Original Article

Management of community-acquired pneumonia in persons with spinal cord injury

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Study design: Retrospective case series.

Objectives: Respiratory disorders are the leading cause of death in persons with spinal cord injury (SCI), but the epidemiology and medical management of pneumonia in persons with chronic SCI is not well characterized. We describe the clinical presentation of persons with SCI with community-acquired pneumonia (CAP), characterize its management and compare practice to recommendations for CAP in the general population.

Setting: Three United States Veterans Affairs Medical Centers with specialized SCI services.

Methods: Chart abstraction was performed for all persons with chronic SCI seen at participating centers for treatment of CAP during a 2-year period. Collected data included presenting signs and symptoms, laboratory and imaging results, initial antibiotic therapy, secretion mobilization techniques, in-patient vs outpatient management, length of stay, and mortality.

Results: In all, 41 persons with SCI received treatment for CAP during the study period. A total of 32 (78.0%) patients were admitted for treatment; two (4.8%) required intubation and mechanical ventilation. Initial antibiotic coverage met guideline recommendations for only half of inpatients and infrequently provided adequate antipseudomonal coverage. Microbiologic testing was performed on 26 cases (63.4%) and demonstrated a specific pathogen in only five cases (12.2% of total). Three cases (7.3%) died during treatment for CAP, and 16 (42.1%) of 38 CAP survivors died within a median follow-up of 3 years.

Conclusion: The majority of chronic SCI patients who present to specialized SCI centers with CAP are admitted for treatment. Short-term mortality is comparable to CAP in the general population.

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Introduction

Respiratory disorders are the leading cause of death in persons with acute and chronic spinal cord injury (SCI),

and pneumonia accounts for 72.3% of these deaths.¹ Data from the United States SCI Model System of Care show, after adjusting for age and sex, that persons with SCI have a 36 times greater risk of death from pneumonia, and persons with high-level motor-complete tetraplegia have more than 150 times greater risk of death from pneumonia than the general population.²

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Community-acquired pneumonia (CAP) is a common medical complication in persons with SCI, but it is not clear what proportion of fatal pneumonia cases begin as CAP.

Our prior study used Department of Veterans Affairs (VA) administrative databases to identify 260 patients with SCI who were hospitalized with a diagnosis of CAP.³ In that study, a specific pathogen was identified in 24% of cases, but pathogen identification was not significantly associated with 30-day mortality or length of stay (LOS). An unexpected finding was *Pseudomonas aeruginosa* as an etiology for pneumonia in 21% of CAP cases in which a specific pathogen was identified.

A considerable body of research has been conducted on CAP in the general population, and professional organizations such as the Infectious Disease Society of America (IDSA) and American Thoracic Society (ATS) have published guidelines on the management of CAP.^{4,5} These guidelines cover such management issues as empiric antibiotic coverage, the advisability of performing microbiologic cultures to establish etiology, and admission criteria. In our prior study, we were unable to characterize most features of the patients' presenting complaints, diagnostic work-up, and management, since we relied solely on administrative databases.

This study utilizes medical record abstraction to describe the clinical characteristics and medical management of a cohort of patients with SCI who received treatment for CAP through three specialized SCI centers. It was anticipated that a substantial proportion of patients did not receive the diagnostic testing and empiric antibiotic treatment recommended by IDSA guidelines for treatment of CAP in the general population. We also sought to characterize the use of assistive techniques to improve mobilization of pulmonary secretions as well as assess short- and long-term mortality following an episode of CAP.

