www.brn.cat

PERMANYER

BRN Rev. 2025;11(2):122-135

BRN Reviews

REVIEW ARTICLE

Aspiration pneumonia: epidemiology, risk factors, etiology, diagnosis, treatment, prophylaxis, and prognosis

Clàudia Sitges-Milà[1,2,3]*, Ramon Boixeda Viu[1,2,3,4], and Jordi Almirall[2,3,4,5]

[1]Internal Medicine Service, Hospital Universitari de Mataró, Consorci Sanitari Del Maresme, Mataró, Barcelona, Spain; [2]Facultat de Medicina, Universitat Autònoma de Barcelona, Barcelona, Spain; [3]Grup d'Estudi al Maresme de la Pneumònia Adquirida a la Comunitat i la MPOC, Consorci Sanitari del Maresme, Barcelona; [4]Centro de Investigación Biomédica en Red de Enfermedades Respiratorias, Madrid; [5]Intensive Care Unit, Hospital Universitari de Mataró, Consorci Sanitari Del Maresme, Barcelona, Spain

ABSTRACT

Aspiration pneumonia (AP) represents an increasing global health concern due to its high incidence and mortality, especially in ageing populations. This review explores AP's definition, epidemiology, etiology, risk factors, diagnosis, treatment, prevention, and costs. This review was conducted through a comprehensive analysis of the existing AP literature. AP primarily affects elders and is closely linked to oropharyngeal dysphagia. Diagnosis requires clinical and radiological evaluation alongside risk factor assessment for oropharyngeal aspiration and oral bacterial colonization. Management is multidisciplinary, with guidelines discouraging routine anaerobic antibiotics. Prevention includes rehabilitation, oral care, vaccination, swallowing, and risk factor assessment. AP leads to poorer outcomes than non-AP, including higher recurrence, mortality, longer hospitalization, and increased healthcare costs. AP requires multimodal and multidisciplinary management, targeted antibiotics, and non-pharmacological prevention. Further research is essential to optimize treatment and prevention.

Keywords: Aspiration pneumonia. Oropharyngeal dysphagia. Multidisciplinary management.

***Correspondence to:**
Clàudia Sitges-Milà
E-mail: csitges@csdm.cat

Received: 16-04-2025
Accepted: 14-05-2025
DOI: 10.23866/BRNRev:2025-M0132
www.brnreviews.com

INTRODUCTION

Pneumonia is a lung infection affecting the alveoli and distal bronchial tree[1]. It is a major global health issue due to its high incidence and mortality[1,2]. The 2019 Global Burden of Disease study reported that lower respiratory infections (LRI), including pneumonia, accounted for approximately 488.9 million new cases worldwide[3]. It primarily affects vulnerable individuals, such as older adults with pre-existing chronic conditions[1]. In 2016, adults aged 70 and older had the highest global incidence rate of LRI, with 18,900 cases/ 100,000, followed by those aged 50-69, who experienced 6,370 cases/100,000. LRI was responsible for 2.4 million deaths in 2019, with an age-standardized rate of 34.3/100,000[3]. A systematic review by Shi et al., which analyzed data from around 17 million pneumonia-related cases in older adults across 101 studies, estimated that in 2015, approximately 6.8 million individuals with pneumonia required hospitalization, accounting for 9% of all pneumonia cases. In addition, the study found that about 1.1 million pneumonia-related deaths occurred in hospitals, with an estimated 92% of all pneumonia-associated deaths taking place in hospital settings[4].

Pneumonia is classified into hospital-acquired pneumonia (HAP), which occurs at least 2 days after hospital admission without prior respiratory infection, and community-acquired pneumonia (CAP), which develops outside hospital settings in individuals not hospitalized in the past month[1]. This classification is crucial for treatment decisions, as diverse microorganisms are involved depending on the setting, as outlined in different international guidelines, such as the European, American, and Japanese ones[5-7].

Furthermore, it is also essential to acknowledge aspiration pneumonia (AP) as a distinct clinical entity. Some perspectives view AP as part of a continuum with both CAP and HAP[8-12]. AP is particularly prevalent among older adults and hospitalized patients, posing a substantial health burden due to its high morbidity and mortality[8,9,13]. The incidence of AP is closely associated with oropharyngeal dysphagia (OD), which is highly prevalent among older adults[9,14,15]. Studies suggest that 5-15% of CAP cases involve AP, leading to recurrent pneumonia, frailty, and increased healthcare costs due to the underrecognition of OD as a critical etiological factor[8,9,15-18].

Despite its clinical importance, the prevalence of AP may be significantly underestimated. Swallowing assessments-essential for identifying patients at risk-are not routinely performed in many hospital settings[9,14,17,19]. In addition, the absence of well-defined diagnostic criteria further complicates the accurate identification and management of AP[8,19,20].

Given the rising elderly population and the associated predisposing factors for aspiration, the incidence of AP is likely to increase[8,21]. Understanding the complexities of its definition, epidemiology, risk factors, and the evolving role of the microbiome is crucial for developing comprehensive diagnostic tools, effective treatment protocols, and targeted prevention strategies to improve outcomes in vulnerable populations and even reduce healthcare costs[8,15,21].

This review aims to define AP and examine its epidemiology, pathogenesis, and key risk factors, particularly in older adults. It seeks to explore clinical characteristics,

prognostic factors, and the evolving microbiologic etiology, including the role of the oral microbiome and anaerobic bacteria. The review also assesses diagnostic strategies, treatment approaches, preventive measures, and the impact of microbiology on therapy. In addition, it highlights essential clinical competencies for managing AP to enhance multidisciplinary healthcare practices in clinical, educational, and research settings.

DEFINITION OF AP

As discussed in the Introduction, AP lacks a universally accepted definition and diagnostic criteria but is generally described as a lung infection with radiological evidence of infiltrates or consolidation, caused by inhaling foreign material, typically bacteria-colonized oropharyngeal secretions or gastric contents, into the lower respiratory tract[1,8-10,11,13-16,18-20,22-26]. It is important to distinguish AP from aspiration pneumonitis, a chemical lung injury from sterile gastric content inhalation, which can sometimes progress to bacterial infection[10,15,18,22,23,27,28]. While small amounts of oropharyngeal secretion aspiration can occur normally, macroaspiration, involving larger volumes of oropharyngeal or upper gastrointestinal contents, is a key driver in the pathogenesis of AP[22].

