Mortality, Morbidity, and Disease Severity of Patients with Aspiration Pneumonia

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BACKGROUND: Aspiration pneumonia is a common syndrome, although less well characterized than other pneumonia syndromes. We describe a large population of patients with aspiration pneumonia.

METHODS: In this retrospective population study, we queried the electronic medical records at a tertiary-care, university-affiliated hospital from 1996 to 2006. Patients were initially identified by International Classification of Diseases, 9th Revision code 507.x; subsequent physician chart review excluded patients with aspiration pneumonitis and those without a confirmatory radiograph. Patients with community-acquired aspiration pneumonia were compared to a contemporaneous population of community-acquired pneumonia (CAP) patients. We compared CURB-65 (a clinical prediction rule based on Confusion, Uremia, Respiratory rate, Blood Pressure, and age)–predicted mortality with actual 30-day mortality.

RESULTS: We identified 628 patients with aspiration pneumonia, of which 510 were community-acquired. Median age was 77 years, with 30-day mortality of 21%. Compared to CAP patients, patients with community-acquired aspiration pneumonia had more frequent inpatient admission (99% vs 58%) and intensive care unit admission (38% vs 14%), higher Charlson comorbidity index (3 vs 1), and higher prevalence of do not resuscitate/intubate orders (24% vs 11%). CURB-65 predicted mortality poorly in aspiration pneumonia patients (area under the curve, 0.66).

CONCLUSIONS: Patients with community-acquired aspiration pneumonia are older, have more comorbidities, and demonstrate higher mortality than CAP patients, even after adjustment for age and comorbidities. CURB-65 poorly predicts mortality in this population. *Journal of Hospital Medicine* 2013;8:83–90. © 2012 Society of Hospital Medicine

Pneumonia is a common clinical syndrome with well-described epidemiology and microbiology. Aspiration pneumonia comprises 5% to 15% of patients with pneumonia,[1] but is less well-characterized despite being a major syndrome of pneumonia in the elderly.[2,3] Difficulties in studying aspiration pneumonia include the lack of a sensitive and specific marker for aspiration, the overlap between aspiration pneumonia and other forms of pneumonia, and the lack of differentiation between aspiration pneumonia and aspiration pneumonitis by many clinicians.[4–6] Aspiration pneumonia, which develops after the aspiration of oropharyngeal contents, differs from aspiration pneumonitis, wherein inhalation of gastric contents causes inflammation without the subsequent development of bacterial infection.[7,8]

A number of validated mortality prediction models exist for community-acquired pneumonia (CAP), using a variety of clinical predictors. One clinical prediction rule endorsed by the British Thoracic Society is the CURB-65, which assigns a score for Confusion, Uremia >19 mg/dL, Respiratory rate >= 30 breaths/min, Blood Pressure < 90 mmHg systolic or < 60 mmHg diastolic, and age ≥ 65). We favor eCURB, a version of the CURB-65 model that uses continuously weighted variables to more accurately predict mortality, validated in CAP populations.[9] Most studies validating pneumonia severity scoring systems excluded aspiration pneumonia from their study population.[10–12] Severity scoring systems for CAP may not accurately predict disease severity patients with aspiration pneumonia.

The aims of our study were to: (1) identify a population of patients with aspiration pneumonia; (2) compare characteristics and outcomes in patients with community-acquired aspiration pneumonia to those with CAP; and (3) study the performance of eCURB and CURB-65 in predicting mortality for patients with community-acquired aspiration pneumonia.

PATIENTS AND METHODS
Study Design and Setting
The study was performed at LDS Hospital, a university-affiliated community teaching hospital in Salt Lake City, Utah, with 520 beds. In retrospective analysis of data from the electronic medical records, we identified all patients older than 18 years who were evaluated in the emergency department at LDS

TABLE 1. Inclusion and Exclusion Criteria for the Study

Inclusion Criteria	Exclusion Criteria
1. Age $\geq$18 years	1. Absence of radiographic evidence of pneumonia within 48 hours after evaluation
2. Either admitted to hospital or evaluated in emergency department	2. Previous episode of aspiration pneumonia within 12 months
3. 507.x code as primary diagnosis	3. Initial admission date >48 hours before transfer to LDS Hospital
4. 507.x code as secondary diagnosis with a primary diagnosis of pneumonia, respiratory failure, or septicemia	4. AIDS
	5. Receipt of antiretroviral therapy
	6. History of solid organ transplant
5. Treating physician indicated a diagnosis of aspiration pneumonia in the history and physical and/or discharge summary	7. Hematologic malignancy
	8. Witnessed isolated aspiration event within 24 hours prior to evaluation
	9. Drug overdose, cardiopulmonary arrest, or seizure prior to hospital admission
	10. Laryngoscopic or bronchoscopic evidence of food material in airway

NOTE: **Abbreviations:** AIDS, acquired immune deficiency syndrome.

TABLE 2. Minor Criteria for Severe Community-Acquired Pneumonia, From the Infectious Disease Society of America/American Thoracic Society 2007 Criteria[17]

Respiratory rate $\geq$30 breaths/minute
$PaO_2/FiO_2 \leq 250$
Multilobar infiltrates
Confusion/disorientation
Uremia (blood urea nitrogen $\geq$20 mg/dL)
Leukopenia (white blood cell count <4000 cells/mm^3)
Thrombocytopenia (platelet count <100,000 cells/mm^3)
Hypothermia (core temperature $\leq$36°C)
Hypotension requiring aggressive fluid resuscitation

Hospital or admitted patients from other sources (direct admission, transfer from another hospital) from 1996 to 2006 with International Statistical Classification of Disease and Health Related Problems, 9th Revision (ICD-9) codes specific for aspiration pneumonia and pneumonitis (507.x). The treating physicians were mostly hospitalists and intensivists. Two physicians (M.L. and N.D.) manually reviewed the electronic medical records, including the emergency room physician's notes, the admission histories and physicals, the discharge summaries, and radiographic reports of the patients identified in the query. Consensus regarding the diagnosis of aspiration pneumonia was achieved in all patients reviewed using criteria listed in Table 1. This study was approved by the LDS Hospital institutional review board, and permission was granted to use the Utah Population Database for determining mortality (#1008505), with a waiver of informed consent. For the contemporaneous group of CAP patients, we used a previously described population identified using ICD-9 codes 481.x to 487.x, captured from the same hospital during the same period.[13]

