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Outcomes of Patients with Healthcare-associated Pneumonia: Worse disease or sicker patients?

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Abstract

Background—Healthcare-associated pneumonia (HCAP) is an entity distinct from community-acquired pneumonia (CAP). HCAP has a higher case-fatality rate, due either to HCAP organisms or the health status of HCAP patients. The contribution of HCAP criteria to case-fatality rate is unknown.

Methods—We conducted a retrospective review of adult patients admitted with a diagnosis of pneumonia from 7/2007–11/2011 to 491 U.S. hospitals. HCAP was defined as having 1 of the following: prior hospitalization within 90 days, hemodialysis, admission from a skilled nursing facility, or immune suppression. We compared characteristics of patients with CAP and HCAP and explored the contribution of HCAP criteria to case-fatality rate in a hierarchical generalized linear model.

Results—Of 436,483 patients hospitalized with pneumonia, 149,963 (34.4%) had HCAP. Compared to those with CAP, HCAP patients were older, had more comorbidities, and were more likely to require ICU care. In-hospital case-fatality rate was higher among patients with HCAP compared to CAP (11.1% vs. 5.1%, $p < 0.001$). After adjustment for demographics, comorbidities, presence of other infections, early ICU admission, chronic and acute medications, early tests and

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therapies, length of stay, HCAP remained associated with increased case-fatality rate (OR 1.35, 95% CI 1.32–1.39); odds of death increased for each additional HCAP criterion (OR (95% CI) 1 criterion = 1.27 (1.23 – 1.31), 2 criteria=1.55 (1.49 – 1.62), and 3 criteria 1.88 (1.72 – 2.06)).

Conclusions—After adjusting for differences in patient characteristics, HCAP was associated with greater case-fatality rate than CAP. This difference may be due to HCAP organisms or to HCAP criteria themselves.

Introduction

Pneumonia is the 8th leading cause of death in the United States,¹ with a case-fatality rate that is estimated to be between 4–10%.² Pneumonia can be categorized by the conditions under which it develops—community acquired (CAP), hospital acquired (HAP) and ventilator-associated (VAP). In 2005, the American Thoracic Society (ATS) and the Infectious Diseases Society of America (IDSA) jointly published guidelines³ for the management of a distinct group of patients with recent exposure to the healthcare system, who are at increased risk of harboring multidrug resistant organisms (MDRO). Healthcare associated pneumonia (HCAP) is identified by the following criteria: hemodialysis, admission to an acute care hospital in the prior 90 days, residence in a skilled nursing facility (SNF), home infusion or wound care therapy, family members with MDRO, and immunosuppressed individuals. The distinction of HCAP is important because although these patients develop pneumonia while living in the community, their outcomes more closely resemble those of HAP or VAP than of CAP, and it is recommended that they be treated empirically for MDRO infection⁴.

Previous studies have shown that patients with HCAP comprise a heterogeneous population with varying rates of MDROs.⁵ It is not known, however, whether outcomes vary according to the setting in which HCAP is acquired. Studies have also shown that outcomes for patients with HCAP are worse than outcomes for patients with CAP, but it is not clear whether this difference is due to a more virulent infection, inappropriate antimicrobial coverage, or simply the higher co-morbidity burden among the chronically ill who are susceptible to HCAP.

Using a national database from 491 US hospitals, we examined a large cohort of pneumonia patients. We aimed to assess the degree to which comorbidities and presenting severity of illness explain the higher case-fatality rate seen among HCAP patients compared to CAP patients, and to assess the impact that the specific HCAP criteria have on outcomes of HCAP patients.

Methods

Setting and patients

We used Premier's inpatient database, which was developed for measuring health care quality and utilization, and is frequently used for health services research.^{6,7} The database contains a date-stamped log of all items and services charged to the patient or insurer including medications, laboratory tests and procedures as well as all elements derived from the uniform billing 04 (UB-04) form such as sociodemographics, International Classification

of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes, and hospital and physician information. Premier-member hospitals are drawn from all regions of the US, and are generally reflective of US acute care hospitals, with slight over-representation of larger hospitals, southern region, and urban facilities. This study was submitted to the Institutional Review Board at Baystate Medical Center and deemed not “Human Subjects Research” as the data in Perspective are de-identified.

