

Registered Nurses' Knowledge of Pneumonia Prevention
Implementing Incentive Spirometry in Adult Hospitalized Postoperative Patients:
A Quality Improvement Project

by

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Abstract

In 2011, the Centers for Disease Control and Prevention (2018) estimated there were 157,500 cases of hospital-acquired pneumonia (HAP). Of those, ventilator associated pneumonia (VAP) had declined with increased efforts aimed at prevention, while non-ventilator pneumonia (NV-HAP) did not have such prevention interventions and escalated, with approximately 2300 cases and 5600 respectively reported in one state (Baker & Quinn, 2018). The 2012 Healthcare Cost and Utilization Project National Inpatient Sample reported only 4 million people were at risk for VAP, while approximately 35 million more people were at risk for NV-HAP in the United States. The purpose of this project was to evaluate surgical unit registered nurses' knowledge related to incentive spirometer (IS) in the prevention of NV-HAP postoperatively. The design of this quality improvement, program development project included a pretest, an evidence-based educational intervention specific to IS and a posttest administered to a small sample of RNs, guided by the Logic Model Framework. The results indicated that RNs' perspectives on patients' use of IS can be influenced following an educational session related to IS; however, the results showed a decrease in agreement reflecting the new knowledge of the nurses of the present evidence as it relates to incentive spirometry. These results also supported previous research findings and contribute to a body of knowledge validating nurses' need for endorsed guidelines on appropriate usage of IS to prevent postoperative pneumonia. The Advanced Practice Nurse has a unique role that can directly impact the prevention of postoperative pneumonia.

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Table of Contents

Background/Statement of the Problem	1
Literature Review	3
Theoretical Framework	20
Method	22
Results	28
Summary and Conclusions	38
Recommendations and Implications for Advanced Nursing Practice	45
References	49
Appendices	56

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Background/Statement of the Problem

Healthcare-associated infections (HAIs) are infections contracted in a healthcare setting such as hospitals, long-term acute care hospitals and inpatient rehabilitation facilities. Annually in the United States (U.S.), 99,000 people die from HAIs and HAIs affect 5% of hospitalized patients. Hospital length of stay (LOS) has increased by 17.6 days related to HAIs, at an estimated cost of \$35 billion per year, and an estimated \$1,100 per patient admission (Dyrda, 2016). One type of HAI is pneumonia, defined by the World Health Organization (2018) as a lung infection most commonly caused by bacteria or viruses.

In 2011, the Centers for Disease Control and Prevention (CDC) (2018) estimated there were 157,500 cases of hospital-acquired pneumonia (HAP). Nonventilator hospital-acquired pneumonia (NV-HAP) was almost 61% of HAPs (Giuliano, Baker, & Quinn, 2018). Giuliano, Baker and Quinn (2018) identified increased costs due to increased LOS, as well as morbidity and mortality associated with NV-HAP and ventilator-associated pneumonia (VAP) compared to nonhospital pneumonias. Estimated costs of NV-HAP were \$156 million, while \$86 million for VAP in 2009-2011, ranging from \$28,000-\$40,000 per patient in Pennsylvania, while the incidence of NV-HAP was 1.6%, similar to other published reports. Mortality ranged from 13.9% -30 % for NV-HAP (Giuliano et al., 2018). There is a plethora of literature written about the incidence

and costs of VAP; however, despite the epidemiology and associated costs of NV-HAP, literature related to preventing nonventilated pneumonia is limited (Cassidy, Rosenkranz, McCabe, Rosen, & McAneny, 2013). The purpose of this project is to evaluate registered nurses' (RN) knowledge related to incentive spirometry (IS) in the prevention of NV-HAP postoperatively.

Next, the literature review will be discussed.

Literature Review

CINHAL, PubMed, MEDLINE and Cochrane were searched to locate research regarding the relationship between IS and prevention of pneumonia in hospitalized adults, specifically prevention of postoperative pneumonia. The search was limited to journals published in English from 2008 to 2018. The following search terms were used: ICOUGH®, pneumonia, postoperative, surgical, Incentive Spirometer, and Incentive Spirometry. Articles published from 2008 to 2018 were selected. A secondary search was utilized for additional articles related to the theoretical frameworks and additional content related to the subheadings. Articles used for the secondary search were published from 2001-2019.

Pneumonia

Pneumonia causes inflammation of the lower respiratory tract of the lung, such as the alveoli and the bronchioles. The etiology of pneumonia consists of noninfectious and infectious agents such as bacteria, viruses, mycoplasma, parasites, and fungi typically specific to the environment of contraction. Noninfectious agents include inhaled irritants such as chemical or environmental agents and aspiration of gastric contents (Boling & Balderrama, 2016). The CDC (2018) determined that *Streptococcus pneumoniae* or pneumococcus was the most common cause of bacterial pneumonia.

The pathophysiology of pneumococcal pneumonia is divided into four stages: edema, red hepatization, gray hepatization, and resolution. In the first stage, the alveoli become edematous with protein rich fluid. The second stage, the red hepatization, is

when the lung has the appearance of the liver, which begins with capillary congestion and a release of polymorphonuclear leukocytes and red blood cells. The third stage, the gray hepatization stage, occurs two or more days later when the macrophages engulf the polymorphonuclear cells, red blood cells, and other cellular debris. The congestion is reduced, the alveolar exudate is removed, and the lung progressively returns to normal in the final stage of resolution (Grossman & Porth, 2014).

Signs and symptoms of pneumococcal pneumonia vary depending on the age and health condition of the affected person. Onset is typically abrupt, characterized by fever, chills, rigors and malaise. Productive cough producing watery sputum, diminished breath sounds, and fine crackles are initial signs. Sputum typically changes from rust colored or blood tinged to purulent sputum. Sharp pleuritic pain is common with respiratory movement. Older adults typically do not experience elevated temperature, and the only signs may be loss of appetite and change in mental status (Grossman & Porth, 2014).

Pneumonia is diagnosed by the patient's medical history, a physical exam, and diagnostic test results. Clinical presentation such as signs, symptoms, onset and location of the patient at the time of infection may determine if the infection is caused by bacteria, virus, or fungi. On a physical examination by a medical provider, auscultation of lung fields may determine a respiratory condition. Diagnostic tests such as chest x-ray, chest computed tomography scan, sputum culture, bronchoscopy, pleural fluid culture, blood cultures, complete blood count, and pulse oximetry may be ordered to determine a pneumonia diagnosis (National Heart, Lung and Blood Institute [NHLBI], 2017).

Treatment goals include infection cure, improvement of symptoms, and complication prevention. Specific antibiotics target the identified organism that caused the pneumonia. Bacterial pneumonias are treated with antibiotics, and symptoms improve after one to three days; viral pneumonia is treated with antivirals, and symptom improvement was typically observed in one to three weeks; fungal pneumonia was treated with antifungals. Symptom management such as supplemental oxygen for hypoxia, and antipyretics for fever may be used (NHLBI, 2017).

Incidence

Pneumococcal diseases are comprised of bacteremia, meningitis and pneumococcal pneumonia, which is the most prevalent form of the disease in adults. The CDC (2018) reported in the U.S. between 2004-2005, 900,000 cases of pneumococcal pneumonia. Of the pneumococcal pneumonia cases, 400,000 required hospitalization; and of those hospitalized, 5%-7% died from pneumococcal pneumonia. Pneumonia was reported as the leading cause of death from an infection (CDC, 2017).

Wuerth, Bonnewell, Wiemken, and Arnold (2018) claimed the prevention, diagnosis and treatment changes may have led to pneumonia epidemiological trends from 2002-2011 in the U.S. They found *S. aureus*, pneumococcus, and *Pseudomonas* were reported most frequently as infectious agents. At the same time, they reported a decrease in *H. influenzae*; and an increase in *Klebsiella* pneumonias. Their data included the H1N1 virus which was prevalent in 2009-2010 (Wuerth, Bonnewell, Wiemken, & Arnold, 2018).