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria are listed in Table 1. To exclude patients with recurrent pneumonia, we included only the first episode of pneumonia in a given 12-month period. LDS Hospital frequently receives patients transferred from surrounding emergency departments and intensive care units. We excluded patients who were transferred >48 hours from their initial emergency department admission and therefore were late in their disease course. Exclusion criteria 8 to 10 were used to exclude patients with clinical presentations more consistent with aspiration pneumonitis. We also excluded immunocompromised patients (criteria 4 to 7).

Healthcare-associated aspiration pneumonia was defined as receipt of chronic hemodialysis, residence in a nursing facility, or hospitalization within any Intermountain Healthcare-affiliated hospital within the past 90 days.[14] The remaining patients were defined as community-acquired aspiration pneumonia.

Measurements

The first vital signs, orientation status, and first 12 hours of routine laboratory results were extracted from the electronic medical records and used to calculate predicted mortality by eCURB and CURB-65. We determined 30-day mortality from the merger of the electronic medical records with vital status information from the Utah Population Database.[15] The first measured SpO_2 and FiO_2 were used to estimate the PaO_2/FiO_2 ratio, using the Severinghaus calculation[16] if no arterial blood gas was available. Presence of American Thoracic Society/Infectious Diseases Society of America (IDSA/ATS) 2007 minor criteria for severe community-acquired pneumonia (SCAP)[17] were obtained from baseline patient characteristics (Table 2). A Charlson comorbidity index was calculated from ICD-9 codes using published methodology.[18,19] Presence of an abnormal swallow was defined as dysphagia or aspiration on modified barium swallow study, fiberoptic endoscopic evaluation, or clinical determination by a speech language pathologist during the index hospitalization. We also looked for causative pathogens, defined by a positive pneumococcus or legionella urinary antigen, or a positive culture from blood, bronchoalveolar lavage, pleural fluid, or tracheal aspirate, collected within 24 hours of admission. Antibiotics administered within the first 24 hours of admission were classified into 4 broad groups based on local physician prescribing patterns. Clindamycin and metronidazole were considered anaerobic-specific antibiotics. Vancomycin or linezolid were considered methicillin-resistant *Staphylococcus aureus* (MRSA) antibiotics. Broad-spectrum antibiotics included any of the following: carbapenems, aztreonam, piperacillin/tazobactam, ticarcillin/clavulanate, cefepime, and ceftazidime. Macrolides, respiratory fluoroquinolones,
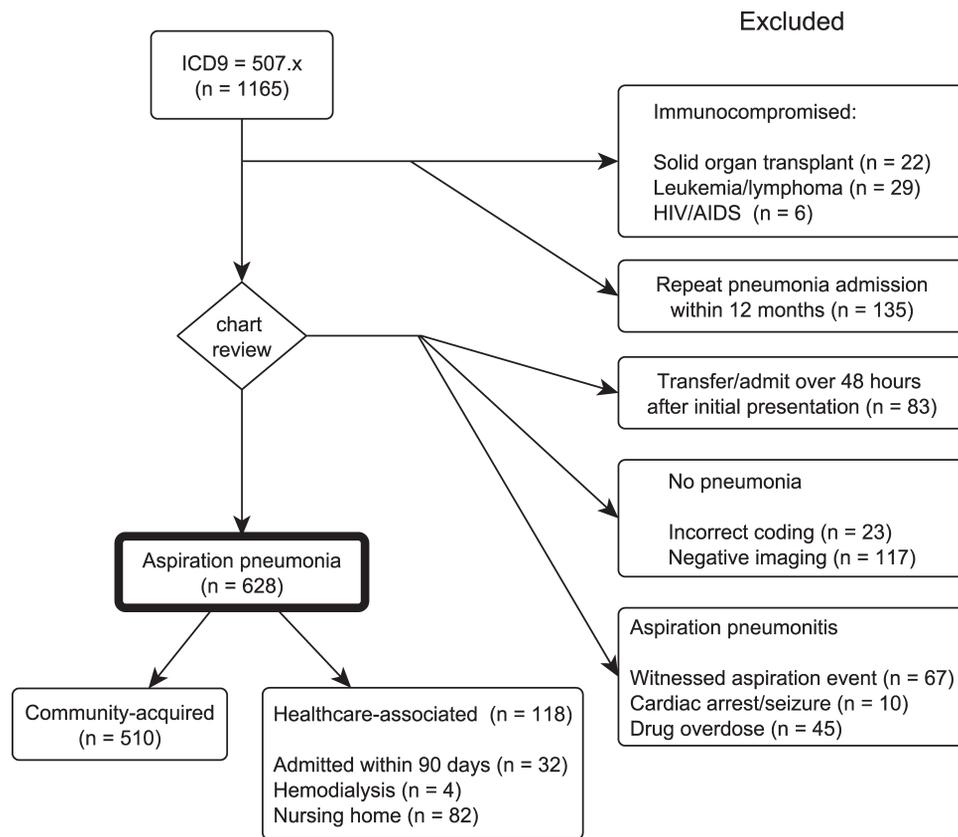
Excluded

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ICD9 = 507.x
(n = 1165)
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Immunocompromised:

Solid organ transplant (n = 22)
Leukemia/lymphoma (n = 29)
HIV/AIDS (n = 6)

Repeat pneumonia admission
within 12 months (n = 135)

chart
review

Transfer/admit over 48 hours
after initial presentation (n = 83)

No pneumonia

Incorrect coding (n = 23)
Negative imaging (n = 117)

Aspiration pneumonia
(n = 628)

Aspiration pneumonitis

Witnessed aspiration event (n = 67)
Cardiac arrest/seizure (n = 10)
Drug overdose (n = 45)

Community-acquired
(n = 510)

Healthcare-associated (n = 118)

Admitted within 90 days (n = 32)
Hemodialysis (n = 4)
Nursing home (n = 82)

FIG. 1. Inclusion and exclusion criteria. Abbreviations: HIV/AIDS, human immunodeficiency virus/acquired immune deficiency syndrome; ICD-9, International Classification of Diseases, 9th Revision.

and third-generation cephalosporins were considered standard-care antibiotics.