It typically occurs in patients with swallowing disorders, OD, or other risk factors for aspiration, such as impaired cough reflexes, and neurological disorders[8-15,23,29]. Moreover, AP is frequently underdiagnosed, partly due to the occurrence of silent aspiration where no overt aspiration event is witnessed[8,19,20]. Unclear diagnostic criteria hinder the proper identification and management of AP[8,19,20]. Difficulty swallowing and poor oral hygiene were identified as two key risk factors significantly linked to the development of pneumonia[14] (Table 1). The primary risk factor in older adults is aspiration due to impaired swallowing function, mainly OD[14]. A second key risk factor is bacterial lung tissue invasion from aspirated material, typically occurring in patients with OD and aspiration[9,14,15]. Poor oral hygiene promotes bacterial growth, leading to oral microbiome dysbiosis, and increasing the concentration of Gram-negative bacteria[8-10,13-15,23,30]. The third major risk factor is host vulnerability, including frailty, malnutrition, and immune impairment[9,13,15,19,20]. AP is also associated with advanced age, dehydration, smoking, antibiotic or inhaler use, frequent hospital readmissions, and increased mortality[8,9,13,15].

Table 1. When to suspect AP

The suspicion of AP is raised when a patient presents with respiratory symptoms and radiological evidence of lung infiltrates, particularly in the context of:

1. Impaired swallowing function (primarily, OD) and other risk factors for oropharyngeal aspiration.
2. Poor oral hygiene and other risk factors for oral bacterial colonization.
3. Host vulnerability (e.g., frailty, malnutrition, and immune impairment).
4. Advanced age.

AP: aspiration pneumonia; OD: oropharyngeal dysphagia.

EPIDEMIOLOGY OF AP

AP is a major health concern, especially among older adults and hospitalized patients, due to its high morbidity and mortality[8,9,13]. Its incidence is strongly linked to OD, which affects 27% of community-dwelling older adults and up to 75% of

those hospitalized with CAP[9,14,15]. In 2013, Almirall et al. reported a prevalence of OD of 91.7% in elderly patients with CAP using the volume-viscosity swallow test, and 75% using videofluoroscopy, being considered the gold standard for the diagnosis of OD[31]. In the same study, 52.8% of patients experienced severe penetration or aspiration during swallowing, and 16.7% had silent aspiration[31]. AP accounts for an estimated 5-15% of CAP cases, contributing to recurrent pneumonia, frailty, and increased healthcare costs due to the underrecognition of OD as a key etiological factor[8,9,15,17,18]. However, the prevalence of AP may be underestimated, as swallowing assessments are not routinely conducted in many hospitals[9,14,17,19], including bedside swallowing clinical evaluation[32-35], videofluoroscopy[32,36-38], fiber optic endoscopic evaluation[37,38] or even artificial intelligence (AI)-based tools. For example, recently, a clinical algorithm was developed based on the Japanese Respiratory Society guidelines to aid in diagnosing AP in older hospitalized adults[19], as well as an AI-based screening for OD called the AI massive screening-OD tool, developed by Martin-Martinez et al.[39] Since OD is the primary etiological factor for AP, this tool would assist in identifying patients likely to have AP.

The incidence of AP is likely to increase due to the rising elderly population and the associated predisposing factors for aspiration, such as ageing-related immune system decline, multiple chronic illnesses, and general frailty[8,12,21].

DIAGNOSIS OF AP

A universally accepted definition and diagnostic criteria for AP remain elusive[1,8,9,13,14,18,19,22,25,26]. As a result, some studies advocate for a multifactorial diagnostic approach, incorporating clinical evaluation, imaging[8-10,15,40], microbiological studies, swallowing assessments, and clinical algorithms[9,11,18-20,24,29,41,42].

AP diagnosis begins with assessing symptoms such as acute respiratory distress, fever, increased sputum production, fatigue, and dyspnea[8,9,27]. In older adults, atypical signs, such as altered mental status, fatigue, and decreased appetite may predominate[13,27]. Physical examination may reveal hypoxemia, tachypnea, crackles, wheezing, and accessory muscle use[27].

Radiological evidence of pulmonary infiltrates or consolidation, often with a gravity-dependent distribution, is essential for AP diagnosis. In upright or semi-recumbent patients, the lower lobe basal segments (particularly of the right lower lobe) are commonly affected, whereas bedridden patients may show posterior upper lobe involvement (especially the right upper lobe and the right apical segment of the lower lobe)[23,40,43]. If a chest X-ray is inconclusive, lung ultrasound or chest computed tomography may be helpful[23,40].

Diagnosing AP can be difficult in cases of silent aspiration or unobserved events[9,15,29,42]. Relying solely on aspiration (whether silent or noticeable) for diagnosing AP may lead to an overestimation, increasing the risk of false positives, particularly in patients with risk factors for heightened oropharyngeal aspiration[15]. Therefore, many experts suggest that an accurate diagnosis should be based on a combination of clinical suspicion, radiological findings, and the presence of risk factors for both oropharyngeal aspiration and oral bacterial colonisation[8,13-15,19,20,24,29,41,43].