Wuerth et al. (2018) also identified gaps or discrepancies in findings related to reported rates of pneumonia. They identified gaps in reporting the diagnostic codes which were entered for pneumonia, sepsis or respiratory failure and secondary diagnoses. Researchers used infectious organisms to calculate rates for hospitalizations, and fatalities when available. Furthermore, specific International Classification of Disease also referred to as ICD-9-CM codes, which were entered at health care sites did not always differentiate between community-acquired or hospital-acquired cases (Wuerth et al., 2018). In the U.S., pneumonias were further classified according to the setting it was acquired, such as community-acquired pneumonia or HAP, which was the second most common HAI (Boling & Balderrama, 2016). In addition, Boling and Balderrama, (2016) reported that 15% of HAIs are HAP. In the intensive care unit (ICU), patients with HAP had a mortality rate up to 50% and those who require ventilation were at increased risk.

It was estimated that there were 4 million cases of nursing home-acquired pneumonia annually in the U.S. (Boling & Balderrama, 2016). Pneumonia was attributed to 16,000 adults' deaths, 65 years or older each year in the U.S. (CDC, 2017). In addition, elderly men were more susceptible to die from pneumonia (Wuerth et al., 2018). Older adults, a vulnerable population, had an increased risk for morbidity and mortality associated with pneumonia. Prevention and early detection were cited as key components in preventing complications.

Healthcare-Associated Pneumonia

In the literature review healthcare-associated pneumonia (HCAP) was the most recent term used to describe pneumonia that occurred 48 hours or longer after the

admission to a healthcare facility. (Some researchers referred to hospital-acquired, while the term nosocomial pneumonia was rarely used.) HCAP was typically bacterial, and when it occurred at early onset, during the first 4 days of hospitalization, it often led to a better prognosis. Late onset HCAP was frequently associated with multi-drug resistant organisms such as Methicillin-Resistant *Staphylococcus aureus* (Boling & Balderrama, 2016). The classifications of early and late onset were not supported for empirical antibiotic therapy (Gastmeier et al., 2009).

Ventilator Associated Pneumonia. VAP referred to a pneumonia developing within 48 hours after intubation and mechanical ventilation. VAP was identified as one of the top HAI impacting patients who received mechanical ventilation, which may lead to increased mortality, lengthened ICU and hospital stays, and increased hospital costs. Specifically, ICU patients had a VAP rate of 10%-22%, mortality rates range from 27% to 43%, an increased ICU stay by 5 to 7 days: hospital stay was prolonged by 2-3 days, and projected cost range of \$9,000 to \$40,000 per patient for treatment of VAP (Gianakis, McNett, Belle, Moran, & Grimm, 2015). VAP was responsible for 50% of antibiotics used in the ICU (Parisi et al., 2016).

There is a vast amount of research identifying VAP risk factors and bundles to prevent VAP. Identified risk factors for VAP include patients who have endotracheal intubation, continuous sedation, lowered head of bed (HOB), and the severity of illness. VAP is caused when the bacteria existing in the oral cavity migrates into the bronchi causing pneumonia. Parisi et al. (2016) indicated that more than 30 years of published guidelines for preventing HAP may have reduced incidence of VAP. VAP may be

prevented by basic nursing care such as routine oral care: the use of mouth swabs, mouthwash and tooth brushing, elevation of the head of the bed, gastrointestinal decompression and prophylaxis of gastroesophageal reflux; early extubation, as well as deep vein thrombosis prevention. These interventions comprised a VAP bundle that demonstrated prevention techniques, which may have decreased incidence of VAP in trauma patients (Gianakis et al., 2015).

Several researchers, including Parisi et al. (2016), have reported reduced VAP rates with the implementation of a VAP bundle. Researchers at John Hopkins found quality improvement teams can prevent ventilator-associated events. Their research focused on oral suctioning; head of the bed elevation; oral care with chlorhexidine mouthwash and tooth brushing; spontaneous awakening by decreasing sedation and narcotics; and screening patients for improvement. In two years, ventilator-associated events decreased by 38%, ventilator-associated complications decreased more than 50%, and this attributed to a decrease in VAP rates by 78% (Rawat et al., 2017). There have been some differences regarding the exact bundle components, and some researchers have argued against the use of VAP bundles, although there were not specific indications of components to bundle or components to omit (Parisi et al., 2016).

Nonventilator-Associated Hospital-Acquired Pneumonia. NV-HAP is a respiratory infection developing 48-hours or more after admission to the hospital in which the patient was not intubated. Baker and Quinn (2018) reported that since 2008, hospitals throughout the US have focused on monitoring for device-associated infections, like VAP, and the implementation of prevention efforts may have led to a decrease in

incidence and costs. Meanwhile NV-HAP had not been examined as extensively and had developed into a major patient safety concern, with corresponding escalation of incidence and costs (Baker & Quinn, 2018). According to the 2012 Healthcare Cost and Utilization Project National Inpatient Sample, more people were at risk for NV-HAP, approximately 35 million, while only 4 million patients were at risk for VAP in the United States. The HAP Pennsylvania study from 2009-2011 determined that NV-HAP affected 5,597 patients, while VAP affected only 2,299 patients. The treatment costs were proportionate: NV-HAP was \$156 million, while VAP was only \$86 million; and had a mortality rate about 18% for both conditions (Baker & Quinn, 2018).

See, et al. (2016) performed a retrospective chart review to determine the clinical diagnoses associated with the National Healthcare Safety Network (NHSN) for pneumonia or lower respiratory infection (LRI) in eight acute-care hospitals in Pennsylvania during 2011–2012. Their study excluded patients with VAP diagnosis. They reviewed 250 cases of the 838 pneumonia and LRI events reported to the NHSN; 29 reported events did not meet either case criteria. Variances in reading radiology reports may have led to improper classifications. Eighty-one adults had NV-HAP; of these, 85% (69 of 81) had a clinical diagnosis of pneumonia; of these, 26% (18 of 69) were attributed to aspiration. Thirty-eight of 43 (88%) of adults with LRI were mechanically ventilated and 35% had no consistent clinical diagnosis at the time of LRI. Mortality rate of 31% was identified in patients with NV-HAP (See et al., 2016).

Sopena et al. (2014) reported limited studies of HAP outside the ICU, although those studies had identified HAP on general units as a recurrent problem, with an

incidence rate from 1.6 to 3.67 cases per 1,000 admissions. However, the risk factors of HAP outside the ICU were not identified. Sopena et al. (2014) studied HAP outside of the ICU in a case-control study to establish the incidence of risk factors for HAP and outcomes of HAP in general hospital floors. Their study included 74 cases of HAP on medical floors and 45 cases of HAP on surgical floors; and 238 controls. The incidence rate was 2.45 cases per 1,000 hospital admissions from 2006 to 2008. They determined several significant risk factors for HAP: anemia, malnutrition, chronic renal failure, depression of consciousness, hospitalization, thoracic surgery and Charlson comorbidity index ≥ 3 . The Charlson comorbidity index is a scale to predict risk of mortality within one year of patients hospitalized with the specific comorbid conditions (National Cancer Institute, 2019). Mortality and complication rate of non-ICU HAP was 27.7% and 57.1% respectively. HAP outside the ICU had increased morbidity, mortality, length of stay and rate of discharge to a skilled nursing facility (Sopena et al., 2014).

According to Klompas (2016), the CDC synthesized data on VAP but had limited data on NV-HAP, which was not adequate for prevention of NV-HAP. Most of the techniques used to prevent NV-HAP stemmed from measures to prevent VAP. Similar to VAP bundles, projected preventive measures for NV-HAP included oral hygiene, head of the bed elevation especially during feeding, encouraging early mobilization, preventing delirium and sedation, and avoiding gastric acid suppression (Klompas, 2016). Quinn et al. (2014) identified a risk of HAP associated with use of acid blocking medications.