Statistical Analysis

We compared baseline patient characteristics and clinical outcomes using the Fisher exact test to compare proportions of categorical variables, and Mann-Whitney U test or Student t test to compare central tendencies of continuous variables, as dictated by the normality of the data. Receiver operating characteristic curves calculated the ability of eCURB and CURB-65 to predict 30-day mortality prediction in patients with community-acquired aspiration pneumonia and CAP, as well as the ability of IDSA/ATS minor criteria for SCAP to predict admission to the intensive care unit (ICU). We performed multivariate logistic regression to predict 30-day mortality in patients with community-acquired aspiration pneumonia and CAP, using stepwise backward elimination. Confounders were included if they were significant at a 0.05 level or if they altered the coefficient of the main variable by more than 10%. For logistic models, we evaluated goodness of fit with the Hosmer-Lemeshow technique; comparisons of area under the curve (AUC) among models were made using the technique of DeLong.[20] Two-tailed P values of ≤ 0.05 were considered statistically significant. Stata version 12 (StataCorp, College Station, TX) was used for all analyses.

RESULTS

Our initial query identified 1165 patients. Physician review of the medical records resulted in 628 patients, 118 of whom were classified as healthcare-associated aspiration pneumonia (Figure 1, Table 3). Of all aspiration pneumonia patients, 80% were seen in the emergency department, 12.5% were directly admitted from the community, and 7.5% were transferred from another healthcare facility. Almost all patients seen in the emergency department (99.0%) were admitted to the hospital, with median length of hospitalization 6.7 days among survivors.

Observed mortality was 21.0%. eCURB significantly underestimated mortality in this group, predicting a mortality rate of 10.6%. When classifying patients by the 2007 IDSA/ATS guidelines, 24.7% of the patients had 3 or more minor criteria for SCAP.[17] The PaO_2/FiO_2 ratio was obtained in 99.7% of patients. The median PaO_2/FiO_2 ratio observed in this population was 221 mm Hg (equivalent to 260 mm Hg at sea level barometric pressure, adjusted for our altitude of 1400 meters), near the threshold sea level definition (250 mm Hg) for SCAP.[13,17] Admission to the ICU was common, as were admission orders for "do not resuscitate" (DNR) or "do not intubate" (DNI). Patients with healthcare-associated aspiration pneumonia had a higher comorbidity index and had a

TABLE 3. Patient Characteristics of Aspiration Pneumonia, Subdivided by Presence of Healthcare Association

	Aspiration Pneumonia (N = 628)	Community-Acquired Aspiration Pneumonia (N = 510)	Healthcare Associated Aspiration Pneumonia (N=118)	P Value
Age (range), y	77 (65–85)	77 (64–85)	80 (67–86)	0.42
Female, %	49.8	50.2	48.3	0.76
30-day mortality, %	21.0%	19.0%	29.7%	0.02
CURB-65 score	2 (1–3)	2 (1–3)	2 (1–3)	0.0012
Confusion	13.9%	12.7%	18.6%	0.10
Blood urea nitrogen (mg/dL)	22 (16–34)	21 (15–32)	30 (20–47)	<0.0001
Respiratory rate (breaths/min)	20 (18–26)	20 (18–24)	21 (18–28)	0.30
Systolic blood pressure (mm Hg)	128 (110–149)	129 (110–150)	127 (105–146)	0.28
eCURB 30-day mortality estimate (median, %)	5.6 (2.4–14.2)	5.2 (2.2–12.4)	8.9 (4.2–22.5)	<0.0001
eCURB 30-day mortality estimate (mean, %)	10.6 ±12.2	9.7 ±11.5	14.6 ±14.1	<0.0001
Hospital admission (of ED visits), %	99.0	98.8	100	0.59
Hospital LOS, d	6.7 (4.1–11.1)	6.5 (4.0–11.0)	7.8 (5.4–12.3)	0.05
ICU admission, %	37.9	37.1	41.5	0.21
ICU LOS, d	3.5 (1.9–8.8)	3.1 (1.8–7.6)	5.6 (3.8–10.8)	0.02
Mean ventilator-free days (of ICU patients, out of 30 days)	25.2 ±8.3	25.9 ±7.7	22.7 ±10.0	0.01
Receipt of mechanical ventilation, %	18.6	17.2	24.6	0.09
Duration of ventilation, d	2.8 (0.9–6.5)	3.1 (1.0–6.6)	1.9 (0.8–6.3)	0.05
Receipt of vasopressor, %	1.8	1.4	3.4	0.13
Charlson comorbidity index	4 (2–6)	3 (2–6)	4 (3–6)	0.0024
Cerebrovascular disease, %	33.9	32.4	40.7	0.11
Chronic pulmonary disease, %	51.0	51.8	47.5	0.42
Congestive heart failure, %	52.4	50.0	62.7	0.01
Connective tissue disease, %	8.4	8.8	6.8	0.58
Dementia, %	14.2	12.0	23.7	0.0019
Hemiplegia/paraplegia	9.4	8.0	15.2	0.02
Myocardial infarction, %	21.0	17.8	29.7	0.02
Peripheral vascular disease, %	17.7	16.3	23.7	0.06
Peptic ulcer disease, %	18.8	19.2	16.9	0.70
Diabetes without complications, %	10.7	9.2	16.9	0.02
Diabetes with complications, %	31.5	30.4	36.4	0.23
Mild liver disease, %	8.6	8.0	11.0	0.28
Moderate or severe liver disease, %	1.8	1.6	2.5	0.44
Malignant solid tumor, %	16.6	17.3	13.6	0.41
Metastatic cancer, %	5.4	5.7	4.2	0.66
Renal disease, %	14.7	4.2	18.6	0.19
3 or more minor SCAP criteria, %*	24.7	23.1	31.4	0.08
PaO$_2$/FiO$_2$ ratio	221 (161–280)	226 (169–280)	181 (133–245)	0.0004
Multilobar disease, %	46.3	43.2	53.9	0.11
Presence of an effusion, %	23.1	19.7	31.9	0.03
Swallow impairment (of tested survivors), %	34.1	34.1	34.1	0.22
Presence of a DNR/DNI order, %	26.4	23.7	38.1	0.0024
Mortality of patients with DNR/DNI order, %	39.1	38.8	40.0	1.00
Receipt of broad-spectrum antibiotic, %	35.4	32.5	47.5	0.0028
Receipt of MRSA antibiotic, %	7.5	5.7	15.3	0.0014
Receipt of anaerobe antibiotic, %	28.7	27.6	33.1	0.26