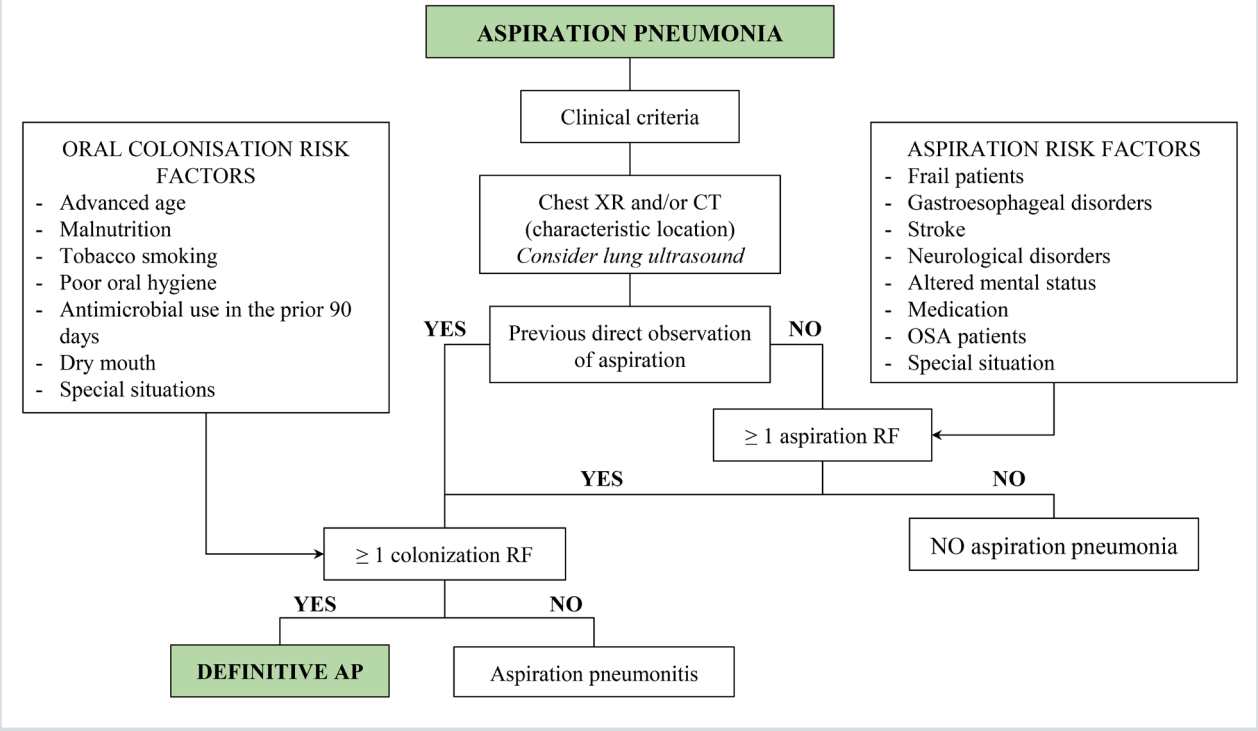

Figure 1. Algorithm for the diagnosis of aspiration pneumonia and aspiration pneumonitism (*adapted from Almirall et al., 2021[15]. Reprinted with the authors' permission*). AP: aspiration pneumonia; XR: X-rays, CT: computed tomography, OSA: obstructive sleep apnea, RF: risk factor.

Some proposed algorithms integrate clinical and radiological signs, aspiration, and risk factors to differentiate AP from aspiration pneumonitis[8,15,20], including the Almirall et al. algorithm (Fig. 1). When clinical symptoms are suggestive, radiological findings confirm infiltrates, and the patient presents with one or more aspiration risk factors along with at least one risk factor for oral contamination, aspiration pneumonitis should be ruled out, and AP should be considered[15]. Biomarkers, such as serum procalcitonin, which tend to be elevated in AP, are being explored for further differentiation[15,17,28,44].

Sputum and blood cultures can support diagnosis and guide antibiotic selection[10,14]. Antibiotic stewardship emphasizes that when culture-based techniques are used, de-escalation should occur within 48-72 h based on the results. However, since conventional methods may yield negative results, modern molecular approaches, such as multiplex polymerase chain reaction or 16S ribosomal ribonucleic acid (16S rRNA) gene sequencing, should be considered in certain situations according to clinical criteria[23].

RISK FACTORS FOR AP

To consider the risk factors for AP, both risk factors for oropharyngeal aspiration and oral bacterial colonization should be considered.

Table 2. Risk factors for oropharyngeal aspiration

- Swallowing disorders (especially OD) and other gastrointestinal motility or obstructive disorders
- Silent aspiration
- Frailty
- Older age
- Medications (sedatives, antipsychotics, and general anesthesia)
- Alcohol and other drugs
- Metabolic encephalopathy
- Impaired cough reflex
- Neurological disorders: some neurodegenerative diseases, cerebrovascular disease, seizures, central nervous system neoplasms
- Muscular disorders: neuromuscular diseases involving respiratory or bulbar muscles, pharyngoesophageal myopathies
- Respiratory disorders: impaired mucociliary clearance (e.g., COPD, bronchiectasis, cystic fibrosis, and interstitial lung disease)
- Heart disorders: chronic heart disease, post-cardiac arrest events
- Airway Manipulation and Respiratory Procedures
- Gastrointestinal and oropharyngeal Interventions

COPD: chronic obstructive pulmonary disease.

Table 3. Risk factors for oral bacterial colonisation

– Malnutrition and dehydration	– Enteral nutrition
– Smoking	– Upper gastrointestinal endoscopy
– Reduced immunity	– Recent history of inappropriate antibiotic treatment
– Poor oral hygiene and increased bacterial load	– Inhaler use
– Tracheal cannulation and endotracheal intubation	– Medications that alter gastric pH (e.g., proton pump inhibitors, H2 blockers)

Risk factors for oropharyngeal aspiration

The primary risk factors for oropharyngeal aspiration (Table 2) include swallowing disorders (especially OD)[8-10,13,21,23,45,46], silent aspiration[8], frailty, and older age[8,9,47]. Other factors include a lower Glasgow Coma Scale Score[46], for example, states that are seen under the effect under some medications (sedatives, antipsychotics, and general anesthesia)[10,23], alcohol and other drugs[10,23], and metabolic encephalopathy[10]; and specific comorbidities such as impaired cough reflex[14,23], gastrointestinal disorders (e.g., gastrointestinal reflux, esophageal or gastric cancer, motility or obstruction disorders, vomiting)[10,23], degenerative neurological diseases[14], dementia[47], Parkinson's disease and other parkinsonisms[23,48], ischemic stroke or intracerebral hemorrhage[23,46], cerebrovascular disease[49], seizures[23], multiple sclerosis[23], central nervous system neoplasms[10], neuromuscular diseases involving respiratory or bulbar muscles[10], pharyngoesophageal myopathies[10], pulmonary diseases with impaired mucociliary clearance (e.g., chronic obstructive pulmonary disease (COPD), bronchiectasis, cystic fibrosis, and interstitial lung disease)[10,23], chronic heart disease[46], and post-cardiac arrest events[10,28].

Procedures that increase the risk include tracheal cannulation[8,43], endotracheal intubation[8,43] and extubation[23], enteral nutrition[8,10,13,23], prolonged mechanical ventilation (over 48 h)[46], cardiopulmonary resuscitation[10], esophageal, gastric, head or neck surgery or radiation[10], bronchoscopy[10], and upper gastrointestinal endoscopy[10,15,50].