Baker and Quinn (2018) suggested numerous interventions to prevent HAP, specifically oral care, elevation of the head of the bed 30-40 degrees, patient mobility, use of incentive spirometry, and deep breathing and coughing exercises. Of the 21

U.S. Hospitals Baker and Quinn (2018) studied, 1,300 patients acquired NV-HAP, and 70.8% of the NV-HAP were acquired outside of ICU, of which 18.8% required transfer to the ICU. Although there were variations between hospital settings and documented care delivery, in the 24-hours prior to diagnosis of NV-HAP, most patients did not have fundamental pneumonia prevention care documented. The study determined that 41.1% had no oral care or only once a day; 64.5% had HOB elevation; 28.7% of patients who could get out of bed were out of bed twice in 24-hours only; 18.2% had IS and 32.6% cough and deep breathing (Baker & Quinn, 2018). In a smaller study by Quinn et al. (2014), they determined missed care for coughing and deep breathing coaching, oral care, mobilization, HOB elevation ranging from 34%-84% per shift in the preceding 24-hours before onset of NV-HAP. The inconsistently delivered standards of care to prevent HAP, considered missed care, may be related to poor outcomes for patients and contribute to increased healthcare costs (Baker & Quinn, 2018; Quinn et al., 2014).

Quinn et al. (2014) applied the Influencer Model™ to guide the intervention process, to focus on the intricacies of changing the basic nursing process such as oral care, which predicted that nursing behaviors would not change unless nurses comprehended the role of oral care in the prevention of NV-HAP. Education and participatory actions facilitated the changes that led to increased oral care, and a 37% reduction of NV-HAP.

A multidisciplinary work group designed a quality improvement program focused on identifying a standard of care, followed by the development of a group of interventions aimed at decreasing postoperative pneumonia at Boston University Medical Center in 2010. An acronym ICOUGH® designated the major components: Incentive

Spirometry, Cough and breathe deeply, Oral care, Understanding ICOUGH®, Get up and move (mobility), and HOB elevation to prevent postoperative pneumonia (Cassidy et al., 2013). Pain control was managed on an individual basis (Cassidy et al., 2013). A year after implementation of ICOUGH®, a 1% reduction in postoperative pneumonia and 0.8% reduction in unplanned ventilation was reported for designated general and vascular surgeries (Cassidy et al., 2013). Comprehensive multidisciplinary education and commitment was articulated throughout the implementation process. The literature regarding bundles of interventions have demonstrated a decrease incidence of NV-HAP.

Postoperative Pneumonia. A systematic review of the literature identified postoperative pulmonary complications as significant disease or dysfunction affecting the postoperative course, which occurs due to shallow breathing, lack of sighs, recumbency, dysfunction of the diaphragm and mucociliary clearance (Overend et al., 2001). Complications associated with pneumonia include bacteremia, dyspnea, pleural effusion, lung abscess, empyema, pleurisy, sepsis, respiratory failure and renal failure (NHLBI, 2017). Wuerth et al. (2018) concluded that emerging data regarding infectious organisms, treatments, and prognosis may facilitate further identification of at-risk populations.

Pneumonia Vaccine

There are two vaccines identified to prevent pneumococcal disease. The pneumococcal conjugate vaccine (PCV13) defends against 13 strains of pneumococcal bacteria. While pneumococcal polysaccharide vaccine (PPSV23) defends against 23 strains of pneumococcal bacteria. The vaccines differ in the pharmacokinetics: the 13 conjugate binds proteins with the cell; while the polysaccharide 23 simulate the surface

of bacteria, allowing the body to protect itself. The CDC (2017) recommends PCV13 for all children at 2, 4, 6, and 12 to 15 months old, all adults 65 years or older, and adults 19 years or older with increased risk of contracting pneumococcal disease. These risks include immunocompromised patients, chronic heart, lung, or liver disease, diabetes mellitus, and alcoholism. The CDC (2017) recommends PPSV23 for adults 65 years or older and for people 2 years or older who are at increased risk, and adults 19 years or older who smoke cigarettes (CDC, 2017).

Incentive Spirometry

The IS devices are comprised of plastic, with flexible tubing and a mouthpiece for patient inhalation. They differ in purpose, flow or volume of which they are named, and number of chambers. The volume-oriented device has one chamber to displace the volume of air in the lung, while the flow has three chambers. In flow-oriented IS, the patient inhales and attempts to rise the three floats through inspiratory flow created by negative pressure. In volume-oriented IS, a piston in the chamber rises to show maximum volume that is measured by metrics on the side of the column, followed by breath holding of maximal inspiratory effort, while in flow-oriented IS, the patient does not hold their breath (Eltorai, Szabo, et al., 2018). Clinical practice guidelines recommend a volume-oriented spirometer be used (Eltorai, Szabo, et al., 2018; Restrepo, Wettstein, Wittnebel, & Tracy, 2011).

IS was introduced following the downfall of intermittent positive-pressure breathing (IPPB), which were used to mimic the sigh or yawn. The device initially provided feedback, or incentive, for patient compliance of achieving a desired inspiratory

volume. The latter devices were developed as disposable units that were marketed as beneficial for deep breaths, which resulted in decreased pleural pressure, increased expansion of the lungs and improved gas exchange. Proper instruction on the use of the device targeted frequency, repetition and volume, as well as breath holding to prevent atelectasis (Eltorai, Szabo, et al., 2018). Patients received visual feedback with attempts to meet their volumetric goal (Eltorai, Szabo, et al., 2018).

Assistive interventions, such as IS, a nonpharmacological intervention, was used broadly to treat and prevent pulmonary complications and has been used to promote lung expansion and gas exchange in patients with pneumonia. IS has been used to reduce dyspnea and lower risk of pulmonary complications, which increases lung expansion, decreases pleural pressure, and promotes better gas exchange to prevent atelectasis and other respiratory complications during the postoperative period (Restrepo et al., 2011).

The American Association for Respiratory Care (AARC) (2011) recommended preoperative screening for risk of postoperative pulmonary complications and identification of baseline parameters. Postoperative pulmonary complication risks included patients with atelectasis and patients at risk for atelectasis. Atelectasis risk included: following coronary artery bypass graft, thoracic or abdominal surgery, patients wearing thorax or abdominal binders, prolonged bedrest, chronic obstructive pulmonary disease, poor pain control, neuromuscular lung disease, inspiratory capacity less than 2.5 L, spinal cord injuries, and sickle cell patients with acute chest syndrome (Eltorai, Baird, Eltorai, et al., 2018 a).

Healthcare providers in 95% of U.S. hospitals prescribed IS to postoperative patients who were at risk for postoperative pulmonary complications (Eltorai, Baird, Eltorai et al., 2018 a). Eltorai, Baird, Pangborn, et al. (2018) first estimated the costs associated with respiratory therapists (RT) educating patients on the use of the IS, as well as the nurses' time reeducating and reminding patients. They used data collected from a survey of the professionals, and observation of clinical care of over 500 patients related to IS on a stepdown unit in 2016, as well as workload costs in their computation. The cost of the IS device used in the computation was approximately \$13, and the estimated cost of implementation was \$107 per patient. Approximately 10 million postoperative inpatients utilize IS annually, which calculates to \$1.04 billion in associated health care costs. The evidence on the utilization of IS to reduce postoperative pulmonary complications has been limited, and the reported personnel costs and clinical efficacy have not yet been justified (Eltorai, Baird, Pangborn, et al., 2018).

