fluids; change to smaller, more regular meals; adapting the environment or adapting utensils. Specific issues relating to swallowing difficulties in learning disability are discussed in theLearning Disability Statement, see comment beside Table 1.[2]

Assessment tools can supplement the standard SLT assessment, including patient-centred quality of life questionnaires.[120] In some circumstances effective swallowing assessments can be performed remotely.[121] Evidence suggests that effective swallowing assessments can reduce AP,[33 122] though others have questioned their value.[123]

Where a clear recommendation cannot be made on the basis of a bedside SLT assessment, and where facilities permit, further investigation of swallowing can be initiated.

Confirmation of microaspiration can be obtained in several ways.

- Videofluoroscopy (VFS) involves a modified barium swallow.[124] Penetration–aspiration is often measured using the 8-point scale introduced by Rosenbek,[125] with aspiration defined as barium visible beneath the true vocal cords. If no throat clearing or coughing is visible, the aspiration is considered 'silent'. Since aspiration is episodic in nature, a single VFS may not completely exclude aspiration.
- Fibre-optic endoscopic evaluation of swallowing (FEES) involves direct visualisation of food boluses of different textures being swallowed.[126] Pharyngeal residue may be visualised in the piriform fossae or in the valleculae at the base of the tongue. FEES also assesses whether upper airway secretions are freely aspirated.
- Scintigraphy can be used to image the lungs after the patient has swallowed a radionuclide-labelled food bolus. This technique is largely a research tool at present.
- Dual-axis accelerometry appears effective in assessing swallowing in specialist centres[127] but has not yet challenged the place of VFS or FEES in clinical practice.

VFS and FEES are regarded as gold standards for swallowing assessment.

Where an upper GI cause is thought to contribute to impairment of swallowing, or where GOR is considered a problem, upper GI endoscopy or oesophageal manometry with oesophageal pH and impedance studies can be considered to assess whether an excess of reflux is reaching the proximal oesophagus.

Physical measures to improve swallowing

General strengthening of the pharyngolaryngeal musculature and optimisation of nutrition are anticipated to improve swallowing. A simple physical method used to improve swallowing is the chin down or chin tuck method, which simply involves touching the chin against the chest during swallowing. This appears to benefit about half of patients in whom it is used appropriately.[37 128–130] Prevention 'bundles' aimed at improving swallowing have also

been shown to prevent AP.[131] Broad introduction of swallowing interventions appeared to improve swallowing in retrospective cohort studies.[54]

Impaired swallowing may also be improved by physical, thermal, transcutaneous electrical or transcranial magnetic stimulation.[132–140] These appear well tolerated and simple electrical techniques can be used by patients at home.[141] However, large-scale phase III trials are lacking, and specialist equipment and training are required for electrical stimulation. More evidence is required before these techniques are routinely adopted.

Pharmacological measures to improve swallowing

ACE inhibitors, by preventing breakdown of substance P and preserving cough mechanisms, have been extensively studied as a potential strategy for reducing poststroke AP. Significant reductions of AP have been demonstrated in large, well-conducted studies among Chinese and Japanese patients after stroke,[142 143] though subgroup analysis has not demonstrated clear benefit in Caucasian patients. A small trial from Hong Kong, comparing low-dose lisinopril and placebo in older patients with neurologic swallowing abnormalities receiving nasogastric feeding (>95% had stroke), was terminated at interim analysis because of increased mortality in the lisinopril group.[144]

Promising results have been demonstrated for drugs targeting similar pathways, mostly in poststroke studies in Japan. These include amantadine, cabergoline, capsiate, mosapride, nicergoline, cilostazol and (in patients with chronic obstructive pulmonary disease (COPD)) theophylline.[90 145–151] Encouraging results have also been reported for some traditional Chinese medicines.[152–154] Metoclopramide, which promotes gastric emptying, has had promising effects in patients fed via a nasogastric tube after a stroke,[155] though the Medicines and Healthcare products Regulatory Agency recommends that metoclopramide should only be used for up to 5 days.[156]

At present, in the absence of contraindications, ACE inhibition is recommended in Chinese or Japanese patients following stroke for prevention of AP, exercising caution in those who are normotensive, in whom blood pressure should be carefully monitored. Insufficient evidence is currently available in other ethnic groups. Other treatments require further evidence from large clinical trials.

Cough and muscle strength

Very few trials have demonstrated beneficial effects of muscle training on aspiration or AP. Cough reflex testing did not alter rates of SAP significantly.[157] In Parkinson's disease, expiratory muscle strength training reduced penetration assessed by VFS,[158] and appeared to have a sustained beneficial effect on swallowing in a small study.[159] Voice exercises in patients with glottal closure insufficiency significantly reduced hospitalisation with AP.[160]

While high-quality evidence is lacking in the specific context of AP, the general proven benefits of early mobilisation, neurorehabilitation and pulmonary rehabilitation on outcomes including mobility, posture, strength and quality of life indicate that rehabilitation should be started as soon as is feasible in all patients at risk of AP.

Oral care

A large literature containing studies of variable quality has assessed aspects of oral care and the effects on bacterial colonisation, aspiration or AP. These studies have almost exclusively been performed in hospital or care sector settings. Chlorhexidine mouthwash appears to reduce colonisation with potential pathogens,[161 162] without improving patient outcomes.[29 163]

Mechanical oral care (usually with toothbrushes) has been associated with reductions in AP and death[164–167] as well as proxy measures such as peak expiratory flow and cough reflex.[168 169] Dedicated oral care has been associated with significant healthcare savings.[170] However, the extent to which health interventions can improve outcomes is currently unclear.[171]

Given the simplicity and safety, we recommend that the mouths of all patients at risk of AP in hospital or care homes should be examined on admission and regularly thereafter. However, implementation of routine oral care is fraught with challenges around time, equipment, culture and inconsistent policies,[172] and oral 'champions' should be identified to ensure implementation.