Risk factors for oral bacterial colonization

Given that AP is an infectious process caused by bacteria from the oropharynx, the presence of risk factors for increased oral bacterial colonization is also important (Table 3). These include malnutrition and dehydration[9], smoking[9], reduced immunity[9], poor oral hygiene and increased bacterial load[8-10,14,28,49], tracheal cannulation[8,43], endotracheal intubation[8,43], enteral nutrition[8,10,13], upper gastrointestinal endoscopy[10,15,50], recent history of inappropriate antibiotic treatment[8,15],

Table 4. Etiological microbiology of AP

Normal lung microbiome Under normal conditions, the lung microbiome is composed of a low-abundance yet diverse microbial community (predominantly obligate anaerobes such as *Prevotella, Veillonella*, and *Streptococcus* species) which helps modulate inflammation and general balance.
AP pathogens Disruptions, whether from aspiration, immunosuppression, or changes in the local environmental factors, reduce microbial diversity and favour pathogenic species. – Main AP pathogens: *Escherichia coli, Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. – Anaerobes (e.g., *Fusobacterium nucleatum, Fusobacterium necrophorum, Peptostreptococcus, Prevotella*, and *Bacteroides*) play a minor role. – CA-AP: *Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis*, and Group A *Streptococci*. – HA-AP: *P. aeruginosa, K. pneumoniae, Acinetobacter* spp., and MRSA.

AP: aspiration pneumonia; CA-AP: community-acquired AP; HA-AP: hospital-acquired AP; MRSA: methicillin-resistant *S. aureus*.

inhaler use[8,9], and medications that alter gastric pH (e.g., proton pump inhibitors, H2 blockers)[8,10].

ETIOLOGICAL MICROBIOLOGY OF AP

The lung microbiome and its role in AP

AP develops when oropharyngeal secretions or gastric contents, colonized with respiratory pathogens, are inhaled into the lower respiratory tract[10,13,14,16,18,22]. In healthy individuals, effective swallowing and coughing mechanisms prevent this; however, in susceptible individuals, aspiration disrupts the lung microbiota, leading to dysbiosis and infection[14]. The lung microbiome, closely resembling the oropharyngeal flora, plays a crucial role in infection development[14]. Experimental studies suggest that obligate anaerobes in the respiratory tract may mitigate disease severity by modulating inflammation[14,23]. Under normal conditions, the lung maintains a low-abundance yet diverse microbial community, primarily comprising *Prevotella*, *Veillonella*, and *Streptococcus* species[14,23]. Disruptions, whether from aspiration, immunosuppression, or changes in the local environmental factors (e.g., temperature variations, pH, oxygen concentration, nutrient availability), reduce microbial diversity and favor pathogenic species[14,23]. Notably, ageing is associated with an increased prevalence of *Pseudomonas* and *Staphylococcus* species, both implicated in pneumonia[23] (Table 4).

Traditional versus modern understanding of AP pathogens

Historically, anaerobic bacteria were considered the primary cause of AP, with early studies identifying *Fusobacterium nucleatum*, *Fusobacterium necrophorum*, *Peptostreptococcus*, *Prevotella*, and *Bacteroides* as common pathogens[14,23]. However, advances in diagnostics have reshaped this perspective[10,14]. More recent findings indicate that the bacterial profile of AP closely resembles that of CAP and HAP[14]. While anaerobes persist, Gram-negative rods, including *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*, are now recognized as predominant pathogens[10,14,15,17,23]. Among hospitalized elderly patients with severe AP, common pathogens include *E. coli*, *K. pneumoniae*, *Serratia* spp., *Proteus* spp., *Staphylococcus aureus*, and *Streptococcus pneumoniae*, with anaerobic bacteria playing a minor role[15].

Microbial variability in different AP settings

The bacterial spectrum of AP varies based on whether the infection is community-acquired or hospital-acquired. In community-acquired AP (CA-AP), prevalent pathogens include *S. pneumoniae*, *Haemophilus influenzae*, *Moraxella catarrhalis*, and Group A *Streptococci*[14]. Risk factors for multidrug-resistant (MDR) Gram-negative organisms (e.g., *P. aeruginosa*, Enterobacteriaceae) include prior colonization, recent hospitalization (> 5 days), antibiotic use within 90 days, immunosuppression, and chronic lung disease (e.g., bronchiectasis, COPD)[10]. For *S. aureus*, particularly methicillin-resistant *S. aureus* (MRSA), risk factors include chronic indwelling catheters, intravenous drug use, and human immunodeficiency virus infection[10]. In Hospital-acquired AP (HA-AP), key pathogens of concern include Gram-negative bacilli (*P. aeruginosa, K. pneumoniae, Acinetobacter* spp.) and MRSA[10]. At present, an estimated 6-10% of all AP cases involve MDR organisms (MDROs)[10,23]. HA-AP is more commonly associated with Gram-negative bacilli such as *P. aeruginosa*, *K. pneumoniae*, and *Acinetobacter* spp., as well as MRSA[14]. Patients in long-term care facilities or those with extended hospital stays are at heightened risk of colonization by MDROs, which can lead to infection[14].

Impact of oral colonization on AP pathogens

Oral hygiene significantly influences AP pathogenesis[14]. Poor oral care facilitates dental plaque accumulation, creating a reservoir for respiratory pathogens[14]. In acidic environments, cariogenic bacteria and *Candida albicans* thrive, while inflamed gums promote the growth of anaerobic Gram-negative bacteria[14]. Macroaspiration of oropharyngeal secretions containing virulent bacteria, such as *S. pneumoniae*, *K. pneumoniae*, and *P. aeruginosa*, can overwhelm host defenses, further contributing to AP development[14]. On the contrary, general oral health has improved over the years, with better overall status, fewer missing teeth, and increased toothbrushing[11]. This may have influenced the oral microbiota and bacteria linked to AP[11]. In addition, a shift in patient demographics-from younger individuals with alcoholism or anesthesia exposure to older patients-may have reduced the prevalence of anaerobic pathogens[11].

TREATMENT AND PREVENTION OF AP

Managing AP requires a comprehensive, multimodal approach that addresses key factors, such as patient history, comorbidities, frailty, consciousness level, differential diagnosis, microbiology results, local resistance patterns, adequate antibiotic treatment, nutrition, swallowing assessment, oral hygiene, and overall response to therapy[11,20,17]. Antibiotic selection should be based on the infection source, the patient's characteristics, and risk factors for MDROs. Standardizing care through clinical education can improve patient outcomes[17]. Preventative strategies, such as rehabilitation, oral feeding techniques, tube feeding, and oral care, are essential. General management of AP is summarised in figure 2.