We identified all adult (age ≥ 18) patients admitted with pneumonia to participating hospitals between July 1, 2007 and November 30, 2011. Cases were identified by an ICD-9-CM principal diagnosis code of pneumonia or a secondary diagnosis code of pneumonia paired with a principal diagnosis of respiratory failure, ARDS, respiratory arrest, sepsis or influenza; in addition each patient had to undergo a chest radiograph and receive antimicrobials by the second hospital day. We excluded any patient who was transferred in from or out to other acute care facilities because we could not assess their antimicrobial therapy or outcomes. We also excluded patients with a length of stay of 1 day or less; patients with cystic fibrosis; those whose attending physician of record was in a specialty that would not be expected to treat pneumonia (for example psychiatry); those whose DRG was inconsistent with pneumonia; and those with pneumonia clearly designated as “not present on admission”.

Patients were considered to have HCAP if they were admitted from a SNF or long-term care facility, were hospitalized in the previous 90 days, were dialysis patients, or were receiving immunosuppressing medications such as chemotherapy or steroids equivalent to 20mg of prednisone per day. We did not assess for family members with MDRO colonization nor patients on home infusion therapy since markers for these conditions were not available in the database. Patients who did not meet any of the HCAP criteria were classified as having CAP.

Demographics and Comorbidities

For each patient, we extracted age, sex, race/ethnicity, insurance status, principal diagnosis, and specialty of the attending physician. Using software provided by the Healthcare Costs and Utilization Project of the Agency for Healthcare Research and Quality (version 3.1), we recorded the presence of comorbid conditions⁸. We also created a numerical co-morbidity summary score based on the work of Gagne, et al.⁹

Diagnostic testing and treatments

We identified acute medications such as antimicrobials, vasopressors, and steroids, and therapies such as mechanical ventilation and blood transfusions. We assessed whether patients were able to take oral medication on hospital day 1 or 2 by the administration of medications that are only available in oral preparations. We also examined use of diagnostic testing such as bronchoscopy, *Legionella*/*Mycoplasma* testing, blood cultures, arterial blood gas, and serum lactate as well as early (hospital day 1 or 2) ICU admission, use of vasopressors, invasive mechanical ventilation (IMV) or non-invasive ventilation (NIV). A full list of the variables assessed has been published elsewhere.¹⁰

Outcomes

Outcomes included in-hospital case-fatality rate, late (>day 3) initiation of IMV, NIV, or vasopressors; hospital length of stay, cost of hospitalization, and discharge disposition.

Analysis

Summary statistics are presented as frequencies and percents for categorical variables and medians with interquartile ranges for continuous variables. Associations between patient demographics, clinical characteristics and HCAP /CAP status are assessed using Chi-square tests for categorical variables and Kruskal-Wallis tests for continuous variables. To predict the case-fatality rate for each patient, we constructed a hierarchical generalized linear model (SAS GLIMMIX) with a random hospital effect, using a logit link that included demographics, co-morbidities, medications (excluding antimicrobials) and treatments administered in the first 2 days of hospitalization.¹⁰ This model had good discrimination (c-statistic 0.86) and calibration. We then adjusted for the patient's length of stay and added an indicator of HCAP status to this model to assess its additional value in predicting death. In additional models, we explored the independent contribution of individual HCAP criteria to case-fatality rate. Lastly, we assessed the independent effect of HCAP vs. CAP on the following secondary outcomes: all cause readmissions, late ICU admission, late mechanical ventilation, length of stay and cost. This was done using multivariable hierarchical generalized linear models as described above, but not adjusted for length of stay. Length of stay and cost were trimmed at three standard deviations above mean and natural log-transformed values were modeled to account for extreme positive skew. Binary outcome models were assessed via logit link, and identity link models were used for continuous outcome models.

All tests were 2-sided with a significance level of 0.05. All analyses were performed using the Statistical Analysis System (version 9.3, SAS Institute, Inc., Cary, NC) and STATA (StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP).