NOTE: All continuous or ordinal data are median values followed by interquartile ranges, unless otherwise specified. Significance testing between community-acquired aspiration pneumonia and healthcare-associated aspiration pneumonia was calculated with Fisher exact or Wilcoxon tests, where appropriate. **Abbreviations:** AUC, area under the curve; DNR/DNI, Do not resuscitate/do not intubate; ED, emergency department; LOS, length of stay; MRSA, methicillin-resistant *Staphylococcus aureus*; SCAP, severe community-acquired pneumonia. *SCAP described in the 2007 Infectious Diseases Society of America/American Thoracic Society guidelines (Table 2).

higher mortality rate than patients with community-acquired aspiration pneumonia, although we found no significant difference in the rate of hospital or ICU admission or the receipt of critical care therapies. Inpatient assessment of dysphagia and aspiration was conducted in 177 patients. Abnormal swallow was noted in 96% of those tested.

We found several differences between patients with community-acquired aspiration pneumonia and 2584 patients with CAP identified during the same time period[13] (Table 4). Patients with community-acquired aspiration pneumonia were older, more likely to have

multilobar disease or effusion on imaging, and had greater disease severity. They also had a higher frequency of ICU and hospital admission, IDSA/ATS minor criteria for SCAP, and higher Charlson comorbidity indices. Patients with community-acquired aspiration pneumonia were more likely to receive mechanical ventilation than CAP patients, although there was no difference in 30-day mortality among intubated patients or a difference in ventilator-free days.

Thirty-day mortality for patients with community-acquired aspiration pneumonia was significantly higher than in CAP patients. Patients with

TABLE 4. Comparison of Community-Acquired Aspiration Pneumonia and Typical Community-Acquired Pneumonia

	Community-Acquired Aspiration Pneumonia (N = 510)	Community-Acquired Pneumonia (N = 2584)	P Value
Age (range), y	77 (64–85)	59 (41–76)	<0.0001
Female, %	50.2	49.5	0.81
30-day mortality, %	19.0	4.2	<0.0001
CURB-65 score	2 (1–3)	1 (0–2)	<0.0001
Confusion, %	12.7	5.1	<0.0001
Blood urea nitrogen	21 (15–32)	16 (11–24)	<0.0001
Respiratory rate	20 (18–24)	20 (18–24)	<0.0001
Systolic blood pressure	129 (110–150)	130 (112–146)	0.67
eCURB 30-day mortality estimate, median, %	5.2 (2.2–12.4)	1.7 (0.9–4.3)	<0.0001
eCURB 30-day mortality estimate, mean, %	9.7 ± 11.5	4.4 ± 7.5	<0.0001
AUC of eCURB versus mortality	0.71 (0.66–0.75)	0.86 (0.83–0.90)	<0.0001
Excluding DNR/DNI patients	0.69 (0.65–0.74)	0.87 (0.83–0.90)	0.0001
AUC of CURB-65 versus mortality	0.66 (0.62–0.69)	0.81 (0.78–0.85)	<0.0001
Excluding DNR/DNI patients	0.65 (0.60–0.70)	0.81 (0.76–0.85)	0.0003
Hospital admission (of ED visits), %	98.8	57.8	<0.0001
Hospital LOS, d	6.5 (4.0–11.0)	3.3 (2.2–5.2)	<0.0001
ICU admission, %	37.1	14.2	<0.0001
ICU LOS, d	3.1 (1.8–7.6)	2.5 (1.1–7.7)	0.01
Mean ventilator-free days (of ICU patients, out of 30 days)	25.9 ± 7.7	25 ± 9	0.75
Receipt of mechanical ventilation, %	17.2	7.8	<0.0001
Duration of ventilation, d	3.1 (1.0–6.6)	3.5 (1.5–7.2)	0.09
Receipt of vasopressor, %	1.4	3.3	0.02
Charlson comorbidity index	3 (2–6)	1 (0–3)	<0.0001
Cerebrovascular disease, %	32.4	10.0	<0.0001
Chronic pulmonary disease, %	51.8	42.5	<0.0001
Congestive heart failure, %	50.0	22.1	<0.0001
Connective tissue disease, %	8.8	5.6	0.0084
Dementia, %	12.0	2.8	<0.0001
Hemiplegia/paraplegia, %	8.0	2.7	<0.0001
Myocardial infarction, %	17.8	10.8	<0.0001
Peripheral vascular disease, %	16.3	7.4	<0.0001
Peptic ulcer disease, %	19.2	7.6	<0.0001
Diabetes without complications, %	9.2	24.7	<0.0001
Diabetes with complications, %	30.4	5.1	<0.0001
Mild liver disease, %	8.0	6.2	0.14
Moderate or severe liver disease, %	1.6	0.8	0.13
Malignant solid tumor, %	17.	8.9	<0.0001
Metastatic cancer, %	5.7	1.3	<0.0001
Renal disease, %	4.2	5.6	<0.0001
3 or more minor SCAP criteria, %*	24.7	19.1	0.01
PaO$_2$/FiO$_2$ ratio	226 (169–280)	260 (148–338)	0.0004
Multilobar disease, %	43.2	37.2	0.0012
Presence of an effusion, %	19.7	18.3	<0.0001
Presence of a DNR/DNI order, %	23.7	9.7	<0.0001
Mortality of patients with DNR/DNI order, %	38.8	12.4	<0.0001
Receipt of broad-spectrum antibiotic, %	32.5	8.4	<0.0001
Receipt of MRSA antibiotic, %	5.7	2.2	<0.0001
Receipt of anaerobe antibiotic, %	27.6	3.1	<0.0001