Methods

Setting, study design and selection of cases

This study is a retrospective case series of patients with SCI who received treatment for CAP at any of three VA medical centers with SCI services. Each center has an in-patient ward and outpatient clinic used exclusively for the treatment of persons with SCI, and approximately 95% of the population served have been injured for greater than 1 year. Institutional review boards at the three participating institutions approved the study procedure. The initial cohort of CAP cases was identified from a national sample of 260 veterans with SCI who were diagnosed with CAP and treated as in-patients between October 1998 and September 2000.³ Cases were identified using the VA National Patient Care Database (NPCD) administrative database. Cases were selected for

chart review if they met any one of the following criteria:

1. Diagnosis of pneumonia in a VA outpatient setting on the same day as a VA hospital admission, with an admitting diagnosis of pneumonia recorded on the discharge summary report.
2. Diagnosis of pulmonary or cardiac symptoms in a VA outpatient setting on the same day as a VA hospital admission, with an admitting diagnosis of pneumonia recorded on the discharge summary report. This allowed for correction of misdiagnosis or miscoding of the admission diagnosis in the outpatient clinic. In these cases, it was verified through review of progress notes that the pneumonia was not considered nosocomial.
3. Direct admission to a VA hospital after initial evaluation in a non-VA setting, with an admitting diagnosis of pneumonia recorded on the discharge summary report.
4. Diagnosis of pneumonia in a VA outpatient setting without subsequent admission.

The first three criteria were classified as the inpatient sample and the last as the outpatient sample. If multiple outpatient visits were made for the same episode of CAP, we used data from the first visit, and if the patient had more than one episode of CAP we used data from the initial evaluation for the most recent event. Exclusion criteria included the following: absence of documentation of CAP in the medical record; hospital discharge within 10 days prior to index (CAP) hospitalization (in order to exclude possible nosocomial infections); diagnostic testing indicating a nonbacterial pneumonia; diagnosis of multiple sclerosis or another primary neurologic disorder not involving the spinal cord.

Data collection and study procedures

Case demographics and characteristics of the hospital stay including diagnosis, comorbidities, LOS, intensive care unit use, and current and previous respiratory complications were collected from the NPCD. Laboratory, radiology, and pharmacy data for inpatient and outpatient events were abstracted from the local Veterans Health Information Systems and Technology Architecture (VISTA) databases at the three study sites. These databases, which constitute electronic medical records containing all progress notes, laboratory testing and results, procedures, and medical complications, were reviewed to determine presenting symptoms, physical examination findings, and use of techniques for secretion mobilization. Short-term mortality was defined as either death during the CAP hospitalization for inpatients or death within 30 days of initial clinic presentation with CAP for both inpatients and outpatients. Long-term mortality was defined as death prior to the time of medical record review, which was performed 2–4 years after the episode of CAP.

The initial therapeutic antibiotic regimen for each patient was classified with respect to meeting empiric coverage recommendations for CAP and providing adequate antipseudomonal coverage. We first classified the initial antibiotic coverage for each patient as either meeting or not meeting the 1998 IDSA guideline recommendations;⁶ this was done using the outpatient (main) and in-patient management (general medical ward) criteria. To meet these criteria, outpatients should have received one of the following three regimens: a tetracycline, a macrolide, or a fluoroquinolone. Inpatients should have received one of the following three regimens: an extended spectrum cephalosporin (eg ceftriaxone) combined with a macrolide; a β -lactam/ β -lactamase inhibitor (eg. ampicillin-sulbactam) combined with a macrolide; or a fluoroquinolone alone. The IDSA guidelines have been endorsed by the United States Centers for Medicare and Medicaid Services and were thus deemed appropriate for determining the adequacy of antibiotic coverage and diagnostic testing.

In light of our prior finding of a high prevalence of *Pseudomonas* pneumonia in persons with SCI,³ we also classified initial antibiotic coverage with respect to antipseudomonal coverage. Since antibiograms from study sites showed high rates of *Pseudomonas* resistance to fluoroquinolones, agents typically considered adequate for antipseudomonal coverage, we also calculated the proportion of cases that received an antibiotic with institution-specific reliable empiric antipseudomonal activity. Agents were considered reliable coverage if the antibiogram for the center showed *Pseudomonas* sensitivity for at least 75% of isolates. We did not determine whether results of microbiologic testing caused the empiric antibiotic coverage to be altered.

Statistical analyses

Comparisons were made using χ^2 and Fisher's exact tests for proportions or *t*-tests for means using the SAS software version 8.0 (SAS Institute, Inc., Gary, NC, USA).

