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Acute Respiratory Infections in Persons with Spinal Cord Injury

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Morbidity and mortality caused by respiratory infections

Respiratory disorders are the leading cause of death in persons with both acute and chronic spinal cord injury (SCI). Pneumonia occurs in 50% of patients with acute tetraplegia during acute hospitalization and rehabilitation [1]. Respiratory disorders account for 28% of deaths in the first year after injury and 22% of deaths in later years [2]. In patients who survive for at least 24 hours after injury, pneumonia or influenza causes 16.5% of all deaths [3]. This contrasts with that of the general population of the United States, for which pneumonia and influenza account for only 2.5% of deaths and the two diseases in combination are the eighth leading cause of death [4]. The standardized mortality ratio, a measure that adjusts for age, sex, and race, indicates that the rate of fatal pneumonia is elevated by a factor of 37 for people with SCI; persons with complete tetraplegia die from pneumonia at a rate that is 150 times higher than a matched population without SCI [2].

Respiratory disorders are also a leading cause of rehospitalization after SCI [5]. Based on United States (US) Model SCI Systems (MSCIS) data,

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they are the third most common reason for hospitalization during the first year after SCI. A population-based study from Alberta, Canada found respiratory complications to be the leading cause of rehospitalization during the first 6 years after injury [6]. For patients with C1 to C4 American Spinal Injury Association (ASIA) Impairment Scale A-C tetraplegia, they account for 30% of rehopitalizations across all years of follow-up [5].

In spite of the importance of respiratory infections as a cause of death in persons with SCI, few studies have examined the topic. The majority have reported on the incidence of respiratory complications during acute care and rehabilitation, in settings such as the MSCIS hospitals. Rehospitalization rates and causes of death in persons with chronic SCI have also been published using data from the US MSCIS as well as from other nations. More recently, data on outpatient respiratory infections in Veterans Affairs (VA) patients with SCI have been reported. The populations included in these studies may not be representative of all persons with SCI. Most have focused on epidemiologic aspects of respiratory infections. There remains a need to conduct clinical trials of preventive measures and treatments to reduce the morbidity and mortality associated with respiratory infections in this population.

Predisposing factors for persons with spinal cord injury

SCI can cause multiple alterations in normal physiology that may increase the likelihood of the development of respiratory infections (incidence) or increase the chance of dying from an infection (case fatality). The most obvious of these dysfunctions caused by SCI is weakness of the respiratory muscles. If the neurologic level is at C5 or rostral, there may be some degree of diaphragm weakness or even complete paralysis with higher level motor-complete injuries. At lower neurologic levels, diaphragm innervation is intact, and this normally is sufficient to maintain at least 60% of the predicted vital capacity. Ventilatory failure caused by inspiratory muscle weakness can occur immediately after injury or develop over the first week after the injury. Patients who require mechanical ventilation are susceptible to ventilator-associated pneumonia (VAP). Over the first weeks to months after injury, many patients with partially intact diaphragm innervation acquire the ability to spontaneously ventilate, which is in part caused by strength recovery in the diaphragm. Approximately 7% of persons with SCI will be ventilator dependent when discharged from rehabilitation [7]. Patients with reduced inspiratory muscle strength are predisposed to microatelectasis, which may promote the development of pneumonia in atelectatic segments of the lung.

Severe expiratory muscle weakness is more prevalent in persons with SCI and is likely the most important factor increasing the incidence and case fatality for pneumonia. Expiratory muscle weakness, resulting in low voluntary cough peak expiratory flow, is strongly associated with unsuccessful

extubation and increased in-hospital mortality in the general population [8]. Because the primary expiratory muscles, the internal intercostals and abdominals, have thoracic innervation, they will be paralyzed completely in all patients with motor-complete tetraplegia. Expiratory strength increases incrementally with each additional neurologic level and is essentially normal at the T12 neurologic level and below; therefore, patients with high-level paraplegia have a similar degree of weakness to those with low-level tetraplegia. The main consequence of expiratory muscle weakness is a reduced peak cough flow, which is ineffective for clearance of bronchial secretions. With a peak cough flow of less than 2.7 L/sec (160 L/min), there is inadequate airflow to mobilize secretions out of the bronchi and trachea [9]. To compensate for weak cough strength, aggressive multimodal respiratory therapy interventions are required for secretion mobilization [10]. Measures to promote secretion mobilization are listed in Table 1.

