Postoperative Pneumonia-Prevention Program for the Inpatient Surgical Ward

Sherry M Wren, MD, FACS, Molinda Martin, BSN, RN, Jung K Yoon, RN, MS, Fritz Bech, MD, FACS

BACKGROUND: Postoperative pneumonia can lead to increased morbidity, length of hospital stay, and costs. Pneumonia-prevention programs have been successfully implemented in ICU settings, but no program exists for surgical ward patients.

STUDY DESIGN: A pilot prevention program was designed and implemented based on literature review. The program consisted of education of physicians and ward staff and a standardized postoperative electronic order set consisting of incentive spirometer, chlorhexidine oral hygiene, ambulation, and head-of-bed elevation. Quarterly staff meetings discussed the results of and compliance with the program. The intervention commenced in April 2007. Baseline incidence of inpatient ward pneumonia was calculated from the National Surgical Quality Improvement Program database for fiscal year (FY) 2006 and FY 2007. Postintervention incidence was calculated in the same manner from FY 2007 through FY 2008. Any patient who contracted pneumonia in the ICU was excluded from analysis.

RESULTS: There was a significant decrease in ward pneumonia incidence from 0.78% in the preintervention group compared with 0.18% in the postintervention group ($p = 0.006$), representing an 81% decrease in incidence from 2006 to 2008.

CONCLUSIONS: The pneumonia-prevention program was very successful in diminishing postoperative pneumonia on the surgical ward. There was a highly statistically significant 4-fold decrease in pneumonia incidence after program implementation. The interventions were not costly but did require ongoing communication and cooperation between physician and nursing leadership to achieve compliance with the measures. This program has great potential for dissemination to hospital surgical wards and could decrease inpatient postoperative pneumonias. (J Am Coll Surg 2010;210:491–495. Published by Elsevier Inc. on behalf of the American College of Surgeons)

Postoperative pneumonia is a common complication that affects many surgical patients and is the third most common infectious complication after urinary tract and wound infections. There has been a large amount of research targeted at lowering the rate of pneumonia, but these have been focused primarily in the ICU and are specific to prevention of ventilator-associated pneumonia (VAP). The incidence of VAP in the ICU is cited as high as 65%, with the expected result of increased length of stay in the ICU and hospital and a mortality rate as high as 20% to 70%.[1,2] VAP is also associated with substantial additional health care costs, estimated as high as $40,000 per patient.[3,4] Prevention strategies have been successful and are a major cornerstone of the Institute of Healthcare Improvement's 5 Million Lives campaign.

VAP-prevention guidelines commonly include the following recommendations: use of orotracheal instead of nasotracheal route for intubation; a new ventilator circuit for each patient; a change of the circuit only when dirty or damaged; routine change of heat and moisture exchangers every 5 to 7 days; use of a closed endotracheal suctioning system; subglottic secretion drainage; head-of-bed elevation to 30 to 45 degrees; oral antiseptic mouth care; daily rest from sedation; and use of gloves when handling respiratory circuit.[5,6] Each of these interventions has some level of evidence supporting its inclusion in prevention programs.

There is a scarcity of literature focusing on prevention programs outside of the ICU; in fact, we were only able to find a single report. In a 2003 report posted on the improvement report area of the Institute of Healthcare Im-

Disclosure Information: Nothing to disclose.

Presented at the Association of VA Surgeons 33rd Annual Meeting, Boston, MA, April 2009.

Received November 22, 2009; Revised January 7, 2010; Accepted January 7, 2010.

From the VA Palo Alto Health Care System, Palo Alto, CA (Wren, Martin, Yoon, Bech) and Stanford University School of Medicine, Palo Alto, CA (Wren, Bech).

Correspondence address: Sherry M Wren, MD, Stanford University School of Medicine, VA Palo Alto Health Care System, G112 3801 Miranda Ave, Palo Alto, CA 94304. email: swren@stanford.edu

ISSN 1072-7515/10/$36.00
doi:10.1016/j.jamcollsurg.2010.01.009

Abbreviations and Acronyms

VA-NSQIP = Veterans Affairs National Surgical Quality Improvement Project
FY = fiscal year
VAP = ventilator-associated pneumonia

provements Web site, a group from Buffalo, New York demonstrated an overall reduction of 61% in the incidence of postoperative pneumonia through a set of nursing interventions, including spirometry; ambulation; pain control; and patient education.[7] This clearly showed that simple interventions resulted in a substantial decrease in pneumonia incidence on the ward. Work in the ICU with VAP guidelines has demonstrated that the success of these programs requires active participation of the staff, rather than just simple creation of prevention bundles without staff education and feedback on program results.[8]

The Veterans Administration National Surgical Quality Improvement Program (VA-NSQIP) is the world's largest risk-adjusted and validated database on surgical outcomes. The data set is prospectively gathered and contains an extensive collection of perioperative data points and patient characteristics. The full details of the VA-NSQIP have been described in detail in publications previously.[9] Data collected contain information from noncardiac surgery patients including thoracic; general; urology; orthopaedics; vascular; plastics; and neurosurgery. Use of VA-NSQIP and its prospective and validated data collection of patient variables, including complications, make it an ideal tool to examine our hypothesis that a nursing intervention could diminish the incidence of postoperative ward pneumonia in our tertiary care and university-affiliated Veterans hospital.