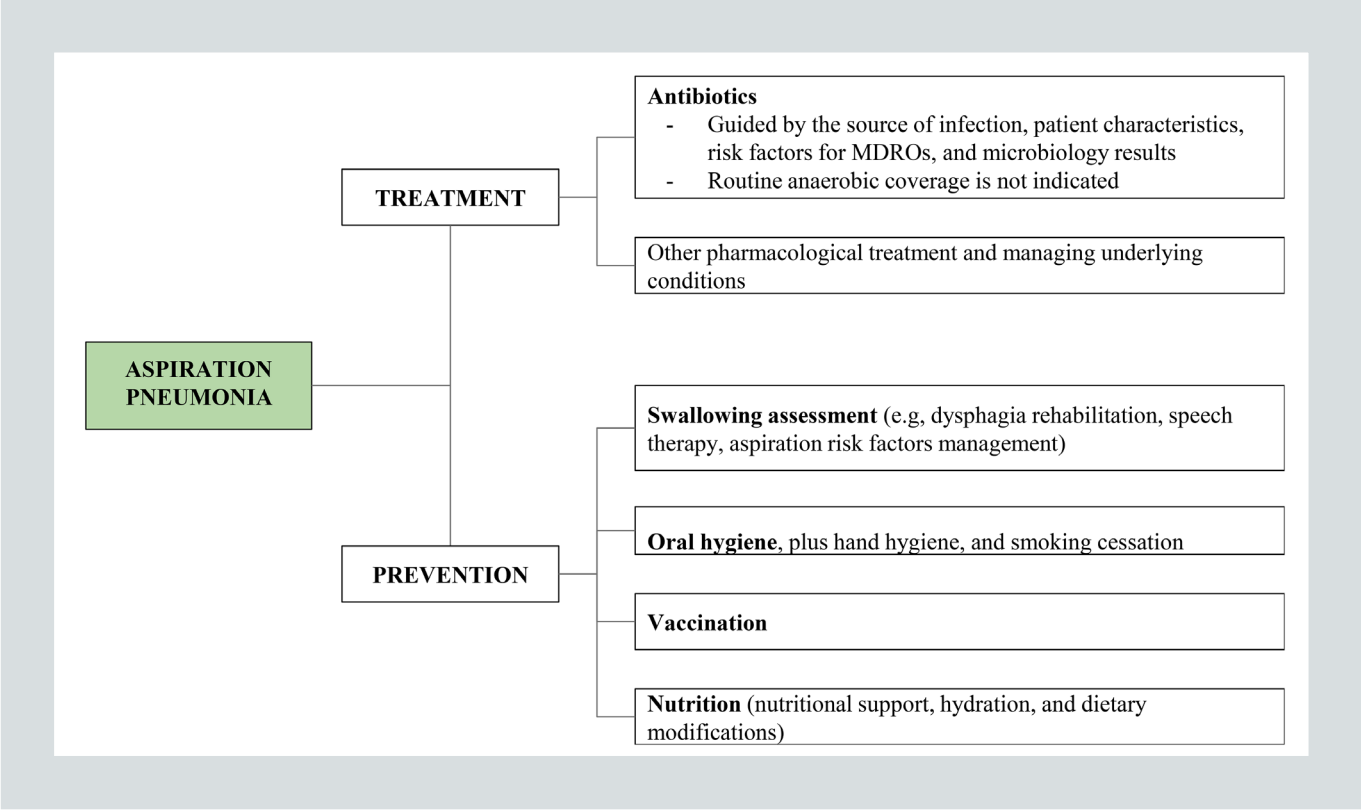

Figure 2. Algorithm for the diagnosis of aspiration pneumonia and aspiration pneumonitism . AP: aspiration pneumonia; XR: X-rays, CT: computed tomography, OSA: obstructive sleep apnea, RF: risk factor.

ANTIBIOTIC TREATMENT

The treatment of AP has evolved significantly, with a shifting focus on the role of anaerobic antibiotics. Historically, anaerobes were a primary concern, with penicillin being a preferred choice, later replaced by clindamycin due to increasing resistance[17].

The infection's origin and specific patient risk factors (e.g., recent antibiotic use or prolonged hospitalization) typically guide antibiotic selection in AP-whether CA-AP or HA-AP[17]. Adjustments are made as microbiological data becomes available[12]. Clinical guidelines, including the European, American, and Japanese guidelines[5-7], now recommend against the routine use of anaerobic antibiotics in the treatment of AP, reflecting the reduced role of anaerobes in both community and HAP[11]. CA-AP is usually treated with narrow-spectrum antibiotics, such as β-lactam (e.g., ampicillin-sulbactam, ceftriaxone) and either a macrolide (azithromycin) or a fluoroquinolone (levofloxacin), which generally provide sufficient coverage for common respiratory pathogens and many anaerobes without the need for specific anaerobic therapy[16,17,29]. Asaga et al.'s systematic review and meta-analysis found that anaerobic coverage does not improve clinical outcomes, such as mortality, length of stay, or intensive care unit (ICU) admission in AP treatment[12]. In cases where MDROs are suspected, including HA-AP, broader-spectrum antibiotics may be employed[10,17], such as piperacillin-tazobactam, cefepime, aminoglycosides, colistin, vancomycin, or linezolid[10,17]. However, recent research

has questioned the necessity of routine anaerobic coverage in the management of AP, particularly in light of changing pathogen profiles and growing concerns over antibiotic resistance and complications, such as a higher risk of *Clostridioides difficile* infection[9-12,16,17]. Present evidence suggests that anaerobic coverage does not provide significant benefits in the absence of complications, such as lung abscess or empyema[10,11,17]. Most cases should be treated for 5-7 days unless complications, such as necrotizing pneumonia, lung abscess, or empyema require extended therapy and drainage[17]. Acute-phase reactants can be helpful to guide antibiotic de-escalation and reduce unnecessary antibiotic exposure without increasing mortality[10].