NOTE: All dichotomous data are proportions. All continuous or ordinal data are median values followed by interquartile ranges, unless otherwise specified. Significance testing was calculated with Fisher exact or Wilcoxon tests, where appropriate. Abbreviations: AUC, area under the curve; CURB-65, a clinical prediction rule based on Confusion, Uremia, Respiratory rate, Blood Pressure, and age > 65; DNR/DNI, do not resuscitate/do not intubate; eCURB, a version of the CURB-65 mode that uses continuously weighted variables; ED, emergency department; ICU, intensive care unit; LOS, length of stay; MRSA, methicillin-resistant *Staphylococcus aureus*; SCAP, severe community-acquired pneumonia *SCAP described in the 2007 Infectious Diseases Society of America/American Thoracic Society guidelines.
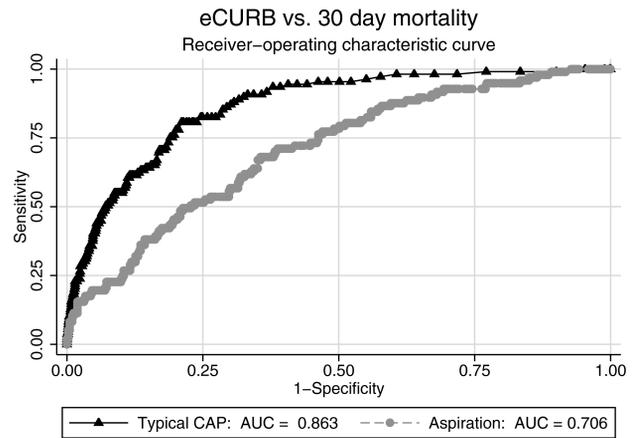

FIG. 2. Receiver operating characteristic curve, comparing the eCURB score against 30-day mortality in patients with typical community-acquired pneumonia and in patients with community-acquired aspiration pneumonia. The eCURB score is an electronic version of the CURB-65 model, validated in the community-acquired pneumonia population, that uses continuously weighted variables to more accurately predict mortality. These curves statistically differ, $P < 0.0001$. Abbreviations: AUC, area under the curve; CAP, community-acquired pneumonia.
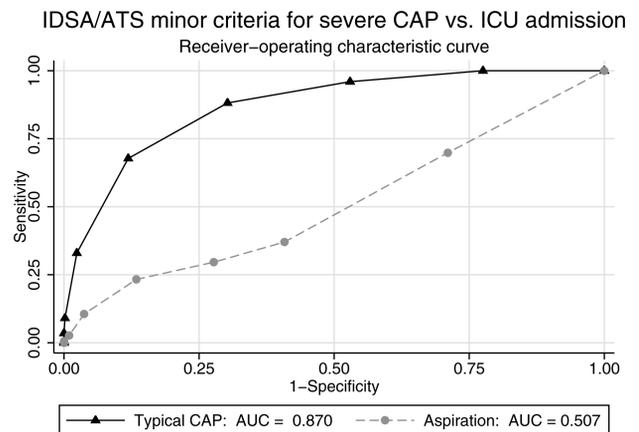

FIG. 3. Receiver operating characteristic curve, comparing the Infectious Diseases Society of America/American Thoracic Society (IDSA/ATS) minor criteria for severe community-acquired pneumonia against intensive care unit (ICU) admission in patients with typical community-acquired pneumonia (CAP) and in patients with community-acquired aspiration pneumonia. These curves statistically differ, $P < 0.0001$. Abbreviations: AUC: area under the curve.

community-acquired aspiration pneumonia also had higher eCURB and CURB-65 scores. However, eCURB was a poor predictor of 30-day mortality, with an AUC of 0.71, compared to 0.86 calculated for the CAP population (Figure 2). CURB-65 performed similarly: AUC was 0.66 vs 0.81. The presence of a DNR/DNI order was twice as prevalent in the community-acquired aspiration pneumonia population vs the CAP population; those patients with a DNR/DNI order were 3 times as likely to die. Excluding patients with a DNR/DNI order did not improve performance of eCURB or CURB-65 (Table 4). The presence of IDSA/ATS minor criteria for SCAP was not predictive of triage to the ICU in the group of patients

with community-acquired aspiration pneumonia (AUC: 0.51), compared with CAP patients (AUC: 0.88, *P* < 0.01 for comparison, Figure 3). This finding persisted in the subset of patients without a DNR/DNI order (AUC: 0.52 in community-acquired aspiration pneumonia vs 0.88 in CAP, *P* < 0.01).

Our regression model of mortality incorporated gender, presence of effusion or multilobar pneumonia, presence of a DNR/DNI order, and all the components of the CURB-65, IDSA/ATS minor criteria for SCAP, and Charlson comorbidity index. The regression model demonstrated that even after adjustment for age, comorbidities, disease severity, and presence of a DNR/DNI order, the presence of aspiration pneumonia was associated with higher mortality than CAP (odds ratio [OR]: 3.46, *P* < 0.001, Table 5). In this model, systolic blood pressure did not predict mortal-

ity, and diabetes with complications was associated with decreased mortality.