METHODS

The pneumonia-prevention quality improvement task force was formed in December 2006. Membership consisted of the assistant chief of surgical service, NSQIP nurse, surgical ward nurse manager, chief nurse inpatient service, chief of infection control, and chief of quality management. The task force met during a 3-month period from January through March 2007. Evidence-based prevention strategies were reviewed and the group agreed on the 8 intervention strategies, which were implemented on April 1, 2007. Education of ward nurses, attending surgeons, and surgical housestaff was done before implementation and, subsequently, nursing education became an ongoing activity and part of new-employee orientations to the surgical ward. All pneumonias in noncardiac surgical patients were tracked in the prospectively collected NSQIP cases and ward-acquired pneumonias were initially reported monthly then quarterly to the quality improvement task force and ward staff.

The 8 intervention steps were:

1. Education of all surgical ward nursing staff about their role in pneumonia prevention;
2. Cough and deep-breathing exercises with incentive spirometer;
3. Twice daily oral hygiene with chlorhexidine swabs;
4. Ambulation with good pain control;
5. Head-of-bed elevation to at least 30 degrees and sitting up for all meals ("up to eat");
6. Quarterly discussion of the progress of the program and results for nursing staff;
7. Pneumonia bundle documentation in the nursing documentation; and
8. Computerized physician pneumonia-prevention order set in physician order entry system.

Compliance with the steps was not prospectively tracked. The hospital has a bar code medication pharmacy program through which the chlorhexidine was distributed and the electronic nursing shift summary note had the pneumonia bundle documented within it and was periodically reviewed for completeness by the nurse manager.

Data

Retrospective review was performed of all inpatient pneumonia cases documented in the NSQIP database at the VA Palo Alto Health Care System from fiscal year (FY) 2006 (October 2005 to September 2006) and the first 2 quarters of FY 2007 (October 2006 to March 2007). Data were then collected prospectively through the NSQIP database for the last 2 quarters of FY 2007 (April 2007 to September 2007) and all of FY 2008 (October 2007 to September 2008). To be scored as a ward-acquired pneumonia, patients had to be noncardiac surgical patients who had an inpatient admission to the surgical ward. Cardiac patients were excluded because their data are entered in a VA Continuous Improvement in Cardiac Surgery Program database and not VA-NSQIP. Additional exclusions from the analysis were all outpatient operations, admissions to the observation 23-hour stay unit, admission to a nonsurgical ward, and patients who were diagnosed with pneumonia in an ICU. For ICU analysis of VAP-related or non−VAP-related pneumonia, a cutoff of 24 hours post-extubation was used to determine VAP versus non-VAP pneumonia. We recognize that the CDC guidelines only diagnose VAP if the patient is currently intubated, but because we were not reporting results of a VAP-prevention program, we chose the extended period post-extubation to help delineate ICU pneumonia more clearly as to risk factors for

Table 1. VA Palo Alto Health Care System Ward Pneumonia Incidence Rates for Preintervention (October 2005 to March 2007) and Postintervention (April 2007 to September 2008)

	Preintervention	Postintervention
Ward pneumonia, n	13	3
Patients at risk, n	1,668	1,651
Incidence, %	0.78	0.18

acquisition. Intervention was defined as the date April 1, 2007, and patients were divided into 2 reporting time periods, 18 months before and 18 months after intervention.

NSQIP definition of pneumonia

The NSQIP nurse reviewer uses the following definition to score patients as having pneumonia. Patients must have 1 of the following: new onset of purulent sputum or change in character of sputum; isolation of an organism from blood culture; isolation of pathogen from specimen obtained by transtracheal aspirate; bronchial brushing; or biopsy or histopathologic evidence of pneumonia. In addition, they must meet 1 of the following 2 criteria: rales or dullness to percussion on physical examination of the chest or chest x-ray that demonstrates a new or progressive infiltrate; consolidation; cavitation; or pleural effusion.[10]

Statistical analysis

Documented cases of ward pneumonia in each reporting period were divided by the total patients at risk in that period and expressed as case rates. Case rates were compared by the Difference of Proportions test (test for H_0: $p_1 - p_2 = 0$; standard error = 0.24; 95% confidence limits set at $\alpha = 0.05$).