Results

Patient characteristics and severity of illness

After exclusions, we identified 436,483 eligible patients from 491 hospitals (Figure 1). Among these, 149,963 (34.4%) were identified as HCAP and 286,520 (65.6%) as CAP patients. HCAP patients were older (median age 73 vs. 70 years, $p<0.001$) had higher comorbidity burden (combined comorbidity score 4 vs. 2, $p<0.001$), and were more likely to have a principal diagnosis of sepsis/respiratory failure (38% vs. 25%, $p<0.001$) than CAP patients (Table 1). Of all patients, 112,071 (25.7%) met only one criterion for HCAP, 33,380 (7.7%) met two criteria for HCAP, and 4,512 (1.0%) met 3 or more criteria for HCAP. HCAP patients were more likely than CAP patients to be initially admitted to an ICU (25% vs. 16%), and to be treated with norepinephrine (9.8% vs. 3.8%) or mechanical ventilation (14% vs. 8%).

Outcomes

Unadjusted outcomes for patients with HCAP and CAP appear in table 1. HCAP patients had a higher case-fatality rate (11.1% vs. 5.1%), longer length of stay and higher costs. They were also more likely to require late (day 3 or later) admission to the ICU (4.7% vs. 3.1% $p<0.001$) and mechanical ventilation. Lastly, discharge disposition was significantly different between HCAP and CAP groups. HCAP patients were more likely to be discharged to a SNF (31.2% vs. 16.8%) or hospice (5.7% vs. 2.7%) and had more all-cause readmission (13.8% vs. 7.3% $p<0.001$) than CAP patients.

After adjustment for demographics, comorbidities, length of stay, need for initial ICU admission, ability to take oral medications, chronic and acute medications, and early tests and procedures to indicate more severely ill patients, the odds ratio of in-hospital death remained higher among HCAP patients than CAP patients (OR 1.35 95% CI 1.32 – 1.39). Adjustment for these same factors minus length of stay also attenuated, but did not extinguish, differences in length of stay, cost and readmission (figure 3).

Among the different HCAP subgroups, adjusted case-fatality rate was highest for patients on hemodialysis (OR: 1.71, 95% CI: 1.58 – 1.86) and lowest for patients who were immune-suppressed (OR: 1.21, 95% CI: 1.15 – 1.27) (figure 2) Reducing the HCAP criteria to an admission within the past 30 days did not affect the adjusted case-fatality rate for HCAP vs. CAP (OR: 1.27, 95% CI: 1.24 – 1.31). Presence of multiple HCAP criteria increased the odds of death. For each additional criterion, the adjusted case-fatality rate increased by about 3%.

Discussion

In this large retrospective cohort study of patients with HCAP and CAP, we observed that the risk of death is higher among HCAP patients than CAP patients even after adjusting for multiple markers of co-morbid illness, indicating that HCAP carries a case-fatality rate that appears to be independent of comorbidities. HCAP patients were also sicker on admission, but even after adjustment for initial treatments—a measure of severity of illness that accurately predicts inpatient outcomes¹⁰—they still had a higher case-fatality rate. This difference in case-fatality rate among the two groups may be due to more virulent or resistant organisms, or additional unmeasured cofounders. Finally, we found that with each additional HCAP criterion, the absolute adjusted case-fatality rate increased by approximately 3%.

Since HCAP was first described as a unique entity almost a decade ago,¹¹ a number of studies have compared HCAP to CAP in hospitalized patients.^{2,11–17} Most studies include several hundred patients at a single institution. The largest study to date was conducted at 59 US hospitals and included 3,209 patients with culture proven pneumonia, 31% of which had HCAP.¹¹ Mortality was 19.8% for HCAP and 10.0% for CAP patients. After adjustment for age and physiologic derangements associated with mortality, the OR for mortality with HCAP compared to CAP was 1.65. The increased mortality was attributed at least in part to infection with more severe organisms, in particular methicillin resistant *Staphylococcus aureus* (MRSA), which was isolated in 27% of HCAP cases. *Pseudomonas* was isolated

from an additional 25% of cases. A more recent study conducted at 66 Spanish hospitals found similar case-fatality rates for HCAP, as well as high rates of infection with MRSA and *Pseudomonas* sp.¹⁷ Both studies confirmed the need to differentiate HCAP from CAP in prescribing guidelines.