Other than respiratory muscle weakness, additional factors predispose patients to respiratory complications. Reduced sympathetic innervation to the lungs occurs with injuries above the mid-thoracic level. The unopposed vagal parasympathetic input in patients with tetraplegia leads to bronchoconstriction and increased bronchial mucus secretion [11]. In patients with acute tetraplegia, bronchial mucus production may exceed 1 L per day, and the secretions are often tenacious, likely because of an altered

Table 1
Secretion mobilization techniques

- Manually-assisted coughing (“quad coughing”).
  - Insufflation using bag-valve-mask (eg, AmbuBag) or glossopharyngeal breathing before quad coughing will increase the peak cough flow.
  - Contraindications: inferior vena caval filter, recent abdominal surgery, rib fractures.
- Mechanical insufflation-exsufflation (CoughAssist; J.H. Emerson Co.; Cambridge, MA; www.coughassist.com).
  - Contraindications: bullous emphysema, susceptibility to pneumothorax or pneumomediastinum, or recent barotraumas.
  - Effective cough at inspiratory/expiratory pressures of + 40/−40 cm H_2O; for patient using device for first time, begin with pressures of 15 cm H_2O to familiarize patient with procedure.
  - Typical cough settings: 3 second inhalation phase, 2 second exhalation phase, then pause for 5 seconds.
  - Perform cycle of 4 or 5 assisted coughs, then rest (spontaneously breathing or back on mechanical ventilator) for 30 seconds. Repeat cycle of coughs and rest up to 6 times as needed. Monitor patient symptoms, oxygen saturation, and secretions retrieved to determine when to terminate treatment.
- Percussion (manual percussion; hand-held mechanical percussor).
- Postural drainage.
- Suctioning.
- Bronchoscopy.
- Intrapulmonary percussive ventilation.
- High-frequency chest wall oscillation (The Vest™; Hill-Rom, Inc.; Batesville, Indiana).
- Inhaled mucolytics or hydrating agents for thick, tenacious secretions.

macromolecular composition [12]. Aspiration is relatively common in patients with acute tetraplegia, especially those with predisposing factors such as mechanical ventilation, tracheostomy, anterior neck surgery, or brain injury [13]. Autonomically mediated dynamic dysfunction of the pharynx and upper esophageal sphincter may be an additional contributing factor [14]. In patients with chronic SCI, normal bacterial flora is altered for a number of reasons, including frequent treatment with antibiotics, autonomically mediated changes to the skin, or residence in health care settings, resulting in increased colonization with gram-negative and antibiotic-resistant organisms.

Subclinical adrenal insufficiency is common in this population, and this may blunt the response to sepsis once an infection is present. A diminished immune response in persons with tetraplegia has also been described, which could increase the susceptibility to infection [15]. However, the antibody responses to both pneumococcal and influenza vaccinations in persons with SCI are similar to those in the general population [16,17].

Respiratory infections in outpatients

Pneumonia in the general population

Pneumonia is an acute infection of the pulmonary parenchyma, diagnosed by the presence of symptoms and either an infiltrate on chest radiograph or examination findings indicating consolidation. The most common and most widely studied epidemiologic category of pneumonia is termed *community-acquired pneumonia* (CAP). The most common CAP pathogen overall, as well as for fatal cases alone, is *Streptococcus pneumoniae* (pneumococcus). Other common pathogens include *Hemophilus influenzae*, *Mycoplasma pneumonia*, and *Chlamydophila pneumoniae*. Common risk factors for CAP include young or advanced age, medical comorbidities including chronic lung disease, smoking, immunosuppression, and alcoholism. Use of gastric acid-suppressive drugs (proton pump inhibitors and H2 blockers) also appears to be a risk factor for CAP [18].