UK National Institute for Health and Care Excellence guidelines suggest the teeth of care home residents should be brushed two times per day with fluoride toothpaste and there should be access to mouth rinse.[173] A soft toothbrush should be used, and the gingiva, tongue and palate should be brushed at the same time. In patients with swallowing difficulties, non-foaming toothpaste should be used to reduce the risk of aspiration of the product.[172] Pink foam swabs should not be used, as they are ineffective at cleaning teeth, and the foam can be aspirated.[174] Soft, small-headed toothbrushes are preferred to stiffer brushes and can be used to brush the tongue and palate.[172] Mucus secretions can often be removed with a soft toothbrush.

Moisturising mouth gel is effective at hydrating dried-on secretions that can be brushed off later.[172] Useful online guidance on providing oral hygiene is available.[175] Specific considerations around oral care in learning disability are discussed in the Learning Disability Statement, see comment beside Table 1.[2]

Oral candidiasis is common in patients at risk of AP, especially those with diabetes or malignancy, or in patients taking antibiotics or corticosteroids. Severe candidiasis may cause dysphonia and abnormal swallowing and may require endoscopic assessment. Topical nystatin is effective treatment.

Sialorrhoea can be managed with glycopyrronium, hyoscine patches, oral atropine, botulinum toxin to the salivary glands, or in severe cases, salivary gland surgery. The issue of sialorrhoea in learning disability is discussed in the Learning Disability Statement, see comment beside Table 1.[2]

Feeding

Whenever feasible, patients with mild swallowing problems in whom the risk of AP is not considered high after a bedside swallow assessment should be fed orally and observed carefully. However, dependence on others for feeding increases the risk of AP,[176] possibly due to time pressures on carers/healthcare workers.[87]

Although it is standard practice to modify the thickness of fluids and the texture of food in patients with impaired swallowing, the evidence base for this practice is not strong.[27 177 178] In a systematic review considering texture-modified food in patients with dementia, there was evidence of lower energy levels and reduced fluid intake.[177] Thickening fluid reduces penetration and aspiration but may increase pharyngeal residue. Serving smaller volumes of thickened fluids, for example, using teaspoons, may reduce pharyngeal residue.[179] Flavouring thickened feeds with honey/nectar can improve pharyngeal clearance, but this is often unpalatable to patients.[128]

Small studies have suggested that drinking carbonated liquids may reduce aspiration,[180–182] suggesting that sensory stimulation

of the pharynx may improve swallow, in line with suggestions that cold or hot food promotes better swallow than food at room temperature.

When an SLT assessment concludes that swallowing is impaired to the extent that there is a significantly high risk of AP, a 'nil by mouth' order can be made. The questions of when and whether to commence tube enteral feeding remain contentious. The detrimental effects of malnutrition need to be balanced against the fact that tube enteral feeding itself is a risk factor for AP. Expert consensus has suggested that if there is no food intake for more than 3 days, or if <50% of nutritional requirement is met for more than 10 days, then enteral feeding should be considered.[27] In patients approaching the end of life, a team discussion involving the patient and/or family members should ideally take place before placing a nil by mouth order.

It is important to recognise that abnormal swallowing frequently resolves,[183] and every effort should be made to carry on with specific and general measures to improve swallowing, with ongoing input from SLTs. Patients who are 'nil by mouth' still have to clear saliva (normal production is up to 1.5L/day), which itself remains an aspiration risk.

In the context of stroke, a landmark study showed that nasogastric feeding improves survival compared with no feeding.[184] Other observational studies have suggested that in patients with pre-existing swallowing impairment, nasogastric feeding may not carry significant additional risk.[185 186]

In general, there is little to suggest a benefit for postpyloric feeding or PEG feeding over nasogastric feeding, and in the context of stroke, there is evidence for a trend towards better outcomes for nasogastric feeding.[184] An exception is in patients who reflux and aspirate nasogastric or PEG feeds, when postpyloric feeding or fundoplication may be beneficial. A further possible exception is in the context of significant pooled oral secretions, for which a recent study suggested PEG feeding may be beneficial.[187]

If abnormal swallowing with high risk of AP persists for weeks, and/or if the patient finds nasogastric tubes uncomfortable/intolerable, a PEG tube is an appropriate alternative. As for nasogastric feeding, PEG feeding should not be regarded as necessarily permanent, and precedent exists for oral feeding restarting when adequate swallow returns.[188]

The nature of the enteral feed to be given is beyond the remit of this statement, and an enteral nutritionist/pharmacist/dietitian should be consulted. However, elemental feeds appear to be associated with less AP and better gastric emptying in gastrostomy-fed patients.[189 190]

Most importantly, 'nil by mouth' orders must never stand alone, but instead should be issued with clear statements on the plan for nutrition, the plan for continued measures to improve swallow, and the plan for timing of the next assessment of swallow.

Hospital pharmacists should be consulted on the best way to administer regular medications when patients are 'nil by mouth', and there are useful examples of publications highlighting general principles.[191]

A shared decision-making approach is required around feeding, especially in older patients with complex comorbidities. Specific considerations relating to eating and drinking with acknowledged risks in the context of palliative care can be found in the Palliative Care section and in online supplemental appendix 2.

Nutrition in the specific context of learning disability is discussed in the Learning Disability Statement, see comment beside Table 1.[2]

Modifiable risk factors

In addition to considering the key issues above, attention should be paid to potentially modifiable risk factors in table 1. In all patients, but particularly those with depressed conscious level, medication review should be undertaken with the aim of reducing doses of sedative medications where possible.

Special considerations in adult patients in ICUs

The principles described above apply in the ICU setting. Prevention of VAP has been extensively studied, and the evidence base is of higher quality than for AP outside the ICU. Guidance recommendations for prevention of VAP are available.[192 193] The best way to avoid VAP is to avoid intubation where possible or to minimise the duration of intubation where it is essential.[193] The remainder of this subsection considers the patient who is already intubated.