Results

Using the administrative databases, we identified 146 patients who had received diagnostic codes indicating CAP from the three study sites with SCI or spinal cord disorders. After review of individual medical records, we excluded 105 patients; the most common reasons for exclusion were incorrect coding regarding the occurrence of CAP (54 patients) or a primary neurologic diagnosis other than SCI or other spinal cord disorders (39 patients). The remaining 41 cases were used for the analysis. This included nine cases (22.0%) who were seen in the outpatient clinic and were not admitted the same day (outpatient sample), and 32 cases (78.0%) who were either seen as outpatients and admitted the same day or directly admitted after being evaluated at a different site (in-patient sample). Four of the cases were started on antibiotic therapy at other sites. Five cases

Table 1 Case characteristic (*n* = 41)

Characteristic	Frequency (%)
Gender	
Male	39 (95.1)
Female	2 (4.9)
Age (years)	
< 50	12 (29.3)
50–64	15 (36.6)
65+	14 (34.1)
Race	
White, non-Hispanic	24 (58.5)
Black	9 (22.0)
Hispanic	1 (2.4)
Native American	1 (2.4)
Information not available	6 (14.6)
Level of injury	
Tetraplegia	27 (65.9)
Paraplegia	14 (34.1)
Duration of injury (years)	
1–10	7 (18.0)
11–20	15 (38.4)
21–30	7 (18.0)
> 30	10 (25.6)

(12.2%) had more than one outpatient visit for CAP during the study period. The majority of CAP cases were male (95.1%), White (58.5%), and tetraplegic level (65.9%) with a mean age of 59.2 years, and a mean duration of injury of 22.3 years (see Table 1). These demographic characteristics are similar to those for the entire population served by the VA SCI Services except for an over-representation of patients with tetraplegia. The most common medical comorbidities in this sample (Table 2) were lung disease (29.2% of cases), cardiac disease (26.8%), and hypertension (26.8%), and the mean number of comorbidities per case was 1.7. Six cases (14.6%) had a history of dysphagia. Documentation of prior pneumococcal vaccine administration was noted for 46% of cases.

The most common presenting complaints were cough and fever (39.0% for each), followed by shortness of breath (26.8%). Physical examination findings at the time of presentation to the outpatient clinic are summarized in Table 3. For cases with documented findings, 87.5% were noted to be awake and alert and 91.3% had normal sinus cardiac rhythm. In total, 88% had documentation of a pulmonary examination. The most common pulmonary findings were reduced breath sounds (33.3%) and rhonchi (30.6%). Only one case had a normal pulmonary examination. The mean ($\pm$ SD) initial oxygen saturation by pulse oximetry was $93.5 \pm 4.3\%$ for the 23 cases where data were available, with only two cases presenting with oxygen saturation below 90%. Mean oxygen saturations were 92.6% for 12 cases breathing room air, 93.0% for seven cases

Table 2 Comorbid conditions

Comorbidity	Frequency (%) ^a
Lung disease	12 (29.2)
Cardiac disease	11 (26.8)
Hypertension	11 (26.8)
Congestive heart failure	8 (19.5)
Diabetes	7 (17.1)
Dysphagia	6 (14.6)
Kidney disease	4 (9.8)
Cancer	3 (7.3)
Stroke	3 (7.3)
Liver disease	2 (4.9)
Alcohol abuse	1 (2.4)
Thromboembolic disease	1 (2.4)

^aSome cases had more than one comorbidity**Table 3** Physical examination findings

Physical examination component	Frequency (%)
Mental status examination (<i>n</i> = 24)	
Awake/alert	21 (87.5)
Lethargic	2 (8.3)
Obtunded	1 (4.2)
Nonresponsive	0 (0)
Not recorded	17
Cardiac examination (<i>n</i> = 23)	
Rhythm	21 (91.3)
Arrhythmia	2 (8.7)
Not recorded	18
Pulmonary examination (<i>n</i> = 36)	
Reduced breath sounds	12 (33.3)
Rhonchi	11 (30.6)
Rales	6 (16.7)
Wheezing	5 (13.9)
Dullness to percussion	1 (2.8)
Normal	1 (2.8)
Not recorded	5

