Major Article

Hospital Acquired Pneumonia Prevention Initiative-2: Incidence of nonventilator hospital-acquired pneumonia in the United States

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Background: Because nonventilator hospital-acquired pneumonia (NV-HAP) is understudied, our purpose was to determine the incidence, overall burden, and level of documented pneumonia preventive interventions of NV-HAP in 24 U.S. hospitals.

Methods: This retrospective chart review extracted NV-HAP cases as per the 2014 ICD-9-CM codes for pneumonia not present on admission and the 2013 Centers for Disease Control and Prevention case definition. Patient demographic data, outcomes, and documented preventive interventions were also collected.

Results: We found 1,300 NV-HAP patients who acquired NV-HAP (rate, 0.12–2.28 per 1,000 patient days) across the 21 hospitals that completed the data collection. Most NV-HAP infections (70.8%) were acquired outside of intensive care units (ICUs); 18.8% required transfer into the ICU. In the 24 hours prior to diagnosis, most of the patients did not have fundamental hospital care associated with pneumonia prevention.

Conclusions: This multicenter, nationwide study highlights the significant burden of NV-HAP in the U.S. acute care hospital setting. We found that NV-HAP occurred on every hospital unit, including in younger, healthy patients. This indicates that although some patients are clearly at higher risk, all patients carry some NV-HAP risk. Therapeutic interventions aimed at NV-HAP prevention are frequently not provided for patients in acute care hospitals.

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case-control study found that patients who developed NV-HAP were 8.4 times more likely to die during hospitalization, more likely to require intensive care, 8.0 times more likely to require mechanical ventilation, and had a longer median hospital length of stay (LOS) than patients who did not develop NV-HAP (15.9 vs 4.4 days, respectively). In a further study of a convenience sample of 8 hospitals in Pennsylvania, most health care–associated pneumonia cases were reported outside of a critical care setting (74.1%), the mortality rate of pneumonia patients reached 30.9%, and a quarter of health care–associated pneumonia cases were attributed to aspiration, a cause which could be minimized through nursing activities targeted at aspiration prevention.

Our previous report from the Hospital-Acquired Pneumonia Prevention Initiative (HAPPI-1) highlighted a significant number of unreported NV-HAP cases (1.2–8.9 per 1,000 hospital days) in a convenience sample of 3 U.S. hospitals. After implementation of an evidence-based, oral care protocol aimed at NV-HAP prevention for all acute care patients in 1 hospital, the rate of NV-HAP per 100 patient discharges decreased by 38.8% from 0.5 to 0.3. The overall number of NV-HAP cases was also reduced by 37% during the 12-month intervention period. The avoidance of NV-HAP cases resulted in an estimated 8 lives saved, $1.72 million in costs avoided, and 500 extra hospital days averted during the study time frame. This initiative began in 2012, and we continue to monitor the rates of NV-HAP. As of 2014, a 70% overall reduction in NV-HAP has been achieved hospital-wide, a reduction in NV-HAP of 164 cases, 31 fewer patient deaths, and $5.9 million cost avoidance (Quinn and Baker, 2016, unpublished quality improvement data).

There are several therapeutic interventions associated with the prevention of HAP, most of which are components of hospital care that patients should receive during their stay. These include (1) oral care, (2) head of the bed elevation to 30°–45°, (3) patient mobility, (4) use of incentive spirometry, and (5) deep breathing and coughing exercises. However, several studies have demonstrated that basic hospital care associated with pneumonia prevention may be missing from care that patients receive during their hospital stay. The inability to provide all aspects of required hospital care is a concept known as missed care (ie, standard care that is not completed). Missed care is also referred to as underused care, omitted care, rationed care, failure to maintain, and unfinished care. Data from some studies support that a large amount of fundamental care is being missed in U.S. acute care hospitals. Furthermore, missed hospital care in both U.S. and international studies has been linked to numerous harmful outcomes for patients and increased cost for hospitals. Two recent systematic reviews of these therapeutic interventions to prevent pneumonia found that the use of oral care was associated with the most evidence of benefit. Unfortunately, oral care is among the most frequent type of missed care.