Widespread use of IS perioperatively, with coronary artery bypass graft surgical patients and with upper abdominal patients (unless at risk of pulmonary complications) was not indicated based on the AARC guidelines (Strickland et al., 2013). Early mobility and ambulation were recommended to prevent these complications based on low-level evidence (Strickland et al., 2013). Restrepo, Wettstein, Wittnebel, and Tracy (2011) had earlier indicated IS was not recommended for routine use for patients following coronary artery bypass graft for prevention of atelectasis.

Overend et al. (2001) studied prevention of postoperative pulmonary complications in a systematic review and found flaws in methods. Of the articles reviewed, there were no positive effect of IS on postoperative cardiac and abdominal

surgeries; however, IS with IPPB and deep breathing were more effective than no treatment for abdominal surgery. Strickland et al. (2013) reported that 7% of operative patients with normal lung function experienced postoperative pulmonary complications such as pneumonia, atelectasis and respiratory failure. The authors reported 70% of operative patients with risks such as age, smoking history, lung disease, obesity, and duration of surgery experienced postoperative pulmonary complications such as pneumonia, atelectasis and respiratory failure. Baker and Quinn (2018) indicated that while surgery was a risk, over 63% of NV-HAP cases were identified in non-surgical units, including obstetrics. Quinn et al. (2014) determined over 80% of patients admitted to the hospital were at risk for NV-HAP and did not advocate for bundled care for only at-risk patients, as they would likely miss others at risk. Lastly, Eltorai, Szabo, et al. (2018) cited flaws in methods that continued to contribute to the controversy regarding the use of IS to prevent postoperative pulmonary complications. Flaws included inaccurate procedure descriptions, insufficient standardized outcomes and appropriate control comparisons, underpowered studies, and failure to isolate IS effects due to co-intervention.

The AARC Clinical Practice Guidelines Steering Committee performed a systematic review of 54 clinical trials to update the IS Clinical Practice Guidelines. Restrepo et al. (2011) determined deep-breathing exercises offered the same benefit as IS in preventing postoperative pulmonary complications in perioperative settings. Restrepo et al. (2011) recommended IS be used only in combination with deep-breathing exercises, directed coughing, early mobilization, and optimal analgesia to prevent postoperative pulmonary complications. Restrepo et al. (2011) did not discuss the use of IS for

treatment of pneumonia. Also, the AARC (2011) indicated IS should not be used alone, but combined with coughing and deep breathing, out of bed and pain control for effective prevention of postoperative pulmonary complications. When used, a volume-oriented spirometer has been recommended (Restrepo, Wettstein, Wittnebel, & Tracy, 2011).

Moore et al. (2018) performed a literature review of published articles from 2006-2016 which had minimal support of the use of IS in patients with pneumonia. The focus was on the effectiveness of IS use related to the prevention of postoperative pulmonary complications with varied results. They performed a small study that compared the effects of IS use with a control and placebo control group on pneumonia patients with dyspnea. They focused on vital capacity (VC) and oxygen saturation. Moore et al. (2018) determined there was no significant difference between the use of IS and a placebo on dyspnea and maximum VC; however, oxygen saturation maintained the same in all patients. The lack of evidence in the literature review, coupled with their results led them to caution practitioners in the effectiveness of IS in the aided treatment in pneumonia. Further research is necessary with a larger and more diverse sample.

Eltorai, Baird, Eltorai, et al. (2018 b) identified professional perspectives on IS. The authors compared RNs and RTs on factors such as education on the clinical indications, perceived patient outcomes, and usage procedures. There were 1,681 participants made up of RTs and nurses with different educational backgrounds, years of experience, and primary practice locations. Most of these health care professions believed IS was a vital component of patient care, improved outcomes, and IS was just as effective as other respiratory interventions to prevent postoperative pulmonary complications. These healthcare professions had different opinions regarding use

procedures with respect to frequency, number of breaths per session, breath-hold duration, and initial target inspiratory volumes and flow. Nearly all participants believed they received adequate IS education and training, which is remarkable for the actual paucity of published evidence-based practice expanded guidelines.

Discrepancies exist in the literature related to frequency of sessions, target inspiratory volume and rate; number of breaths per session; duration of breath holds; perioperative IS use; and graduated use procedures. Eltorai, Baird, Eltorai, et al. (2018 a) compiled a literature review and listed the following discrepancies regarding the recommendations of IS frequency of sessions: every hour; every two hours; two times per day; four times per day; five times per day; two times per day; every four hours; four times per hour; three times per hour; 10 times per hour; 30 times per hour; or every 10 minutes. Eltorai, Baird, Eltorai, et al. (2018 a) found several different recommendations for target inspiratory volume: 50–70% of preoperative vital capacity; 1,400– 1,770 mL; 200–2,000 mL; or at maximal inspiration above residual volume. They found recommendations regarding number of breaths per session: three breaths per session; three to five breaths per session; five breaths per session; 10 breaths per session; 15 breaths per session; and 20 breaths per session (Eltorai, Baird, Eltorai, et al., 2018 a). The AARC (2011) guidelines recommended five breath holds. Others have recommended three breath holds or holding the breath for as long as possible (Eltorai, Baird, Eltorai, et al., 2018 a). Perioperative practices regarding IS use vary in recommended time. Eltorai, Baird, Eltorai, et al. (2018 a) found recommendations for IS usage at several different times after surgery. These included the first three days after surgery; starting four to 72 hours after surgery; preoperatively and during the first five

days after surgery; during the first five days after surgery; throughout postoperative day three; during postoperative days one through four; starting one hour after surgery for three days; and starting four hours after extubation. The American Thoracic Society has not provided guidelines to assist with the discrepancies identified in the literature related to IS (Eltorai, Baird, Eltorai, et al., 2018 a).

The lack of professionally endorsed guidelines; variations in professional education regarding IS; limited evidence-based recommendations; and clear evidence that IS alone may not be effective in preventing postoperative pulmonary complications has been reported (Eltorai, Szabo, et al., 2018; Restrepo et al., 2011; Strickland et al., 2013). The use of IS in bundles, such as the ICOUGH®, has demonstrated a reduction of NV-HAP, (Cassidy et al., 2013). Eltorai, Szabo, et al. (2018) cited the paucity of data regarding documented patient adherence to IS therapy and therefore may have contributed to results that do not support IS. Eltorai, Baird, Eltorai, et al. (2018 a) identified that practice was not based on evidence in their national survey. The proliferation and widespread use of IS in the U.S. at a substantial cost, is an additional compelling indication that healthcare providers require further education on the use of IS in the attempted prevention of postoperative pulmonary complications. An evidence-based training to increase RNs' knowledge related to IS in the prevention of NV-HAP postoperatively was developed.

Next, the theoretical framework will be discussed.

Theoretical Framework

To consistently provide quality health care that is safe, effective and achieves positive patient outcomes, the analytic tool of the logic model provides a framework for implementation of the health system quality improvement projects (Siriwardena & Gillam, 2013). A logic model is a systematic and visual way to present a program, the activities planned, and the changes or expected results (W.K. Kellogg Foundation, 2004). The processes of delivering care is delineated into components that identify the initial definition of the problem; prioritization of the goal; and the identification of the population the improvement is intended. The risk of NV-HAP in postoperative patients has been identified for improvement, by an evaluation of knowledge of IS by surgical RNs providing care. The input was comprised of an actual educational session provided by the project manager, for the RN, while the output was evidence-based practice related to IS for the RN, which includes a pretest, educational session and posttest.

Reynolds and Sutherland (2013) emphasized the monitoring and evaluation of systems to ensure systematic approaches to provide strong evidence-based results to guide decisions and utilize resources wisely. The outcomes are anticipated benefits or unintended consequences, which may have short, medium or long-term effects. Short term effects of the program included RN acknowledgement of IS variants, their role in patient compliance and adherence to medical orders for IS, as well as the evaluation of the educational program. The medium and longer-term effects that were identified upon the conclusion of the project include the development of RN orientation training and annual competencies on the topic of IS. The development and promulgation (or review

and revision) of organizational protocols regarding IS; monitoring quality, and evaluating outcomes, were areas for future projects.

