Aspiration and Aspiration Pneumonia

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Abstract: It is not rare for aspiration to occur in association with a severe paroxysm of coughing in elderly people. In such cases, a depressed cough reflex may result in severe aspiration pneumonia. Aspiration becomes clinically evident when the patient chokes or has a fit of coughing during a meal. In contrast, a less obvious form of aspiration, which is almost asymptomatic, is called micro-aspiration. When food or drink, saliva containing oral microbial flora, or regurgitated gastric acid is aspirated into the airway, severe inflammation of the lower respiratory tract and lung parenchyma occurs. Since aspiration can cause pneumonia and serious airway damage, the prevention of aspiration is important, particularly in elderly people. Pathogenic microorganisms are more likely to colonize the oral cavity in patients with swallowing disorders. Thus, when patients with swallowing disorders are admitted to a hospital, they are at a higher risk of encountering nosocomial pathogens, i.e., multidrug-resistant bacteria. Therefore, protection against aspiration and prevention of lower respiratory tract infection by ensuring good oral hygiene may be the most practical and effective means for the prevention of pneumonia in the elderly.

Key words: Aspiration pneumonia; Hospital-acquired pneumonia; Depressed cough reflex; Anaerobic infections

Introduction

Progressive aging of the society poses the problems of susceptibility of a significant section of the population to infections associated with age-related multiorgan dysfunction, and of dealing with the seriousness and refractoriness of the infections complicating various underlying diseases in this subject population.

Aspiration becomes clinically evident when the patient chokes or has a fit of coughing during a meal. In contrast, a less obvious form of aspiration, which may sometimes be associated with mild coughing but is more often largely asymptomatic, is called micro-aspiration. When food or drink, saliva containing oral flora, or regurgitated gastric acid is aspirated into the airway, severe inflammation of the lower respi-

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Table 1 Risk Factors for Nosocomial Respiratory Tract Infections[3)]

		Parenteral alimentation group (n = 26)*	Oral alimentation group (n = 54)	P-value
Gram-negative bacilli				
Rate of colonization of the upper respiratory tract (number of specimens with positive results/the number of specimens tested)		61% (106/175)	3.6% (4/111)	0.001
Number of episodes of respiratory infections		31 (average, 1.2)	1 (average, 0.02)	0.001
MRSA				
Rate of colonization of the upper respiratory tract (number of specimens with positive results/the number of specimens tested)		47% (83/175)	5.4% (6/111)	0.001
Number of episodes of respiratory infections		17 (average, 0.64)	3 (average, 0.06)	0.001
Total number of episodes of respiratory infections/month		1.5	0.2	0.001
Doses of antimicrobials (g/month)	Injectable penicillin	7.2	0.86	0.001
	Second-generation cephalosporins	8.9	0.44	0.001
	Third-generation cephalosporins	9.1	0.37	0.001
	Other β-lactams	3.2	0.08	0.001
	Minomycin®	0.16	0.01	0.02
	Aminoglycosides	0.13	0.002	0.01
Hemoglobin (g/d*l*)		8.6	11.8	0.01
Serum total protein (g/d*l*)		5.9	6.5	0.02
Presence of decubitus ulcers		25 (96%)	5 (9%)	0.001

* including 4 patients with tracheostomy.

Note: Preliminary testing revealed that the MRSA and Gram-negative bacilli colonization rates of the upper respiratory tract were higher in the parenteral alimentation group than in the oral alimentation group, and that the use of antimicrobials was more frequent in the former.

(This survey was conducted from February 1991 to September 1991 in a geriatric hospital)

ratory mucosa occurs, often complicated by pneumonia. Although aspiration by itself is one of the most important risk factors for pneumonia, the situation is obviously more serious when nosocomial multidrug-resistant pathogens, which cause hospital-acquired pneumonia, are contained in the aspirate.