The HAPPI-2 study continued our HAPPI program of research, adding to the current body of knowledge of NV-HAP incidence and the essential aspects of therapeutic interventions for pneumonia prevention. Specifically, we sought to look at the incidence and impact of NV-HAP in a group of 24 U.S. hospitals, and included a measurement of the frequency of care associated with pneumonia prevention. We included oral care as a fundamental aspect of pneumonia prevention care because it is (1) well recognized as a strategy for the prevention of VAP, (2) has the largest body of knowledge of all the currently known interventions for NV-HAP prevention, and (3) is consistent with the Centers for Disease Control and Prevention’s (CDC) perspective on modifiable risk factors. In addition, it is the only modifiable risk factor that applies to 100% of patients.

It is our hope that the findings from this study will provide a foundation for future research in this critical area of patient safety, and lead to specific clinical measures and refinement of successful pneumonia prevention strategies that can be widely deployed.

Our specific aims included the following: (1) What is the incidence of NV-HAP in a sample of 24 U.S. hospitals as defined by the CDC? and (2) What is the amount of missed hospital care associated with pneumonia prevention in the 24 hours prior to the diagnosis of NV-HAP in the same sample of 24 U.S. hospitals, specifically frequency of oral care; head of the bed elevation ≥ 30°–45°; if allowed, out of bed ≥2 times; incentive spirometry use; and deep breathing and coughing exercises?

**METHODS**

**Study oversight and hospital selection**

Oversight was provided by the National Patient Safety Foundation’s (NPSF) National Study Advisory Board for the HAPPI research project. The NPSF distributed a Web-based request for application; responding hospitals were selected through convenience sampling and approved by the NPSF’s HAPPI Advisory Council. We elected to engage the NPSF oversight board to maximize transparency and external validity of results and to avoid bias. Hospital selection aimed to provide a representative sample of U.S. geographic regions, hospital size, and hospital type (community, private, profit or nonprofit, and university hospitals). Central institutional review board approval was provided by the Western Institutional Review Board (approval no. 20150684). Study approval was also granted by the Sutter Institute for Medical Research. Each participating hospital had the option of using the Western Institutional Review Board or to obtain institutional review board approval at their own institution.

**Inclusion criteria**

Hospitals meeting the following inclusion criteria were eligible to participate: (1) no previous hospital-wide NV-HAP monitoring, (2) no specific NV-HAP prevention interventions within the last 5 years, (3) no implemented change in systematic oral care in the last 5 years, and (4) provision of a letter of support from nursing administration. Hospitals were required to have the ability to extract the required electronic medical records data. All adult discharges from all units in the hospitals between January 1, 2014, and December 31, 2014 were reviewed.

**Data collection and electronic medical record review**

All data were collected through retrospective chart review. Prior to any data collection, all site investigators received webinar training by the coprincipal investigators on the data extraction process. NV-HAP cases were determined using a 2-step process: (1) all cases coded with the 2014 ICD-9-CM codes for pneumonia and not present on admission were extracted; and (2) reported NV-HAP cases were then verified by the site investigators using the 2013 CDC’s case definition of pneumonia (eg, positive chest imaging, clinical signs and symptoms, laboratory evidence). Case report forms, developed by content experts and tested in the pilot study, were used to gather patient demographic data, NV-HAP diagnosis, clinical unit of NV-HAP acquisition, patient outcomes, mortality, LOS, 30-day readmission rate, admission and discharge location disposition, and documented nursing care. Individual sites entered their data into REDCap (Vanderbilt University, Nashville, TN), a secure HIPAA, 21 CFT Part 11-compliant Web application for building and managing online surveys and databases. REDCap data collection and analysis was managed by Researcher’s Institute for Medical Research. All data were deidentified before entry into REDCap. Each
Although previous studies indicate that most surgical departments (43.1%; n = 64), orthopedic (2.8%; n = 3), neurology (1.5%; n = 19), and obstetric departments (0.2%; n = 3). Location of NV-HAP acquisition was not specific for 33 patients (2.5%; reported as other department) and for 25 patients (1.9%) was unavailable. Of the patients who acquired NV-HAP on floor wards, 245 (18.8%) were transferred to ICUs.

LOS was defined by 5 categories: 2-7, 8-10, 11-14, 15-20, and ≥20 days. For approximately one-third (37.3%; n = 485) of patients, LOS was >20 days, and for over half (57.7%; n = 749), LOS was ≥15 days. Of those NV-HAP patients transferred to the ICU, 40.8% had LOS >20 days.