Nutley and Reynolds (2013) described the assumptions of the logic model to identify potential weaknesses with the program as information is obtained and to facilitate them to strengthen the data. The assumptions of this project were RNs would participate in all three components and an educational session would increase RN knowledge regarding IS. The external factors were the environmental factors, which the project administrator did not have control over. External factors included RNs may not have read the email announcement, chose not to participate in the program, or not participate in all segments. (See Figure 1.)

Next, the methods will be discussed.

Method

Purpose

The purpose of this project is to evaluate RNs' knowledge related to IS in the prevention of NV-HAP postoperatively. The research question proposed for this project is: Do RNs have sufficient knowledge to effectively educate patients on the use of incentive spirometer to prevent postoperative pneumonia?

Design

The design of this quality improvement, program development project included a pretest, educational intervention, and posttest. The review of the literature had yielded a tool that was used for this project. The tool comprised a 15-item Likert scale; open ended response, multiple choice questionnaires and a select all statement. Permission was granted by Dr. Adam E. M. Eltorai, PhD, to use his validated tool.

Setting

A community hospital in Southeastern Massachusetts was the setting identified for this quality improvement initiative. The project took place in an urban hospital on a 45-bed surgical unit. During the summer of 2018, permission to complete the project was obtained from the surgical floor nurse manager and the Assistant Chief Nursing Officer (ACNO), as well as the organizational Ethics Committee. The completed *Clinical Submission Form Nursing* (revised 7/2018) was submitted to the professional development office for review, and permission has been obtained via electronic transmission (Appendix A). The anticipated ethical considerations were minimal. The

project involved human subjects and was reviewed and approved by the Institutional Review Board (IRB) through Rhode Island College (RIC) (Appendix B).

Sample

The sample was provided from an updated list of 40 RNs' names by the nurse manager of the postoperative unit. An email announcement was provided to all the RNs on the list soliciting their voluntary participation. The sample included all 40 RNs employed on the surgical unit as per-diem, part time and full-time, and all ages and experience levels. The sample excluded RNs in the float pool, RNs from other departments who float to the surgical floor, and RN's on orientation because they may not have been educated in IS related to the postoperative bundle project.

Verbal informed consent was obtained when participants agreed to participate in the project. An anonymous identifier comprised of each RNs' mothers' maiden name initials and numerical of their fathers' birth month was used to facilitate anonymities and determined RN participation in both tests for comparison. Confidentiality was maintained by keeping the participants' results anonymous. There was minimal risk to the participants.

Procedures

An evidence-based educational session was developed in September 2018. A pilot study was conducted in October 2018 with expert RNs who did not participate in the sample for feedback on the training, pretest and posttest questions. No revisions were made to the validated tool, and changes were made to the educational content based on

the feedback. Changes included an additional slide on the site specific ICOUGH® and grammatical changes to the educational session PowerPoint.

An informational email (Appendix C) was sent to all surgical RNs on the unit. The email included an informational letter (Appendix D) discussing the project and its purpose as well as a brief overview of the procedure and how test results would be used. This letter also explained that participation was voluntary and that there was no identifying demographic data collected.

Consent was implied when the nurse read the informational letter, completed the anonymous tests, and attended the educational session. The project took place from January 19, 2019 through January 26, 2019, which provided equal opportunities for all RNs in the sample to participate, regardless of their work schedule. The validated tool administered in this project was completed as a stapled four-page paper survey. It was unchanged from the landscape-view from which it was received, except for the following handwritten additions in the upper right-hand corner of page 1: “mother’s maiden name initials”; “and father’s birth month”; and the words “Pretest” and “Posttest”.

The participants received identical copies of the tests completed pre-intervention and post-intervention (Appendix E) which were completed on the day of an educational session. A copy of the educational session is outlined in Appendix F. The pretest was completed by each participant and was collected immediately prior to the evidence-based educational session. The session included postoperative pulmonary care, using the IS guidelines, to participating RNs who are responsible to provide IS as ordered for postsurgical patients. The posttest was then administered and collected by the project

administrator. The tests were matched by the unique anonymous identifiers mother's maiden name initials and father's birth month to identify corresponding tests pre and post educational intervention. Completed tests were placed in a folder, which were then placed in a locked filing cabinet until data analysis began.

The results were compiled following the final session by comparing the pretest to the posttest results to determine rate of completion of tests. Results were compared from pre-assessment and posttests administered to RNs.

Program Development

The project leader completed an educational assessment by identifying a knowledge base of the RN providing perioperative care related to postoperative pulmonary care, specifically IS. This program development project involved the improvement of an existing program where it was implemented. There had been a recently instituted postoperative pneumonia prevention bundle which includes IS designated for thoracic surgeries only, however, IS as an unbundled order was a postoperative standard of care for all general surgical patients.

Ethical

Ethical considerations were minimal. By excluding some nurses such as RNs on orientation and float RN there may be inconsistent IS practices that affect patient utilization of the device.

Next, the data analysis will be discussed.

Data Analysis

Descriptive statistical analyses including means were calculated to measure the effectiveness of the educational program development. Pretest responses were compared and analyzed to post-education posttest responses utilizing percentiles and total scores. Data are presented in the results section.

The components of the tool were identified for the purpose of this paper, as Items 1-15, Questions 16-24, and Statement 25. Results, except Question 23, from national online surveys were reported in published literature:

- Item(s) 1-13, and Question(s) 16-22 in Perspectives on incentive spirometry utility and patient protocols (Eltorai, Baird, Eltorai, et al., (2018 a).
- Items(s) 14, 15 and Statement 25 in Incentive spirometry adherence: a national survey of provider perspectives (Eltorai, Baird, Eltorai, et al., 2018 b).
- Question 24 Financial impact of incentive spirometry. (Eltorai, Baird, Pangborn, et al., 2018).

As stated previously, there is a lack of evidence to support routine use of IS postoperatively, due to poorly designed clinical trials, flaws in methods related to procedures, controls, and additional intervention with IS (Eltorai, Szabo, et al., 2018).

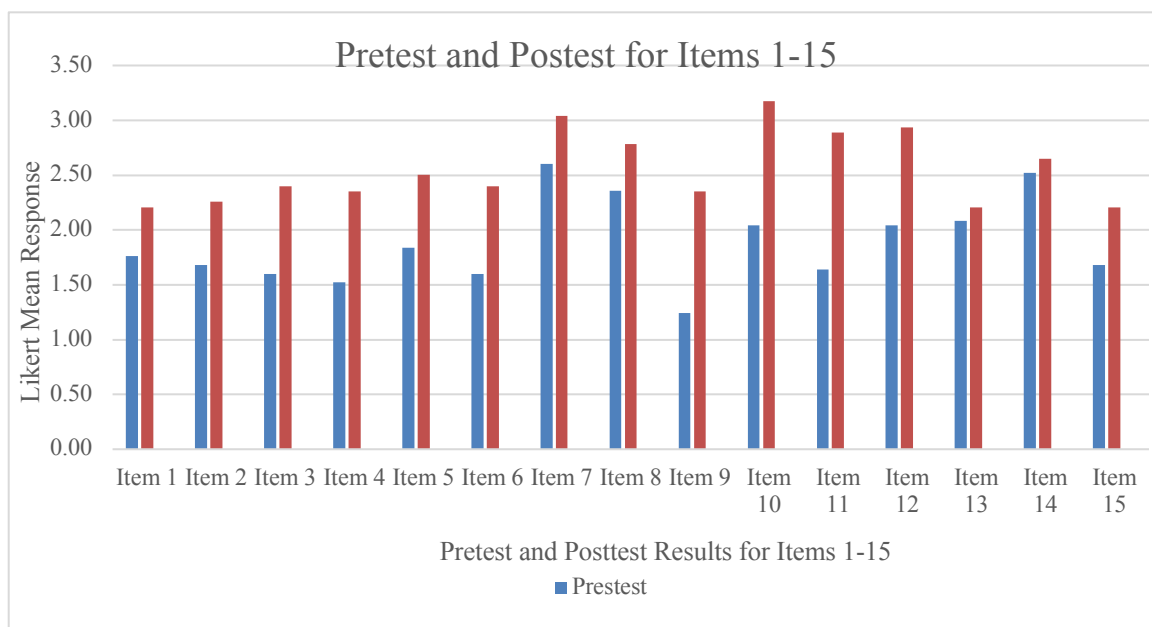
Next, the results will be discussed.