OTHER PHARMACOLOGIC TREATMENT

The role of adjunctive therapies, such as corticosteroids, remains unclear. While some studies suggest benefits in severe CAP, there is no solid evidence supporting their use in AP specifically[10,17]. Furthermore, some medications such as angiotensin-converting-enzyme inhibitors, and cilostazol (a phosphodiesterase 3 inhibitor), which enhance substance P levels, and emerging treatments such as amantadine, strengthen both swallowing and cough reflexes, particularly in stroke patients[29]. Mosapride, a gastroprokinetic agent, may help prevent gastroesophageal reflux, further lowering aspiration risk in enterally fed patients[29]. While promising, these therapies require further research to confirm their effectiveness in reducing the incidence of AP[10,29]. Managing underlying conditions that increase aspiration risk and supporting lung function are also key strategies in preventing AP[20,29]. In patients with chronic lung diseases such as COPD, bronchiectasis, or pulmonary tuberculosis, bronchodilators-particularly combined long-acting β2-agonist and long-acting muscarinic antagonist therapy can help improve respiratory function and reduce the risk of AP[29].

In contrast, medications that may impair consciousness, disrupt swallowing function, or increase the risk of aspiration should be avoided or used with caution[20,29]. These include anticholinergics, tricyclic antidepressants, diuretics, selective serotonin reuptake inhibitors, hypnotics, and sedatives[29].

OTHER THERAPIES AND PREVENTION

Non-pharmacologic strategies also play a crucial role in managing AP[9,11,20,29]. Dysphagia management through rehabilitation and proper oral care reduces bacterial load and minimizes aspiration risks[9,11,20,24,29]. Moreover, an elevated head positioning of about 30° can help prevent aspiration events[29]. Preventative measures, such as vaccination against pneumococcus and influenza, are crucial in vulnerable populations like the elderly, who are at higher risk for AP[20,29]. Multidisciplinary approaches to care, including speech therapy, nutritional support (especially caloric and protein evaluation), dietary modifications (e.g., modified textures and fluid thickeners), hydration, smoking cessation, hand hygiene, aspiration risk factors management, and swallowing assessments, are key in preventing recurrent aspiration and improving patient outcomes[9,13,20,29].

In cases where AP proves difficult to manage, such as in patients with severe dysphagia due to neurologic conditions or head and neck cancer, aspiration prevention surgeries may be considered[51]. However, these surgeries, which modify the pharyngolaryngeal structure to reduce aspiration, have mixed outcomes and should be carefully evaluated[51].

In conclusion, effective management of AP involves tailored antibiotic therapy based on microbial risk, with a growing consensus that routine anaerobic coverage is unnecessary in most cases. Multidisciplinary care, including dysphagia management, oral care, and preventive measures, is essential for improving outcomes. Ongoing research is needed to refine treatment strategies and explore new therapeutic options for patients at high risk of AP[10-12,17].

PROGNOSIS OF AP

AP is increasingly recognized as a severe and life-threatening respiratory infection, particularly among frail and elderly patients requiring hospitalisation[15]. Compared to non-AP, patients with AP exhibit more severe clinical presentations[8], and higher rates of pneumonia recurrence[9,18,25,40,41,43], rehospitalisation[27,40,43], longer hospital stays[18,28,43], frailty[9], impaired functionality[9], and elevated short and long-term mortality[8,9,12,13,18,24,27,40,41,43,47]. In particular, 1-year mortality rates after AP have been reported as high as 65% in Parkinson's disease patients[48] and 35.7% in Japanese cohorts[40]. In cases of large volume aspiration or low pH aspirates, mortality may reach 70%[28].

Several risk factors have been consistently associated with worse outcomes in AP, including advanced age[15,18,19,27,40,41,43,46], male sex[41,46,47], frailty[15,18,19,41,43], malnutrition[19,41,47], low body mass index[18,43], decreased cough reflex[22], bedridden[41], impaired consciousness[11,46], and anesthetics, sleeping and sedative drugs[23,41]. Specific comorbidities such as OD[9,41,43,46], gastrointestinal diseases[23], neurological disorders[23], cerebrovascular disease[22,41,46,49], dementia[41], chronic heart failure[47,49], coronary heart disease[46,49], diabetes mellitus[49]and malignancy[47] further increase mortality risk and poor prognosis. Mechanical ventilation for more than 48 h[46], failure of protective mechanisms[52], an exaggerated inflammatory response[14], aspiration of colonized gastric contents[46], and the need for antibiotic escalation[47] have been associated with worse outcomes.

Common pathogens in AP include *E. coli*, *K. pneumoniae*, *P. aeruginosa*, and *S. aureus*. However, a direct association between specific microorganisms and worse prognosis in AP has not been clearly established[10,14,15,49].

HEALTHCARE COSTS

AP is associated with a significant economic burden due to increased hospitalizations, prolonged length of stay, increased disease complexity, and high mortality[18,44,46,48]. The extended need for intensive care further contributes to these costs[48]. Reducing the incidence and improving the management of AP can help alleviate this burden[44].

For instance, a recent study found that 71% of pneumonia patients admitted to the ICU in the United States (US) had AP, making it the third leading contributor to rising hospital

costs, alongside antibiotic therapy[46]. The risk of aspiration in hospitals is notably high, affecting approximately 56% of patients[46]. Implementing preventive measures and early speech therapy evaluations could be a cost-effective strategy, potentially saving up to $169.83/hospitalisation[46]. Moreover, in 2012, the median hospitalization cost for AP in the US was estimated at nearly $30,000[27]. In addition, research on the long-term financial impact of OD after a stroke shows that complications, such as respiratory infections can drastically increase healthcare expenses[9]. Malnourished patients or those at risk of malnutrition who experienced at least one respiratory infection faced significantly higher costs (€19,817.58) compared to those without OD (€7,242.80)[9].

CONCLUSION

AP is a serious and increasingly recognized respiratory infection, particularly affecting frail and elderly hospitalized patients. It represents a growing global health burden due to its high incidence, morbidity, mortality, and associated healthcare costs.

While there is no universally accepted definition of AP, the diagnosis should combine clinical suspicion, radiological findings, and the presence of risk factors for oropharyngeal aspiration and oral bacterial colonization.

Compared to non-AP, patients with AP often present with more severe illness, higher rates of recurrence and rehospitalization, prolonged hospital stays, greater functional decline, and increased short and long-term mortality.

Effective management requires a comprehensive, multidisciplinary approach that considers patient history, comorbidities, frailty, consciousness level, microbiology results, local resistance patterns, appropriate antibiotic therapy, nutrition, swallowing assessment, oral hygiene, and response to treatment. Routine anaerobic antibiotic coverage is generally not recommended unless clearly indicated. Antibiotic choice should be guided by the source of infection, patient characteristics, risk factors for MDROs, and microbiology results.