There is good evidence that raising the head of the bed, for example by nursing critically ill patients at between 30° and 45° reduces the likelihood of VAP,[194 195] though maintaining this position in practice is challenging.[195]

In keeping with principles described earlier, sedation breaks are also associated with a reduction in VAP.[196 197]

In the ICU setting, chlorhexidine mouthwash reduces VAP in patients undergoing cardiac surgery.[198] In other ICU cohorts, a trend to increased mortality has been described,[198 199] although a trial of deadoption of chlorhexidine mouthwash showed no reduction in mortality.[200] On the basis of current evidence, chlorhexidine use in critical care should be confined to patients having cardiac surgery. Oral toothbrushing appears safe and worthwhile. Small studies have suggested that oral suction prior to position change may positively influence rates of VAP and mortality.[201]

As the endotracheal tube is effectively a conduit for microaspiration, interest has focused on its composition. Infected secretions from the subglottis are thought to access the lung down crevices in the lining of the tube cuff, to cause VAP. This has led to the widespread adoption of subglottic suction drainage, which significantly reduces the incidence of VAP.[202–205] Lubrication of the cuff generally appears to reduce the risk of VAP.[206 207] Several studies have sought to determine whether tapered cuffs, or tubes of different composition reduce VAP. While physical leak may be reduced by tapered cuffs, and while modern tubes might reduce bacterial colonisation, these have not convincingly translated into significantly reduced VAP or other important outcomes.[208–210] Continuous pneumatic inflation of the cuff does not appear to reduce VAP.[50]

While there is no place for prophylactic antibiotics to prevent microaspiration in adults outside the ICU setting, there is some evidence in comatose patients requiring emergency intubation that one or two doses may reduce the incidence of VAP.[211–214] A full course of antibiotics is not required in this setting.[215]

Special considerations in children

A priority is to identify whether any structural abnormality can be repaired (box 1). In more complex cases, identification of primary, retrograde and salivary aspiration allows bespoke interventions to be considered.

VFS is the gold standard in assessment of swallow in children and can demonstrate subtle abnormalities.[216] A formal clinical feeding assessment by an SLT is essential for planning the VFS, to establish appropriate testing conditions.

FEES allows real-time direct visualisation of the swallow using different textures. FEES is also well placed to assess whether upper airway secretions are freely aspirated.[217]

Microlaryngobronchoscopy can establish whether the larynx is structurally competent. It can exclude structural causes of aspiration including laryngeal cleft and vocal cord palsy, and the otolaryngology surgeon will be able to review the dynamics of the oropharynx and larynx during spontaneous breathing.

Primary aspiration

SLTs can improve the safety of the swallow by restricting feeding to specific fluid consistencies, optimising positioning, using pacing strategies to prevent fatigue, optimising utensils and beakers and establishing routine. Healthy infants, with aspiration ascribed to maturational delay of swallowing reflexes, will benefit from exposure to ongoing swallow stimulation.

Severe swallowing abnormalities, for example in a child with cerebral palsy, may not be amenable to conservative interventions, and these children will often need nasogastric feeds (or gastrostomy if the problems are thought to be long term).

Retrograde aspiration from GOR

If medical therapy is ineffective and there is good evidence of retrograde aspiration, then a 'super-safe' feeding approach should be considered where both primary and retrograde aspiration are managed. A trial of nasojejunal feeds or, for children with an established gastrostomy, a trial of gastro-jejunal feeds via a gastrojejunostomy tube, may be useful to establish whether GOR is contributing to lung disease before definitive antireflux surgery is planned.

Laparoscopic fundoplication is the most common definitive antireflux approach to managing GOR and improves respiratory morbidity in children with learning disability.[218]

Upper airway secretions

Long-term prophylaxis with azithromycin may be useful in the specific situation of children with recurrent AP. Potentially beneficial effects may relate to promotility and anti-inflammatory effects of azithromycin. Attention should be given to positioning, so that secretions can drain out of the mouth. Physiotherapy in the morning (to remove retained oropharyngeal secretions accumulating overnight) and in the evening (in preparation for the night ahead) may be beneficial. Anticholinergic therapies such as a hyoscine patch, glycopyrronium liquid or ipratropium nasal spray/nebuliser may help reduce secretion volume, but care should be taken since these medications may thicken secretions, increase the risk of urinary retention and constipation, lead to blurred vision, or cause confusion. Anticholinergics may need to be stopped temporarily during intercurrent infections.

Volume of saliva can be reduced by salivary gland botulinum toxin injection, at 2–3 monthly intervals. In severe cases, salivary ablation is possible with removal of the submandibular glands and parotid duct ligation.

Intractable aspiration

Children with recurrent aspiration may be managed with a tracheostomy, particularly if they have had severe exacerbations leading to respiratory failure and multiple admissions. A cuffed tracheostomy may enable material above the cuff to be effectively suctioned or aspirated.

Care should be taken when considering a tracheostomy, however, since this can increase the risk of aspiration, increase secretion production and render the child more dependent on regular suction and physiotherapy, which can be uncomfortable. Intractable aspiration can be managed with radical surgery such as supraglottic laryngeal closure with tracheostomy, where phonation is preserved, or laryngotracheal separation with tracheostomy where phonation is lost. These procedures should only be undertaken after wide specialist consultation.