Results

Twenty-six out of a possible 40 surgical nurses completed the pretest portion of this quality improvement project (n=26, 65%). Twenty-five of a possible 40 nurses attended the educational session and completed the posttest portion of this quality improvement project, (n=25, 62.5%). Years of experience were used to divide nurses into four groups: 0-5 years; 6-10 years; 11-19 years and greater than 20 years of experience. Fifteen nurses (60%) comprised the 0-5 group, five nurses (20%) were in the 6-10 group, three nurses (12%) were in the 11-19 group, and two nurses (8%) made up the greater than 20-year group.

For the purpose of presenting the first 15 items, only those tests with corresponding pre and post responses were utilized, (n=25). Items number 1-15 were Likert scale statements, which can be found in Appendix E. For the purpose of reporting data via Microsoft Excel (Microsoft Corporation, Redmond, Washington), the Likert scale was converted to numerical data. The numbers 1-6 were used to report data, 1-strongly agree, 2-agree, 3-somewhat agree, 4-somewhat disagree, 5-disagree, and 6-strongly disagree. The nurses' mean responses from pretest and posttest are presented in Figure 2.

Figure 2: Mean Likert Response Scores Items 1-15 (n=25)



Some answers were not completed in the pretest regarding Items 1-15: Item 3 was of 24 responses; Item 5 was of 23 responses; and Item 7 was of 24 responses, which are indicated with * in the results section. In the posttest, all of items 1-15 were answered. Overall there was an increase in the scores from pretest to posttest, trending towards disagreement, or away from strength of agreement. The pretest scores ranged from 1.24 to 2.6 out of a possible 6 points for each statement, with a mean response rate of 1.88. In comparison, posttest scores ranged from 2.21 to 3.18, with a mean response rate of 2.56. The average posttest response rate increased by 0.68 points, indicating that these perspectives on the use of IS in these nurses' clinical practice could be influenced by an educational session. In addition, the pretest Items 3, 5, 7 that were not completed did have responses in the posttests.

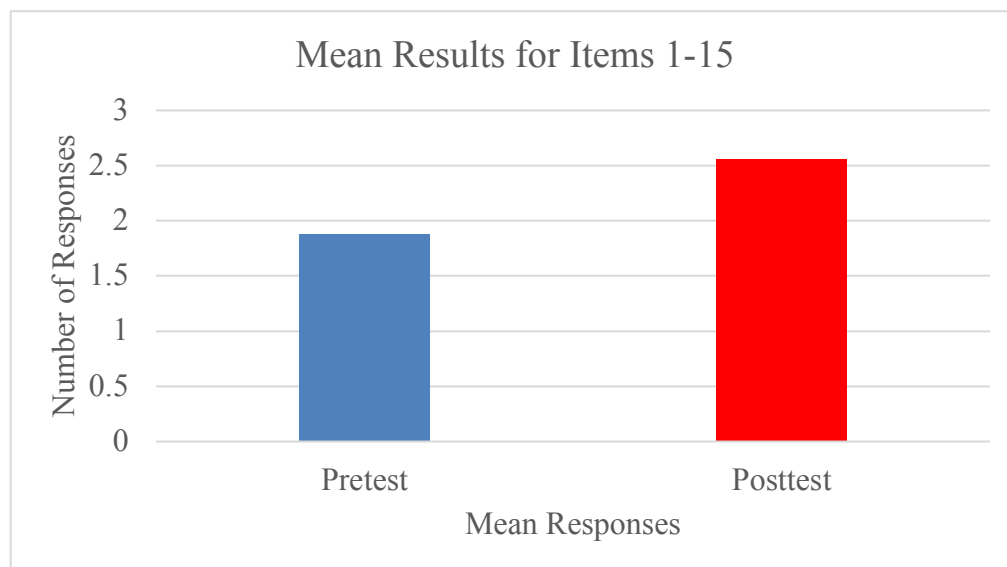


Figure 3. Mean response rate Items 1-15

In review of Item 1 regarding the importance of IS, a majority (84% pretest and 76% posttest) nurses strongly agreed or agreed, in both pre and posttests, that ISs are essential for patient care. Regarding the utility of IS, in Item 2, again, the majority of (88% pretest and 76% posttest) nurses agreed or strongly agreed in both pre and posttests that ISs improve pulmonary function. In review of Item 3, most nurses (91.7% pretest* and 76% posttest) in both pretest and posttest agreed or strongly agreed that ISs improve inspiratory capacity.

The effectiveness of IS in decreasing atelectasis and pneumonia yielded the following responses. The majority of nurses (96% pretest and 68% posttest) in both pretest and posttest agreed or strongly agreed that ISs helps prevent atelectasis in Item 4. Responses for Item 5 indicated that the majority of nurses (82.6% pretest* and 68% posttest) in both pretest and posttest agreed or strongly agreed that ISs help reverse atelectasis. Likewise, the majority of nurses (88% pretest and 72% posttest) in both

pretest and posttest agreed or strongly agreed that ISs help prevent pneumonia in Item 6. Most noteworthy in Item 7, about half of the nurses (47.8% pretest* and 52% posttest) in both pretest and posttest agreed or strongly agreed that ISs help reverse pneumonia.

There were an equal number of nurses (56% pre/posttest) in both pretest and posttest that agreed or strongly agreed, ISs should be used routinely preoperatively in Item 8. While respondents were initially unanimous in routine postoperative IS use, 100% pretest, in agreement or strongly in agreement, they were 80% posttest in agreement or strongly in agreement in Item 9.

Regarding the nurses' perspectives of the effectiveness of IS compared to other treatments, there was a trend towards decrease in agreement. Nurses (64% pretest and 44% posttest) in both pretest and posttest agreed or strongly agreed that in general, ISs are as effective as early ambulation in Item 10. In Item 11, the majority of nurses (88% pretest and 66% posttest) in both pretest and posttest agreed or strongly agreed that in general, ISs are as effective as deep breathing exercises. Initially, the nurses (68% pretest and posttest 56%) in both pretest and posttest agreed or strongly agreed that in general, ISs are as effective as directed coughing in Item 12.

In Item 13, all the nurses had a level of agreement in the pretest that "my education and training regarding ISs was adequate", but their level of agreement decreased following the educational session.

Regarding nurses' perspectives in patients' compliance to IS use, Item 14 indicated that many of nurses (52% pretest and 60% posttest) in both pretest and posttest agreed or strongly agreed that in general, patient IS use compliance is poor. Regardless,

Item 15, the majority of nurses (88% pretest and 76% posttest) in both pretest and posttest agreed or strongly agreed that patient IS use should improve.

Figure 4 and Figure 5 illustrate the pre and posttest response rates by the number of nurses who answered strongly disagree, agree, somewhat agree, somewhat disagree, disagree, and strongly disagree for each Item 1-15.