Non-pharmacological strategies are essential for both the prevention and management of AP. These include dysphagia management, good oral hygiene to reduce bacterial load, aspiration risk reduction (e.g., elevating the head of the bed), swallowing assessment, management of underlying conditions for aspiration risk, rehabilitation, nutritional support, dietary modifications, hydration, smoking cessation, and hand hygiene.

Improving diagnostic accuracy and implementing evidence-based treatment and prevention strategies may not only improve patient outcomes but also reduce healthcare costs. Further research is needed to optimize management approaches and explore new therapies for patients at high risk of AP.

ACKNOWLEDGMENT

This document is a component of C. Sitges-Milà's doctoral dissertation. This work has been carried out within the framework of the Doctorate in Medicine Program of the Universitat

Autònoma de Barcelona (UAB). The authors would like to express their gratitude to the Department of Medicine and the Doctoral School at UAB for providing a valuable opportunity for professional development.

FUNDING

The authors did not receive funds, grants, or support from any organization for the submitted work.

CONFLICTS OF INTEREST

None declared.

ETHICAL CONSIDERATIONS

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. The study does not involve patient personal data nor requires ethical approval. The SAGER guidelines do not apply.

Declaration on the use of artificial intelligence. The authors declare that no generative artificial intelligence was used in the writing of this manuscript.

REFERENCES

1. Torres A, Cilloniz C, Niederman MS, Menéndez R, Chalmers JD, Wunderink RG, et al. Pneumonia. Nat Rev Dis Primers. 2021;7:25.
2. Calabretta D, Martìn-Loeches I, Torres A. New guidelines for severe community-acquired pneumonia. Semin Respir Crit Care Med. 2024;45:274-86.
3. GBD 2019 LRI Collaborators. Age-sex differences in the global burden of lower respiratory infections and risk factors, 1990-2019: results from the global burden of disease study 2019. Lancet Infect Dis. 2022;22:1626-47.
4. Shi T, Denouel A, Tietjen AK, Lee JW, Falsey AR, Demont C, et al. Global and regional burden of hospital admissions for pneumonia in older adults: a systematic review and meta-analysis. J Infect Dis. 2020;222 Suppl 7:S570-6.
5. Martin-Loeches I, Torres A, Nagavci B, Aliberti S, Antonelli M, Bassetti M, et al. ERS/ESICM/ESCMID/ALAT guidelines for the management of severe community-acquired pneumonia. Intensive Care Med. 2023;49:615-32.
6. Metlay JP, Waterer GW, Long AC, Anzueto A, Brozek J, Crothers K, et al. Diagnosis and treatment of adults with community-acquired pneumonia. An official clinical practice guideline of the American thoracic society and infectious diseases society of America. Am J Respir Crit Care Med. 2019;200:e45-67.
7. Yatera K, Yamasaki K. Management of the diagnosis and treatment of pneumonia in an aging society. Intern Med. 2025;64:503-17.
8. Almirall J, Boixeda R, De La Torre MC, Torres A. Epidemiology and pathogenesis of aspiration pneumonia. Semin Respir Crit Care Med. 2024;45:621-5.
9. Ortega O, Guidotti L, Yoshimatsu Y, Sitges C, Martos J, Miró J, et al. Swallowing and aspiration: how to evaluate and treat swallowing disorders associated with aspiration pneumonia in older persons. Semin Respir Crit Care Med. 2024;45:678-93.
10. Pan D, Chung S, Nielsen E, Niederman MS. Aspiration pneumonia. Semin Respir Crit Care Med. 2024;45:237-45.
11. Yoshimatsu Y, Aga M, Komiya K, Haranaga S, Numata Y, Miki M, et al. The clinical significance of anaerobic coverage in the antibiotic treatment of aspiration pneumonia: a systematic review and meta-analysis. J Clin Med. 2023;12(5):1992.
12. Asaga R, Haruyama T, Zhang L. The uselessness of anaerobic antibiotic coverage in aspiration pneumonia: a systematic review and meta-analysis. J Clin Quest. 2024;1:24-30.
13. Lisiecka D, Kearns Á, Evans W, Farrell D. Aspiration pneumonia in nursing literature-a mapping review. Front Rehabil Sci. 2024;5:1393368.
14. Fadell F, Saliba R, El-Solh AA. Bacteriology of aspiration pneumonia: The lung microbiome and the changing microbial etiology. Semin Respir Crit Care Med. 2024;45:626-33.
15. Almirall J, Boixeda R, De La Torre MC, Torres A. Aspiration pneumonia: a renewed perspective and practical approach. Respir Med. 2021;185:106485.
16. Bai AD, Srivastava S, Digby GC, Girard V, Razak F, Verma AA. Anaerobic antibiotic coverage in aspiration pneumonia and the associated benefits and harms: a retrospective cohort study. Chest. 2024;166:39-48.
17. Mandell LA, Niederman MS. Aspiration pneumonia. N Engl J Med. 2019;380:651-63.
18. Wakabayashi T, Hamaguchi S, Morimoto K, Adult Pneumonia Study Group - Japan. Clinically defined aspiration pneumonia is an independent risk factor associated with long-term hospital stay: a prospective cohort study. BMC Pulm Med. 2023;23:351.
19. Yoshimatsu Y, Melgaard D, Westergren A, Skrubbeltrang C, Smithard DG. The diagnosis of aspiration pneumonia in older persons: a systematic review. Eur Geriatr Med. 2022;13:1071-80.
20. Yoshimatsu Y, Ohtake Y, Ukai M, Miyagami T, Morikawa T, Shimamura Y, et al. "Diagnose, treat, and support". Clinical competencies in the management of older adults with aspiration pneumonia: a scoping review. Eur Geriatr Med. 2024;15:57-66.
21. Ebihara T. Comprehensive approaches to aspiration pneumonia and dysphagia in the elderly on the disease time-axis. J Clin Med. 2022;11:5323.
22. Scannapieco FA. Poor oral health in the etiology and prevention of aspiration pneumonia. Clin Geriatr Med. 2023;39:257-71.
23. Vallianou NG, Skourtis A, Kounatidis D, Margellou E, Panagopoulos F, Geladari E, et al. The role of the respiratory microbiome in the pathogenesis of aspiration pneumonia: implications for diagnosis and potential therapeutic choices. Antibiotics (Basel). 2023;12:140.

