Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Brief report

Non-ventilator associated hospital acquired pneumonia incidence and health outcomes among U.S. veterans from 2016-2020

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A B S T R A C T

Among 1,635,711 Veteran acute care admissions (FY2016-2020), the risk of non-ventilator associated hospital acquired pneumonia (NV-HAP) was 1.26 cases per 1,000 hospitalized days and decreased linearly over time with an uptick in cases in the last year coinciding with the onset of the covid-19 pandemic. Veterans who develop NV-HAP experience remarkably higher 30-day and 1-year mortality, longer length of stay, and higher rates of inpatient sepsis. Monitoring and prevention measures may substantially reduce negative outcomes.

INTRODUCTION

Hospital acquired pneumonia is the most common hospital acquired infection and more commonly occurs in nonventilated patients.[1–3] However, there is a paucity of nationally reported data identifying trends in incidence, risk factors, and patient outcomes for non-ventilator associated hospital acquired pneumonia (NV-HAP), a largely preventable complication.[4] As the largest integrated healthcare system in the United States (U.S.), the Veterans Health Administration (VHA) is uniquely positioned to monitor and prevent NV-HAP and its sequelae.

The objectives of this work are: (1) identify the trends in the incidence rate of NV-HAP and (2) identify differences in demographics, clinical comorbidities, diagnoses documented as present on admission, and Veteran outcomes associated with developing NV-HAP.

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1 Conception and design
2 Acquisition, analysis, or interpretation of data
3 Drafting of the manuscript
4 Critical revision of the manuscript
5 Statistical analysis6. Led or assisted with obtaining funding

Material and methods

This retrospective cohort analysis identified U.S. Veterans at risk for NV-HAP hospitalized in VA acute care settings between 2016-2020. Acute care admissions between October 1, 2015 and October 1, 2020 were identified (2,766,610 admissions among 1,208,124 unique Veterans) with the following exclusions: length of stay less than 48 hours (n = 1,110,921), no admission diagnosis present (n = 37), diagnosis of acute respiratory distress, failure, asphyxia, or respiratory arrest present on admission (n = 175,626), and discharge date after 10/28/2020 (n = 12). These criteria excluded a total of 1,130,899 admissions, leaving 1,635,711 admissions (816,720 Veterans) at risk for NV-HAP.

NV-HAP cases were identified by the presence of an ICD10 code for bacterial pneumonia >48 hours after admission with present on admission (POA) indicated as 'no', consistent with prior publications.[2] The following list of ICD-10 codes were used: B95.3, B96.0, J13., J15.X, J16.X, J17.X, J18.X, J84.111, J84.116, J84.117, J84.2, J85.1, and J85.2.

Other clinical outcomes assessed included development of sepsis, length of stay, 30-day and 1-year mortality. Sepsis (CCS-R INF002), severe sepsis (R65.2X), and septic shock (R65.21) was identified if it was not POA. Clinical comorbidities and risk factors present on or prior to hospital admission for NV-HAP were summarized as the Quan-Charlson Index using Healthcare Cost and Utilization Project (HCUP) Clinical Classifications Software Refined (CCS-R) categories.[5]

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Table 1
Demographics, clinical comorbidities, diagnoses documented as present on admission, and Veteran outcomes among Veterans hospitalized in acute care settings and at risk of NV-HAP