In contrast, a more recent study from the United Kingdom¹⁶ found that although HCAP patients had a 30-day mortality rate more than twice that of CAP patients, after adjusting for baseline pneumonia severity index, co-morbidities and antimicrobial therapy, the odds of mortality with HCAP fell to 1.29 and were no longer significant. With further adjustment for aspiration risk and functional status, the odds of mortality with HCAP were 0.97. However, rates of infection with both MRSA and pseudomonas were low (<2% each). The authors concluded that for their cohort there was no need for broad spectrum antimicrobials for HCAP patients.

In our study, we also found that HCAP was an independent risk factor for death, but after adjustment for multiple co-morbidities, the risk associated with a single HCAP criterion was 1.35—similar to that seen in the UK study. However, because of our much larger sample size, the findings were highly significant. This estimate does not include adjustment for direct measures of aspiration risk or functional status, but we did adjust for co-morbidities and treatments that are surrogate markers for both aspiration risk and functional status, including paralysis, neurological disorders, tube feeds, medications for Alzheimer's and Parkinson's Disease, nutritional supplements, appetite stimulants, use of restraints, antipsychotic medications and Foley catheters, all of which were significantly more common among HCAP patients. The excess case-fatality rate associated with HCAP and the fact that patients who met multiple HCAP criteria had an even higher case-fatality rate, imply that HCAP may be caused by more virulent pathogens encountered in the healthcare environment. However, because we did not have access to microbiology data, we were unable to ascertain whether the differences in case-fatality rate were due to specific organisms or inappropriate initial antimicrobial coverage.¹⁸ Moreover, we cannot exclude the possibility of residual confounding due to functional status or advanced directives.

Our study adds to the findings of previous studies in several ways. First, we examined over 400,000 patients at almost 500 hospitals that are broadly representative of US hospitals as a whole. This large sample allowed us to adjust for numerous patient co-morbidities to better isolate the effects of HCAP on case-fatality rate, complications, cost, length of stay and readmissions. We found that HCAP patients were fundamentally different from CAP patients in terms of demographics, co-morbidities and medications and treatments received in the hospital. After adjustment for these, HCAP was still strongly associated with increased risk of death and readmission, but less so for complications of pneumonia, length of stay and cost. The impact on readmissions has been noted by others in a small single-institution cohort.¹⁹ Second, this is the first study that we are aware of to describe the relationship between the number of HCAP criteria and the case-fatality rate. Each additional criterion appears to increase the adjusted case-fatality rate by 3%. This is similar to the finding by Murayama et. al, that patients with 2 or more MDR risk factors have higher 30-day mortality than those with 0–1 risk factors.²⁰ Lastly, we were able to compare the effects of the different HCAP criteria on case-fatality rate, and found that hemodialysis is a stronger

predictor of death than other HCAP factors. Whether the risk of hemodialysis is due to repeated exposures to resistant organisms or to hemodialysis itself cannot be determined from this data set.

There were several limitations to our study. First, the data are derived from administratively coded ICD-9 diagnoses rather than clinical data or individual chart review. We did require supporting evidence of pneumonia based on chest radiographs and the administration of antimicrobials, but it is possible that some patients in our sample did not have pneumonia. It is also possible that some CAP patients actually had HCAP, but we were unable to obtain their exposure status in our database (e.g. if they were previously hospitalized at a non-Premier hospital, or if they were admitted from a SNF but the admission source was recorded as the emergency department). In contrast, our specificity for HCAP was high, because exposure is determined by admission from a SNF, hemodialysis or recent admission, all of which are reliable, if present. We may also have missed cases of HCAP if they were coded as aspiration pneumonitis (ICD-9 code 507.0), rather than as pneumonia. These cases would have been excluded rather than misclassified in our data set. We did not have access to microbiologic results so we were unable to determine whether the increased case-fatality rate from HCAP was due to antimicrobial-pathogen mismatching or more virulent organisms. Similarly, we did not have access to advanced directives, which may have been more common among HCAP patients, and could have influenced the intensity of care. Although HCAP patients in general were more likely than CAP patients to be admitted to intensive care, individual HCAP patients may have chosen to forego life-sustaining therapy. Finally, our mortality outcome was limited to inpatient case-fatality rate. However, it is unlikely that other measures of mortality, such as 30-day mortality, would yield a lower relative risk associated with HCAP, as HCAP patients had more co-morbid illness and would therefore be more likely to die within 30 days than CAP patients.