Intensive effort to protect against aspiration and encourage maintenance of good oral hygiene in elderly patients could be expected to result in a reduction in the incidence of nosocomial pneumonia. How thoroughly can we take these preventive measures in the clinical setting in Japan? In this study, we attempt to discuss the clinical presentations of aspiration pneumonia and the measures adopted in Japan to prevent this condition, from the prevailing clinical setting.

Lower Respiratory Tract Infection Caused by Pathogenic Bacteria Originating from the Upper Respiratory Tract

1. Decreased swallowing ability increases the risk of colonization of the upper respiratory tract by pathogenic bacteria

Cough is an important clinical manifestation of pneumonia. The cough reflex is, however, often compromised in elderly individuals. We previously examined whether colonization of the upper respiratory tract by pathogenic microorganisms is more frequently associated with the onset of lower respiratory tract infection in bedridden patients in geriatric hospitals.[1–5)]

The results indicated that the frequency of pharyngeal colonization by *Staphylococcus*

aureus strains, particularly methicillin-resistant *Staphylococcus aureus* (MRSA) and Gram-negative bacilli, was significantly higher in patients on parenteral alimentation than in those on oral alimentation. Furthermore, the incidence of lower respiratory tract infection caused by MRSA and Gram-negative bacilli was also higher in the parenteral alimentation group than in the oral alimentation group (Table 1). Both the frequency of MRSA colonization of the pharynx and the incidence of lower respiratory tract infection were about 10 times higher in the parenteral alimentation group than in the oral alimentation group.

These findings indicate that pathogenic bacteria are more liable to persist and grow in the oral cavity of patients with depressed swallowing function. It is also indicated that normal deglutition and salivary secretion may facilitate the smooth swallowing of saliva as well as food and drink, and act as self-cleansing mechanisms of the oral cavity.

2. Pharyngeal colonization by pathogenic bacteria following viral infection (common cold syndrome)

In another study, we investigated the colonization of the pharynx by pathogenic organisms in healthy subjects, from children to the elderly. Healthy subjects were defined as people who had rarely consulted a physician, except for common cold, and in the case of adults and the elderly, also those who had no underlying disease that might predispose to infection, such as diabetes mellitus or chronic respiratory disease. The subjects were classified into two groups: those presenting with the common cold syndrome, including pharyngolaryngeal pain and running nose, within the week prior to commencement of the study (the acute respiratory tract inflammation group), and those without any symptoms of common cold during the corresponding period (the healthy group).

In the healthy group, the frequency of pharyngeal colonization by pathogenic bacteria was substantially higher in children and was almost nil in adults and the elderly, except in those who frequently came in contact with children (mothers, school staff, etc.). On the other hand, the frequency of pharyngeal colonization by pathogenic organisms was about one and half to two times higher in children belonging to the acute upper respiratory tract inflammation group than in the children assigned to the healthy group. Pharyngeal colonization by pathogenic organisms, although at a low percentage, was also confirmed in adults and older adults assigned to the acute upper respiratory tract inflammation group.

These findings indicate that in healthy adults, systemic and local immune mechanisms might prevent colonization of the pharynx by pathogenic organisms with the help of the barrier established by the resident microbial flora on the surface of the pharyngeal membrane. However, when the defense of the membrane is weakened by viral infection, pathogenic organisms can easily establish themselves on the airway membrane and cause lower respiratory tract infection and pneumonia, especially in the immunocompromised elderly.[6)]

3. Destruction of the barrier of indigenous microbial flora on the pharyngolaryngeal mucosal epithelium by pathogenic organisms

Indigenous microbial flora is believed to block adhesion of pathogenic organisms to the pharyngolaryngeal mucosal epithelium in healthy adults. Adhesion factors and receptors are known to be closely linked to the adhesion of bacteria to the host epithelium; the underlying molecular processes, however, remain to be elucidated in detail.