Chest radiography is the primary test for establishing the diagnosis of CAP and distinguishing it from acute bronchitis. For patients who are hospitalized, it is recommended that they also have the following tests: complete blood count and differential, serum chemistry panel, liver function tests, oxygen saturation, and blood cultures [19]. A sputum gram stain and culture has also been recommended, but its utility has been debated. A good-quality sputum with a predominant organism can only be obtained in 14% of patients. However, the presence of gram-positive diplococci on Gram stain is highly specific (98%) for pneumococcus [20].

Case fatality for CAP varies widely across studies with varying patient populations. Population-based data on patients receiving care in any setting (inpatient or outpatient) indicate a 1.5% to 2.3% mortality rate, whereas

cohort studies indicate a 5.2% mortality rate [21,22]. The Pneumonia Patient Outcome Research Team (Pneumonia PORT) derived an algorithm for determining whether adults with CAP should be hospitalized or treated in the community, based on short-term mortality risk [22]. Patients are stratified into five severity classes, and outpatient treatment is generally recommended for the two lowest risk classes. To qualify for the lowest risk class, an adult would be age 50 years or less, have none of the important comorbidities (cancer, liver disease, congestive heart failure, renal disease, or cerebrovascular disease), have normal mental status, and have normal or only mildly abnormal vital signs. Patients in the two lowest risk categories are anticipated to have a short-term mortality risk of 0.5% or less. The rule is not meant to supersede clinical judgment, nor does it take into account other reasons for hospitalization besides the predicted risk of death from pneumonia. These could include the risk for other adverse events, the availability of support at home, and the likelihood of adherence to therapy and follow-up recommendations.

More recently, it has been recognized that specific outpatient populations with pneumonia are at increased risk for the same highly resistant bacterial pathogens that occur in hospitalized patients. In such cases, the pneumonia is more correctly defined as a health care–associated pneumonia (HCAP), rather than CAP [23]. Risk factors for HCAP include the following: 2 or more days of acute care hospitalization in the prior 90 days; antibiotic therapy, chemotherapy, or wound care in the prior 30 days; residence in a nursing home or long-term care facility; or hemodialysis at a hospital or clinic. The etiologic pathogens in this population as well as treatment principles are thought to be similar to hospital-acquired pneumonia (HAP; see below).

Pneumonia in outpatients with spinal cord injury

Excess mortality caused by an acute condition in a specific population, as with pneumonia in persons with SCI, can be attributable to an increased incidence of the disorder, an increased case fatality when the disorder does develop, or a combination of both factors. There is limited evidence to support both an increased incidence and increased case fatality for pneumonia in persons with chronic SCI. The primary evidence comes from epidemiologic studies that used VA administrative data for persons with SCI.

Smith and colleagues [24] determined outpatient visit rates for acute respiratory infections including pneumonia, based on administrative data for more than 8700 respiratory-related visits by a population of over 13,000 veterans with SCI. Annual outpatient visits for either pneumonia or influenza (nearly all of which were for pneumonia) averaged 29 to 35 per 1000 veterans. A smaller population-based study from Alberta, Canada [6] reported a similar rate of 46 episodes of pneumonia per 1000 patients per year, during the first 6 years after injury. Comparable data for the overall US population indicate a rate of 10 cases of pneumonia per 1000 patients per year.

Using the same VA administrative data as in the study by Weaver and colleagues [25], the outcomes for pneumonia were estimated by determining hospitalization rates and all-cause mortality within 60 days of the visit. After outpatient visits for pneumonia, 46% of patients were hospitalized on the same day, and overall 7.9% of patients died within 60 days of the outpatient visit. By comparison, roughly 25% of the general population with pneumonia will be hospitalized for management [21]. Because the VA study used administrative data, the link between pneumonia diagnosis and subsequent death was not clearly established. However, the case fatality appears to be much higher than the previously cited 1.5% to 2.3% case fatality seen in the general population [21].

Etiologic pathogens for CAP have also been examined using VA administrative data for all SCI veterans hospitalized for treatment of CAP during a 2-year period [26]. The authors also determined whether identification of a causative pathogen for CAP was associated with outcomes in persons with SCI. Cases were identified as CAP if the hospital admission was preceded immediately by outpatient care with a diagnostic code for pneumonia. No significant association was found between the identification of a specific pathogen and mortality in 260 hospitalized SCI patients with CAP. The mean length of stay was 13.5 days, and the overall case fatality was 8.5%.

