Epidemiology and pathogen characteristics of pneumonia types in the US hospital setting

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INTRODUCTION

- Despite advances in antimicrobial therapy, better supportive care and increased use of preventive measures, pneumonia in hospitals remains an important cause of mortality and morbidity.[1]
- Pneumonia is classified into community-acquired pneumonia (CAP) and nosocomial pneumonia (NP), depending upon the setting and onset of disease.[2]
- NP can be further classified into types that identify the means by which the infection has been contracted:
  - ventilator-associated pneumonia (VAP) describes an infection that arises > 48–72 hours after endotracheal intubation[1]
  - hospital-acquired pneumonia (HAP) includes pneumonia that occurs ≥ 48 hours after hospital admission with patients not being intubated at the time of admission[1]
  - healthcare-associated pneumonia (HCAP) includes infection within 48 hours of hospital admission with patients who have had recent contact with the healthcare system through nursing homes or long-term care facilities, hemodialysis clinics, or administration of intravenous antibiotic therapy, chemotherapy or wound care.[3]
- Pneumonia classification scheme reflects the differences in the pathogens responsible for infection, and forms the basis for treatment decisions and choice of antibiotic therapy.[4]
- Limited information is available on the distribution of pneumonia types and associated pathogens in hospitals.

OBJECTIVE

- To determine the epidemiology and pathogen characteristics of pneumonia types in hospitalized patients in the US.

METHODS

- A retrospective cohort analysis was conducted using the Premier hospital database, which provides comprehensive billing, medication, diagnoses, procedure, etc., data from over 700 US hospitals.[5]
- Hospitalized patients with a primary or secondary ICD-9-CM code for pneumonia (ICD-9 CM: 481.x-483.x, 485.x- 486.x, 997.31) between January 1, 2008 and March 31, 2015 were identified and included in the analysis.
- Patients were then grouped into pneumonia types in a stepwise manner, according to the case definitions as shown in Figure 1. In addition to the types described above, CAP patients were classified into those who were intubated anytime during their hospital stay (intubated CAP [iCAP]) and those who were not (non-intubated CAP [niCAP]).
- Distribution of pneumonia types and associated pathogens were the primary outcomes of interest. Microbiology data (available among a sub-set of data from 2009-2015) with positive bacterial cultures were used to identify the most common pathogens by pneumonia types.

RESULTS*

- A total of 2,801,674 pneumonia patients were deemed eligible for the analysis. Mean age was 65 years (SD ± 22), with 48.9% males, 69.7% whites, and 65% on Medicare plan (Table 1).
- Among eligible patients, 79.5% (n = 2,233,429) and 17.9% (n = 504,055) were CAP and NP, respectively (Figure 3). Among CAP patients, 18.8% (n = 420,272) were iCAP. NP patients were further categorized into 57.6% HCAP, 35.4% HAP, and 7.0% VAP patients.
  - In comparison with other pneumonia types, VAP patients were marginally younger with a mean age of 60 years (SD ± 20), higher proportion of males (59.1%), fewer whites (59%), and fewer with Medicare coverage (53.1%).
  - Mean age was the highest among HCAP patients (68 years [SD ± 21]).
  - Mortality at discharge was the highest amongst patients who were intubated vs. those not intubated.
- Microbiology data were available for 20% of eligible pneumonia patients. Of these, positive bacterial cultures were observed in 57% of CAP (77% of iCAP and 53% of niCAP) and 66% of NP (90% of HCAP, 62% of HAP, and 92% of VAP) patients.
- The most commonly identified pathogens by pneumonia types are shown in Figure 2.
  - *Staphylococcus* sp. and *Pseudomonas* sp. were the most commonly identified organisms in VAP patients (40% and 24%, respectively), followed by *Escherichia* sp. (17%) and *Klebsiella* sp. (18%). These pathogens were more predominant in VAP than other pneumonia types.
  - *Streptococcus* sp. was the most commonly identified organism in CAP; *Staphylococcus* sp. and *Pseudomonas* sp. were more commonly found in patients with iCAP in comparison with niCAP (28% vs. 15% and 12% vs. 5%, respectively).