In conclusion, we found that HCAP patients had outcomes that were worse than those of CAP patients, even after adjusting for comorbidities and presenting severity of illness, although the difference appears to be less than has been observed by others. The difference might be due to the specific HCAP organisms or to unmeasured confounders such as functional status or do-not-resuscitate orders. Patients who met multiple HCAP criteria appear to be at highest risk for death and might be expected to benefit most from broad spectrum empirical antimicrobials. Further studies are required to determine the extent to which antimicrobial resistance contributes to the increased case-fatality rate associated with HCAP in the US.

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Figure 1.

Patient selection flow chart:

PN – Pneumonia; ARDS – Acute Respiratory Distress Syndrome; CXR – Chest X-Ray; CH CT – Chest CT; ABX – Antimicrobial; LOS – Length of Stay; MS DRG – Medicare Severity Diagnosis Related Group; POA – Present on Admission

Figure 2.

Odds ratios (95% confidence intervals) for in-hospital death with HCAP compared to CAP in a multivariable adjusted model.

Model accounts for clustering of patients in hospitals and is adjusted for patient demographics, co-morbidities, length of stay, medications and treatments in first two days of hospitalization.

Abbreviations: HCAP, Health-care associated pneumonia; SNF, Skilled Nursing Facility; ICF, Intermediate Care Facility

Figure 3.

Odds ratios and risk ratios for HCAP compared to CAP for secondary outcomes

All analyses account for clustering of patients in hospitals.

†Adjusted for patient demographics, co-morbidities, medications and treatments in first two days of hospitalization

*Odds ratio (95% CI)

**Risk ratio (95% CI)

Table 1

Demographics, comorbidities, tests and procedures among patients with CAP and HCAP.

Characteristic	Overall	CAP	HCAP	CAP vs HCAP
	N (%)	N (%)	N (%)	p-value *
	436,483 (100)	286,520 (65.6)	149,963 (34.4)	(2 sided)
Age [‡] , Median (Q1 – Q3), years	71 (57 – 82)	70 (56 – 82)	73 (61 – 83)	<0.001
Sex				
Female	230,810 (52.9)	153,737 (53.7)	77,073 (51.4)	<0.001
Male	205,673 (47.1)	132,783 (46.3)	72,890 (48.6)	
Race/Ethnicity				
White	305,994 (70.1)	201,616 (70.4)	104,378 (69.6)	<0.001
Black	50,030 (11.5)	31,068 (10.8)	18,962 (12.6)	
Hispanic	18,031 (4.1)	12,249 (4.3)	5782 (3.9)	
Other	62,428 (14.3)	41,587 (14.5)	20,841 (13.9)	
Marital status				
Married	169,252 (38.8)	113,196 (39.5)	56,056 (37.4)	<0.001
Single	225,891 (51.8)	145,983 (51)	79,908 (53.3)	
Other/Missing	41,340 (9.5)	27,341 (9.5)	13,999 (9.3)	
Insurance payor				
Medicare	298,338 (68.4)	184,100 (64.3)	114,238 (76.2)	<0.001
Medicaid	36,233 (8.3)	24,143 (8.4)	12,090 (8.1)	
Managed care	55,512 (12.7)	42,016 (14.7)	13,496 (9)	
Commercial-Indemnity	16,198 (3.7)	11,858 (4.1)	4340 (2.9)	
Other	30,202 (6.9)	24,403 (8.5)	5799 (3.9)	
Discharge disposition				<0.001
Home	223,938 (51.3)	171,613 (59.9)	52,325 (34.9)	
Home health	60,505 (13.9)	38,910 (13.6)	21,595 (14.4)	
Hospice	16,267 (3.7)	7736 (2.7)	8531 (5.7)	
Other	9315 (2.1)	5331 (1.9)	3984 (2.7)	
Expired	31,421 (7.2)	14,715 (5.1)	16,706 (11.1)	
SNF/ICF	95,037 (21.8)	48,215 (16.8)	46,822 (31.2)	
Comorbidities				
Combined comorbidity score [‡] , Median (Q1 – Q3)	2 (1 – 5)	2 (1 – 4)	4 (2 – 6)	<0.001
Congestive heart failure	118,502 (27.1)	64,920 (22.7)	53,582 (35.7)	<0.001
Valvular disease	38,544 (8.8)	19,126 (6.7)	19,418 (12.9)	<0.001
Peripheral vascular disease	34,228 (7.8)	18,973 (6.6)	15,255 (10.2)	<0.001
Hypertension	267,204 (61.2)	169,505 (59.2)	97,699 (65.1)	<0.001
Neurological disorders	59,454 (13.6)	35,501 (12.4)	23,953 (16)	<0.001
Chronic pulmonary disease	210,309 (48.2)	139,302 (48.6)	71,007 (47.3)	<0.001