We previously clarified that the adhesion factors of *Haemophilus influenzae* and *Moraxella (Branhamella) catarrhalis* are sugar chains, and that several drugs effectively prevent these pathogenic bacteria from adhering to the mucosa of the respiratory tract. Easy adhesion of pathogenic bacteria to the pharyngeal epithelium may increase the risk of lower respira-

tory tract infection. Thus, proper gargling is useful in the prevention of adhesion of pathogenic bacteria to the upper respiratory tract. The aforementioned drugs can also be used to decrease the frequency of episodes of lower respiratory tract infections.[7)]

On the other hand, various types of non-pathogenic bacteria adhere to and grow on the surface membrane of the upper respiratory tract in healthy adults. The barrier formed by the non-pathogenic microbial flora inhibits the adhesion of pathogenic organisms to the surface membrane of the respiratory tract. These non-pathogenic bacteria strongly adhere to the membrane of the respiratory tract and their rate of proliferation is much higher than that of pathogenic bacteria.

Accordingly, destruction of the barrier formed by the resident microbial flora would be expected to increase the chances of pathogenic bacteria adhering to the airway membrane. Damage to the membrane of the respiratory tract by orotracheal and nasotracheal catheters, and decreased or increased oropharyngeal secretions related to advanced age or underlying disease, may directly or indirectly induce the adhesion of pathogenic bacteria to the surface membrane of the respiratory tract.

Mechanisms by which Aspiration Causes Severe Pneumonia

Aspiration pneumonia is often a progressive or refractory disease. The following factors may be involved.

1. Aspirated saliva, gastric acid, and food debris injure the airway membrane and damage the mucociliary clearance system.
2. Microorganisms originating in the oral microbial flora can easily invade the lower respiratory tract and grow there.
3. Although aspiration induces infections by various types of pathogens, if the initial antibiotic treatment is inappropriate, multidrug-resistant bacteria, anaerobes, and fungi survive and exert pathogenicity.
4. Aspiration of regurgitated gastric acid, because of its strong acidity, frequently causes severe chemical pneumonitis.
5. Repeated aspiration, whether it is micro-aspiration, or a frank large-volume incident during a meal (macro-aspiration), causes inflammation that is often prolonged and refractory.

The lung segments involved greatly depend on the posture of the patient during the aspiration, and most often include the dorsal segments bilaterally. Extensive lobar pneumonia, pulmonary abscess, and pleural empyema may occur in severe cases. Airway obstruction by food debris or other materials in combination with aspiration pneumonia may manifest as atelectasis and obstructive pneumonitis, with a poor prognosis.

The following factors may influence the severity of aspiration pneumonia:

1. The number of episodes of aspiration. The more frequent the aspiration, the more severe the complications.
2. The degree of airway obstruction by the aspirated material and the amount of airway-injurious substances contained in the aspirate, such as gastric acid.
3. Aspiration of massive amounts of indigenous microbial flora alone, or of a mixture of pathogenic organisms, is associated with increased severity of complications.
4. Failure of initial therapy, including drainage procedures or the antibacterial chemotherapy, is associated with refractory complications.

Key Points in the Treatment of Aspiration Pneumonia

The first step in the treatment of aspiration pneumonia is proper respiratory care and prevention of respiratory failure. Food debris and other materials that may cause airway obstruction should be removed through transbronchial suctioning or other appropriate methods at the earliest. After securing the airway, proper oxy-

genation (proper intervention, varying from nasotracheal intubation to mechanical ventilation, may be required, depending on the severity of the disease) should be ensured in patients with respiratory failure or hypoxia. In regard to antibiotic treatment, a broad-spectrum antimicrobial agent (β-lactam as the first choice) should first be administered intravenously.