In that study, a causative pathogen was identified in 24% of cases, with pneumococcus the leading cause of pneumonia (32% of cases), as is true for the general population with CAP. *Pseudomonas*, which is an uncommon pathogen for CAP in the general population, was the second most commonly identified pathogen, occurring in 21% of cases. This finding should prompt clinicians to consider whether their patient with pneumonia has risk factors for HCAP rather than CAP. *Pseudomonas* colonization of the perineum, lower urinary tract, and urine collection system is common in persons with SCI and may be a risk factor for *Pseudomonas* pneumonia in this population [27]. More well-recognized risk factors for gram-negative pneumonia, such as antibiotic treatment or hospitalization in the prior 30 days, pulmonary comorbidity, or aspiration [28], are relatively common in this population as well. In the general population, the relative risk of death is elevated by a factor of 2.6 to 6.4 with *Pseudomonas* pneumonia when compared with other pathogens [29].

An additional VA study characterized the clinical management of CAP at three VA hospitals with specialized SCI services [30]. It used abstraction of individual electronic medical records for SCI veterans who received outpatient or inpatient treatment of CAP during the study period. Cases were identified initially from VA administrative databases using the same method used by Chang and coauthors [26], with the addition of cases that solely received an outpatient diagnosis of pneumonia but did not require hospitalization. Medical records were then reviewed to confirm the diagnosis of CAP, and detailed information on clinical presentation, diagnostic evaluation, and treatments were abstracted from the records. Of the 41 patients,

32 (78%) were hospitalized and only 9 (22%) were treated as outpatients. Because these patients were treated at hospitals with specialized SCI services, this may indicate that SCI specialists are more likely to recommend admission for treatment of HAP. The mean length of stay for hospitalized patients was 19.7 days. The antibiotic coverage received was in accordance with recommendations from the Infectious Disease Society of America for only one half of the patients [19]. After accounting for the relatively high rate of fluoroquinolone resistance at the participating institutions, only 24% of patients received reliable antipseudomonal coverage. The in-hospital mortality rate was 7.3%, and after 3 years of follow-up, 42.1% of hospitalization survivors had died.

General population studies have been used to develop CAP treatment algorithms, involving decisions whether to hospitalize the patient and choice of empiric antibiotic coverage for the most common pathogens. Unfortunately, it is not clear which of these principles may be directly applied to the population with SCI residing in the community. For example, the Pneumonia PORT algorithm assigns no increased risk for either expiratory dysfunction or marginal ventilatory status that may be present because of SCI [22]. Its use is not recommended for persons with SCI, because it is likely to underestimate mortality risk. Recommendations for management of CAP in persons with SCI are summarized in Table 2.

Table 2
Recommendations for management of CAP in persons with SCI

Hospitalization versus Outpatient Treatment:
- Criteria derived from non-SCI population (Pneumonia PORT) may not accurately predict mortality in persons with SCI.
- Hospitalization is strongly encouraged because of high case fatality, likelihood of resistant organisms, and possibility of inadequate secretion mobilization.
- Consider the assistance available at home, the skill of the patient or caregivers with secretion mobilization, the likelihood of compliance with therapy, and the availability and accessibility of follow-up care.

Optimize secretion mobilization:
- Multimodal treatment
- "Quad coughing" (manually assisted coughing); may precede with insufflation.
- Mechanical insufflator-exsufflator (CoughAssist).

Sputum Gram stain and culture.
- Low diagnostic yield but should strongly be considered.
- Could identify an unsuspected highly resistant organism.
- If a low virulence organism is identified, the antibiotic spectrum may be narrowed to avoid promoting antibiotic resistance.

Antibiotics
- Evaluate risk factors for resistant organisms. Should this be considered HCAP?
- Consider empiric antipseudomonal coverage.
- Prompt administration of antibiotics.