RESULTS

Pneumonia diagnosed on the surgical ward was found in 13 of 1,668 inpatient admissions in the preintervention time period, an incidence of 0.78%. In comparison, there were only 3 of 1,651 inpatient admissions with pneumonia diagnosed on the ward in the postintervention study period; an incidence of 0.18% (Table 1). This absolute decrease of 0.60% is highly significant (95% CI, 0.13−1.07; p = 0.006). When the first (FY 2006; ward pneumonia, n = 6) and last (FY 2008; ward pneumonia, n = 2) fiscal years were compared, there was an absolute decrease in risk of pneumonia of 0.68%, which represented an 81% overall decline is risk of pneumonia diagnosis on the surgical ward (95% CI, 0.13−1.23; p = 0.008).

The overall incidence of all site (ie, ward, ICU, observation, nursing home, medical ward, and hospice) noncardiac surgery pneumonias collected in NSQIP at the VA Palo Alto Health Care System was 1.7% (FY 2006), 1.2% (FY 2007), and 1.6% (FY 2008) (Table 2). In each of the measured years, observed rate of pneumonia at our facility was higher than the incidence seen throughout the entire VA system, with the largest difference seen before the study time period of FY 2006 to FY 2008. During this study period, there was no substantial drop in overall incidence of pneumonias at the facility compared with national VA. We analyzed the location of patients at the time of pneumonia diagnosis to help explain how the overall pneumonia incidence remained relatively unchanged during the postintervention time, when there was such a substantial drop in the number of ward-diagnosed pneumonia cases. Data demonstrated that the number of ICU-diagnosed pneumonias increased such that the total number of pneumonias remained relatively unchanged (Fig. 1). During the 3-year study period, the number and percentage of non-VAP ICU pneumonias increased. The non-VAP rate in FY 2006 was 4 (36%), and this increased to half of pneumonia's diagnosed in the ICU in FY 2007 (n = 7; 54%) and FY 2008 (n = 10; 50%). The only prevention program in the ICU was for VAP, these patients were not covered by the ward prevention program.

Table 2. Observed Incidence of All Cases of Pneumonia in the National Surgical Quality Improvement Project Database for the VA Palo Alto Health Care System and the Entire VA System

Fiscal year	VA Palo Alto Health Care System, %	VA national, %
2004	2.6	1.6
2005	2.6	1.6
2006	1.7	1.5
2007	1.2	1.3
2008	1.6	1.5

VA, Veterans Affairs.

DISCUSSION

Pneumonia is a common postoperative infection seen throughout the VA in approximately 1.5% of patients and in non-VA hospitals in up to 1.6%.[7] A facility that performed 10,000 noncardiac operations per year would be expected to have approximately 150 cases of postoperative pneumonia. Before VAP-prevention strategies, a large majority of those cases would have occurred with intubated patients in the ICU, but clearly many patients who had never been intubated would also suffer prolonged hospitalization and possible mortality from postoperative pneumonia. Our quality improvement task force decided to take prevention strategies that did not pertain to the management of endotracheal tubes and apply them to ward patients.[6,11]

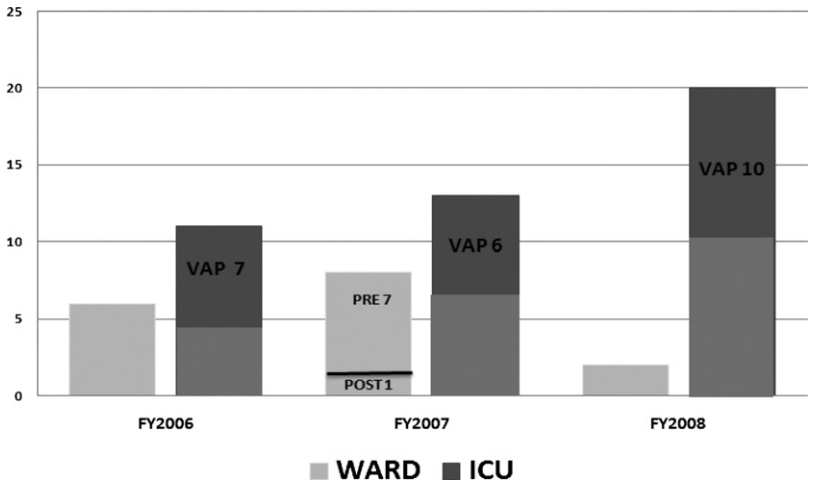

Figure 1. Breakdown of locations where pneumonia was diagnosed by fiscal year. The ward pneumonias diagnosed in fiscal year 2007 bridge the intervention time period with 7 cases preintervention and 1 case postintervention (6 months each period).

