Sustaining Quality Improvement

Long-Term Reduction of Nonventilator Hospital-Acquired Pneumonia

Dian Baker, PhD, RN, APRN-BC; Barbara Quinn, MSN, RN, CNS-BC;
Victoria Ewan, PhD, MRCP, BMBS, B MedSci (Hons); Karen K. Giuliano, PhD, RN, FAAN

ABSTRACT

Background: Hospital-acquired pneumonia is now the number one hospital-acquired infection. Hospitals have addressed ventilator-associated pneumonia; however, patients not on a ventilator acquire more pneumonia with significant associated mortality rates.

Local Problem: In our hospital, non-ventilator-associated pneumonia was occurring on all types of units.

Methods: The Influencer Model was used to reduce nonventilator hospital-acquired pneumonia rates. Statistical process control R and X-bar-charts were monitored monthly.

Interventions: After a gap analysis, an interdisciplinary team implemented enhanced oral care before surgery and on the units, changed tube management, and monitored stress ulcer medication.

Results: We achieved a statistically significantly reduction ($P = .01$) in pneumonia rates that have been sustained over 4 years.

Conclusions: Sustaining change requires (*a*) a continued team-based, collaborative approach, (*b*) ongoing stakeholder and executive leadership engagement, (*c*) monitoring that easy-to-use protocols and required equipment remain in place, and (*d*) embedded analytics to monitor results over a prolonged period.

Key words: nonventilator hospital-acquired pneumonia, nursing care, oral health, quality improvement

Hospital-acquired pneumonia (HAP) is a common health care-acquired infection (HAI) globally, occurring at a rate of up to 25 cases per 1000 hospital admissions.[1] HAP is defined to include both ventilator-associated pneumonia (VAP) and nonventilator hospital-acquired pneumonia (NV-HAP). Findings from a multistate point-prevalence survey using the National Healthcare Safety Network criteria for HAIs suggest that NV-HAP (60%) and VAP (40%) combined accounted for 21.8% of all HAIs. This makes HAP the most common HAI in Europe and the United States.[2] As a result, a 2016 report from the Centers for Disease Control and Prevention (CDC) has recognized HAI as a top 10 public health concern.[3]

Over the past decade, hospital-based quality improvement (QI) initiatives have focused primarily on the prevention of VAP, resulting in significant decreases in reported cases of VAP.[4] With the reduction in VAP, NV-HAP now has a larger overall impact on patient morbidity, mortality, and cost of care than VAP.[5-7] Data support an incidence of NV-HAP ranging from 1.22 to 5.9/1000 patient days and associated mortality of 13.9% and 30%.[2,4,5,7-10] Nosocomial respiratory tract infections increase the average cost of hospital care by up to 75%[11]; increase length of hospital stay by up to 12 days[11,12]; require the prescription of broad-spectrum antibiotics, which may contribute to antimicrobial resistance and increase mortality[11,13]; and are associated with loss of independence.[7,11] The prevention of NV-HAP has the potential to improve patient outcomes[6,10] and may be the "next frontier in patient safety."[14]

At present, because there are virtually no requirements to monitor or report cases of NV-HAP, hospitals are less likely to monitor

Author Affiliations: *School of Nursing, California State University, Sacramento, Sacramento (Dr Baker); Sutter Medical Center, Sacramento, California (Ms Quinn); James Cook University Hospital, Middlesbrough, and Institute for Cellular Medicine, Newcastle University, Newcastle upon Tyne, United Kingdom (Dr Ewan); and Northeastern University, and Yvonne L. Munn Center for Nursing Research, Massachusetts General Hospital, Boston (Dr Giuliano).*

This work was supported during the initial quality improvement project (through 2014) by Sage Products LLC, and those results have been previously reported. Since 2014, the study has been supported internally by the second author's institution. Dian Baker and Barbara Quinn were previously on the Sage Products Speaker's Bureau, and Karen Giuliano was previously an employee of Sage Products, LLC. Victoria Ewan has no conflict of interest to report.