Variable		NV-HAP	No NV-HAP	SMD
Total unique index admissions		11,291	1,624,420	
Demographics				
Age, mean (SD)		70.46 (10.82)	68.23 (12.54)	**0.191**
Male Gender, N (%)		10,991 (97.3)	1,542,840 (95.0)	**0.123**
Race, N (%)				0.03
	Caucasian	8,174 (72.4)	1,161,236 (71.5)	
	African American	2,382 (21.1)	357,738 (22.0)	
	American Indian	69 (0.6)	11,743 (0.7)	
	Asian	53 (0.5)	6,986 (0.4)	
	Pacific Islander	74 (0.7)	12,260 (0.8)	
	Missing	539 (4.8)	74,457 (4.6)	
Ethnicity, N (%)				0.07
	Hispanic Latino	945 (8.4)	105,109 (6.5)	
	Not Hispanic Latino	10,011 (88.7)	1,469,835 (90.5)	
	Missing	335 (3.0)	49,476 (3.0)	
Clinical Comorbidities in 1 year prior to admission				
Myocardial infarction, N (%)		957 (8.5)	121,823 (7.5)	0.036
Congestive heart failure, N (%)		2,800 (24.8)	367,258 (22.6)	0.052
Peripheral vascular disease, N (%)		2,345 (20.8)	281,419 (17.3)	0.088
Cerebrovascular disease, N (%)		1,332 (11.8)	173,509 (10.7)	0.035
Dementia, N (%)		915 (8.1)	118,775 (7.3)	0.03
Chronic pulmonary disease, N (%)		4,111 (36.4)	460,867 (28.4)	**0.172**
Connective tissue disease, N (%)		246 (2.2)	31,734 (2.0)	0.016
Peptic Ulcer disease, N (%)		268 (2.4)	29,470 (1.8)	0.039
Mild Liver Disease, N (%)		1,351 (12.0)	179,825 (11.1)	0.028
Diabetes without comp, N (%)		4,016 (35.6)	599,685 (36.9)	0.028
Diabetes with comp, N (%)		2,336 (20.7)	334,657 (20.6)	0.002
Hemiplegia paraplegia, N (%)		539 (4.8)	56,737 (3.5)	0.064
Renal disease, N (%)		2,877 (25.5)	361,263 (22.2)	0.076
Cancer, N (%)		2,861 (25.3)	299,649 (18.4)	**0.167**
Sever liver disease, N (%)		244 (2.2)	36,530 (2.2)	0.006
Metastatic solid tumor		640 (5.7)	66,411 (4.1)	0.073
AIDS		125 (1.1)	15,724 (1.0)	0.014
Charlson index, mean (SD)		3.51 (3.07)	3.04 (2.93)	**0.156**
Discharge Diagnoses documented as present on admission (30 most frequent conditions for each group)				
Chronic kidney disease, N (%)		3,535 (31.3)	412,226 (25.4)	**0.132**
Diabetes mellitus, Type 2, N (%)		3,979 (35.2)	639,425 (39.4)	0.085
Disorders of lipid metabolism, N (%)		4,202 (37.2)	697,159 (42.9)	**0.117**
Hyperplasia of prostate, N (%)		2,091 (18.5)	327,398 (20.2)	0.041
Essential hypertension, N (%)		3,617 (32.0)	641,179 (39.5)	**0.156**
Heart failure, N (%)		3,338 (29.6)	401,196 (24.7)	**0.11**
Coronary atherosclerosis and other heart disease, N (%)		3,539 (31.3)	495,727 (30.5)	0.018
Diabetes mellitus with complication, N (%)		2,441 (21.6)	340,421 (21.0)	0.016
Fluid and electrolyte disorders, N (%)		3,440 (30.5)	393,026 (24.2)	**0.141**
Hypertension with complications and secondary hypertension, N (%)		3,964 (35.1)	487,519 (30.0)	**0.109**
Chronic obstructive pulmonary disease and bronchiectasis, N (%)		3,543 (31.4)	419,799 (25.8)	**0.123**
Bacterial infections, N (%)		2,254 (20.0)	326,687 (20.1)	0.004
Cardiac dysrhythmias, N (%)		2,941 (26.0)	376,208 (23.2)	0.067
Esophageal disorders, N (%)		2,567 (22.7)	400,398 (24.6)	0.045
Sleep wake disorders, N (%)		1,944 (17.2)	347,541 (21.4)	**0.106**
Diabetes mellitus without complication, N (%)		1,625 (14.4)	313,457 (19.3)	**0.131**
Acute and unspecified renal failure, N (%)		2,784 (24.7)	311,932 (19.2)	**0.132**
Aplastic anemia, N (%)		2,628 (23.3)	283,237 (17.4)	**0.145**
Depressive disorders, N (%)		1,701 (15.1)	277,755 (17.1)	0.055
Tobacco-related disorders, N (%)		1,694 (15.0)	250,656 (15.4)	0.012
Alcohol-related disorders, N (%)		1,249 (11.1)	188,506 (11.6)	0.017
Abnormal findings without diagnosis, N (%)		1,292 (11.4)	211,425 (13.0)	0.048
Other general signs and symptoms, N (%)		1,382 (12.2)	182,798 (11.3)	0.031
Neurocognitive disorders, N (%)		1,210 (10.7)	149,023 (9.2)	0.052
Other specified and unspecified gastrointestinal disorders, N (%)		1,582 (14.0)	183,137 (11.3)	0.082
Thyroid disorders, N (%)		1,265 (11.2)	184,584 (11.4)	0.005
Trauma- and stressor-related disorders, N (%)		1,059 (9.4)	181,205 (11.2)	0.059
Other specified nervous system disorders, N (%)		1,434 (12.7)	172,826 (10.6)	0.064
Other specified status, N (%)		1,118 (9.9)	159,926 (9.8)	0.002
Nervous system pain and pain syndromes, N (%)		1,098 (9.7)	172,299 (10.6)	0.029
Malnutrition, N (%)		1,840 (16.3)	96,836 (6.0)	**0.333**
Pressure ulcer of skin, N (%)		1,033 (9.1)	93,030 (5.7)	**0.131**
Septicemia, N (%)		1,167 (10.3)	123,727 (7.6)	0.095
Secondary malignancies, N (%)		837 (7.4)	72,857 (4.5)	**0.124**
Peripheral and visceral vascular disease, N (%)		1,235 (10.9)	134,706 (8.3)	0.09
Veteran outcomes following index hospitalization				