Clinical practice points

- ⇒ Good oral hygiene appears to reduce the rate of AP.
- ⇒ For patients in hospital or care homes, oral hygiene should include brushing of the teeth, tongue and palate with a soft toothbrush, using non-foaming toothpaste, at least two times per day.
- ⇒ Oral examination should be performed in all hospitalised patients at risk of AP or with suspected AP, and at least weekly in care home residents, checking for infection (eg, candidiasis), quality of dentition, food residue and cleanliness of mucosal surfaces. Any abnormalities should be treated.
- ⇒ People with swallowing difficulties should be referred to an SLT.
- ⇒ Whenever feasible, patients with mild swallowing problems who are not considered at high risk of AP after a bedside swallow assessment should be fed orally and observed carefully.
- ⇒ When consuming food and liquid as normal is felt to present a high risk of AP, cold carbonated drinks may be trialled; alternatively, thickened fluids or feeds may be trialled.
- ⇒ In patients approaching the end of life and/or with moderate–severe dementia, a best interests discussion should take place prior to a 'nil by mouth' instruction.
- ⇒ When an SLT considers a patient's swallow presents a high and imminent risk of AP and a 'nil by mouth' instruction is issued, a plan should be formulated (a) seeking to restore effective swallow and (b) arranging further assessment of swallow. A 'nil by mouth' instruction should be considered temporary and steps taken to minimise duration where possible.
- ⇒ In patients with a newly diagnosed abnormality of swallowing that presents a high risk of AP, who are not felt to be approaching the end of life, early nasogastric feeding (within 3 days of presentation with swallowing difficulties) improves nutritional status and outcomes. Attempts to improve swallow, with a view to restoring eating and discontinuing nasogastric feeding, must be continued.
- ⇒ PEG should be considered when abnormal swallow presents a continuing high risk of AP and when nasogastric tubes are either poorly tolerated or fail to provide adequate nutrition.
- ⇒ PEG tubes should not always be considered permanent. If safe swallow returns PEG tubes can be removed.
- ⇒ In Chinese and Japanese patients at risk of AP after stroke, and in the absence of contraindications, ACE inhibitors should be prescribed to reduce the risk of AP. Insufficient evidence currently exists to support this practice in other ethnic groups.

DIAGNOSIS

Guidelines for the diagnosis of CAP and HAP/VAP provide clear recommendations on diagnosis[3 4 219 220] and diagnosis of CAP in learning disability is discussed in the Learning Disability Statement, see comment beside Table 1.[2] The advice that follows seeks to complement the above guidance by specifically considering

patients with suspected AP. A systematic review has suggested that there is generally good consensus on the constellation of clinical, radiological and laboratory features supporting a diagnosis of AP in published studies.[221]

In all patients presenting with breathlessness, new hypoxia, and an abnormal chest X-ray (CXR), the clinical history should include enquiry about conscious level, swallowing efficiency, recent choking on tablets/food/liquids and risk factors for AP. In older and/or debilitated patients, AP should be considered as a potential cause of frailty syndrome presentations (eg, hypoactive delirium, falls or reduction in mobility).

A good clinical history should cover cardinal respiratory, oral, neurological and GI symptoms, their temporal relationship, the frequency of previous pneumonia, eating and drinking patterns, smoking, alcohol intake, medication history and compliance with treatment. A collateral history from relatives or carers may be especially helpful, particularly if there is cognitive impairment. Physical examination should incorporate cognitive assessment, along with oral, respiratory, GI and neurological examination. Specific elements of history and examination to consider in learning disability are discussed in the CAP in Learning Disability Statement, see comment beside Table 1.[2]

Diagnosis of AP rests on the principles of

- A history of an acute, infective, respiratory illness (some or all from: acute/subacute onset; breathlessness; cough; sputum; fever; sweats; malaise; anorexia).
- A history of factors associated with increased risk of microaspiration (see table 1).
- Radiological evidence of consolidation, particularly where this corresponds to the pulmonary segments in which aspiration is anatomically most likely (basal segments of the lower lobe if the patient has been mostly upright; apical segment of the lower lobe or posterior segment of the upper lobe if the patient has mainly been supine; the right lung is more likely to be affected than the left).

Diagnostic confidence is increased further if there are

- Compatible signs (eg, inspiratory crackles or bronchial breathing on chest auscultation; tachycardia).
- Compatible investigations (eg, white cell count $>11\times10^9$/L or $<4\times10^9$/L; temperature >37.5°C; low oxygen saturations on pulse oximetry (SpO_2) or low partial pressure of arterial oxygen (PaO_2).
- Compatible microbiology (identification of a relevant bacterial pathogen on culture).

Some caveats should be kept in mind, however.

- First, it is rare to obtain a causative pathogen in suspected AP. Patients often do not produce sputum (and may be too weak to cough efficiently), antibiotics may have been administered before cultures are considered (rendering the culture result less reliable), and invasive procedures such as bronchoscopy and BAL are often contraindicated or impractical in patients with suspected AP.
- Second, CXR fails to detect AP in up to 25% of cases, when compared with thoracic CT.[222–224]
- Third, older patients commonly fail to mount the same systemic inflammatory response that younger patients do, and so may not have fever or a raised white cell count.

The differential diagnosis of AP includes other acute/subacute conditions producing alveolar shadowing with or without systemic inflammation. In practical terms, outside the ICU setting, this largely spans:

- Aspiration pneumonitis, generally involving a chemical insult in the lung from aspiration of gastric acid. Aspiration pneumonitis is usually distinguished from AP on the history. In aspiration pneumonitis the aspiration is often witnessed, of large volume, and the patient usually has reduced conscious level. The distinction is important, because aspiration pneumonitis does not require antibiotic treatment unless secondary infection arises later in the lungs.[8 12]
- Pulmonary oedema, especially negative pressure pulmonary oedema. In general, radiological alveolar shadowing is more diffuse and symmetrical in pulmonary oedema. Cardiomegaly favours pulmonary oedema.
- Pulmonary embolism with radiological pulmonary infarction may present subacutely with fever and systemic inflammation. Risk factors for aspiration are rare in acute pulmonary embolism, and where there is sufficient doubt, a CT pulmonary angiogram can readily distinguish the two.