Most patients were admitted from home or assisted living (n = 964), followed by other health care facilities or specialized nursing facilities (SNFs). Of the 964 patients admitted from home or assisted living, 40.6% (n = 391) returned to home or assisted living, with the remainder discharged into a health care facility. Of the 245 patients transferred to an ICU after pneumonia diagnosis, 26.1% (n = 64) were discharged to home or assisted living. Of the 1,094 surviving patients, 19.3% were readmitted to hospital within 30 days.

### Discussion

We identified the NV-HAP incidence rate in 21 hospitals as 0.12-2.28 cases per 1,000 patient days. This is similar to rates reported in other studies: in the HAPPI-1 study,1 the rate of unreported NV-HAP was 1.25 cases per 1,000 patient days before intervention, and in 1 study on non-ICU HAP, 3 ± 1.4 cases per 1,000 hospital admissions were reported.30 Although previous studies indicate that most NV-HAP cases occur in older patients,31 we found that over half of NV-HAP cases (50.9%) were in patients <66 years of age. Although increased age is a known independent risk factor for NV-HAP,31 our findings support that younger patients are also at some risk and do acquire pneumonia while hospitalized.

Our findings also indicate that patients in all types of hospital units are at some risk for NV-HAP. Surgery is an established pneumonia risk factor32,33; however, the risk for patients on the medical services is not widely appreciated outside of specialty units such as oncology. We found that 63% of cases originated from nonsurgical departments; however, this figure should be interpreted with caution given that not all hospital sites had the same medical-surgical bed balance. Surprisingly, there were some cases—although few of them (n = 10)—that originated from the women’s health service/obstetrics and gynecology. The department previously identified as most at risk for pneumonia, and with protocols in place to prevent ventilator-associated pneumonia, is the ICU.34-36 However, in our study we found that 27.3% of NV-HAP cases were identified among ICU patients. That is, patients in the ICU, not on the ventilator, are acquiring HAP despite the preventive emphasis for patients who are on a ventilator. Seventy-three percent of NV-HAP cases originated outside the ICU. This demonstrates there is a risk on general floors and in the nonventilated ICU patients.31,37
There is a direct impact on ICU utilization from NV-HAP both from nonventilated ICU patients and from patients transferred to the ICU. In our study, 27.3% of NV-HAP cases was acquired in the ICU, and an additional 18.8% of NV-HAP were transferred to the ICU from the medical-surgical units: that means a total of 46.1% of NV-HAP patients spent bed days in the ICU for a preventable illness. Patients transferred to the ICU remain in hospital for longer. Our data show that transfer to the ICU was associated with increased LOS: 65.7% of patients transferred to the ICU had a LOS ≥ 15 days, compared with 57.6% of all patients. NV-HAP has been associated with increased mortality, the in-house mortality rate for NV-HAP cases in our study was 15.8%, which was similar to that reported by Mick et al (15.5%) but less than See et al (30.9%). In addition, hospital stays with ICU involvement are 2.5 times costlier than hospital stays with no ICU stay. Therefore, patients in the ICU with NV-HAP contribute to increased LOS, mortality, and cost.

The societal impact of NV-HAP on the patient can be seen by comparing discharge disposition with patient location prior to admission; patients admitted in a hospital should be able to return to their previous level of function, and require the same level of care. Regarding discharge to SNFs, the national average among Medicare patients is 9%; however, for patients who acquire NV-HAP, there is an associated 4.13-fold increased risk of discharge to SNFs. Although only 25% of patients were admitted from another health care facility, 47.2% were discharged to higher-level care facilities (SNF, acute rehabilitation, or hospice or comfort care). Of the patients admitted from home, only 40.6% were discharged back to home. The societal impact for patients not returning to home adds substantially to the overall cost of NV-HAP, results in a decreased quality of life in previously independent individuals, and likely places significant emotional and financial burdens on both patients and families. In addition, the harm from NV-HAP does not stop after hospital discharge; Kopp et al found that in patients with spinal injury, 45% suffered consequences of HAP. Patients who developed NV-HAP showed lower gains in functional mobility up to 5 years later, and a higher mortality risk up to 10 years later.