24. Ashford JR. Impaired oral health: a required companion of bacterial aspiration pneumonia. Front Rehabil Sci. 2024;5:1337920.
25. Torres A, Niederman M. Aspiration pneumonia: preface. Semin Respir Crit Care Med. 2024;45:619-20.
26. Sanivarapu RR, Vaqar S, Gibson J, Overmeyer KA. Aspiration pneumonia (nursing). In: StatPearls. Treasure Island, FL: StatPearls Publishing; 2025.
27. Ocrospoma S, Restrepo MI. Severe aspiration pneumonia in the elderly. J Intensive Med. 2024;4:307-17.
28. Košutova P, Mikolka P. Aspiration syndromes and associated lung injury: incidence, pathophysiology and management. Physiol Res. 2021;70 Suppl 4:S567-83.
29. Teramoto S. The current definition, epidemiology, animal models and a novel therapeutic strategy for aspiration pneumonia. Respir Investig. 2022;60:45-55.
30. Mira A, Simon-Soro A, Curtis MA. Role of microbial communities in the pathogenesis of periodontal diseases and caries. J Clin Periodontol. 2017;44 Suppl 18:S23-38.
31. Almirall J, Rofes L, Serra-Prat M, Icart R, Palomera E, Arreola V, et al. Oropharyngeal dysphagia is a risk factor for community-acquired pneumonia in the elderly. Eur Respir J. 2013;41:923-8.
32. O'Horo JC, Rogus-Pulia N, Garcia-Arguello L, Robbins J, Safdar N. Bedside diagnosis of dysphagia: a systematic review. J Hosp Med. 2015;10:256-65.
33. Velasco LC, Imamura R, Rêgo AP, Alves PR, Da Silva Peixoto LP, De Oliveira Siqueira J. Sensitivity and specificity of bedside screening tests for detection of aspiration in patients admitted to a public rehabilitation hospital. Dysphagia. 2021;36:821-30.
34. Brodsky MB, Suiter DM, González-Fernández M, Michtalik HJ, Frymark TB, Venediktov R, et al. Screening accuracy for aspiration using bedside water swallow tests: a systematic review and meta-analysis. Chest. 2016;150:148-63.
35. Rofes L, Arreola V, Almirall J, Cabré M, Campins L, García-Peris P, et al. Diagnosis and management of oropharyngeal dysphagia and its nutritional and respiratory complications in the elderly. Gastroenterol Res Pract. 2011;2011:818979.
36. Marques CH, Abrahão-Júnior LJ, Lemme EM. The dysphagia investigation: is there still space for the videofluoroscopic method? Arq Bras Cir Dig. 2022;35:e1650.
37. Fattori B, Giusti P, Mancini V, Grosso M, Barillari MR, Bastiani L, et al. Comparison between videofluoroscopy, fiberoptic endoscopy and scintigraphy for diagnosis of oro-pharyngeal dysphagia. Acta Otorhinolaryngol Ital. 2016;36:395-402.
38. Baijens LW, Clavé P, Cras P, Ekberg O, Forster A, Kolb GF, et al. European society for swallowing disorders - European union geriatric medicine society white paper: oropharyngeal dysphagia as a geriatric syndrome. Clin Interv Aging. 2016;11:1403-28.
39. Martin-Martinez A, Miró J, Amadó C, Ruz F, Ruiz A, Ortega O, et al. A systematic and universal artificial intelligence screening method for oropharyngeal dysphagia: improving diagnosis through risk management. Dysphagia. 2023;38:1224-37.
40. Komiya K, Yamatani I, Kadota JI. Treatment strategy for older patients with pneumonia independent of the risk of drug resistance in the world's top country for longevity. Respir Investig. 2024;62:710-6.
41. Suzuki J, Ikeda R, Kato K, Kakuta R, Kobayashi Y, Ohkoshi A, et al. Characteristics of aspiration pneumonia patients in acute care hospitals: a multicenter, retrospective survey in Northern Japan. PLoS One. 2021;16:e0254261.
42. Wankap R, Azzoug L, Rossi F, Chan Sui Ko A, Lanoix JP. Measuring the prevalence of aspiration pneumonia in view of improving the relevance of antibiotic prescription of antibiotics: a retrospective, observational study. Infect Dis Now. 2024;54:104885.
43. Niederman MS, Cilloniz C. Aspiration pneumonia. Rev Esp Quimioter. 2022;35 Suppl 1:73-7.
44. Zhang D, Yang G, Hu X, Liu X, Zhang J, Jia D, et al. Antibiotics versus non-antibiotic in the treatment of aspiration pneumonia: analysis of the MIMIC-IV database. BMC Pulm Med. 2024;24:621.
45. Pereira ST, Farias AD. Systematic review on the prevention of aspiration pneumonia in the elderly. SCT Proceed Interdiscip Insights Innov. 2023:1:69.
46. Santos DD, Arcanjo DD, Silva GM, Mendes AL, Mendonca SC, Lima TR, et al. Factors associated with aspiration pneumonia and preventive measures in hospitalized elderly: a systematic review of observational studies. Rev CEFAC. 2020;22:e2920.
47. Araki T, Yamazaki Y, Goto N, Takahashi Y, Ikuyama Y, Kosaka M. Prognostic value of geriatric nutritional risk index for aspiration pneumonia: a retrospective observational cohort study. Aging Clin Exp Res. 2022;34:563-71.
48. Chua WY, Wang JD, Chan CK, Chan LL, Tan EK. Risk of aspiration pneumonia and hospital mortality in Parkinson disease: a systematic review and meta-analysis. Eur J Neurol. 2024;31:e16449.
49. Xu H, Zhang R, Zhang X, Cheng Y, Lv L, Lin L. Microbiological profile of patients with aspiration pneumonia identified by combined detection methods. Infect Drug Resist. 2024;17:2077-88.
50. Kyodo R, Kudo T, Horiuchi A, Sakamoto T, Shimizu T. Pureed diets containing a gelling agent to reduce the risk of aspiration in elderly patients with moderate to severe dysphagia: a randomized, crossover trial. Medicine (Baltimore). 2020;99:e21165.
51. Ueha R, Magdayao RB, Koyama M, Sato T, Goto T, Yamasoba T. Aspiration prevention surgeries: a review. Respir Res. 2023;24:43.
52. Gonçalves-Pereira J, Mergulhão P, Froes F. Medications to modify aspiration risk: those that add to risk and those that may reduce risk. Semin Respir Crit Care Med. 2024;45:694-700.