A number of biomarkers have been proposed for the diagnosis of AP. Because pepsin, bile acids and alpha amylase are produced in the stomach, bile ducts and salivary glands, respectively, but not in the lungs, their presence in BAL, sputum or other respiratory secretions has been taken to imply aspiration.[62 225 226] However, these largely remain research tools, and no practical, validated cut-off for aspiration has so far been identified for clinical use.

Serum procalcitonin was evaluated as a potential means of distinguishing AP from non-infective pneumonitis in critically ill patients but performed poorly in this setting.[227]

While serum albumin does not add diagnostic information, a low concentration has been shown to predict adverse outcomes in AP.[228]

Thoracic ultrasound has potential to aid the diagnosis of pneumonia, particularly in settings where transferring patients to radiology departments is more difficult (eg, in suspected VAP or in frail care home residents).[229–232] However, this remains observer-dependent, and greater standardisation and multicentre trials assessing outcome are still required.

It is proposed that the diagnostic work-up for patients in hospital with suspected AP should include:

- History and examination, with assessment of risk factors for AP.
- Assessment of oxygenation.
- CXR (or CT where there is remaining doubt after an inconclusive CXR or where CT is likely to distinguish AP from other differential diagnoses more confidently).
- Full blood count.
- Urea and electrolytes, liver function tests including albumin, and C reactive protein.
- Microbiological sampling—sputum and blood culture in patients considered to have moderate–severe AP; sputum from any patient with AP if it is readily produced. Sampling should not delay antibiotic treatment beyond the few minutes required to take blood cultures and assess whether sputum can be produced.

Clinical practice points

⇒ A careful history is key to increasing the likelihood of an accurate diagnosis of AP. In patients presenting with a likelihood of CAP, risk factors and features of the history particularly suggestive of aspiration should be covered.
⇒ CXR fails to detect AP in up to 25% of cases, when compared with thoracic CT scans.
⇒ Older patients may have a blunted systemic inflammatory response compared with younger patients.

Special considerations in children

There is no gold standard test for diagnosis of AP in children. Since silent aspiration is common, a high index of suspicion is needed in children with established respiratory disease.

CXR findings are generally non-specific, and the CXR may be normal. There may be perihilar bronchial wall thickening, air trapping and hyperinflation, ground glass change or atelectasis and streaky consolidation, particularly in the dependent lobes.

MANAGEMENT

Guidelines on management of CAP (including a separate guideline for children), HAP and VAP have been published.[3 4 219 220] The management principles in these should be applied according to patients' circumstances. The guidance below seeks to complement the CAP guidelines by specifically considering patients with suspected AP.

Limited evidence suggests that, at least after stroke, there is a trend to improved outcomes for AP if documented care pathways are adhered to.[233]

For patients in hospital who have AP, oxygen saturation, pulse, blood pressure and temperature should be monitored regularly, so that deterioration can be identified rapidly. Deteriorating patients should have prompt access to increased respiratory support/extrapulmonary organ support and monitoring, in a high dependency unit or ICU, as appropriate. Where death is considered likely, honest conversations with patients and their families should take place even while active treatment is pursued, ensuring appropriate treatment choices can be made. The palliative care needs of patients with AP who are dying, and their families, are considered in the Palliative and Supportive Care section.

Antibiotics

Antibiotics for patients managed in hospital

There have been several antibiotic trials in AP in recent years.[57 58 234–240] Of note, narrower spectrum antibiotic regimens, such as those used in UK practice, have not been robustly compared with the broader-spectrum regimens evaluated in trials. The published trials have generally compared different broad-spectrum regimens and have shown broadly similar outcomes. Collectively these trials suggest that around two-thirds of patients in hospital with AP respond to treatment, 10–15% die, and the remainder survive with persistent symptoms/morbidities.

The polymicrobial and unpredictable microbiology of AP, coupled to the poor outcomes dictates that, in patients who are in hospital and who have a high likelihood of AP, antibiotics should be started promptly. If it is possible to obtain microbiological samples without delay, these should be sent before starting antibiotics. If a plausible pathogen is detected the antibiotic regimen should be appropriately focused, in accordance with antimicrobial stewardship practice.[241 242] In the absence of a clear advantage of any particular published regimen, there is no strong evidence base on which to recommend a specific antibiotic regimen.

In this setting, for patients managed in hospital, local Medical Microbiology guidance should be sought on which first-line antibiotic regimen to deploy, based on local epidemiology. This should be guided by the patient's location when the infection was acquired. The first-line regimen used may also need adjusted to take account of individual patient factors such as recent antibiotic exposure and recent microbiology results when available. A difficult balance must be struck between providing sufficient cover for the polymicrobial nature of AP, set against the risk of broad-spectrum antibiotics promoting the emergence of antimicrobial resistance or infections such as *Clostridium difficile* diarrhoea. While noting that clinical trial data exist supporting the efficacy of cephalosporins for AP, use of these antibiotics has been de-emphasised in UK practice to minimise adverse ecological effects associated with their use. Taking these considerations into account, and based on clinical experience and expert opinion, in most cases, co-amoxiclav is considered a reasonable initial antibiotic, pending the return of microbiological cultures and sensitivities. It is recognised that amoxicillin-based regimens are widely used for AP in UK hospitals; while combinations with beta-lactamase inhibitors have been better evaluated in trials, amoxicillin may be reasonable in non-severe infections. Patients with AP often have difficulty swallowing, so antibiotics may need to be given intravenously if oral preparations cannot be taken safely.

For patients allergic to penicillin, a fluoroquinolone (eg, levofloxacin) is a suitable option. It is recognised that other antibiotics (eg, doxycycline or co-trimoxazole) are also widely used for AP in the UK, particularly for patients with penicillin allergy. While fluoroquinolones are supported by more substantial trial data, an alternative regimen may be reasonable for non-severe community-acquired AP in the setting of penicillin allergy. Whichever regimen is used initially, patients should be monitored carefully for clinical improvement—where there is lack of clinical response and evidence of treatment failure, consultation with an infection specialist may be sought and a second-line regimen (eg, piperacillin-tazobactam) should be considered.