Microbiological Findings

Blood cultures were performed at admission in 67.4% of aspiration-pneumonia patients, and a tracheal aspirate in half (50.7%) of intubated patients with aspiration pneumonia. Organisms were recovered in 90 patients (14.3%), although 41 of those patients had tracheal aspirates of organisms commonly thought to be nonpathogenic (nonpneumococcal alpha-hemolytic streptococcus, nonhemolytic streptococcus, diphtheroids, micrococci, coagulase negative staphylococcus). Tracheal aspirate was the most common method of recovering an organism (7.8% of patients), followed by blood culture (4.3%). Bronchoalveolar lavage, urinary antigen, and pleural fluid culture were less common (1.3%, 1.1%, 0.3%, respectively). The microbiologic results were grouped into: *Staphylococcus aureus*, *Streptococcus pneumoniae*, enteric bacilli, *Haemophilus* species, *Neisseria* species, *Moraxella catarrhalis*, and *Pseudomonas aeruginosa* (Figure 4). Comparing healthcare-associated with community-acquired aspiration pneumonia, healthcare-associated patients were more likely to have a confirmed infection with MRSA (4.2% vs 1.4%, *P* = 0.06) and enteric bacteria (5.1% vs 1.6%, *P* = 0.03). There were no other statistically significant differences in microbiologic recovery between the 2 groups. Antibiotics targeting anaerobic pathogens were administered in 28.7% of patients with aspiration pneumonia, with no correlation to the presence of healthcare-associated risks. Healthcare-associated patients were more likely to receive broad-spectrum antibiotics (47.5% vs 32.5%, *P* < 0.01) and MRSA coverage (15.3% vs 5.7%, *P* < 0.01) than patients with community-acquired aspiration pneumonia.

TABLE 5. Final Logistic Regression Model Predicting 30-Day Mortality in Patients With Community-Acquired Pneumonia and Community-Acquired Aspiration Pneumonia

	Odds Ratio	*P* Value
Presence of aspiration pneumonia	3.46 (2.11–5.67)	<0.001
Age, y	1.03 (1.01–1.04)	<0.001
Confusion	3.14 (1.95–5.05)	<0.001
Blood urea nitrogen, mg/dL	1.03 (1.02–1.04)	<0.001
Respiratory rate, breaths/minute	1.03 (1.00–1.06)	0.04
PaO₂/FiO₂ ratio, per 1 mm Hg	0.99 (0.99–1.00)	<0.001
Moderate or severe liver disease	9.21 (3.16–26.86)	<0.001
Paraplegia/hemiplegia	2.43 (1.13–5.27)	0.02
Diabetes with complications	0.42 (0.20–0.87)	0.02
Leukocytosis	4.47 (2.27–8.82)	<0.001
DNR/DNI	1.75 (1.11–2.75)	0.02

NOTE: Initial model also included gender, presence of multilobar pneumonia, and all components of the CURB (Confusion, Uremia, Respiratory Rate, Blood Pressure) score and Charlson comorbidity index, and minor criteria for severe community-acquired pneumonia. Area under the curve of the final model = 0.87. Odds ratios are followed by 95% confidence intervals in parentheses. Exclusion of DNR/DNI status did not significantly alter the regression model. **Abbreviations:** DNR/DNI, do not resuscitate/do not intubate.
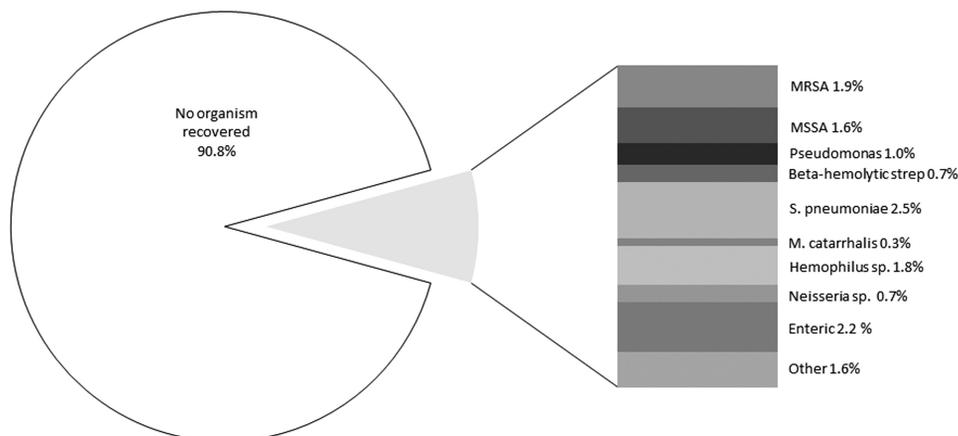

FIG. 4. Distribution of bacterial organism recovered from 628 patients with aspiration pneumonia. Percentages are expressed as a fraction of 628 patients. Note that the total exceeds 100% due to polymicrobial infection. Viral, fungal, and acid fast bacilli cultures were not routinely obtained and not included in this graphic. Other = *Bacillus cereus* (1), *Serratia marcescens* (1), *Nocardia* species (1), *Acinetobacter bauminii* (1), *Capnocytophaga* (1), *Eikenella corrodens* (1), *Proteus* (1), *Saccharomyces cerevisiae* (1). Abbreviations: *M. catarrhalis, Moraxella catarrhalis*; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *Staphylococcus aureus*; *S. pneumoniae, Streptococcus pneumoniae*.

DISCUSSION

Our study identifies a larger cohort of patients with aspiration pneumonia than previous studies.[21–25] Patients with community-acquired aspiration pneumonia are older and more likely to die than CAP patients. They are more likely to be admitted to the hospital or ICU. Thirty-day mortality in this patient population was significantly underestimated by CURB-65 and eCURB, models developed and validated in CAP populations.[9,26] This finding supports a prior study.[27] It appears that a traditional prognostic model assessing mortality risk in the CAP patient does not apply to the aspiration-pneumonia patient. One reason for eCURB and CURB-65's poor utility in community-acquired aspiration pneumonia may be their reliance on objective clinical features rather than comorbidities, which may influence mortality to a greater degree in aspiration pneumonia.