Upper respiratory infections and acute bronchitis

Given the high incidence and case fatality seen with pneumonia in outpatients with SCI, the importance of seemingly benign and self-limited conditions as viral upper respiratory infections (URI) and acute bronchitis is not self evident. Both categories of respiratory infections are exceedingly common in the general population. Although they frequently present to primary care settings for evaluation and cause much absenteeism from work and school, they are not generally recognized as causes of morbidity and mortality, with the exception of epidemic influenza A.

However, viral respiratory infections commonly precede or precipitate hospitalizations, especially in patients with chronic underlying pulmonary conditions. Nearly 45% of patients hospitalized with acute respiratory conditions have evidence of recent respiratory tract viral infections [31]. Viruses include those commonly associated with more severe respiratory infections, such as influenza and respiratory syncytial virus but also those associated with the common cold, such as rhinoviruses and coronaviruses [32,33]. In ventilator-dependent patients with neuromuscular disorders, more than 90% of pneumonias and hospitalizations are preceded by upper respiratory tract infections [34].

Upper respiratory infections are primarily viral in etiology. Approximately 10% of pharyngitis cases involves group A *Streptococcus*. The inflammatory response is initially localized to a primary level of the respiratory tract, but in some cases there is spread to adjacent, deeper portions as well. With involvement of the trachea, cough and sputum production can be significant, and symptoms may last for up to 2 weeks. Acute bronchitis indicates an acute respiratory infection involving lower portions of the respiratory tract, with cough as the predominant feature, with or without sputum production. The incidence of acute bronchitis in the general population is about 5%, and up to 90% will seek medical attention. In those without underlying medical conditions, the disorder is usually self-limited with almost no associated mortality, and the key component of evaluation is to rule out more serious conditions such as pneumonia. Because more than 90% of cases are caused by nonbacterial pathogens, routine antibiotic treatment is not recommended [35].

There are limited data to support increased mortality in patients with SCI after acute bronchitis [24]. Based on VA administrative data, veterans with SCI are evaluated in outpatient settings at rates of 26 to 33 visits per year per 1000 veterans for lower respiratory infections (98% of which was acute bronchitis) and 72 to 75 visits per year per 1000 veterans for upper respiratory infections. The mortality rate during the 60 days after the visit was 1.6% for acute bronchitis and 0.7% for upper respiratory tract infections. Only 3.5% of patients seen for acute bronchitis were hospitalized on the day of their outpatient visit; however, 21.9% required hospitalization during the subsequent 60 days. These findings indicate that for persons with SCI,

acute bronchitis is associated with a small increase in mortality, and that hospitalization is relatively common after an outpatient evaluation for bronchitis. The study design precluded determining whether pneumonia was misdiagnosed as acute bronchitis in any of these patients or whether pneumonia subsequently developed as a consequence of retained excess bronchial secretions.

Prevention of respiratory infections in outpatients with spinal cord injury

Although respiratory infections are an important source of morbidity and mortality in persons with SCI, it is challenging to conduct prospective research on preventive strategies. Because of the lack of research in this population, the recommendations for prevention are primarily derived from other patient populations, knowledge of pathophysiologic alterations that follow SCI, and clinical experience managing patients who are at high risk for severe respiratory infections.

Influenza vaccine reduces influenza-related hospitalizations, deaths, and secondary complications in elderly patients with and without high-risk medical conditions such as diabetes. Currently, the Centers for Disease Control and Prevention (CDC) recommend annual influenza vaccination for other groups at risk for severe complications from influenza, including those with chronic pulmonary or vascular diseases and residents of chronic care facilities [36]. In 2005, the CDC extended the recommendation to include children and adults with SCI [37].

Pneumococcus is the leading cause of CAP for both the general population and persons with SCI. Pneumococcal polysaccharide vaccine has been shown to reduce the risk of invasive (ie, bacteremic) pneumococcal disease and is considered cost effective for elderly persons. It is also recommended for persons aged 2 years or older who have chronic illnesses including pulmonary diseases [38]. Based on these recommendations, it is routinely offered to persons with SCI, the majority of who have some degree of respiratory impairment. However, only a minority of pneumococcal pneumonias result in bacteremia. The vaccine has not been found to be effective for noninvasive disease, and in elderly patients the rate of CAP and pneumonia hospitalization is unaffected by pneumococcal vaccination [39].