We do not recommend routine anaerobic cover for AP, on the grounds that anaerobes have not been proven to influence outcomes adversely and have become progressively less important pathogens in recent decades. We suggest that it is important to ensure that anaerobic coverage is included when patients with AP are at particularly high risk of anaerobic infection, for example in those with obvious dental/periodontal disease, putrid sputum production or those in whom lung abscess/empyema is suspected. This may be achieved by choosing an agent with anti-anaerobic activity (eg, co-amoxiclav or piperacillin-tazobactam) or by adding metronidazole to agents with weak antianaerobic activity (eg, levofloxacin).

When intravenous antibiotics have been used initially, changing to an oral regimen is reasonable when the patient is improving clinically and if the patient can swallow safely (patients may be given liquid or suspension formulations if there is continuing difficulty with swallowing tablets).[241] Assessment of improvement may be guided by parameters such as: improvement in symptoms; improvement in oxygenation; return to normal of temperature and improvement in blood pressure and heart rate. Where microbiology culture and sensitivity results have become available, these should be used to narrow the spectrum of antibiotic cover as appropriate.[242] We suggest that, if patients have improved clinically, antibiotic treatment should be for 5 days in total.

If clinical improvement does not occur, adherence to antibiotics should be confirmed, microbiology results should be carefully reviewed and, where possible, samples obtained for culture. Careful clinical review should consider (1) whether an alternative (or additional) non-infective illness may be responsible for the patient's illness (and if so, treated accordingly), (2) whether AP may have been complicated by a pleural effusion, empyema or lung abscess and/or (3) whether antibiotic cover is insufficient (in which case second-line treatment may be considered, in conjunction with an infection specialist).

Antibiotics for patients managed in the community

In patients managed in the community and not requiring hospital care, we recommend an oral regimen, in line with local microbiological guidance for AP, for 5 days. Appropriate first-line regimens include amoxicillin or co-amoxiclav. Where there is penicillin allergy a fluoroquinolone, a macrolide or a tetracycline could be considered, informed by local microbiology guidance. Including antianaerobic coverage, for example by adding metronidazole, could be considered for those patients at high risk of anaerobic infection, as outlined above, when the primary agent chosen does not have antianaerobic activity.

It should be noted that the published clinical trials to date have tended to recruit relatively ill, hospitalised patients, assessing broad-spectrum antibiotic regimens. In the absence of data on less unwell patients with AP, we support the above prescribing strategy for hospitalised and non-hospitalised patients. Recommended antibiotics for CAP in learning disability are discussed in the Learning Disability Statement, see comment beside Table 1.[2]

Oxygen

Oxygen should be administered in keeping with BTS Emergency Oxygen guidelines[243] and prescribed according to target SpO_2. The BTS guidelines recommended a target of 94%–98%. However, there is increasing evidence to support the use of more conservative oxygen targets in acutely unwell patients,[244] and an upper target of 94%–96% inclusive may be optimal. In adult patients at risk of hypercapnic respiratory failure, such as those with underlying neuromuscular disease, kyphoscoliosis, obesity or COPD, discussion with a respiratory specialist is recommended. In these settings, oxygen should be prescribed and administered to a target SpO_2 of 88%–92% inclusive. Aspects of oxygen use and ventilation strategies in learning disability are discussed in the Learning Disability statement, see comment beside Table 1.[2]

Prophylactic anticoagulation

Patients with AP are at heightened risk of venous thromboembolism and should receive thromboprophylaxis with subcutaneous low-molecular weight heparin, unless it is contraindicated.

Hydration

Assessment of hydration should be made clinically, and fluid balance normalised as appropriate.

Nutrition

AP is associated with a catabolic state. Strategies to provide adequate nutrition should be discussed early, in conjunction with SLTs and dietitians.

Respiratory physiotherapy

In most cases of AP, lung consolidation exists without excess secretions. In this situation, there is no evidence that respiratory physiotherapy is of benefit.[245] BTS guidelines state that patients with pneumonia should not be routinely treated with airway clearance techniques (ACTs).[3 4 246]

However, respiratory physiotherapy should be initiated when secretions are present clinically, or when there is radiological evidence of atelectasis. The initial aims are to clear secretions resulting from aspiration and to re-expand areas of atelectasis, in the expectation of improving oxygenation. Respiratory physiotherapy seeks to loosen secretions and move them to the central airways (peripheral ACTs). Once secretions reach the central airways a huff or cough should be sufficient to clear them. However, in patients with respiratory muscle weakness, techniques to enhance cough are likely to be required (proximal ACTs).[247 248] Treatment with conventional physiotherapy has been shown to be effective in AP secondary to stroke.[249] Once ACTs have been initiated, these should be continued until the patient is free of secretions and atelectasis.

In situations where aspiration has led to airway changes and secretions, or in patients with ineffective cough, or reduced