(*continued*)

Table 1 (*Continued*)

Variable		NV-HAP	No NV-HAP	SMD
At-risk length of stay, mean (SD)		27.26 (65.46)	5.09 (15.40)	**0.466**
Inpatient Sepsis, N (%)		3,060 (27.1)	12,175 (0.7)	**0.823**
Inpatient Septic Shock, N (%)		1,280 (11.3)	4,965 (0.3)	**0.485**
Inpatient Severe Sepsis, N (%)		1,787 (15.8)	6,561 (0.4)	**0.589**
30-day mortality, N (%)		2,157 (19.1)	91,300 (5.6)	**0.419**
1-year mortality, N (%)		5,346 (47.3)	362,717 (22.3)	**0.544**
30-day readmission, N (%)				**0.55**
	at least 1 readmission	2,011 (17.8)	283,333 (17.4)	
	deceased during index stay	1,971 (17.5)	32,981 (2.0)	
	no readmission	7,309 (64.7)	1,308,106 (80.5)	

Note: Differences between Veterans who developed NV-HAP and those who didn't are summarized as standardized mean differences (SMD), with SMD's above 0.1 bolded.

Demographics, comorbidities, common diagnoses documented as POA, and outcomes were compared between Veterans who developed NV-HAP and those who did not with descriptive statistics and standardized mean differences (Table 1). We quantified the rate of NV-HAP cases per 1,000 at-risk hospitalized days overall and by year-quarter (Fig 1).

The activities undertaken in the project supported VHA operational programs and did not constitute research. This work was supported by the VA Quality Enhancement Research Initiative (QUERI) program of the VHA Health Services Research and Development Service and the Diffusion of Excellence Initiative under a VHA program evaluation.

RESULTS

In this cohort of 1,635,711 acute admissions between 2016 and 2020 and at risk for NV-HAP, Veterans who developed NV-HAP were older, more likely to be male, and have previously documented comorbidities including chronic obstructive pulmonary disease (COPD), cancer, and higher comorbidity index (Table 1). Discharge