Percentages are calculated for cases with documentation of the examination component

Table 4 Initial radiology and laboratory tests

Test (%)	In-patient frequency (%) (<i>n</i> = 32)	Outpatient frequency (<i>n</i> = 9)
Chest X-ray	28 (93.3)	7 (77.8)
Electrolyte panel	23 (74.2)	5 (55.6)
Complete blood count	25 (80.7)	4 (44.4)
Blood culture*	19 (65.5)	0 (0.0)
Sputum culture**	15 (46.9)	1 (11.1)

P* = 0.001 and *P* = 0.07 for difference between inpatient and outpatient cases (Fisher's exact test)

receiving a mean 3.0 (range 1–6) l/min supplemental oxygen, and 97.6% for four cases lacking information on supplemental oxygen usage.

Table 4 shows the diagnostic testing performed on the day of presentation, grouped for inpatient and outpatient cases. Overall, 35 cases (85.4%) had a chest X-ray performed on the day of admission, and diagnostic reports were available for 33 cases (80.5% of total cases). Left-sided infiltrates were the most common finding, occurring in 16 (48.5%) of 33 cases with reports available, and these were always located in the left lower lobe. Right-sided infiltrates accounted for 27.3% of cases, and these were distributed across upper (one case), middle (two cases), and lower (six cases) lobes. Bilateral infiltrates were present in two cases (6.1%), and in six cases (18.2%) no infiltrate was present on the initial chest X-ray. When only the cases with unilateral infiltrates are considered, 64% were located in the left lower lobe. Additional chest X-ray findings included atelectasis in four cases. Three cases underwent chest imaging with computed tomography. In addition, three cases underwent swallowing evaluations while hospitalized, with one case receiving a diagnosis of dysphagia.

Laboratory testing on the day of admission included electrolyte panels (68.3% of cases), complete blood counts (70.1%), blood cultures (46.3%), and sputum Gram stains and cultures (39.0%). Some form of microbiologic testing (either blood or sputum culture) was performed on 26 cases (63.4%). Table 4 shows the frequency of laboratory tests grouped for in-patient and outpatient cases. None of the cases managed as outpatients received blood cultures (*P* = 0.001 for inpatient versus outpatient frequency), and only one outpatient received a sputum Gram stain and culture (*P* = 0.07). Of the 29 cases with white blood cell count (WBC) data, 16 had abnormal values, including 14 with elevation (mean 17,100 cells/mm³) and two with abnormally low counts (mean 3900 cells/mm³). Blood cultures were obtained prior to administration of antibiotics in eight of 12 cases with data on administration times. Microbiologic testing identified a causative organism in only five cases (12.2% of all cases), including two with *Streptococcus pneumoniae*, one with *Haemophilus influenzae*, and two with other Gram-negative rods, all of which were identified from sputum cultures. Of the three cases that died while undergoing treatment for CAP, one had a sputum culture showing *S. pneumoniae*, and another had a sputum culture with *Acinetobacter baumannii* as well as a blood culture with *Staphylococcus aureus*.

Most cases (90.2%) began antibiotic therapy on the first day; 42.1% received monotherapy, while 57.9% received combination therapy. Nearly all (21 of 22; 95.5%) cases prescribed combination therapy were admitted, while only nine of 16 (56.3%) cases receiving monotherapy were admitted (*P* = 0.005). Over half (58.9%) of these antibiotics were delivered intravenously. A variety of antibiotic classes were used (Table 5), but the most common classes were penicillin derivatives (received by 60.0% of inpatients), fluoroquinolones