The authors declare no additional conflicts of interest.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.jncqjournal.com).

Correspondence: *Dian Baker, PhD, RN, APRN-BC, School of Nursing, California State University, Sacramento, 7667 Folsom Blvd, Sacramento, CA 95819 (dibaker@csus.edu).*

Accepted for publication: July 5, 2018
Published ahead of print: September 6, 2018

DOI: 10.1097/NCQ.0000000000000359

their own incidence and the associated harm. Our initiative started in 2011, after nursing staff observed increasing numbers of patients admitted to the intensive care unit with HAP.[10] We then formed a team to explore the reasons for NV-HAP. Based on our findings, we launched an interprofessional hospital-acquired pneumonia prevention initiative (HAPPI); our goal was to reduce and sustain a reduction in NV-HAP cases.

METHODS

Through our review of the literature, we learned that the most easily modifiable risk factor for NV-HAP prevention would be reduction of bacterial pathogens in the oral biofilm that cause NV-HAP, thus providing source control.[15,16] Using the CDC's model to target the health risk with most potential for effect, our HAPPI team chose to begin with an enhanced oral care protocol. Our data demonstrated that NV-HAP cases were occurring on every type of ward; therefore, we elected to implement a universal standard of care.

Our implementation approach was guided by the Influencer Model and SQUIRE guidelines for QI reporting.[17] Because most organizational changes are not maintained, we also set long-term sustainability of reduction of NV-HAP as an essential outcome. Sustainability refers to the ability to stabilize change and improvements, even when organizations face turnover and destablizing events. The National Health Services report that up to 70% of organizational change is not sustained, and 30% of QI projects are not maintained even within 1 year postimplementation.[18] In addition, the average time for monitoring QI projects is 1 year.[19] To avoid "improvement evaporation effect," our goal was to achieve an ongoing and a sustained practice change in our approach to NV-HAP reduction.[20] During the 4 years of our HAPPI implementation, our organization underwent several challenges including overall systemwide governance restructuring, merging 2 separate hospital buildings into a single new building, changes in C-suite leadership, product recall, and implementation of electronic health records (EHRs). The Institute of Healthcare Improvement's *Principles for Sustaining Change* guided our QI and quality control approach.[21] We have previously published a detailed report of the first 18 months of the HAPPI project.[10] Therefore, in this article we focus on the key factors that have been required to sustain and maintain improvements in patient safety.

Implementation: HAPPI

The study took place in a 523-bed, community medical center, located in a large metropolitan city, with an average of 27 000 admissions per year. Our QI study was approved by the principal investigators' Institutional Review Board and renewed annually until the last set of data collected in 2016.

Quality improvement: Gap analysis and proposed system change

The team began with a systematic literature review to determine the best available evidence for pneumonia prevention in the hospital setting. We explored risk factors for the development of pneumonia and found that the oropharynx is a major reservoir of infection for NV-HAP.[22] Respiratory pathogens in the oropharynx are associated with subsequent respiratory tract infection, via misdirection of these organisms into the respiratory tree through microaspiration.[15,16,22-25] There is limited but credible evidence that improving oral hygiene may reduce the incidence of NV-HAP by removing the potential reservoir for infection.[26-28]

We therefore examined current hospital oral care practice compared with national (CDC) standards and found several areas of discordance. First and most important, there were inequalities in oral care provision, in that the hospital oral care policy only included mechanically ventilated patients, rather than universal oral care as recommended by the CDC.[25,29] Second, the oral care products were sometimes unavailable or inadequate (eg, toothbrush bristles fell out on first use). Third, nursing staff had significant knowledge gaps about frequency and logistics of performing oral care, and concerns over the time these interventions would require. In addition, there were no practice guidelines about how to address patients who refused oral care or patients with altered mental status at risk of aspiration.