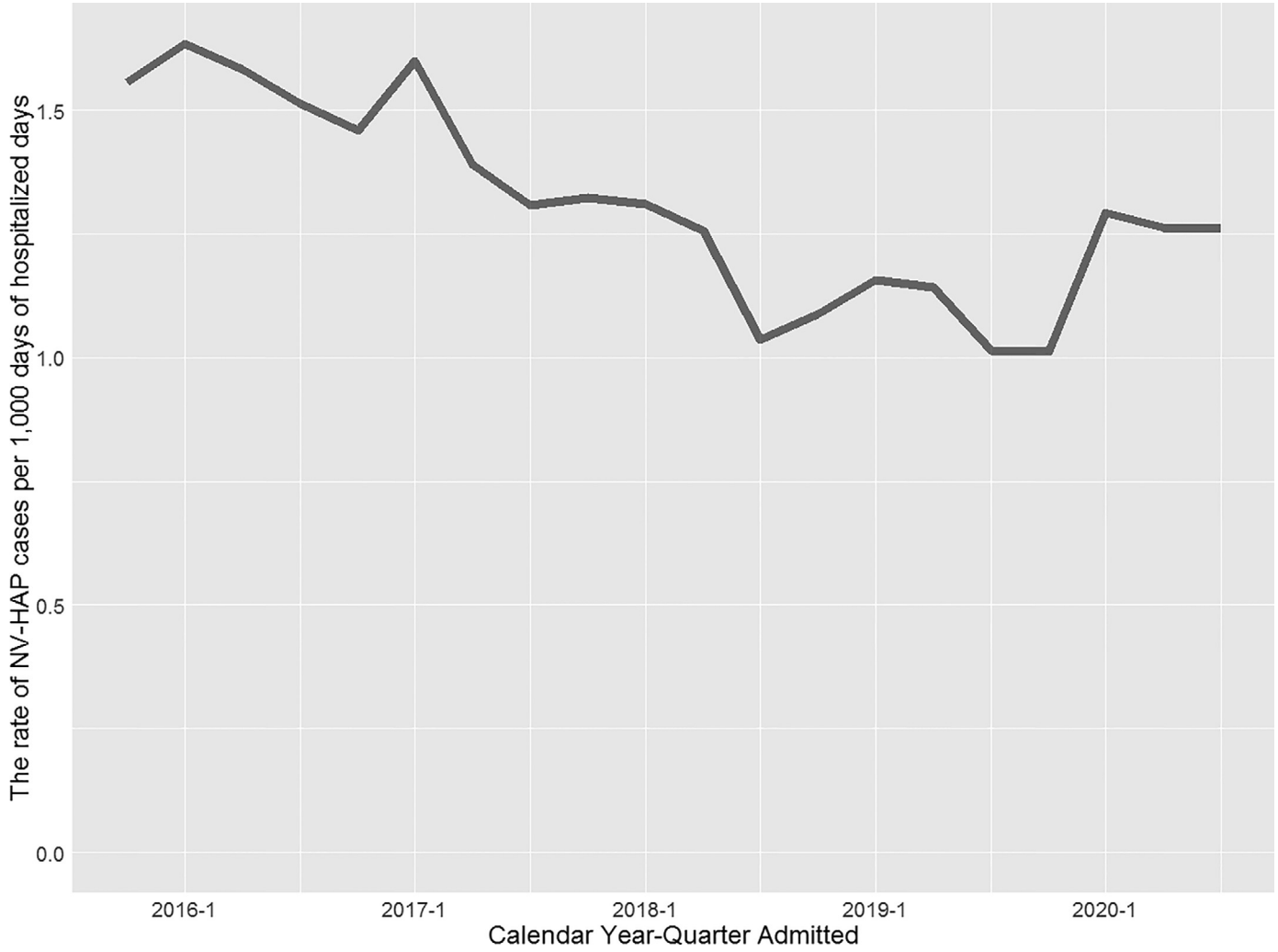

Fig 1. The rate NV-HAP cases per calendar year quarter between 2015Q4-2020Q2.

diagnoses documented as POA were imbalanced between those who developed NV-HAP and those who did not (Table 1). The overall rate of NV-HAP was 1.26 per 1,000 hospitalized days. It decreased from 1.56 in 2015Q4 to 1.01 in 2019Q4, but then increased to 1.26 in 2020Q2 coinciding with the onset of the COVID-19 pandemic (Fig 1). Outcomes were worse among Veterans who developed NV-HAP compared to those who did not: the average length of stay (LOS) was 27.3 days (22 days longer), 30-day mortality was 19.1% (3.3 times higher), 1-year mortality was 47.3% (2.1 times higher), and septic shock occurred in 11.2% of admissions (36 times higher).

DISCUSSION

The overall NV-HAP rates found in VHA acute care settings are less than half the previously published NV-HAP rates estimated from U.S. hospitals in 2012 using similar research methods.[2] The trend in NV-HAP rates was generally decreasing between FY2016-2020 with apparent seasonality; however, NV-HAP rates started to increase after the onset of the COVID-19 pandemic in 2020 Q2 (Fig 1). The observed decrease in the NV-HAP rates may be due to NV-HAP focused VHA quality improvement (QI) programs such as HAPPEN (Hospital Acquired Pneumonia Prevention by Engaging Nurses).[6] Further robust evaluation of facility level exposure to the QI programs and changes in associated NV-HAP rates is warranted.

The observed increase in secondary bacterial pneumonia cases including NV-HAP post pandemic is concerning. An increased focus on COVID-19 infection prevention measures may reduce some HAI's[7]; however, known NV-HAP prevention measures not typically associated with infection control may be neglected including consistent oral care, head of bed elevation, and early and frequent ambulation.[8] Alternatively, the average risk profile of Veterans hospitalized in acute care settings likely increased during the pandemic; if these Veterans are at higher risk of NV-HAP, the observed increase could be due to the changing inpatient population composition and associated average NV-HAP risk. Risk over time models adjusted for individual traits should be implemented to further understand and monitor this potential patient safety issue.

Veterans who developed NV-HAP had dramatically worse outcomes compared to those who did not, yet there were only moderate differences in any individual clinical comorbidity, demographic, or discharge diagnosis present on admission. Further analysis of patient risk using multivariate modeling techniques should be explored to identify if more effective risk stratification is feasible.

CONCLUSIONS

NV-HAP is a largely preventable complication that is costly in terms of morbidity, mortality, and burden to the health care system and larger community. Although the risk of NV-HAP is low for individuals, health outcomes for Veterans who experience NV-HAP are dramatically worse than previously reported in the literature. Amidst focused efforts to decrease NV-HAP transmission, the rate of NV-HAP among Veterans generally decreased between 2016-2020. However, there was an uptick in NV-HAP cases correlated with timing of the U.S. COVID-19 outbreak, highlighting the need to maintain quality of care during a period of unprecedented stress to the system. Further studies identifying the impact of NV-HAP QI programs such as HAPPEN are warranted and may explain the apparent decrease in the risk of NV-HAP observed between 2016-2019.

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