Table 5 Classes of antibiotics used for in-patient and outpatient treatment

Antibiotic class	Number of cases receiving antibiotic (%)	
	In-patients [n=30]	Outpatients [n=8]
Penicillin derivatives	18 (60.0)	1 (11.1)
Fluoroquinolones	11 (36.7)	4 (44.4)
Macrolides	9 (30)	3 (33.3)
Cephalosporins	8 (26.7)	0 (0)
Clindamycin	4 (13.3)	1 (11.1)
Vancomycin	4 (13.3)	0 (0)
Aminoglycosides	3 (10)	0 (0)
Other	8 (26.7)	0 (0)

Notes: In all, 22 cases were prescribed more than one antibiotic, so the number of antibiotics is greater than the number of cases. Pharmacy data are missing for two in-patients and one outpatient

(36.7%), and macrolides (30%). Fluoroquinolones were the most common class used for treatment of outpatients (44.4%).

Complete antibiotic data were available for all but one outpatient and two in-patient cases. We classified the initial antibiotics by two characteristics: compliance with IDSA guidelines for treatment of CAP, and adequacy of coverage for *Pseudomonas*. For outpatients, antibiotics complied with IDSA recommendations for seven of the eight cases, but for inpatients the IDSA guidelines were met in only half (15/30) of the cases with antibiotic data. Combining outpatient and in-patient cases with complete antibiotic data, 21 of 38 (55.3%) received antipseudomonal antibiotic coverage. However, antibiograms from study sites showed fluoroquinolone susceptibility rates of 39–63% for *Pseudomonas* isolates. In 11 cases, the only antipseudomonal coverage was from a fluoroquinolone with an institution-specific antibiogram sensitivity of 39–42%, and in another case the only antipseudomonal coverage was from an aminoglycoside with an institution-specific sensitivity of 45%. Therefore, only nine cases (23.7%) received an antibiotic with reliable institution-specific antipseudomonal activity. Institution-specific practice variations in use of antipseudomonal antibiotics were also noted. While two of the three study sites relied heavily on fluoroquinolones in their practices (used 75.0% of the times an antipseudomonal antibiotic was administered), the third site typically used an antipseudomonal cephalosporin (used 83.3% of the times an antipseudomonal antibiotic was administered). Of note, both sites with high fluoroquinolone use showed highly resistant *Pseudomonas* in their antibiograms, including resistance to nonfluoroquinolone antipseudomonal agents.

Two cases required intubation and mechanical ventilation. With the exception of one instance of quad coughing (manually assisted coughing) performed for an outpatient, use of assisted cough therapies occurred only with the in-patient cases. These included quad coughing (18.8% of in-patients), tracheal suctioning (12.5%), and

chest PT (12.5%). There was no recorded use of mechanical insufflation–exsufflation therapy for any case.

As noted earlier, 78% of CAP cases were admitted, and the mean LOS was 19.7 (± 19.5) days. The proportion of cases that were admitted and the mean LOS did not differ significantly between the three study sites. Three cases (7.3%) died while undergoing treatment for CAP; this included two who were managed as in-patients and one managed as an outpatient who died 4 days after the initial clinic visit for CAP. Of the 38 cases that survived treatment for CAP, 16 (42.1%) died prior to our medical record review, which occurred 2–4 years after initial presentation with CAP.

Discussion

This study was undertaken to better characterize details of the clinical presentation and management of CAP in persons with SCI. The demographic characteristics of these cases were similar to the veteran population served by the centers, with a predominance of males, a mean age of nearly 60 years, and a duration of injury of 10 years or greater for the majority. Nearly half of cases had previously received a pneumococcal vaccination. As in the overall veteran population, pulmonary and cardiac comorbidities were common, with higher rates of cardiovascular disease than reported for an SCI population of similar age.⁷ The proportion of cases with a prior diagnosis of dysphagia (14.3%) was also relatively high. We did not determine whether the treating clinicians considered aspiration to have contributed to pneumonia in these cases, and we are aware that aspiration pneumonias are frequently excluded in general population studies of CAP.