Figure 4. Pretest response rate Items 1-15

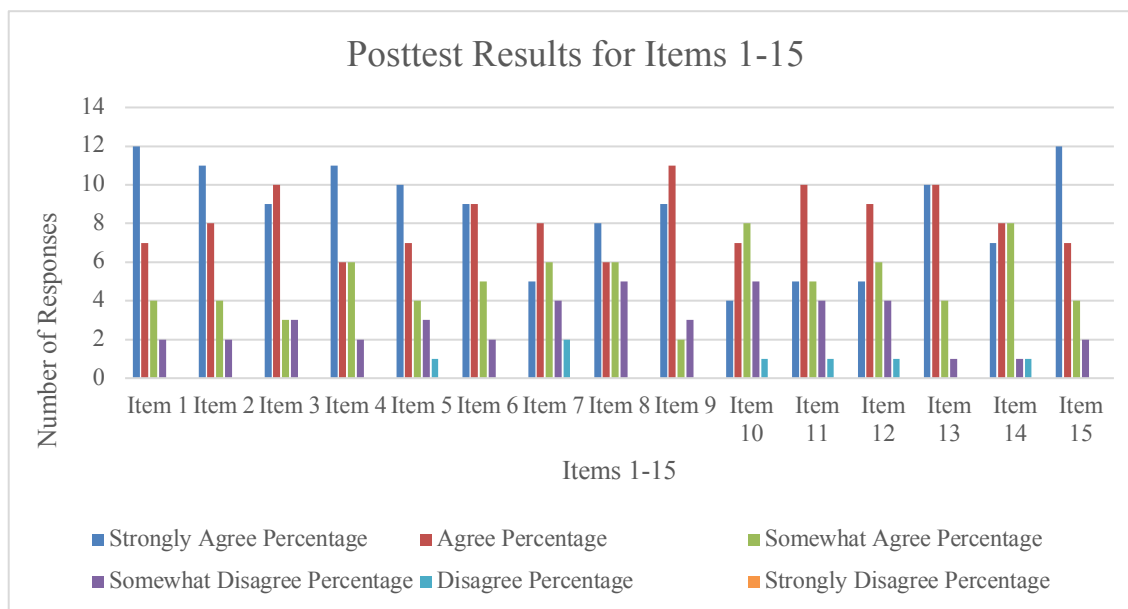


Figure 5. Posttest response rate Items 1-15

Questions 16 through 20 were all presented as open-ended questions. The topics of Questions 16-22 for this project include frequency of sessions, target inspiratory volume and rate; number of breaths per session; duration of breath holds; perioperative IS use; and graduated use procedures. The topics of questions 16-22 for this project frequency of sessions, target inspiratory volume and rate; number of breaths per session; duration of breath holds; perioperative IS use; and graduated use procedures. Most questions, 17-20 provided an indicator of numerals to guide the respondents of the lowest and highest in a range of possible responses on the technical measurements of IS. There were some questions that were answered with a range of numbers, rather than a numeral, or phrases of clinical variants rather than numbers. As described in the previous section, some questions were not answered by all participants.

However, although Question 16 asked “Ideally, how frequently should a patient use their IS?”, the tool provided did not have an indicator of a range of responses. All the

participants in this project hand-wrote responses in number of times per hour for pre and posttest, rather than actual frequency. Participants' responses remained essentially unchanged, as in times per hour, with 85% entering 10 times per hour. Because all the answers were entered as times per hour, the actual frequency could not be determined in this project.

Question 17 asked "Ideally, how many breaths should a patient take per session? Please enter a number 0-100 breaths?" Thirty six percent indicated that the ideal number of breaths was 1-5, while the remaining 64% indicated 10 breaths were ideal; the results were unchanged in the posttest.

Not all of the participants entered an answer on both tests for Question 18, "What is the ideal breath hold duration? (seconds) 0-180 seconds" Initially, 59% of those that did respond, indicated "3-5 seconds", (entering a range that would not be possible for the online version), and one-third entering 10 seconds. There was a slight increase of responses in the 3-5 seconds, with a decrease to 17% for 10 seconds, and a phrased response "as long as possible", which wouldn't be accepted in the online version.

The responses to Question 19 "What is the initial target inspiratory volume? (mL) 0-4000 mL" included numerical data as well as responses indicating variations of phrases related to the height, weight, age and/or gender of the patient. Initially 10 responses were based upon some dynamic of this, and posttest only 7. Initially, 50% that entered a numeral, responded 1500 mL, which was the median. The median changed in the post test, when 1500 mL was entered as the smallest amount by those that entered a number, about 53%, and the remainder up to 3000 mL.

Lastly, in the open-ended procedural queries, Question 20 asked “What is the ideal daily improvement in inspiratory volume? (mL) 0-4000”. Again, there were responses in both phases of the tests that were phrases rather than number, such as “varies” and “any improvements”, as well as ranges, exact numbers and no entries. Question(s) 21 and 22 each had three choices from which the participant could select. Question 21 asked “What is the most important factor for successful IS use?” Answers on the pretest were the following: achieving target inspiratory flow was 83.3%; achieving target inspiratory volume was 12.5%; and breath hold was 4.2%. Results of the posttest respectively were 48%; 24%; and 16%. There were also dual entries for flow and volume at 8%, and entries for all three factors for 4%.

Question 22 had a similar format to 21, and asked “What is the target inspiratory flow?” Answers on the pretest were the following: as slowly as possible was 16%; piston hovers in the target range (ie. in the “smiley-face” zone) was 84%. Answers changed only slightly in the posttest to 20% and 76% respectively, and an entry for both. Selections for the provided responses while as quickly as possible, and not incredibly important were null.

Question 23, the next open-ended query provided a numerical range to determine “In an average 8-hour shift, how many times do you typically remind a patient to use their IS? Please give a number. 0-480 times”. There were again entries for ranges, single numbers, and phrased response “anytime in room”. The lowest was once, but the highest number of times was 10 in the pretest and posttest, while some of these responses changed.

Likewise, Question 24, another open-ended question that should not have different responses from pre to posttest, asked, “In an average 8-hour shift, typically how much time do you spend educating or reminding a patient to use their IS? Please report in minutes. 0-480 minutes.” There were entries for ranges, single numbers, and phrased response “start of shift”. About one third reported less than 5 minutes per shift in pre and posttests, and another third reported 10 minutes in the pre, but dropped to about 20% in the post. In the post test, there was a slight increase to 15 minutes, slight decrease to 10 minutes.

The last component of the survey, Statement 25 was presented as “Patients IS use is compliance is hindered by” with a corresponding list of 16 hindrances from which the RN participants selected all that applied. The first eight hindrances were specific to patients use of the device, followed by pain and sleep factors; provider factors of time, resources and staff; as well as cognitive and language factors; and an opportunity to select “other” if applicable.

The items were ranked: patients forgetting to use IS and having too much pain was selected by 23 nurses or 92%; not understanding how, and infrequent use was chosen by 21 nurses or 84%; and 19 nurses or 76% indicating patients had not received the device. The posttest results for those participants of the educational session indicated pain response remained unchanged, 23/23 nurses agreed that pain interferes with IS use. Changes in response related to patients not using IS effectively increased from 68% to 96%. Other noteworthy changes in responses were in the category of provider factors of time 40%-56%; resources 24%-44; and staff 24%-48%.

Figure 6, Appendix G, reveals Statement 25, the number of responses from nurses who answered each question for the pretest and posttest. Again, only those tests with corresponding pretest and posttest scores were utilized.

Next, the summary and conclusions will be discussed.

Summary and Conclusions

The purpose of this project was to evaluate surgical unit registered nurses' knowledge related to incentive spirometer (IS) in the prevention of NV-HAP postoperatively. Following a comprehensive literature review on the topic of IS and the identification of a tool a quality improvement project was developed. The Logic Model Framework, developed by the Kellogg Foundation, guided this quality improvement project with a pretest, evidence-based educational session and posttest for a small sample in a local hospital.