Development of the HAPPI oral care protocol

Based on this gap analysis, we determined that a universal standard of oral care delivery was required throughout the hospital. However, we

could not locate any published oral care standards for nonventilated patients. After examining available evidence, an expert panel therefore came to consensus and wrote an Oral Care Protocol for Acute Care Hospitalized Adult Patients, which was then ratified by the American Dental Association. This approval provided credibility for both frontline staff and executive leadership. We also analyzed inpatient characteristics and determined that 80% of patients would be able to provide self-care, alleviating some of the concerns over intervention time requirements.

Early phase: Pilot testing the HAPPI approach

We began with a 3-month small test of change in July 2012 by implementing the new oral care protocol on 3 hospital units: medical, telemetry, and orthopedics. Briefly, the HAPPI protocol included 4 times daily toothbrushing with toothpaste containing a dentifrice, followed by an oral rinse with antiseptic mouthwash, using suction toothbrushing for patients at risk of aspiration, and oral care for patients with dentures. Our process to increase compliance with the oral care protocol was successful, and we achieved a reduction in NV-HAP on all 3 test units.

In May 2012, we then launched the oral care protocol hospitalwide, and this initiative has continued to the present day. We undertook ongoing gap analysis, with monthly reviews of the literature, and were therefore able to adapt to new, emerging literature and quickly incorporate changes. Based on this ongoing gap analysis, we also added 3 additional interventions: (*a*) updated oropharyngeal tube care, (*b*) pharmacy services introduced a protocol to reduce the use of stress ulcer prophylaxis,[28] and (*c*) oral care preoperatively because the persistent cases of NV-HAP were more frequent in postoperative patients.[27,30]

Sustaining the change

During this period (2012 to present), there have been multiple, complex changes from both internal and external forces, which have threatened to undermine our gains. In the Institute of Healthcare Improvement model, quality control's primary function is to ensure that gains are maintained. Quality control means that there is ongoing, real-time analysis of performance aimed at sustaining positive outcomes. The analysis is received and acted upon by "operating forces" responsible for the patient safety outcome.[21] By adhering to the principles of quality control and ongoing real-time data analysis, we were able to address both internal and external forces as a team.[21]

Sustaining change at the unit level

To establish oral care as *standard work*,[31] the team convened monthly and visited units on a rotating basis with real-time coaching for staff members. We used visual branding with the HAPPI logo and ran awareness days to maintain visibility of the initiative. We also produced a light-hearted video to continue to keep the initiative fresh in the minds of clinicians and nurses' aides. Empowerment, education, and support were required for all frontline staff—especially nursing assistants—who were instrumental in the creation of effective staff training materials.[32] Therefore, in addition to our HAPPI team, nursing assistants were engaged in the entire QI process. Monthly outcomes reports were posted for each unit, to engage staff in responsible action and accountability.[21] By establishing and supporting oral care as a universal standard of care, it became *usual work* that persisted through changing conditions within the hospital system.[31]

Establishing and maintaining gains in patient safety also requires engagement of patients and families.[33] Posters and pamphlets with oral care health information were displayed in the hospital elevators and units. Patient and family education materials were developed and approved by our newly formed patient and family advisory council, including flyers for the meal trays informing patients about the benefits of maintaining oral care while in hospital.

High-quality equipment

The quality of equipment influences how staff view the priority of any new program, including oral hygiene. By providing staff with high-quality, evidence-based oral care tools, we accomplished 3 important goals: (*a*) illustrating the hospital's commitment and value to our enhanced oral care intervention, (*b*) making oral care interventions safer and easier to complete, and (*c*) improving patient comfort.

Sustaining change at the organizational level

We identified key decision-makers early and tailored our messages to address the perspectives and interests of the different stakeholder groups. For example, executive leadership received regular economic reports. During the first 2 years, extra cost for new therapeutic oral care equipment was $285 000/30 months. Cost savings were calculated using the published costs of $28 000 to $40 000/per case of NV-HAP.[2,5,7] Between 2012 and 2014, 164 NV-HAP cases were avoided, saving an estimated $4.5 million to $6.5 million. Estimated savings for the organization were $4.3 million to $6.2 million in avoided costs, and an estimated 31 lives saved.

