INTERNATIONAL SOCIETY FOR INFECTIOUS DISEASES

GUIDE TO INFECTION CONTROL IN THE HEALTHCARE SETTING

Pneumococcus

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Topic Outline

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KEY ISSUE

- *Streptococcus pneumoniae* (*Pneumococcus*) remains a major pathogen worldwide, mainly in young children (<5 years), adults with immunosuppressive or chronic diseases as well as smokers and alcohol abusers, and older adults (≥65 years). Pneumococcal disease is more common in developing countries and occurs more often during winter. In recent years, important changes in the epidemiology of pneumococcal infections have been observed:
  1. The emergence and spread of antibiotic-resistant pneumococci which make invasive pneumococcal infections (e.g., meningitis) difficult to treat.
  2. The increased prevalence of pneumococcal disease in the elderly and in patients with chronic and serious underlying conditions (e.g., HIV, malignancies).
  3. The increasing recognition of pneumococcal infections in patients admitted to healthcare institutions and nursing homes, childcare centers, and other closed institutions (e.g., jails, military camps). Several of these infections appeared as outbreaks due to antibiotic-resistant pneumococci.
  4. In the years 2000s, there was a reduction in the incidence of pneumococcal infections after the introduction of pneumococcal conjugate vaccines (7-valent “PCV7”, 10-valent “PCV10”, and 13-valent “PCV13”) in children.
- Most pneumococcal infections are considered community-acquired infections, and little attention has been paid to nosocomial and healthcare-associated pneumococcal infections. In addition, infection control measures for preventing pneumococcal infections in hospital and healthcare settings and nursing home facilities have not been widely considered in the literature. And this is the main objective of this chapter.

KNOWN FACTS

- *S. pneumoniae* is the leading cause of several community-acquired infections such as pneumonia, otitis media, sinusitis, exacerbation of chronic bronchitis, and adult meningitis. Patients with severe pneumococcal pneumonia or meningitis may have a mortality rate of about 20-30%.
- *Pneumococcus* is transmitted from person-to-person by close contact and can colonize the nasopharynx of healthy people. The prevalence of nasopharyngeal colonization varies widely with age as well as environmental and seasonal conditions. Thus, the nasopharyngeal carrier rates in children are approximately 30-50%, and over 95% of them were initially colonized before the age of 2. The pneumococcal serotypes that colonize the nasopharynx in children show a high rate of antibiotic resistance. In adults, the rates of nasopharyngeal pneumococcal colonization decrease to approximately 5-10%.
- Several studies have shown a link between age and susceptibility to pneumococcal infection, with an incidence peak in children aged less than 2 and another one in elderly people. Pneumococcal disease in young adults occurs mainly in patients with underlying conditions (e.g., chronic and immunosuppressive diseases, smoking, high alcohol intake). For instance, failure to produce antibodies is a determining factor for the susceptibility to pneumococcal infection, and it occurs mainly in patients with multiple myeloma, chronic lymphocytic leukemia and lymphoma, as well as in HIV-infected patients. Patients with splenectomy, diabetes mellitus, malnutrition, chronic renal failure, chronic liver disease, heart failure, chronic obstructive pulmonary disease (COPD), asthma, smoking, and high alcohol intake are also at risk of pneumococcal infection.
- A previous viral infection, mainly due to influenza virus, is a major predisposing condition of pneumococcal pneumonia. Viral infections modify the local defense mechanisms of the respiratory tract,

contributing to nasopharyngeal colonization and facilitating the entrance of microorganisms into the pulmonary alveolus. Other processes that modify the local defense mechanisms of the respiratory tract such as chronic bronchitis, asthma, and smoke or toxic inhalation may also predispose to pneumococcal pneumonia.

- The pneumococcus can be transmitted among persons in closed institutions. For example, children attending daycare centres have an increased risk of pneumococcal nasopharyngeal colonization and pneumococcal infections; this increased risk also occurs in adults who live with these young children. The spread of *S. pneumoniae* leading to colonization or infection has been documented in hospitalized patients, in nursing home residents as well as in persons admitted to military camps and prisons and other closed communities, being likely to cause epidemic outbreaks.
- During the last decades, the emergence of antibiotic resistance in pneumococci has become a problem worldwide. Resistance to penicillins, cephalosporins as well as to macrolide and fluoroquinolones has been increasingly reported. Prior antibiotic use and nosocomial acquisition of the infection are important risk factors for antibiotic-resistant pneumococcal infection.