Based on estimates reported in the literature ($28,000-$40,000 additional costs per case), the cases identified in our study would generate $36.4 - $52.56 million in extra costs, and an additional 9,198-11,826 inpatient days. There is a further economic impact to be considered. In U.S. hospitals 30-day readmissions for pneumonia, as the admit diagnosis are reported to affect 1 in 5 patients. We found a similar readmission rate of 19.3% for NV-HAP. These rates are comparable with 30-day readmission rates for diseases that require reporting, such as congestive heart failure, which may result in nonpayment or penalties as part of the U.S. Hospitals Readmission Reduction Program.

HAP risk factors have been well reported, and in HAP prevention, the CDC recommends a focus on modifiable risk factors for prevention. However, our study suggested that a narrow focus on patient-specific risk factors for NV-HAP prevention would limit the full potential impact of NV-HAP prevention. Previous studies support that the impact of NV-HAP goes beyond specific patient risk groups and occurs on all types of hospital units and departments. Our data provide further support for the findings from these previous studies. We found that NV-HAP occurs both within and outside of the ICU in a wide age range of patients, not just older adults. It is likely that some of these patients were not subjected to active pneumonia prevention programs nor routine monitoring for pneumonia; indeed, current hospital practices are primarily focused on prevention of VAP and other device-related HAIs that are routinely monitored. The documented care interventions measured in this study were specifically chosen for their relevance in the prevention of all HAP, both VAP and NV-HAP, and belonged to the VAP preventive care bundle. Our results found multiple missed care opportunities in the 24 hours before diagnosis of pneumonia. Numerous previous studies have reported that missed fundamental hospital care is linked to poorer patient outcomes, a finding that is also supported by our data.

Strengths and limitations

The hospitals in our study were selected through convenience sampling, a methodology that is prone to selection bias and a high level of sampling error. The use of the CDC criteria to verify each NV-HAP case was a strength of the study. The retrospective nature of the study prevents us from identifying the exact reasons for missed fundamental hospital care; however, reasons from other research
include labor, material resources, and poor communication.\textsuperscript{7,21} Furthermore, the ICD–9–CM codes may underestimate the actual number of NV-HAP cases because a point-prevalence observation was not conducted. Because we required CDC criteria, cases in immunocompromised patients may have been missed if cultures for pneumonia were not obtained, which is often the case. Documentation of oral care was obtained from the nursing care records, and because the hospitals included in the study may have a variety of standards and definition of oral care, the provided oral care may have included less effective measures for removal of oral plaque, such as swabbing or foam sponges.

CONCLUSIONS

Pneumonia prevention presents several challenges. A primary challenge is that NV-HAP remains a hidden harm in hospitals because there are no requirements in the United States to track hospital-wide rates of pneumonia. To overcome this challenge, hospitals should consider the growing body of evidence which supports NV-HAP as a common HAI, and—as demonstrated in our study—it occurs in all types and sizes of hospitals and on all types of units. Therefore, these findings support the use of universally applied NV-HAP prevention strategies.

There are well-known methods to prevent NV-HAP and most are related to processes that should be in place in hospitals as part of fundamental hospital care.\textsuperscript{50–52} Hospitals can apply a public health approach and use surveillance and monitoring to follow trends in NV-HAP rates. Scaling up interventional studies across all units of a hospital can be daunting. However, all patients, even those who appear quite healthy, are at some risk. Previous HAP prevention studies were aimed at specific patient populations; outside of ventilated patients, most intervention studies targeted residents in SNFs and postoperative settings. These studies demonstrated promising results that may be adapted for acute care hospitals.\textsuperscript{50} Furthermore, there are at least 2 interventional studies that successfully reduced pneumonia hospital-wide.\textsuperscript{3,51} Most pneumonia prevention research relies on therapeutic interventions delivered with high reliability. These studies also noted that missed care was associated with cases of NV-HAP; however, no randomized controlled trials in acute care hospitals are currently available in the literature.

Further surveillance and assessment of NV-HAP incidence is required to determine the full extent and impact of NV-HAP. NV-HAP prevention standards should be developed and studied. If a U.S. national effort was made to address NV-HAP, we predict that with appropriate intervention to prevent NV-HAP by even 50%, we could save approximately 9,886 lives, 487,622 extra hospital days, and $2.43 billion annually.\textsuperscript{22} When the morality rate from a preventable hospital harm is as high as 14%–31%, it is time for a call to action. NV-HAP should be elevated to the same level of importance of non-device-associated healthcare-associated infections: a relative proportion and incidence study at an academic medical center, 2008–2012. Infect Control Hosp Epidemiol 2014;35:200–2.

References

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