This study has several limitations. There is no gold standard for the definition of aspiration pneumonia, and it is difficult to distinguish aspiration pneumonia from typical pneumonia. It is plausible that older patients with greater comorbidities are being designated as aspiration pneumonia. If this is the case, then aspiration pneumonia merely represents the end of the pneumonia spectrum with highest mortality risk, and it is no surprise that these patients fare poorly.

It appears that the hospitalist or emergency department physician implicitly appreciates that aspiration pneumonia has a higher mortality risk than predicted by traditional severity assessment. With such high mortality and morbidity, a patient presenting to the emergency room with aspiration pneumonia is almost always admitted to the hospital. Further work in this area should investigate other factors to improve prognostic modeling in patients with aspiration pneumonia, although the utility of such a model may be limited to determining ICU admission. Our data indicate that IDSA/ATS minor criteria for SCAP are not useful in predicting admission to the ICU in patients with aspiration pneumonia.

In this study, a DNR/DNI order was twice as common in the community-acquired aspiration pneumonia population than the CAP population. However, patients with community-acquired aspiration pneumonia and a DNR/DNI order were more than 3 times more likely to die than patients with CAP and a DNR/DNI order. Our regression model suggested that the presence of a DNR/DNI order was an independent predictor of mortality (OR: 1.75, *P* < 0.001). Although a DNR/DNI order may correlate with the withholding or withdrawal of medical therapy, it is also a surrogate for increased age or comorbidities.[28] In our study, however, the increased prevalence of DNR/DNI orders did not explain the poor mortality prediction of the eCURB or CURB-65, as exclusion of those patients did not significantly alter the AUCs in either the aspiration group or the CAP group.

Controversy exists regarding treatment of aspiration pneumonia. Historically, some have advocated for treatment of aspiration pneumonia with a regimen designed to cover anaerobic bacteria.[29] This recommendation was based on early microbiologic studies that obtained the samples late in the course of illness, or other studies where the sample was obtained transtracheally, where oropharyngeal flora may contaminate the sample.[30–32] Our clinically obtained microbiologic recovery of organisms was similar to the flora recovered in more recent CAP studies, in respect to both the incidence of pathogen recovery and the relative frequencies of recovered organisms.[33,34] Our data do not support inferences regarding the prevalence of anaerobic infections, as the recovery of anaerobic organisms was limited to blood and pleural fluid cultures in this study, rather than techniques used in research settings that might have greater yield. As expected, patients with healthcare-associated risk factors trended toward increased incidence of MRSA. Given the similarity of the organisms recovered to those recovered in CAP,[35] this study supports IDSA/ATS recommendations that antibiotic therapy in aspiration pneumonia be similar to that of higher-risk CAP, with the addition of vancomycin or linezolid for MRSA coverage in patients with risk factors for healthcare-associated pneumonia.[17]

Our study is limited by its single-center retrospective design. However, beginning in 1995, the LDS Hospital emergency department initiated a standardized pneumonia therapy protocol and deployed electronic medical records, which prospectively recorded a wide array of clinical, therapeutic, and biometric data. Most data elements used in this analysis were routinely charted for clinical purposes in real time. Although the eCURB, CURB-65, and some comorbidities could be extracted electronically for each patient, it was not possible to calculate the pneumonia severity index score due to our inability to rigorously identify the necessary comorbid illness elements. Other comorbidities, not present in our model, may have been identified by the physician who makes a diagnosis of aspiration pneumonia. Our identification of swallow impairment is also methodologically limited. The decision to obtain a swallow study was clinical, usually occurring upon convalescence. Therefore, it is not possible to distinguish between antecedent oropharyngeal dysfunction and post-critical illness dysfunction.

Our definition of aspiration pneumonia required the treating physician to diagnose and code the patient as having aspiration pneumonia, followed by excluding patients more likely to have aspiration pneumonitis. Although we relied on ICD-9 codes to initially identify aspiration pneumonia, all patients in our database were confirmed by physician chart review. Our incidence of community-acquired aspiration pneumonia is congruent with other studies using different methodologies.[1,36,37] Unfortunately, there is no standard and

widely accepted definition for separating aspiration pneumonia from usual CAP. A younger and healthier patient who has developed pneumonia subsequent to aspiration may be more likely to be diagnosed with CAP, resulting in selection bias for older patients with greater comorbidities.

CONCLUSION

Patients diagnosed with aspiration pneumonia are older, have more comorbid conditions, and demonstrate greater disease severity and higher 30-day mortality than CAP patients. Mortality prediction using CURB-65 and eCURB in this population was poor, possibly due to a greater effect of comorbidities on mortality. The pneumonia severity index, which incorporates patient comorbidities, might perform better than the eCURB or CURB-65, and should be studied in aspiration pneumonia populations where comorbid illness information is prospectively collected. Further areas of study include creating an improved mortality prediction model for aspiration pneumonia that incorporates comorbid conditions, DNR/DNI status, and disease severity.