CONTROVERSIAL ISSUES

- Little is known about the prevalence of nasopharyngeal carriage and the modes of transmission of *S. pneumoniae* among hospitalized patients or nursing home residents. Moreover, there is little information regarding pneumococcal infections occurring in the hospital setting. It is often difficult to differentiate between endemic nosocomial pneumococcal infections and small outbreaks in hospitals. Studies on serotypes and clones may help to identify the pneumococcal strains causing outbreaks in the hospital.

- While it is well known that healthcare workers (HCWs) can transmit some infections to patients, the extent to which this occurs for *S. pneumoniae* is less appreciated. We can hypothesize the following modes of transmission:
    1. From HCWs to patients by exhaling or coughing the pneumococcus. This may occur when the HCW is a nasopharyngeal carrier and has close contact with the patient using inadequate precautions.
    2. From patient to patient by means of contaminated respiratory secretions (sputum or saliva). In this case, HCWs can disseminate the pneumococcus through contact with contaminated material when using inappropriate barrier precautions (e.g., gloves, gowns, masks).
    3. From patient to patient by exhaling or coughing the pneumococcus in overcrowded hospitals and long-term care institutions where space and ventilation are inappropriate.
- Once colonized, hospitalized patients are at risk for pneumococcal infections when:
    1. They suffer from serious underlying diseases with impaired immunity, chronic pulmonary conditions, and other debilitating diseases.
    2. They receive antibiotics which may select resistant pneumococci.
    3. They undergo instrumentations (e.g., endotracheal or nasopharyngeal tubes) or surgical procedures (e.g., surgery of abdominal cavity, lungs, and head and neck).
- Recent studies of nosocomial-acquired pneumonia have found that *S. pneumoniae*, among other Gram-positive cocci, is increasingly recognised as an important agent.
- Nosocomial pneumococcal pneumonia can be classified into two categories:
    1. Early pneumonia (<5 days) occurs mainly in patients who require emergent tracheal intubation (e.g., head trauma with low level of

consciousness). This infection is usually caused by the own patient's flora (previous pneumococcal carriers), and the intubation process spreads the pneumococcus into the lower respiratory tract.

2. Late pneumonia (≥5 days) may occur more often in patients undergoing surgery, who are immunosuppressed or debilitated, as well as in intubated patients in intensive care units (ICUs). This is more often caused by drug-resistant strains. Other nosocomial-acquired pneumococcal infections may include: nosocomial sinusitis in patients with nasogastric tube; meningitis after otic surgery or neurosurgery; and post-surgical intra-abdominal infection.

- Few data are available regarding the global burden of pneumococci in nosocomial pathogens. In our institution (Hospital Bellvitge, University of Barcelona) among 381 cases of pneumococcal bacteremia, 6% were nosocomial-acquired, 30% were healthcare-associated, and 64% were community-acquired. On the other hand, *S. pneumoniae* accounted for 1% of nosocomial-acquired bacteremia cases (n=3628), 5% of healthcare-associated bacteremia cases (n=2217), and 11% of community-acquired bacteremia cases (n=2205).

SUGGESTED PRACTICE

- The hospital epidemiologist and infection control practitioners should know the target population at high risk for pneumococcal infections (see *Controversial Issues*), and identify possible outbreaks caused by multiple antibiotic resistant pneumococci in the hospital setting. It is fundamental for the microbiology laboratory to conduct a surveillance of all pneumococcal isolates and their antibiotic susceptibility and to study, when necessary, serotypes and clones.