Characteristic	Overall	CAP	HCAP	CAP vs HCAP
	N (%)	N (%)	N (%)	p-value*
	436,483 (100)	286,520 (65.6)	149,963 (34.4)	(2 sided)
Diabetes	139,020 (31.9)	84,112 (29.4)	54,908 (36.6)	<0.001
Hypothyroidism	66,322 (15.2)	41,282 (14.4)	25,040 (16.7)	<0.001
Metastatic cancer	17,363 (4)	8745 (3.1)	8618 (5.7)	<0.001
Obesity	49,389 (11.3)	34,424 (12)	14,965 (10)	<0.001
Weight loss	44,532 (10.2)	24,052 (8.4)	20,480 (13.7)	<0.001
Anemia	137,978 (31.6)	76,611 (26.7)	61,367 (40.9)	<0.001
Depression	59,646 (13.7)	37,660 (13.1)	21,986 (14.7)	<0.001
Endstage Renal Disease	38,895 (8.9)	22,750 (7.9)	16,145 (10.8)	<0.001
Principal diagnosis				<0.001
Pneumonia/Influenza	306,465 (70.2)	213,697 (74.6)	92,768 (61.9)	
Sepsis	96,211 (22)	52,295 (18.3)	43,916 (29.3)	
Respiratory failure/arrest	33,807 (7.7)	20,528 (7.2)	13,279 (8.9)	
Urinary tract infection	61,850 (14.2)	34,583 (12.1)	27,267 (18.2)	<0.001
Treatments or tests on hospital day 1 or 2				
Intensive Care Unit	81,388 (18.6)	44,563 (15.6)	36,825 (24.6)	<0.001
Invasive Mechanical Ventilation	44,590 (10.2)	23,308 (8.1)	21,282 (14.2)	<0.001
Non-invasive Ventilation	39,323 (9)	22,699 (7.9)	16,624 (11.1)	<0.001
Vasopressors				
Dopamine	14,952 (3.4)	6,884 (2.4)	8,068 (5.4)	<0.001
Norepinephrine	25,596 (5.9)	10,889 (3.8)	14,707 (9.8)	<0.001
Other [§]	11,667 (2.7)	4,886 (1.7)	6,781 (4.5)	<0.001
Loop Diuretics	123,383 (28.3)	72,569 (25.3)	50,814 (33.9)	<0.001
Insulin	119,467 (27.4)	70,989 (24.8)	48,478 (32.3)	<0.001
Arterial or venous blood gas	168,496 (38.6)	102,618 (35.8)	65,878 (43.9)	<0.001
Blood lactate level	104,538 (24)	60,534 (21.1)	44,004 (29.3)	<0.001
Foley Catheter	54,166 (12.4)	31,024 (10.8)	23,142 (15.4)	<0.001
Outcomes				
In-hospital case-fatality rate	31,421 (7.2)	14,715 (5.1)	16,706 (11.1)	<0.001
All cause readmission (30 days)	38,128 (9.4)	19,795 (7.3)	18,333 (13.8)	<0.001
Late ICU [^] (day 3 and later)	12,780 (3.6)	7489 (3.1)	5291 (4.7)	<0.001
Late IMV [^] (day 3 and later)	15,905 (4.1)	9097 (3.5)	6808 (5.3)	<0.001
Length of stay [‡] , Median (Q1 – Q3), days	5 (3 – 8)	5 (3 – 7)	6 (4 – 10)	<0.001
Cost [‡] , Median (Q1 – Q3), USD	7,906 (4,900 – 14,263)	7,005 (4,489 – 12,204)	10,049 (6,080 – 18,309)	<0.001