References

1. Torres A, Serra-Batlles J, Ferrer A, et al. Severe community-acquired pneumonia. Epidemiology and prognostic factors. *Am Rev Respir Dis*. 1991;144(2):312–318.
2. Koivula I, Sten M, Makela PH. Risk factors for pneumonia in the elderly. *Am J Med*. 1994;96(4):313–320.
3. Marik PE, Kaplan D. Aspiration pneumonia and dysphagia in the elderly. *Chest*. 2003;124(1):328–336.
4. Mylotte JM, Goodnough S, Naughton BJ. Pneumonia versus aspiration pneumonia in nursing home residents: diagnosis and management. *J Am Geriatr Soc*. 2003;51(1):17–23.
5. Marik PE. Aspiration pneumonia: mixing apples with oranges and tangerines. *Crit Care Med*. 2004;32(5):1236; author reply 1236–1237.
6. Kozlow JH, Berenholtz SM, Garrett E, Dorman T, Pronovost PJ. Epidemiology and impact of aspiration pneumonia in patients undergoing surgery in Maryland, 1999–2000. *Crit Care Med*. 2003;31(7):1930–1937.
7. Marik PE. Aspiration syndromes: aspiration pneumonia and pneumonitis. *Hosp Pract (Minneap)*. 2010;38(1):35–42.
8. Marik PE. Aspiration pneumonitis and aspiration pneumonia. *N Engl J Med*. 2001;344(9):665–671.
9. Jones BE, Jones J, Bewick T, et al. CURB-65 pneumonia severity assessment adapted for electronic decision support. *Chest*. 2011;140(1):156–163.
10. Lim WS, van der Eerden MM, Laing R, et al. Defining community acquired pneumonia severity on presentation to hospital: an international derivation and validation study. *Thorax*. 2003;58(5):377–382.
11. Fine MJ, Hanusa BH, Lave JR, et al. Comparison of a disease-specific and a generic severity of illness measure for patients with community-acquired pneumonia. *J Gen Intern Med*. 1995;10(7):359–368.
12. Espana PP, Capelastegui A, Gorordo I, et al. Development and validation of a clinical prediction rule for severe community-acquired pneumonia. *Am J Respir Crit Care Med*. 2006;174(11):1249–1256.
13. Brown SM, Jones BE, Jephson AR, Dean NC. Validation of the Infectious Disease Society of America/American Thoracic Society 2007 guidelines for severe community-acquired pneumonia. *Crit Care Med*. 2009;37(12):3010–3016.
14. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *Am J Respir Crit Care Med*. 2005;171(4):388–416.
15. Skolnick M. The Utah genealogical database: a resource for genetic epidemiology. In: Cairns JL, Skolnick M, eds. Banbury Report No 4; Cancer Incidence in Defined Populations. New York, NY: Cold Spring Harbor Laboratory; 1980:285–297.
16. Severinghaus JW. Simple, accurate equations for human blood O2 dissociation computations. *J Appl Physiol*. 1979;46(3):599–602.
17. Mandell LA, Wunderink RG, Anzueto A, et al. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis*. 2007;44(suppl 2):S27–S72.
18. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. *J Clin Epidemiol*. 1994;47(11):1245–1251.
19. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol*. 1992;45(6):613–619.
20. DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics*. 1988;44(3):837–845.
21. Feinberg MJ, Knebl J, Tully J. Prandial aspiration and pneumonia in an elderly population followed over 3 years. *Dysphagia*. 1996;11(2):104–109.
22. Langmore SE, Skarupski KA, Park PS, Fries BE. Predictors of aspiration pneumonia in nursing home residents. *Dysphagia*. 2002;17(4):298–307.
23. Terpenning MS, Taylor GW, Lopatin DE, Kerr CK, Dominguez BL, Loesche WJ. Aspiration pneumonia: dental and oral risk factors in an older veteran population. *J Am Geriatr Soc*. 2001;49(5):557–563.
24. El-Solh AA, Pietrantoni C, Bhat A, et al. Microbiology of severe aspiration pneumonia in institutionalized elderly. *Am J Respir Crit Care Med*. 2003;167(12):1650–1654.
25. Johnson ER, McKenzie SW, Sievers A. Aspiration pneumonia in stroke. *Arch Phys Med Rehabil*. 1993;74(9):973–976.
26. Capelastegui A, Espana PP, Quintana JM, et al. Validation of a predictive rule for the management of community-acquired pneumonia. *Eur Respir J*. 2006;27(1):151–157.
27. Heppner HJ, Sehlhoff B, Niklaus D, Pientka L, Thiem U. Pneumonia Severity Index (PSI), CURB-65, and mortality in hospitalized elderly patients with aspiration pneumonia [in German]. *Zeitschrift fur Gerontologie und Geriatrie*. 2011;44(4):229–234.
28. Bedell SE, Pelle D, Maher PL, Cleary PD. Do-not-resuscitate orders for critically ill patients in the hospital. How are they used and what is their impact? *JAMA*. 1986;256(2):233–237.
29. Gilbert DN, Moellering RC, Eliopoulos GM, Chambers HF, Saag MS. The Sanford Guide to Antimicrobial Therapy: 2010. 40th ed. Sperryville, VA: Antimicrobial Therapy, Inc.; 2009.
30. Bartlett JG, Gorbach SL, Finegold SM. The bacteriology of aspiration pneumonia. *Am J Med*. 1974;56(2):202–207.
31. Cesar L, Gonzalez C, Calia FM. Bacteriologic flora of aspiration-induced pulmonary infections. *Arch Intern Med*. 1975;135(5):711–714.
32. Lorber B, Swenson RM. Bacteriology of aspiration pneumonia. A prospective study of community- and hospital-acquired cases. *Ann Intern Med*. 1974;81(3):329–331.
33. Marik PE, Careau P. The role of anaerobes in patients with ventilator-associated pneumonia and aspiration pneumonia: a prospective study. *Chest*. 1999;115(1):178–183.
34. Mier L, Dreyfuss D, Darchy B, et al. Is penicillin G an adequate initial treatment for aspiration pneumonia? A prospective evaluation using a protected specimen brush and quantitative cultures. *Intensive Care Med*. 1993;19(5):279–284.
35. Torres A, El-Ebiary M, Riquelme R, Ruiz M, Celis R. Community-acquired pneumonia in the elderly. *Semin Respir Infect*. 1999;14(2):173–183.
36. Marrie TJ, Durant H, Kwan C. Nursing home-acquired pneumonia. A case-control study. *J Am Geriatr Soc*. 1986;34(10):697–702.
37. Moine P, Vercken JB, Chevret S, Chastang C, Gajdos P. Severe community-acquired pneumonia. Etiology, epidemiology, and prognosis factors. French Study Group for Community-Acquired Pneumonia in the Intensive Care Unit. *Chest*. 1994;105(5):1487–1495.