Aggressive mobilization of secretions could play an important role in reducing respiratory infections in outpatients with SCI. A small proportion of patients, primarily those with cervical level injuries, appear to benefit from routine bronchial secretion clearance even in the absence of an acute respiratory infection. This typically can be achieved using quad coughing or mechanical insufflation-exsufflation on a daily basis. More commonly, assistance for secretion mobilization only becomes necessary when a respiratory infection develops. As noted earlier, viral upper respiratory infections

or acute bronchitis may lead to subsequent development of pneumonia. Prompt clearance of bronchial secretions may prevent formation of microatelectasis, an increasing bacterial load in the lower respiratory tract, and the development of pneumonia.

Hospital-acquired respiratory infections

Hospital-acquired pneumonia in the general population

HAP is defined as pneumonia occurring 48 hours or more after hospital admission that was not incubating at the time of admission [23]. The rate of HAP in the general population is 5 to 15 per 1000 hospital admissions, and it is the leading cause of death for all hospital-acquired infections. Most findings on HAP have been derived from patients with ventilator-associated pneumonia (VAP), because the risk of pneumonia is 6 to 20 times greater than in nonventilated patients. Risk factors for HAP in the general population include prolonged hospitalization, malnutrition, respiratory failure, sedating medications, dysphagia, central nervous system disorders, supine position during feeding, chronic obstructive pulmonary disease, and the prolonged use of antibiotics [23]. The case fatality rate for HAP may be as high as 70% in certain subpopulations, such as mechanically ventilated patients, although only one third to one half of these deaths are directly attributable to the infection [23].

The most common HAP pathogens include aerobic gram-negative rods such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella*, and *Acinetobacter*, as well as gram-positive cocci, with an increasing rate of methicillin-resistant *Staphylococcus aureus*. The spectrum of pathogens is similar for elderly residents of long-term care facilities who have HCAP. The sources of the multidrug-resistant pathogens include health care devices (especially respiratory care equipment), other fomites in the hospital environment, and other patients, and the pathogens are transferred to the patient during routine care. Bacteria may then reach the lower respiratory tract through gross or microscopic aspiration, inhalation, or direct inoculation by respiratory care equipment.

Guidelines on the management and prevention of HAP have been published by the American Thoracic Society, the Infectious Disease Society of America, and the Centers for Disease Control and Prevention [23,40]. Selected recommendations from these documents are summarized in Table 3. As noted earlier, the etiologic pathogens for HCAP are similar to HAP, and most of the HAP management principles are thought to apply to HCAP as well.

Hospital-acquired pneumonia in acute spinal cord injury

Respiratory complications, including pneumonia, are common during both acute care and initial rehabilitation after SCI. Their occurrence is closely associated with both acute care length of stay and hospitalization cost for

Table 3
Selected recommendations for prevention and management of hospital-acquired, ventilator-associated, and health care-associated pneumonia

Prevent person-to-person transmission of bacteria
- Use standard precautions, including hand washing, gloving for handling objects contaminated with respiratory secretions, and gowning when soiling with respiratory secretions is anticipated.
- Use aseptic technique and sterilized tubes when changing tracheostomy tubes.

Modify host risk factors for infection
- Administer pneumococcal vaccination to high-risk patients.
- Remove endotracheal, tracheal, and or/naso-enteric tubes as early as possible.
- Consider noninvasive positive-pressure ventilation in place of invasive ventilation.
- Perform orotracheal rather than nasotracheal intubation, unless contraindicated.
- Clear secretions above the endotracheal tube cuff before deflating the cuff.
- Unless contraindicated, elevate the head of the bed to 30 to 45 degrees for patients at high risk of aspiration who are receiving enteral tube feedings (note: this is typically contraindicated in patients with SCI because of risk of pressure ulcer formation secondary to skin shearing).