The continued presence of the same committed team members over the course of the initiative has also been critical to its momentum, especially in terms of communication with stakeholders and unit-based teams. By engaging all stakeholders using this information, support was garnered to continue purchase of effective oral care supplies and fund effective, off-duty time education for all direct care providers.

Challenges

Our interprofessional HAPPI team carefully monitored internal and external forces that could impact our initiative. Shortly after launch of the HAPPI protocol, we found that material supplies had not adequately planned for the uptake in product usage, and we had to adjust ordering and organization on the hospital units. More recently, we experienced a recall of some of our oral care products. The gap analysis we had completed previously helped us make this change quickly with replacement products that were evidence-based. Ongoing monitoring of required equipment and quality is key to sustaining improvements in patient safety.[21]

Due to organizational restructuring, our team sought out the new leadership to provide frequent formal and informal reporting to promote buy-in and to ensure continued approval of resources required for equipment and access to analytic data monitoring. The combination of economic data and the presence of a committed team were essential to providing the evidence to the new leadership to continue the initiative. Maintaining engagement of the health system executive leadership, especially during turnover, is required to sustain changes.[32]

By working closely with our analytics department, we engaged in ongoing data collection even though our hospital moved to an EHR and merged 2 separate hospitals into single large hospital building. With the EHR, we were challenged about how and where to document oral care. Because many items (eg, ice chips) were listed as oral care, a team met with the EHR builders. Eventually a new oral care documentation screen was built based on the American Dental Association's oral care protocol. The alignment of the EHR data collection screens and actual practice is a significant challenge and should be addressed at the launch of any QI project.

Scaling up

Maintaining communication about the project and its success is essential for ongoing support.[34] Through the course of our initiative, we continued regular reports to the Board and various hospital committees about the ongoing success of our project. In addition, we expanded our marketing approach to include other disciplines such as respiratory therapy and pharmacy. As a result, there is ongoing executive leadership support and 17 hospitals in our health care system plan to launch the HAPPI protocol in 2018.

Evaluation

Sustaining change requires ongoing access to analytics and support from the informational technology team.[18] Monthly reports were generated from data extracted from EHRs and *International Classification of Diseases* (*ICD*) codes for pneumonia, not present on admission, into Statistical Package for the Social Sciences version 24 (IBM Corp, Armonk, New York) for statistical analysis. Oral care frequency audits and a randomization check for accuracy of data coding were completed. Clinical researchers reviewed each case for accuracy and completeness prior to data input. Odds ratio and confidence intervals were determined through pre/post-incidence data analysis. Statistical process control charts were run each month for the total hospital and for each unit to monitor oral care frequency and NV-HAP incidence. NV-HAP rates were calculated as:

$$\text{Rate per 1000 patient days} = \text{Number of NV-HAP cases} / \text{Total patient days} \times 1000$$

Rate per 100 patients
= Number of NV-HAP cases/
Total discharges × 100

Initially, cases of NV-HAP were identified by screening *ICD-9-CM* codes for pneumonia not present on admission using retrospective case notes review. In the first 30 months, NV-HAP cases were verified as NV-HAP by using the 2013 CDC case definition of pneumonia (including positive chest imaging, clinical signs and symptoms, and laboratory evidence).[29] An external challenge was the introduction of new *ICD-10* codes in October 2015, requiring careful alignment the *ICD-9* and 10 codes. Recent research has indicated that use of *ICD* codes is predictive of clinical confirmed NV-HAP; therefore, we changed to monthly data collection of *ICD* codes for NV-HAP cases.[9] The change in *ICD-10* coding impacted the overall trend data, and we observed an increase in NV-HAP cases with the new, more accurate coding system.