The most common symptoms at presentation were similar to those expected in the general population, but no single common symptom was present in more than half of the cases. Clinical examination revealed relatively typical findings for pneumonia, but no single pulmonary examination finding was present in more than one-third of cases. Together, these findings suggest that the absence of a specific symptom or sign is not useful in determining whether CAP is present, and this agrees with the findings of general population studies.⁸ Findings that support the presence of CAP include fever, chills, increased sputum production, tachypnea, tachycardia, decreased breath sounds, dullness to percussion, or pulmonary infiltrates on CXR. However, this study did not investigate subjects without CAP, so the specificity of these findings in persons with SCI is unclear. The majority of cases would not be considered critically ill at initial presentation. Less than half showed elevated WBC counts, and only two were noted to have low oxygen saturations.

Initial chest radiographs showed pulmonary infiltrates in the majority of cases, and there was a predominance of left-sided infiltrates. However, the left-sided predominance was not as great as in a prior study of patients with acute SCI.⁹ Those investigators hypothesized that

left-sided infiltrates were more common in acute SCI due to difficulty in suctioning bronchial secretions from the left lung, because of a greater angulation of the left main stem bronchus at the carina. Copious bronchial secretions usually resolve during the first months postinjury, so ineffective secretion management with tracheal suctioning may not be as important in the development of pneumonia in persons with chronic SCI.

Blood and sputum cultures each were obtained in slightly less than half of the cases. The proportion of cases with a specific pathogen identified was low compared to that reported for the general population. The ATS and the IDSA estimate that 40–60% of CAP cases have an identified etiology,^{4,5} while only 12.2% of cases in this series had microbiologic confirmation of a specific pathogen. Impaired cough strength in persons with SCI¹⁰ could potentially make it more difficult to obtain an adequate expectorated sputum sample for analysis. Although our prior study also had a relatively low rate for identification of pathogens, the larger sample size in that study provides a better characterization of pneumonia etiology than the current data.³ Our findings indicate that many cases did not receive all diagnostic tests recommended by the IDSA, which include chest X-ray, oxygen saturation determination, and pretreatment blood cultures and sputum Gram stain with cultures.⁴ In particular, use of microbiologic testing was rare in outpatients, where no blood cultures were obtained, and sputum Gram stain and culture was obtained in only one case. The proportion of in-patients undergoing blood culture (65.5%) was similar to the 68.7% rate seen in a general population study of CAP.¹¹ The utility of blood cultures in patients hospitalized with CAP has been questioned,¹² but it may have a greater contribution in persons with SCI due to the frequency of atypical pathogens such as *Pseudomonas*.³ Not all admitted cases were initially recognized as having CAP, and this may have contributed to incomplete diagnostic evaluations.

We characterized initial antibiotic therapy with respect to IDSA recommendations for empiric coverage of CAP. While nearly all outpatients received antibiotic coverage that met the IDSA criteria, only half of in-patients received recommended antibiotics. For many in-patient cases that were considered to have inadequate coverage, the addition of a macrolide agent would have met IDSA criteria. Inclusion of a macrolide is recommended for treatment of CAP in the general population as this class of antibiotics is considered first-line coverage for atypical pneumonias, such as *Legionella* and *Mycoplasma*, which are relatively common in the general population and may not be covered adequately with other antimicrobial agents. It is not clear that these are common pathogens for CAP in persons with SCI.

We assessed the adequacy of coverage against *Pseudomonas*, since our prior work identified this pathogen in 21% of CAP cases in persons with SCI.³ In addition to being three times as common in SCI as in the general population, *Pseudomonas* pneumonia has been associated with a high risk of death.^{13,14} Risk