Figure 1. Algorithm used to group patients into pneumonia types

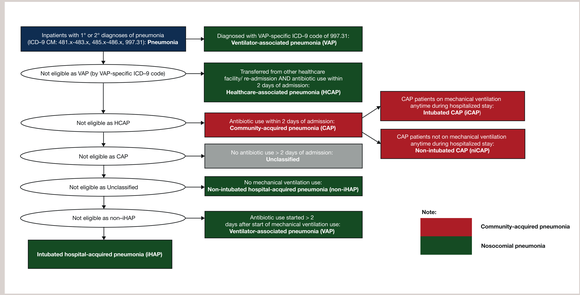


Table 1. Patient characteristics

	Pneumonia	CAP	iCAP	niCAP	NP	VAP	HAP	HCAP
Total, n	2,810,674	2,233,429	420,272	1,813,157	504,055	35,208	178,537	290,310
Male, %	48.9	48.5	51.6	47.8	50.3	59.1	51.6	48.5
Mean age, years (SD)	65 (22)	64 (22)	65 (18)	64 (22)	67 (21)	60 (20)	67 (19)	68 (21)
Age range, %								
< 18 years	5.4	5.5	2.4	6.2	4.2	3.6	3.1	5.0
18–49 years	13.1	13.5	13.1	13.6	11.3	20.3	12.3	9.5
50–64 years	21.7	22.1	27.3	20.9	20.4	29.3	21.5	18.7
65–84 years	42.5	42.2	45.5	41.4	44.2	39.9	45.3	44.0
85+ years	17.3	16.7	11.7	17.8	19.9	6.9	17.8	22.8
Race, %								
White	69.7	70.0	69.3	70.2	68.7	59.0	65.1	72.0
Black	12.3	12.4	12.7	12.4	11.3	16.6	12.9	9.7
Hispanic	2.2	2.4	2.2	2.5	1.5	2.6	1.9	1.1
Other	15.8	15.1	15.8	15.0	18.5	21.7	20.1	17.1
Payer, %								
Medicare	65.0	64.4	65.3	64.2	69.3	53.1	67.3	72.5
Medicaid	11.9	12.1	12.5	12.0	11.2	17.3	10.8	10.7
Managed care	12.7	13.1	11.9	13.4	10.4	14.7	12.0	8.9
Commercial	3.7	3.7	3.6	3.7	3.3	5.4	3.5	2.9
Self-pay	3.4	3.6	3.3	3.6	2.8	4.1	3.2	2.4
Other/ unknown	3.2	3.1	3.4	3.0	3.0	5.3	3.1	2.6
Mortality at discharge, %	7.7	6.6	21.8	3.1	11.1	19.2	9.7	11.1

CAP = community-acquired pneumonia; iCAP = intubated community-acquired pneumonia; niCAP = non-intubated community-acquired pneumonia; NP = nosocomial pneumonia; VAP = ventilator-associated pneumonia; HAP = hospital-acquired pneumonia; HCAP = healthcare-associated pneumonia; Unclassified, n=73,190 (data not shown).

Figure 2. Commonly isolated bacterial pathogens by pneumonia types (US Premier Jan 2009–Mar 2015)

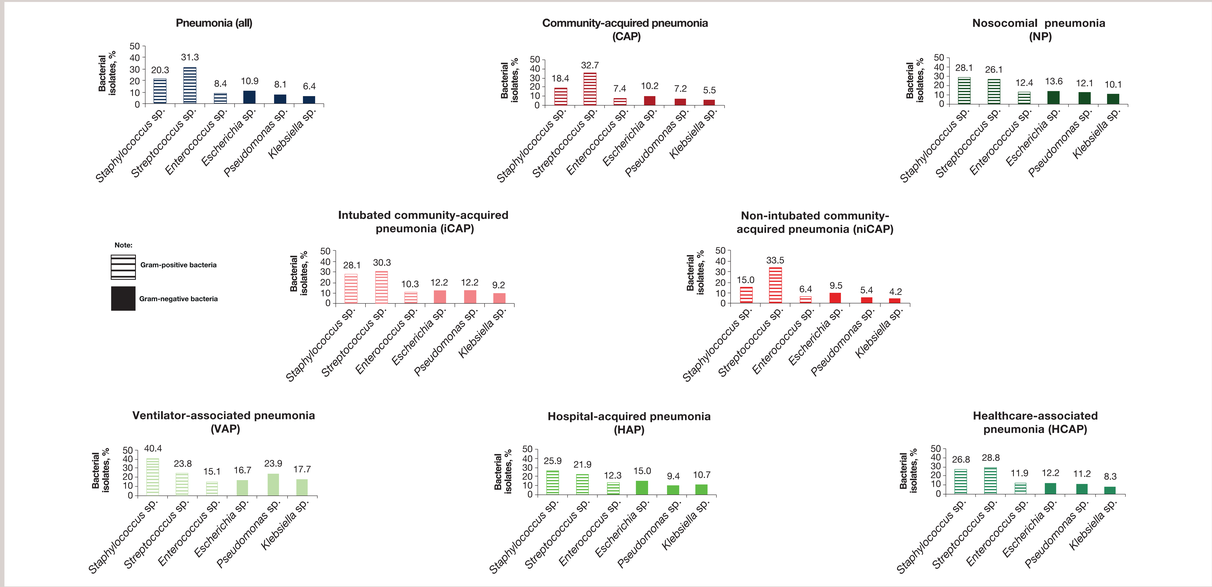
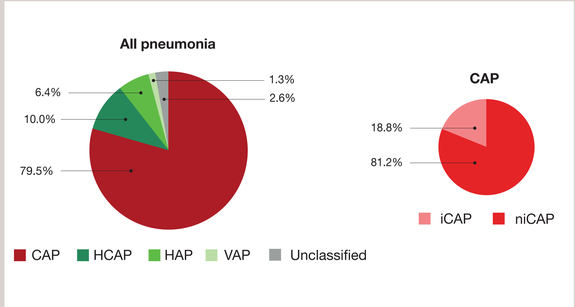


Figure 3. Distribution of pneumonia types (US Premier Jan 2008–Mar 2015)



CAP = community-acquired pneumonia; iCAP = intubated community-acquired pneumonia; niCAP = non-intubated community-acquired pneumonia; VAP = ventilator-associated pneumonia; HAP = hospital-acquired pneumonia; HCAP = healthcare-associated pneumonia.

CONCLUSIONS

- Our study provides detailed information about the distribution of pneumonia types amongst hospitalized patients and associated pathogens in the US.
- CAP, identified based on antibiotic use within 2 days of admission, could potentially result in an overestimate, as real-world use of antibiotics could be influenced by other factors (e.g., viral infections, surgeries).
- To our knowledge, our study is the first to characterize the serious iCAP population, who may require a different treatment management than traditional CAP patients.

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* Minor edits have been made to data since abstract submission.

ACKNOWLEDGMENTS

- Support for third-party writing assistance for this poster, furnished by Dr. Kristina Standeven of MediTech Media, UK, was provided by F. Hoffmann-La Roche Ltd.

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