RESULTS

We successfully implemented the desired change in (*a*) oral care in both the perioperative area (99% of patients) and general clinical units (improved frequency of oral care from 0.25 to 3 times/24 hours), (*b*) improved tube care management, and (*c*) reduced use of adult stress ulcer prophylaxis (33%-9% reduction). These interventions contributed to a significant reduction ($P = .01$) in the incidence of NV-HAP that has been sustained over 4 years (Table). Statistical process control R and X-bar-charts demonstrate a significant improvement in the number of NV-HAP following each of the intervention periods. Control limits were calculated from the baseline data. Data starting in July 2013 indicate special cause with all the subsequent points below that mean (15.89). The control chart demonstrates 4 operating modes, with each phase operating below the baseline mean (see the Supplemental Digital Content, Figure, available at: http://links.lww.com/JNCQ/A487).

DISCUSSION

This was the first hospitalwide intervention project to prevent NV-HAP that began with enhanced oral hygiene. Our team-based, collaborative approach was effective in establishing and sustaining an effective and multidisciplinary NV-HAP prevention program. Similar to other HAIs, such as methicillin-resistant *Staphylococcus aureus* bacteremia, and *Clostridium difficile* infections, routine data collection of cases of NV-HAP was critical to understanding the patient safety implications and the effectiveness of interventions. The potential to improve patient outcomes, lower mortality, reduce antibiotic prescriptions and cost, and presumably reduce length of hospital stay are substantial. Other potential savings for hospitals might include the reduction of unnecessary intensive care unit days and 30-day readmissions. Implementation and maintenance of this successful intervention required (*a*) a sustained team-based, collaborative approach, (*b*) ongoing stakeholder and executive leadership engagement, (*c*) monitoring that easy-to-use protocols and required equipment remain in place, and (*d*) analytics to monitor results over a prolonged period.[35] Lastly, sustainability required monitoring of dynamic forces, both internal and external, with rapid adaptive responses to avoid negative impact on quality outcomes.[36] Further work is needed to better understand the impact of this initiative on lengths of patient stay, patient flow, and antibiotic prescribing by data collection at new implementation sites.

Table. *ICD*-Coded Data, Number of Cases of NV-HAP

Year	NV-HAP Cases	Total Discharges	Reduction, %	Rate 1000 Patient Days	OR (95% CI)
2011	181	25 067		1.91	Reference
2013	132	24 871	27	1.39	0.73 (0.58-0.92)[a]
2014	98	24 057	46	1.08	0.56 (0.44-0.72)[a]
2015	103	24 594	43	1.09	0.57 (0.45-0.74)[a]
2016	139	25 386	23	1.37	0.76 (0.61-0.94)[a]

Abbreviations: CI, confidence interval; ICD, International Classification of Diseases*; NV-HAP, nonventilator hospital-acquired pneumonia; OR, odds ratio.*
[a]$P < .05$.

Limitations

NV-HAP is difficult to diagnose accurately without invasive sampling. Therefore, it could be argued that a proportion of cases of NV-HAP represent false positives (ie, treated for NV-HAP but had another illness such as pulmonary edema) or reduced reporting because of the presence of the HAPPI initiative. However, the continued reduction in numbers of cases makes either of these possibilities less likely. In addition, although not reported here, similar outcomes have been achieved in other hospitals implementing the HAPPI oral care protocol. It is also possible that improving oral care might prevent other causes of nosocomial respiratory illness (eg, exacerbation of chronic obstructive pulmonary disease) via similar pathophysiological mechanisms.

More than 1 intervention was employed in this hospital, and it is unclear to what extent the other interventions (tube care, reduction of stress ulcer prophylaxis, etc) were important in achieving the outcomes described. Further work is needed to determine which elements of the interventions are important, including frequency of oral care provision.

Hospitals are dynamic, rapidly changing organizations, and the link between any new evidence-based protocol and outcomes is not always clear. In addition, there is natural variation in the outcomes such as NV-HAP over time. However, hospital admission rates and types were closely monitored, and no differences between the pre/postperiod in hospital admission patterns or types of diagnosis were observed. Ongoing monitoring of the trend data will continue to clarify the impact of *ICD* change in coding for NV-HAP.