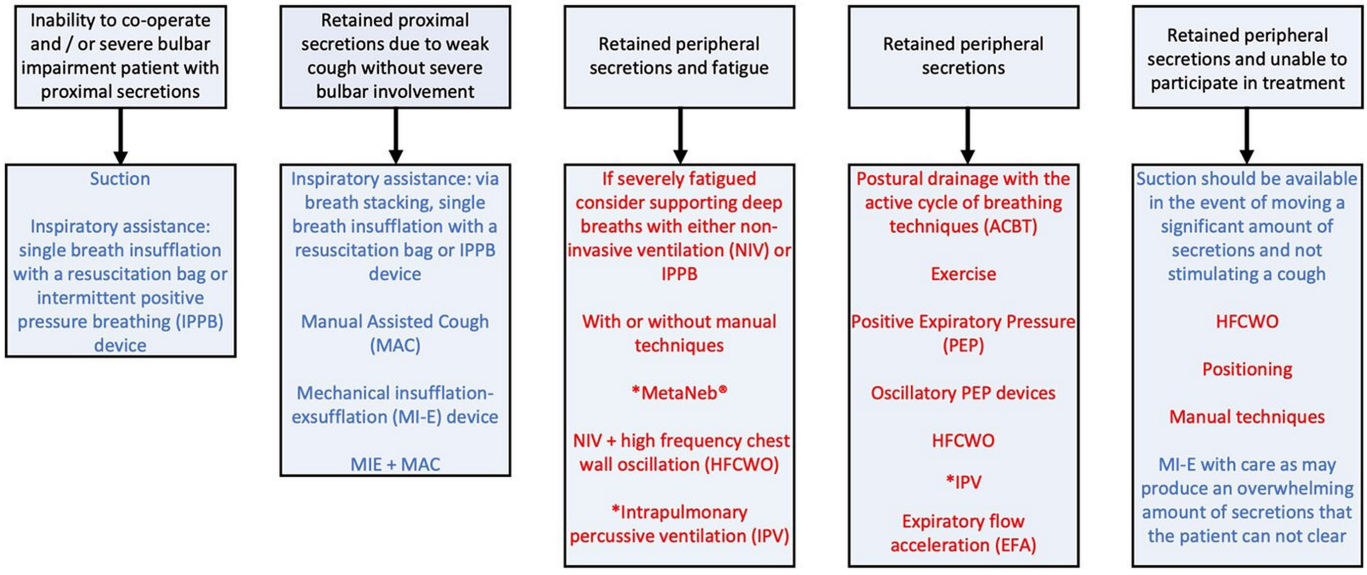

Figure 2 Physiotherapy algorithm for AP. AP, aspiration pneumonia. Respiratory physiotherapy options for patients with AP and retained secretions. Techniques in blue are proximal ACTs and techniques in red are peripheral ACTs. Note that *IPV (if available) and the *MetaNeb are used in the acute setting. ACBT, active cycle of breathing techniques; EFA, expiratory flow acceleration; HFCWO, high-frequency chest wall oscillation; IPPB, intermittent positive pressure breathing; IPV, intrapulmonary percussive ventilation; MAC, manual-assisted cough; MI-E, mechanical insufflation-exsufflation; NIV, non-invasive ventilation; PEP, positive expiratory pressure.

conscious level, a range of options are available (figure 2). An approach tailored to the individual patient and their circumstances is recommended, guided by expert local respiratory physiotherapists. Patients with chronic aspiration or persistently ineffective cough are likely to need a long-term home treatment programme of ACTs and ongoing review by a respiratory physiotherapist. ACTs for use in learning disability are discussed in the Learning Disability statement, see comment beside Table 1.[2]

Initiation of preventive measures

This Management section considers the treatment of patients with suspected or established AP. The majority of such patients will have impaired swallowing, and so the general preventive measures discussed in the Prevention section should also be implemented to avoid further aspiration. Measures to promote return of swallowing, cough, mobility and general strength should be started as early as possible.

It is important to keep in mind that AP itself induces muscle atrophy,[250] and so patients run the risk of entering a vicious cycle of decline if early strategies to encourage adequate nutrition and rehabilitation are not pursued early.

Liaison with community teams

Patients with AP are at high risk for further swallowing difficulties and recurrent AP. There will often be ongoing rehabilitation, nutritional and oral care needs after the patient leaves hospital, and ongoing support may be required for smoking cessation, weight management and exercise. The patient and their family should be educated in all these aspects prior to discharge from hospital, and encouraged to take ownership for addressing these, as much possible. Prior to discharge, liaison with primary care and relevant community teams is strongly encouraged (eg, community SLTs, community physiotherapists, community dietitians and district nurses).

Advance care planning

For some patients, AP may be a 'sentinel event' either uncovering a previously unidentified condition with a poor prognosis or signalling deterioration of a known condition.[251] In these situations, even when the patient makes a good recovery, it is important for clinicians to explain that further deterioration is expected and to give the patient the opportunity to consider their treatment preferences.

Advance care planning supports patient choice and ensures optimal management, including advocacy for active intervention if clinically appropriate. Where possible, challenging decisions about treatment at the end of life are best discussed in advance, when the patient feels well enough to participate fully in decisions.[252–254] A patient may also choose to write a legally binding Advance Decision to Refuse Treatment, specifying the interventions that would not be wanted in specific situations.[255] Specific aspects of palliative care are discussed in the following section and in online supplemental appendix 2.

Special considerations in children

Acute AP in children should be managed with oxygen, antibiotics and physiotherapy as needed. Acute large volume aspiration usually occurs in children with multiple comorbidities and vulnerabilities. In cerebral palsy, for example, intercurrent viral infection, worsening upper airway obstruction, loss of seizure control, sedating antiseizure medication, gastrointestinal dysmotility, constipation, musculoskeletal pain, hypertonicity and spasms may all trigger a cycle of deterioration in health, ultimately resulting in AP. Comorbidities must, therefore, be carefully assessed and treatments optimised.

Each aspiration event should precipitate a re-evaluation of safe-feeding interventions to reduce the likelihood of recurrence.

PALLIATIVE AND SUPPORTIVE CARE

This section is particularly relevant for patients in three categories.

1. Patients already known to be reaching the end of life who develop AP either as a direct consequence of their other underlying condition(s) or due to increasing frailty.
2. Patients for whom AP acts as a 'sentinel event' bringing an underlying serious condition to light for the first time or signalling a deterioration in a known progressive incurable condition.
3. Patients who have significant symptom burden or who appear to be ill enough to die as a result of AP, even if there is uncertainty and active treatment is being pursued.