factors for Gram-negative pneumonia in the general population include antibiotic treatment or hospitalization in the prior 30 days, pulmonary comorbidity, and aspiration,¹⁴ and many of these are present in persons with SCI. In addition, *Pseudomonas* colonization of the perineum, lower urinary tract, and urine collection system is highly prevalent in persons with SCI.¹⁵ In this study, we found that slightly more than half of the cases received antipseudomonal coverage, with more than half meeting the criteria with use of a fluoroquinolone. Institution-specific sensitivity patterns revealed high rates of fluoroquinolone resistance at study centers, so a smaller proportion (23.7% of total cases) received empirically reliable antipseudomonal coverage. Resistance rates at study sites were somewhat higher than those seen at other United States hospitals.¹⁶ Of note, the two study sites with the highest rates of fluoroquinolone-resistant *Pseudomonas* were also the sites that relied most heavily on these agents (used 75% of times an antipseudomonal antibiotic was administered). The causes and consequences of these site-specific practice variations are unclear, and physicians should be attentive to population-specific pathogen-disease associations as well as institution-specific antimicrobial resistance patterns. Based on our prior work, we recommend that institution-specific antipseudomonal coverage can be considered for patients with SCI, particularly if other risk factors for Gram-negative pneumonias are present. The antibiotic should also have high activity against the most common pathogen, *Pneumococcus*.

The in-patient medical records indicated infrequent use of measures for mobilization of secretions. The most commonly used measure was quad coughing, which was used in five cases. Based on our clinical experience managing persons with SCI undergoing treatment for pneumonia, we question whether the records accurately reflect the use of all assistive measures for secretion mobilization. These measures are frequently performed on inpatient SCI units without specific prescription by a physician, and thus may not be documented by nursing or respiratory therapy staff. A recent evidence report on treatment of pulmonary disease in this population suggests that mechanical insufflation–exsufflation is a commonly used technique for secretion clearance.¹⁷ However, there was no record of this device being used for the cases in this study.

The choice of whether to treat as an in-patient or an outpatient is one of the most critical decisions in the management of CAP, as in-patient management is clearly indicated for some patients with severe illness, but is significantly more expensive.⁴ Prediction rules for mortality using demographic variables, medical comorbidities, physical examination findings, laboratory values, and radiographic findings have been validated for the general population by Fine et al.¹⁸ Using these rules, the majority of general population CAP cases would not be admitted to the hospital. However, more recent work indicates that the Fine criteria have a low positive predictive value for identifying inappropriate hospitalizations, primarily due to other medical

comorbidities.¹⁹ In our series, over three-quarters of cases were managed as inpatients. Although we did not use the Fine criteria for risk stratification, it is likely that they would have recommended hospitalization for a smaller proportion of our cases. The physicians providing care for patients at specialized SCI centers may appreciate that pneumonia is the leading cause of death in this population, and they may also recognize that mobilization of pulmonary secretions can be challenging in an outpatient setting. The relatively high rate of hospitalization for treatment of CAP in this population may be appropriate, as the general population predictors for mortality may not be valid in this population. In particular, the Fine criteria do not include neuromuscular weakness and impaired cough strength. Other considerations in the decision to hospitalize a patient include the risk for other adverse events, the availability of caregivers, and the ability to return for follow-up appointments.⁸ Hospitalization should also be considered for persons with SCI for management of acute bronchitis, as mobilization of copious bronchial secretions may be inadequate in the home environment, and this may place some patients at risk for ventilatory failure or pneumonia.

The average LOS for these cases of CAP in persons with SCI (19.3 days) was substantially longer than that reported for the general population hospitalized with CAP. Mean LOS for the general North American patient population hospitalized with CAP is 5.8–9.8 days.^{20,21} Another study examined LOS in CAP and found that in a somewhat similar population (veterans with multiple comorbid illnesses) the average LOS ranged from 4.6 to 9.7 days.²² The prolonged LOS is noteworthy as studies have shown that LOS can at least be partially reduced with little impact on outcomes.²⁰ Furthermore, the projected mean savings associated with a 1-day reduction in LOS is \$680.²³ However, factors other than difficulty in attaining medical stability may contribute to the long LOS in patients hospitalized at these centers. In our prior study, LOS at non-SCI centers was half that of SCI centers, and we speculated that the CAP hospitalization may be extended to address other needs such as treatment of nonrespiratory complications (eg pressure ulcers), prescription of new equipment, or completion of annual medical evaluations.