CONCLUSION

We demonstrated that it is possible to implement and maintain a hospitalwide, patient safety initiative, using existing staff, and achieve and maintain significant reductions in NV-HAP. Hospitals may consider sustainability measurement tools such as the UK's Sustainability and Model Guide to assist them in this work.[20] Given that the interventions we used are safe and grounded in basic nursing care, hospitals should consider monitoring their own NV-HAP cases and designing interventions based on their unique gap analysis.

REFERENCES

1. Magill S, Wilson LE, Thompson DL, Reduction in the prevalence of healthcare-associated infections in US acute care hospitals, 2015 vs. 2017. Centers for Disease Prevention and Control Point Prevalence Study. Infectious Disease Week abstract 1768. 2017. San Diego, CA.
2. Magill SS, Edwards JR, Bamberg W, et al. Multistate point-prevalence survey of health care–associated infections. *N Engl J Med*. 2014;370(13):1198-1208.
3. Centers for Disease Prevention and Control and Prevention. Prevention status report, healthcare associated infection. https://wwwn.cdc.gov/psr/NationalSummary/NSHAI.aspx. Published 2016. Accessed April 1, 2017.
4. DiBiase LM, Weber DJ, Sickbert-Bennett EE, Anderson DJ, Rutala WA. The growing 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(02):200-202.
5. Davis J, Finley E. The breadth of hospital-acquired pneumonia: non-ventilated versus ventilated patients in Pennsylvania. *Pennsy Patient Saf Adv*. 2012;9(3):99-105.
6. Micek ST, Kollef KE, Reichley RM, Roubinian N, Kollef MH. Health care-associated pneumonia and community-acquired pneumonia: a single-center experience. *Antimicrob Agents Chemother*. 2007;51(10):3568-3573.
7. Giuliano KK, Baker D, Quinn B. The epidemiology of non-ventilator hospital-acquired pneumonia in the United States. *Am J Infec Control*. 2018;46(3):322-327.
8. Sopena N, Heras E, Casas I, et al. Risk factors for hospital-acquired pneumonia outside the intensive care unit: a case-control study. *Am J Infect Control*. 2014;42(1):38-42.
9. See I, Chang J, Gualandi N, et al. Clinical correlates of surveillance events detected by national healthcare safety network pneumonia and lower respiratory infection definitions—Pennsylvania, 2011–2012. *Infect Control Hosp Epidemiol*. 2016;37(07):818-824.
10. Quinn B, Baker DL, Cohen S, Stewart JL, Lima CA, Parise C. Basic nursing care to prevent nonventilator hospital-acquired pneumonia. *J Nurs Scholars*. 2014;46(1):11-19.
11. Thompson DA, Makary MA, Dorman T, Pronovost PJ. Clinical and economic outcomes of hospital acquired pneumonia in intra-abdominal surgery patients. *Ann Surg*. 2006;243(4):547-552.
12. Redelmeier DA, McAlister FA, Kandel CE, Lu H, Daneman N. Postoperative pneumonia in elderly patients receiving acid suppressants: a retrospective cohort analysis. *BMJ*. 2010;340:c2608.
13. Burton LA, Price R, Barr KE, et al. Hospital-acquired pneumonia incidence and diagnosis in older patients. *Age Ageing*. 2016;45(1):171-174.
14. Klompas M. Hospital-acquired pneumonia in nonventilated patients: the next frontier. *Infect Control Hosp Epidemiol*. 2016;37(7):825-826.
15. Heo SM, Haase EM, Lesse AJ, Gill SR, Scannapieco FA. Genetic relationships between respiratory pathogens isolated from dental plaque and bronchoalveolar lavage fluid from patients in the intensive care unit undergoing mechanical ventilation. *Clin Infect Dis*. 2008;47(12):1562-1570.
16. Ewan VC, Sails AD, Walls AW, Rushton S, Newton JL. Dental and microbiological risk factors for hospital-acquired pneumonia in non-ventilated older patients. *PLoS One*. 2015;10(4):e0123622.
17. Ogrinc G, Davies L, Goodman D, Batalden P, Davidoff F, Stevens D. Standards for QUality Improvement Reporting Excellence 2.0: revised publication guidelines from a detailed consensus process. *J Surg Res*. 2016;200(2):676-682.