Palliative care considerations specific to learning disability are discussed in the Learning Disability Statement, see comment beside Table 1.[2]

Good palliative and holistic care should identify and address physical, social, psychological and spiritual concerns and requires a multidisciplinary approach. Patients reaching the end of life should be offered choice, when possible, about where they receive ongoing care and about the things that help them to retain quality of life, even if some choices include additional risk to their health. If the patient does not want a particular intervention, or the best interest decision is that the burdens of escalating treatment outweigh the potential benefits, good care must not cease. Efforts should be made to manage symptoms, and to stop any interventions or investigations that are unlikely to improve the patient's well-being. If there are persistent unmet needs, the treating team should involve a specialist palliative care team.

If a patient is discharged to a community setting for end of life care, continuity of care is essential. Continuity can be supported by liaison with general practitioners, community nursing teams and palliative care teams, and through an advance care plan including agreed Do Not Attempt Cardiopulmonary Resuscitation directives, which should be shared with relevant community, acute and emergency services.

Clinical practice points

- ⇒ For patients being managed for AP in a hospital, the antibiotic regimen should be informed by Medical Microbiology guidance on local epidemiology, taking into account recent antibiotic exposure, recent microbiology results when available, and where the patient was when the pneumonia began.
- ⇒ A 5-day course of antibiotics is considered adequate for AP unless there is failure to improve, in which case alternative sources of illness, complications of AP and/or an alternative antibiotic regimen should be sought.
- ⇒ Patients being managed for AP should receive thromboprophylaxis (unless contraindicated), adequate hydration and (if required) supplemental oxygen.
- ⇒ Patients hospitalised with AP should have early access to physiotherapy (to reduce the risk of sputum retention or atelectasis), with early referral for general, respiratory or neurorehabilitation as appropriate.

Use of antibiotics at the end of life

The use of antibiotics to treat infection at the end of life remains controversial. On one hand, antibiotics may be considered a futile treatment risking side effects. On the other hand, studies have suggested that in some cases, the use of antibiotics in a person who is dying with sepsis can reduce suffering and improve quality of life.[256 257] Antibiotics have been shown to relieve symptoms of fever, cough and purulent secretions in some patients at the end of life.[258–260] Individualised decisions must, therefore, be made, which take into account the wishes and priorities of the patient, the symptoms experienced and evidence of any benefit gained from prior antibiotic treatment.

We suggest antibiotics could be considered in end of life treatment when the following criteria are all met:

- If a patient has significant symptoms directly relating to their pneumonia (including excessive secretions, cough, fever or delirium).
- If other symptom management approaches have not improved the patient's well-being.
- If the patient is able to take oral antibiotics safely or is likely to remain in a setting where parenteral antibiotics can be administered, and this treatment is acceptable to the patient.

Treatment goals should be discussed with the patient and their family and clearly documented with a plan to review symptomatic response within 48 hours. It is important to be clear that this treatment is not expected to 'cure' the patient.

Clinically assisted nutrition and hydration

Where impaired swallowing persists and is considered to present a significant risk of AP, decisions must be made around appropriate means of maintaining nutrition and hydration. Again, the benefits must be weighed against the burdens of possible interventions, and it is important to understand the patient's own goals and priorities. Any decision, whether to give or to withhold clinically assisted nutrition or hydration, must be made on an individual basis and reviewed regularly. Guidelines have been developed to support decision-making around withholding and withdrawing clinically assisted nutrition and hydration for adults[261] and children.[262 263]

In general, clinically assisted nutrition offers limited benefit for the patient in the last days of life. It is unlikely to improve symptoms or prolong life, and for some can cause discomfort through bloating, vomiting or GOR.[264] Although evidence is limited,[265] it is recognised that continuing artificial hydration may reduce thirst or delirium for some. In others, however, it may exacerbate pulmonary and peripheral oedema, and worsen bronchial secretions.

Ensuring that family members are informed about the patient's condition and able to participate in advance care planning if the patient wishes, helps to reduce painful effects of bereavement.[266] After death, family members may benefit from an opportunity to ask questions or speak to someone who cared for their loved one.

Clinical practice point

⇒ The palliative care needs of patients approaching the end of life, and their families, should be addressed, including advance care planning and referral to specialist palliative care services as appropriate.

Further details relating to palliative care are found in online supplemental appendix 2.

SUGGESTED AREAS FOR FUTURE RESEARCH

Several important issues require to be addressed to reduce the prevalence and improve the management of AP. We believe that two of the most pressing issues relate to

- The relative absence of patient-centred outcomes as relevant, validated primary outcome measures for clinical trials.
- The relative absence of information on AP in resource-poor healthcare systems.

These shortcomings are linked, in that interventions and outcomes typically studied in resource-rich countries may not be available or relevant in developing countries.

Additional questions that should be addressed include:

- What is the minimum effective and safe duration of antibiotics for AP?
- Which patients can be safely treated with oral antibiotics, and managed in the community?
- Are there biomarkers that can reliably differentiate AP from other acute presentations, and which can predict outcomes or inform safe and effective de-escalation of antibiotics?
- Can a reliable severity score be developed and validated specifically for AP and can such a score guide more rational prescribing of antibiotics?
- Are there biomarkers that identify people at risk of future swallowing difficulties?
- Which oropharyngeal or laryngeal sensory pathways are most affected in patients at risk for AP, which are most amenable to pharmacological or physical stimulation, and can such interventions reduce AP?
- Does transcutaneous electrical stimulation improve outcomes in a multicentre setting?
- Can thoracic CT or thoracic ultrasound improve on the diagnostic accuracy of CXR sufficiently to drive improved treatment and outcomes in patients with suspected AP?
- What are the immune characteristics of patients with (or at risk of) AP and, if abnormal, can these be boosted to improve outcomes?
- How well do specific findings at VFS or FEES predict or correlate with AP development?
- Can transient pharmacological or non-pharmacological interventions to increase muscle strength improve outcomes in AP? For example, can agents that boost mitochondrial number and function improve neuromuscular performance and outcomes?

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