Prevent postoperative pneumonia
- Instruct preoperative high-risk patients on deep breathing exercises.
- Use incentive spirometry postoperatively.
- Remobilize patients out of bed as soon as medically feasible.

Diagnostic procedures
- Obtain chest radiographs to assist with confirming the diagnosis, assessing the severity, and ruling out associated complications such as pleural effusions.
- Obtain lower respiratory tract cultures.

Treatment
- Initiate appropriate broad-spectrum antibiotics as early as possible.
- Antibiotics should be chosen based on duration of hospitalization and the likelihood of multidrug-resistant antibiotics.
- Empiric antibiotics should include agents from a different antibiotic class than the patient has received recently.
- Consider narrowing the antibiotic coverage based on results of lower respiratory tract cultures and the patient's clinical response.
- For patients with uncomplicated pneumonia and a good clinical response to initially appropriate antibiotic therapy, consider a shorter treatment course (7 to 8 days) in the absence of nonfermenting gram-negative rods (eg, *Pseudomonas* or *Acinetobacter*).
- Perform serial assessments to monitor the clinical response. Patients who have not improved within 72 hours should be evaluated for noninfectious mimics of pneumonia, drug-resistant organisms, other sites of infection, and complications of pneumonia or its treatment, such as emphysema or *clostridium difficile* colitis.

Note: these recommendations are based on research performed in non-SCI patient populations. Except as noted, they are likely to apply to persons with acute or chronic SCI who have HAP or HCAP.

Data from American Thoracic Society and Infectious Disease Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and health-care-associated pneumonia. Am J Respir Crit Care Med 2005;171(4):388–416 and Tablan O, Anderson L, Besser R, et al. Guidelines for preventing health-care–associated pneumonia, 2003: recommendations of CDC and the healthcare infection control practices advisory committee. MMWR Recomm Rep 2004;53(RR-3):1–36.

persons with new tetraplegia, and they are a more important determinant of cost than is the injury level [41]. Most published findings on pneumonia in persons with SCI come from patients undergoing acute care and initial rehabilitation at MSCIS hospitals. Jackson and Groomes [42] found a 31.4% rate of pneumonia during acute care and rehabilitation. Fishburn and colleagues [1] reported a combined rate of 50% for pneumonia or atelectasis during the first month after injury, with a 74% rate in patients with high-level tetraplegia. While receiving inpatient rehabilitation after acute care, 21.6% of patients with complete tetraplegia will have atelectasis or pneumonia [43]. Of note, 80% of pneumonias that develop soon after injury are left sided [1]. This has been attributed to difficulty with clearing secretions from the left bronchial tree using tracheal suctioning because of the more acute takeoff angle of the left mainstem bronchus.

There are no published data on etiologic organisms for pneumonia that develops during acute care or initial rehabilitation phases in person with SCI. These patients likely have a similar risk as other hospitalized patients for colonization with multidrug-resistant bacteria after 5 or more days of hospitalization. Therefore, the choice of empiric antibiotic coverage should be identical to that for HAP in neurologically intact patients and based in part on duration of hospitalization [23].

Hospital-acquired pneumonia in chronic spinal cord injury

The high incidence and case fatality for CAP is likely to be the primary reason that pneumonia is a leading cause of death after SCI. However, HAP could potentially account for a substantial proportion of the pneumonia-related deaths in persons with chronic SCI. To date, no studies have examined the epidemiology, pathogens, or risk factors for HAP in the chronically injured population. Many risk factors for HAP in the general population are prevalent in hospitalized persons with chronic SCI. These include expiratory dysfunction, prolonged antibiotic treatment, sedating medications, and supine position during feeding.

Summary

Respiratory infections are common in persons with SCI. Pneumonia, and to a lesser degree, acute bronchitis, are associated with significant morbidity and mortality. Guidelines for treatment of CAP were developed for use in the general population and may not be appropriate for persons with SCI. Optimal management of respiratory infections must take into account the severe expiratory dysfunction that is highly prevalent in this population as well as risk factors for HCAP in outpatients who have pneumonia. Persons with SCI should be informed of their risk of respiratory infections and be encouraged to seek prompt evaluation by physicians who are knowledgeable about complications of SCI.

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