- Infection control measures for nosocomial-acquired pneumococcal infections have not been widely established. To properly implement these measures, we should consider the following:
- Compliance with barrier precautions.
- Prudent use of antibiotics.
- Use of pneumococcal vaccination.
- Although it is thought that transmission of pneumococci in the hospital is uncommon, the application of isolation measures and barrier precautions could be necessary, particularly when an outbreak caused by multiple antibiotic-resistant strains is detected. During an outbreak, these patients should be isolated in a single room, and HCWs should ensure the following infection control measures: appropriate hand washing and correct utilization of gloves, gowns and masks when in contact with respiratory secretions. In addition, disinfection of respiratory equipment should be strengthened.
- During an outbreak caused by a multiresistant pneumococcal strain in a closed institution, the screening of nasopharyngeal carriers could be appropriated. However, the administration of antibiotics to persons in contact with infected patients to eradicate the carriers is a controversial issue.
- Prudent use of antibiotics is essential to prevent the emergence of resistant pneumococci. Prolonged use of beta-lactams, particularly at low doses, is associated with carriage of penicillin resistant pneumococci in children. Thus, antibiotics may produce a selective pressure of pneumococci harbouring in the nasopharynx, eliminating the susceptible strains and emerging the resistant ones, mostly concentrated in a few serotypes and clones. The appropriate use of antibiotics is particularly important in the hospital setting, nursing homes, and other closed institutions where the emergence and spread of resistant pneumococcal clones is easier.
- Prevention of pneumococcal infection by means of vaccination programs is essential. The use of PPV-23 may prevent the development of

pneumococcal bacteremia in adults, but it is less immunogenic in children. Recently, the use of conjugate pneumococcal vaccines (PCV7, PCV10, and PCV13) in children has been associated with a decreased incidence of pneumococcal disease in children as well as in adults (herd protection). However, it is not well elucidated if these vaccines produce a permanent reduction of carriers or if there will be a problem of replacement with serotypes not included in the vaccine. Future vaccine developments including the pneumococcal surface proteins, which are non-serotype dependent, may substantially improve the current options.

SUGGESTED PRACTICE IN UNDER-RESOURCED SETTINGS

- Pneumococcal disease (pneumonia and other invasive pneumococcal infections) is a leading cause of morbidity and mortality in under-resourced settings, and occurs mainly in children, particularly in those infected with HIV. Most of these infections are community-acquired and little is known about nosocomial and healthcare-associated pneumococcal infections in low-income countries, where hospitals and healthcare institutions have scarce resources. Thus, it would be necessary to avoid outbreaks in healthcare institutions by applying preventive measures (as mentioned earlier) as much as possible.
- Overall, to reduce the burden of pneumococcal disease in under-resourced countries, prevention is crucial and should include improvement of HIV care and pneumococcal vaccination. However, pneumococcal conjugate vaccines are expensive and, in developing countries where need is greatest, these vaccines are often inaccessible. Nonetheless, some encouraging national programs in Africa with these vaccines (in children) have demonstrated an enormous benefit in reducing pneumococcal disease incidence by direct and indirect (herd protection) effects; some studies have shown significant reductions in pneumonia rates and fewer deaths among children.

- Surveillance efforts should be intensified in developing countries to improve the epidemiologic data, vaccine impact, and cost benefit. The establishment, in low-income countries, of regional platforms to facilitate diagnostic techniques and monitor surveillance, serotypes coverage, and pneumococcal susceptibility will provide data for antimicrobial prescribing recommendations and prevention strategies, either in the community or in healthcare settings.

SUMMARY

- *S. pneumoniae* is increasingly reported as a pathogen causing infections in hospitals, healthcare settings, and nursing homes. These infections are often due to multiple antibiotic resistant pneumococcal serotypes and are likely to appear as small outbreaks. Therefore, it is mandatory for the microbiology laboratory to survey all invasive pneumococcal isolates together with their antibiotic susceptibility and study of serotypes and clones whenever necessary.
- Currently, there is scarce information about the prevalence of pneumococcal carriers and the transmission mechanisms of *S. pneumoniae* in hospitals and nursing homes. Besides, infection control measures to prevent endemic and epidemic nosocomial pneumococcal infections have not been properly undertaken. However, compliance with barrier precautions, prudent use of antibiotics in the hospital setting, and pneumococcal vaccination should be strengthened when an outbreak is suspected.
- Since the introduction of pneumococcal conjugate vaccines in children, there has been a decline in the incidence of invasive pneumococcal disease in children and adults (herd protection). However, there are some data suggesting that emergence of virulent clones of non-vaccine serotypes (serotype replacement) may be a problem in the future. Epidemiological surveillance is essential to evaluate the best vaccination strategy in different patient populations.

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