A number of observations became evident during the implementation of the prevention steps. First, nursing education and leadership from the nurse managers were key to the program's success. The nurse manager's and chief nurse's commitments to the program were critical to success because all of the interventions were implemented by the nursing staff. Second, ongoing feedback, initially monthly then quarterly, served as an important motivator for the ward staff. Third, orientation of new staff was also an important variable to continue the program and ensure that all staff implemented the guidelines and documented compliance in patient charts using the pneumonia bundle. The physicians, specifically the resident housestaff, were a challenge to educate and orient to the program because of their changing schedules at different times according to their specialty. At the start of the program, orders had to be actively chosen in the electronic order entry. We quickly changed the electronic order set so that the pneumonia package was loaded automatically, allowing modification by the physician if clinically indicated. The auto-loading of orders allowed for fairly uniform adoption throughout all of the surgical services.

Initially we were disappointed that overall incidence of pneumonia in our facility did not decrease substantially. The large increase in ICU pneumonias in FY 2008 was somewhat surprising because our facility has had a VAP bundle implemented in the ICU for many years. Even though our rate of VAP has risen during the last year, this increase in ICU pneumonia is not all explainable by VAP cases. A portion of the ICU pneumonias are now occurring in nonventilated ICU patients. A possible explanation for the increase in ICU pneumonias in nonventilated patients might be related to challenges of lack of ward beds for transfers. When patients have to stay in the ICU because there is no floor bed open for transfer, they are no longer participating in a pneumonia-prevention program because they no longer fit VAP-prevention criteria and are not on the ward to fall under the ward-prevention program. Our next step is to take the pneumonia program to the ICU for the nonintubated patients to address this group, especially as the hospital's high occupation rate occasionally means a longer ICU stay for floor-ready patients.

It is not a surprise that simple steps in pneumonia prevention can have such a substantial effect. As hospitals, physicians, and nurses embrace the quality movement and adopt prevention strategies, large effects are seen downstream in prevention of complications and infections. Simple hand-washing or gel/foam decontamination before and after patient contact is an example of a straightforward intervention with profound consequences. Our simple nursing intervention program, including ambulation, breathing exercises, mouth care, head-of-bed elevation, and "up to eat" resulted in an 81% decrease in our ward pneumonia rate. This would not have been possible without cooperation and buy-in from surgery, nursing, and quality management. This program, if expanded to other VA or private hospitals, could help improve patient care and lower morbidity, mortality, and overall health care costs.

Author Contributions

Study conception and design: Wren, Martin, Yoon
Acquisition of data: Wren, Martin, Yoon
Analysis and interpretation of data: Wren, Bech
Drafting of manuscript: Wren, Bech
Critical revision: Wren, Bech

REFERENCES

1. Dodek P, Keenan S, Cook D, et al. Evidence-based clinical practice guidelines for the prevention of ventilator-associated pneumonia [clinical guidelines]. Ann Intern Med 2004;141:305–313.
2. Koleff M. Prevention of hospital-associated pneumonia and ventilator-associated Pneumonia. Crit Care Med 2004;32: 1,396−1,405.
3. Warren DK, Shukla SJ, Olsen MA, et al. Outcome and attributable cost of ventilator-associated pneumonia among intensive care unit patients in a suburban medical center. Crit Care Med 2003;31:1312–1317.
4. Gupta R, Wargo KA. An update on the management of nosocomial pneumonia. J Pharmacy Pract 2008;21:380–389.
5. Muscedere J, Dodek P, Keenan S, et al. VAP Guidelines Committee and the Canadian Critical Care Trials Group. Comprehensive evidencebased clinical practice guidelines for ventilator-associated pneumonia: prevention. J Crit Care 2008;23:126–137.
6. US Department of Health and Human Services. HHS Action Plan to Prevent Healthcare-Associated Infections: Prevention—Prioritized Recommendations. Available at: http://www.hhs.gov/ophs/initiatives/hai/prevention.html. Accessed May 2, 2009.
7. Institute for Healthcare Improvement. Improvement Report: Reduction in Incidence of Post-Operative Pneumonia. Available at: http://www.ihi.org/IHI/Topics/PatientSafety/SafetyGeneral/ImprovementStories/MemberReportReductioninIncidenceofPostoperativePneumonia.htm. Accessed May 2, 2009.
8. Hawe CS, Ellis KS, Cairns CJ, Longmate A. Reduction of ventilator-associated pneumonia: active versus passive guideline implementation. Intensive Care Med 2009;35:1180–1186.
9. Khuri SF, Daley J, Henderson W, et al. The National Veterans Administration Surgical Risk Study: risk adjustment for the comparative assessment of the quality of surgical care. J Am Coll Surg 1995;180:519–531.
10. https://vhadennsqipweb.v19.med.va.gov/Operations%20Manual/Chapter%204%20September%204%202008.pdf. Accessed May 2, 2009.
11. Muscedere J, Dodek P, Keenan S, et al. Comprehensive evidence-based clinical practice guidelines for ventilator-associated pneumonia: prevention. J Crit Care 2008;23:126–137.