The selection of antibiotics should be based on a consideration of the following points: 1) broad spectrum of activity (preferably covering both Gram-positive cocci and Gram-negative bacilli), 2) stability against β-lactamase, 3) awareness of the fact that more and more strains of bacteria are acquiring resistance that does not depend on the production of β-lactamases (e.g., alteration of penicillin-binding protein), 4) the extent of drug penetration into airway foci (confirmed by the sputum levels of the drug), and 5) the severity of adverse effects. In patients with severe airway damage caused by gastric acid or other injurious substances, however, the medication administered should also provide coverage for less virulent species within the hospital environment, including Gram-negative bacteria such as *Pseudomonas aeruginosa*, *Serratia, Citrobacter*, enterococci, *Staphylococcus aureus*, and *Staphylococcus epidermidis*.

Before the commencement of therapy with a β-lactam antibiotic in elderly patients, it is essential to check the renal and liver functions. In principle, the drug dose should be decreased to 1/2 to 1/3 in the elderly, while ensuring that therapeutic concentrations are achieved at the foci of damage.

The efficacy of the initial treatment should be determined on the 3rd day of treatment. If neither clinical nor radiographic improvement is noted, the medication should be modified based on a consideration of the following:

1) If no improvement in oxygenation is observed, it must be ascertained that the airway is patent; the necessity of thorough drainage should also be considered.
2) When the disease has advanced to the stage of lung abscess or pleural empyema, the involvement of tissue-invasive bacteria, such as *Staphylococcus aureus* and *Streptococcus pneumoniae*, or anaerobes should be suspected. In the case of anaerobic infection, combined therapy with clindamycin is widely adopted.

It should be noted that if proper specimen collection, be it sputum or bronchial aspirate, has been ensured, and the causative bacteria have been appropriately identified, the drug of second choice will be self-evident even if the initial therapy has failed.

Most elderly patients with aspiration pneumonia have underlying cerebrovascular disease. Therefore, as described in the section on the mechanism of development of aspiration pneumonia, measures to prevent reinfection and superinfection should be adopted in concert with antimicrobial chemotherapy.

Measures to Prevent Aspiration Pneumonia

It is known that a depressed deglutition reflex or cough reflex often predisposes elderly individuals to aspiration, including microaspiration. Sasaki *et al.* reported that damage of the cerebral cortex by cerebrovascular disease impairs the synthesis of substance P, which is distributed to the pharynx and airway through sensory nerves, associated with suppression of the deglutition and cough reflexes. They indicated that Symmetrel® (amantadine hydrochloride), an antiparkinsonian drug that stimulates the synthesis of substance P, as well as ACE inhibitors, which inhibit neutral endopeptidase known to be involved in the degradation of substance P, are helpful in reducing the frequency of aspiration.[8,9]

We previously reported that measures for the prevention of nosocomial infections focusing on a thorough cleaning of the oral/nasal cavity with povidone iodine in patients dramatically decreased the incidence of hospital-acquired pneumonia caused by MRSA and

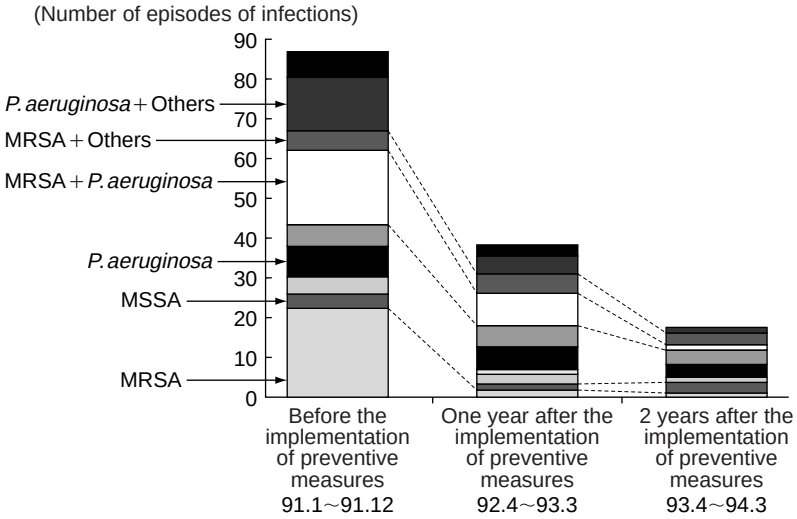

Fig. 1 The usefulness of measures adopted to prevent nosocomial pneumonia[10)]