* p-value based on chi-square test

[‡] p-value based on Kruskal-Wallis test

[^] Among patients who were not treated early (days 0/1/2)

[§] Includes vasopressin, epinephrine and phenylephrine

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Table 2

Early treatments and Outcomes by HCAP Criteria

Early treatments	Admitted from SNF n (%)	Hemodialysis n (%)	Hospitalized past 90 days n (%)	Immune-suppressed n (%)	2 or more components n (%)
	14667 (3.4)	9110 (2.1)	60685 (13.9)	27609 (6.3)	37892 (8.7)
Early Invasive mechanical ventilation	2,112 (14.4)	1,355 (14.9)	6,443 (10.6)	4,659 (16.9)	6,713 (17.7)
Early non-invasive ventilation	1,426 (9.7)	887 (9.7)	7,170 (11.8)	2,633 (9.5)	4,508 (11.9)
Early Vasopressors					
Dopamine	562 (3.8)	517 (5.7)	2,087 (3.4)	2,200 (8.0)	2702 (7.1)
Norepinephrine	963 (6.6)	889 (9.8)	3,104 (5.1)	4,566 (16.5)	5185 (13.7)
Other [§]	358 (2.4)	421 (4.6)	1,350 (2.2)	2,248 (8.1)	2404 (6.3)
Early Admission to ICU	3,179 (21.7)	2,246 (24.7)	12,010 (19.8)	8,218 (29.8)	11,172 (29.5)
Outcomes					
Late Invasive mechanical ventilation (day3+)*	457 (3.6)	449 (5.8)	2,418 (4.5)	1,397 (6.1)	2,087 (6.7)
Late Non-invasive ventilation (Day 3+)*	602 (4.6)	428 (5.2)	3,021 (5.7)	1,557 (6.2)	2,293 (6.9)
Late Vasopressors*					
Dopamine	171 (1.2)	266 (3.1)	864 (1.5)	500 (2.0)	864 (2.5)
Norepinephrine	291 (2.1)	407 (5.0)	1,369 (2.4)	822 (3.6)	1,397 (4.3)
Other [§]	316 (2.2)	533 (6.1)	1,772 (3.0)	1,162 (4.6)	1,814 (5.1)
Late Admission to ICU (Day 3+)*	338 (2.9)	381 (5.6)	2,036 (4.2)	1,019 (5.3)	1,517 (5.7)
Length of stay, Median (IQR), days	6 (4 – 9)	6 (3 – 10)	6 (4 – 9)	6 (4 – 10)	7 (4 – 11)
Cost, Median (IQR), USD	9,113 (5,748 – 15,970)	10,601 (6,340 – 20,837)	9,044 (5,663 – 15,572)	10,137 (5,873 – 20,093)	12,284 (7,292 – 22,268)
Discharge Disposition					
Home	1,392 (9.5)	4,836 (53.1)	23,700 (39.1)	14,261 (51.7)	8,136 (21.5)
Home health	589 (4.0)	1,184 (13.0)	11,724 (19.3)	4,022 (14.6)	4,076 (10.8)
Hospice	836 (5.7)	214 (2.4)	3,863 (6.4)	1,001 (3.6)	2,617 (6.9)
SNF/ICF	9,959 (67.9)	1,691 (18.6)	14,427 (23.8)	4,501 (16.3)	16,244 (42.9)
Expired	1,483 (10.1)	967 (10.6)	5,419 (8.9)	3,138 (11.4)	5,699 (15.0)
Other	408 (2.8)	218 (2.4)	1,552 (2.6)	686 (2.5)	1,120 (3.0)

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* Each of these outcomes are assessed among patients who were not treated early (days 0/1/2)

§ Includes vasopressin, epinephrine and phenylephrine