18. NHS. Improvement Leaders' Guide: Sustainability and its Relationship with Spread and Adoption. www.institute.nhs.uk/. Published 2010. Accessed May, 2013.
19. Alexander J, Hearld L. What can we learn from quality improvement research? *Med Care Res Rev*. 2009;66(3):235-271.
20. NHS. *Improvement Leaders' Guide to Sustainability and Spread*. Ipswich, England: NHS Modernisation Agency; 2010.
21. Scoville R, Little K, Rakover J, Luther K, Mate K. *Sustaining Improvement*. IHI White Paper. Cambridge, MA: Institute for Healthcare Improvement; 2016.
22. Bassis CM, Erb-Downward JR, Dickson RP, et al. Analysis of the upper respiratory tract microbiotas as the source of the lung and gastric microbiotas in healthy individuals. *MBio*. 2015;6(2):e00037.
23. Flanders SA, Collard HR, Saint S. Nosocomial pneumonia: state of the science. *Am J Infect Control*. 2006;34(2):84-93.
24. Altman KW. Dysphagia evaluation and care in the hospital setting: the need for protocolization. *Otolaryngol Head Neck Surg*. 2011;145(6):895-898.
25. Tablan OC, Anderson LJ, Besser R, Bridges C, Hajjeh R; CDC; Healthcare Infection Control Practices Advisory Committee. Guidelines for preventing health-care–associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR Recomm Rep*. 2004;53(RR-3):1-36.
26. Pássaro L, Harbarth S, Landelle C. Prevention of hospital-acquired pneumonia in non-ventilated adult patients: a narrative review. *Antimicrob Resist Infect Control*. 2016;5(1):43.
27. Pedersen PU, Larsen P, Håkonsen SJ. The effectiveness of systematic perioperative oral hygiene in reduction of postoperative respiratory tract infections after elective thoracic surgery in adults: a systematic review. *JBI Database System Rev Implement Rep*. 2016;14(1):140-173.
28. Yoneyama T, Yoshida M, Ohrui T, et al. Oral care reduces pneumonia in older patients in nursing homes. *J Am Geriatr Soc*. 2002;50(3):430-433.
29. Centers for Disease Control and Prevention. *CDC/NHSN Surveillance Definitions for Specific Types of Infections*. Atlanta, GA: Centers for Disease Control and Prevention; 2014:1-24.
30. Gomes G. The nasogastric feeding tube as a risk factor for aspiration and aspiration pneumonia. *Curr Opin Clin Nutr Metab Care*. 2003;6(3):327-333.
31. Mann D. *Creating a Mann, 2010 Culture: Tools to Sustain Mann*. 2nd ed. Boca Raton, FL: CRC Press; 2010.
32. Health Quality Ontario home page. www.hqontario.ca. Published 2013. Accessed December 15, 2017.
33. NHS. *Sustainability: Model and Guide*. Leeds, England: NHS; 2007.
34. Nadeem E, Olin SS, Hill LC, Hoagwood KE, Horwitz SM. Understanding the components of quality improvement collaboration: a systematic review of the literature. *Millbank Q*. 2013;91(2):354-394.
35. Stone S, Lee H, Sharek P. Perceived factors associated with sustained improvement following participation in a multicenter quality improvement collaborative. *Jt Comm J Qual Patient Saf*. 2016;42(7):309-315.
36. Silver S, McQuillan R, Harel Z, et al. How to sustain change and support continuous quality improvement. *Clin J Am Soc Nephrol*. 2016;11(5):916-924.