Our population's short-term mortality (7.3%) was similar to that reported for the general population, although the small sample size limits our confidence in this estimate. A validation study of risk stratification criteria for the general population showed an overall mortality rate of 5.2%, with 8% mortality for inpatients and 0.6% mortality for outpatients.¹⁸ It is not surprising that the mortality rates are comparable, since the frequency of comorbidities was relatively high, and the mean age in our sample (59 years) was nearly the same (61 years) as reported for a meta-analysis of general population CAP studies.²⁴

After a median follow-up period of 3 years (range, 2–4 years) the cumulative mortality for survivors of CAP in our series was 42.1%. High long-term mortality rates

following CAP have also been reported in the general population. One study showed a mortality rate of 32% over a 2-year follow-up period, with mortality related to the severity of medical comorbidities and not patient age.²⁵ A study with 12-year follow-up after CAP demonstrated a relative risk for pneumonia-related mortality of 2.1 and a relative risk for overall mortality of 1.5.²⁶ We suspect that a large proportion of late deaths in our cohort was due to respiratory disorders such as pneumonia, but we did not determine the cause of death for those who died after hospitalization or completion of outpatient treatment. Clinicians who treat persons with SCI should be aware that those who survive CAP are at high risk for mortality in subsequent years. This group should receive measures for prevention of pulmonary complications, and they should be encouraged to seek prompt evaluation for respiratory infections. We did not obtain data on influenza immunization rates for cases, but we found that slightly less than half had documentation of pneumococcal vaccination. Although the true immunization rate may be somewhat higher than indicated in the reviewed records, there is clearly room to increase the rate in this population. However, the effectiveness of pneumococcal vaccination in this population has not been established, and recent work questions its effectiveness for prevention of nonbacteremic pneumonia in the general population.²⁷

Potential limitations of the study include the relatively small number of cases, the retrospective analysis of the data, and the derivation of data from only three specialized SCI centers. Each of these sites has an inpatient ward used solely for treatment of patients with SCI, and each center follows hundreds of outpatients with chronic SCI. In our prior work,³ we used administrative data to characterize care provided through any VA hospital in the United States, regardless of presence of a specialized SCI unit. The veteran population with SCI that receives treatment from these centers is predominantly male, and on average is older and has more medical comorbidities than the overall population with chronic SCI.²⁸ Owing to the expertise with management of SCI at these centers, management techniques may have differed and outcomes may have been better than if care had been received in other settings. Our prior work suggested that CAP outcomes are better at specialized SCI centers, but this requires validation in future studies.

As noted above, CAP was not always recognized at the time of presentation to clinic, and the delay in making the diagnosis may have contributed to omission of some components of the recommended work-up. Owing to this, the proportion of cases with care that met guideline recommendations should not be directly compared with most general population studies and should not be viewed as a performance indicator for the care received. Finally, we assessed components of the IDSA guidelines for CAP since they have been widely accepted, but this choice of guidelines was arbitrary. None of the individual guideline recommendations has been validated in SCI populations. There are other

evidence-based guidelines on CAP that contain different recommendations, and the IDSA guidelines are not currently endorsed by the VA Office of Quality and Performance.

Conclusion

We characterized the treatment of CAP in persons with SCI at three specialized centers. Although the individual symptoms and signs at presentation were typical for CAP, most cases did not present with classic findings, indicating that the clinical evaluation of suspected pneumonia in persons with SCI is complex. The majority of cases were hospitalized, the mean LOS was 19.7 days, and the mortality rate for the episode of CAP was 7.3%. Many cases did not receive the full diagnostic work-up recommended in guidelines for management of CAP. Prescribed antibiotics met current guideline criteria for most outpatients, but only half of inpatients. After a median follow-up of 3 years, 42.1% of the survivors of CAP had expired. Preventive measures, such as pneumococcal and influenza immunization, should be encouraged in the at-risk population, and use of secretion mobilization techniques is likely to be beneficial in both inpatients and outpatients with respiratory infections. Since diagnosing pneumonia in persons with SCI can be difficult, clinicians should strongly consider inpatient management if the diagnosis is unclear, and persons managed as outpatients may benefit from close follow-up.

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