Gram-negative rods in a geriatric hospital (Fig. 1).[10)] Sasaki and associates also emphasized the importance of good oral hygiene in the prevention of aspiration pneumonia in elderly patients.[11)]

The method of feeding may need to be modified in patients with normal appetite who have repeated episodes of aspiration. It is important to balance the patient's nutritional status and the measures needed to reduce the risks of aspiration and infection. Gastrostomy has been considered as an alternative for the prevention of aspiration in several institutions.

The use of intravenous hyperalimentation (IVH) immediately after aspiration may sometimes be unavoidable for the prevention of the onset of aspiration pneumonia, since the clinical course of aspiration pneumonia is more prolonged than that of other bacterial pneumonias. Thus, a patient care program that incorporates preventive measures against aspiration as an integral part of the management should be implemented in elderly patients in both institutional care and home care.

Conclusion

Aspiration pneumonia occurs mainly in elderly people, particularly in those with underlying disease, such as cerebrovascular disease. Although the case-fatality rate is very high, patient care embracing preventive measures against aspiration can reduce the risk of protracted and refractory disease.

REFERENCES

1) Nagatake, T., *et al.*: Study of causative bacteria of bacterial pneumonia and decubitus infections in a geriatric hospital (the first report) — MRSA as nosocomial pathogen. *Chemotherapy* 1986; 34: 240–249. (in Japanese)
2) Matsumoto, K. and Takahashi, J.: I. Biology (epidemiology) of MRSA. 5. The present status of MRSA infections. *Nihon Naika Gakkai Zasshi* 1992; 81: 1609–1614. (in Japanese)
3) Rikitomi, N.: IV. Management of patients with serious condition for the prevention of nosocomial infections 1. In the case of tracheotomy (endotracheal intubation). *Nihon Naika Gakkai Zasshi* 1993; 82: 1215–1220. (in Japanese)
4) Sakamoto, A.: MRSA respiratory infection and the usefulness of the preventive measures in hospital environments of a geriatric hospital focusing on the mechanism of the onset of the disease and changes in pathogens over time based on the types of coagulase after careful selection of antimicrobial chemotherapeutic

agents. *Chemotherapy* 1993; 41: 239–249. (in Japanese)
5) Masaki, H. *et al.*: Decrease in the incidence of bacteremia and nosocomial pneumonia and changes in causative organisms in a geriatric hospital after the implementation of measures to prevent nosocomial infections. *Kansenshogaku Zasshi* 1995; 69(4): 390–397. (in Japanese)
6) Nagatake, T. *et al.*: The involvement of viruses and bacteria in respiratory infection. *Nihon Naika Gakkai Zasshi* 1997; 86: 491–495. (in Japanese)
7) Nagatake, T. and Nakayama, T.: Prevention of infections 1. Pharyngeal sterilization. *Antibiotics & Chemotherapy.* 1991; 7: 90–98. (in Japanese)
8) Sekizawa, K. *et al.*: Lack of cough reflex in aspiration pneumonia. *Lancet* 1990; 335: 1228–1229.
9) Nakagawa, T. *et al.*: High incidence of pneumonia in the elderly patients with basal ganglia infarction. *Arch Intern Med* 1997; 157: 321–324.
10) Nagatake, T. *et al.*: Fundamentals and clinical practice for the prevention of nosocomial infections focusing on the minimization of the incidence of respiratory infection in elderly patients. *Nihon Saikingaku Zasshi* 1996; 51(3): 871–876. (in Japanese)
11) Itabashi, S. and Sasaki, H.: Features of pneumonia in elderly patients and signs to cause caution. *Rinsho To Kenkyu* 2000; 77: 6–10. (in Japanese)