Permission was granted by Dr. Adam E. M. Eltorai, PhD, to use his validated tool. Permission to complete the project was obtained from the surgical floor nurse manager and the ACNO, as well as the organizational Ethics Committee. The project involved human subjects and was reviewed and approved by the IRB through RIC. An informational email with an attached letter was sent to all surgical RNs on the unit discussing the project and its purpose. The letter also explained that it was voluntary and that there was no identifying demographic data collected. Consent was implied when the nurse read the informational letter, completed the anonymous tests, and attended the educational session.

The pretest was completed by each participant and was collected immediately prior to the evidence-based educational session. The session included postoperative pulmonary care, using the IS guidelines, to participating RNs who are responsible to provide IS as ordered for postsurgical patients. The posttest was then administered and collected by the project administrator. The results were compiled following the final

session by comparing the pretest to the posttest results to determine rate of completion of tests. Results were compared from pre-assessment and posttests administered to RNs.

Twenty-six out of a possible 40 surgical nurses completed the pretest, 25 of a possible 40 nurses attended the educational session and completed the posttest portion of this quality improvement project. It is noteworthy that 60% reported 0-5 years of RN experience, but it was beyond the scope of analysis of this small sample, to relate years of experience to this response. Adding the query regarding highest degree or certification may become pertinent to the purpose of a replicated program focusing on education and responses.

Following the educational session, the data for Items 1-15 indicated an overall trend towards lesser agreement, and disagreement regarding the importance, utility, effectiveness of IS to decrease atelectasis and pneumonia, and effectiveness compared to other treatments. The pretest scores ranged from 1.24 to 2.6 out of a possible 6 points for each statement, with a mean response rate of 1.88. In comparison, posttest scores ranged from 2.21 to 3.18, with a mean response rate of 2.56. The average posttest response rate increased by 0.68 points, indicating that these perspectives on the use of IS in these nurses' clinical practice could be influenced by an educational session. The results indicated that RNs' perspectives on patients' use of IS can be influenced following an educational session related to IS; however, the results showed a decrease in agreement reflecting the new knowledge of the nurses of the present evidence as it relates to incentive spirometry. These results also supported previous research findings and contribute to a body of knowledge validating nurses' need for endorsed guidelines on appropriate usage of IS to prevent postoperative pneumonia.

There was no previous published literature available related to an educational sessions that measured changes in responses for RNs regarding patients use of IS to prevent postoperative pneumonia; however, the survey measured attitudes and assessed beliefs, as an affective domain, as well as perspectives, and not knowledge, the cognitive domain of practice. There were not necessarily right, or wrong, grounded-in-evidence answers to the various items in the survey.

Despite that, the underpowered research published regarding IS presented in the educational session decreased nurses' agreement of the adequacy of their education and training related to IS. Their post responses may be indicative that the evidenced-based knowledge influenced them to alter their perception regarding the adequacy of their education and training of IS. In the Items 1-12 and Questions 16-22 which required cognitive responses, an educational session with weak evidence may have led to a decrease in their confidence in their IS education and training. More IS training as related to the prevention of NV-HAP is warranted.

A flaw in the design of the paper versions of the pre and posttests was for Question 16 specifically did not request data points. The successive Question(s) 17-20 provided data points from which respondents could select. Question 18 responses were in a range rather than actual numbers.

For Question 19, the responses regarding height, weight, age and gender were likely influenced by the facility's IS product specifications published and provided by the manufacturer in the packaging of the IS, which includes a predictive nomogram for inspiratory capacity, based upon gender, height and age. Throughout the literature

review there was no published research that identified patient characteristics such as gender, height and age related to IS use. The product manufacturer was not utilizing evidence-based metrics to guide utilization of the IS device. The facility's instructions, which the RN received prior to the recently implemented ICOUGH® program, in the use of IS, directed the RN to follow the manufacturer's instructions included in the device. Those respondents appeared to be uninfluenced to change based on content from an evidence-based educational session.

Question 20 sought the ideal inspiratory volume, did not change much from the pre and posttest. Regarding the most important factor for successful IS use, as indicated in Question 21, results of 48% for volume; 24% for flow; and 16% for breath hold. Again, for Question 22, these pre and posttest results remained somewhat consistent for target inspiratory flow rate at 76% for piston hovers in the target range, and as slowly as possible was 20%.

The responses to Question(s) 23 and 24 that appeared in pre and posttests were remarkable for the answers that changed. But because there were different entries, although not drastic, the validity of responses posed a concern. Although the results of Question 23, asking nurses how many times during an 8-hour shift is typical to remind patients to use IS, was not identified in published literature, the results of Question 24 were expanded into clinical research to calculate financial impact. During the literature review for this project and the manuscript, as well as the preparation of the educational session, published data related to the amount of time nurses spent educating or reminding patients to use their IS, previously described as Questions 23 and 24, was not available; however, following that session, the results of the national survey, and the information

cultivated, led researchers towards additional evidence-based knowledge. In this program, the discrepancies in the time reported by nurses on the pre and posttests, in estimations of minutes spent reminding or educating patients on the use of IS were not always consistent, a limitation that wasn't identified in published literature may be a bias in reporting.

Previously reported results for Item 15 indicated that these participants agreed that patient adherence was poor and patient compliance should be improved. In Statement 25 forgetting to use their IS was ranked high in pre and posttests. Ineffective use increased from 68% to 100% following the educational session which indicated that nurses determined that patients weren't using the device properly. Based upon these responses, reminders would be necessary, along with proper instructions and at frequent intervals in attempt to improve adherence, frequency and proper use.

Utilizing a validated tool provided an advantage. The comprehensive survey components previously prioritized by the authors of the tool were properly formatted for queries. The tool was replicated in its entirety. The results from the national survey were compiled into three separate articles. However, assimilating a small amount of data from the Items, Questions and Statement of 25 responses into one manuscript provided a challenge. The results pre and posttest from Item(s)1-15 and Statement 25 were viewed in charts. Questions 16-20 requested a numerical answer, but some respondents hand-wrote a variety of entries in ranges, thus the data points as well as specific patient characteristics, which could not be demonstrated on a chart. The most prominent theme was the responses to Question 19 regarding the patient characteristics of age, height and

gender. These responses may be reflective of the inconsistent evidence described in published research.

Recommendations of smaller data points for future replications of this tool may facilitate identification of key information. The replication of a specific portion of the validated tool, based upon the purpose of the study, and administered online as it was intended by the national study, may eliminate some of the problems posed by the paper version of the survey. The online-administered tool was not reformatted in any way, other than it was completed on paper, which was previously described in the results section. The handwritten responses that included ranges, and phrases was a limit to reporting some of the results; however, it did yield valuable information regarding the RN responses related to the facility IS product informational insert regarding the use of the predictive nomogram. Because this is the only available metric for RNs to use at the facility level, there is evidence that it is utilized based upon these responses.

Limitations of the project included a small sample, recruiting participation from peers, not all participants answered every question, and the project occurred during work time. If this program is replicated, scheduling the session away from the patient care unit, when nurses do not have patient care assignments may be beneficial. In addition, a larger sample with inclusion of an educational session between pre and posttests while administering the entire program online may yield information that was not possible from a homogeneous sample. Beyond the scope of this project was a comparison of the results to those obtained by the national survey, which may further contribute to knowledge. Lastly, there was no post educational session evaluation provided to the participants.

More research is required to determine the future utility of IS for postoperative care that focuses on patient compliance and adherence, and nurses' interactions with patients for reminding and educating them to use their IS. The results demonstrated that education on prevention of postoperative complications has an effect on nursing knowledge, attitudes, perspectives. The RNs knowledge of the evidence as it relates to IS increased exemplified by the mean average towards the disagreement. Educating the RN administering the IS and those who educate the patients who are using the IS in an organized manner with policies and procedures that identify the indications and metrics for patients' use of IS, documentation parameters, and outcomes is one intervention to determine the effects on a preventable complication such as postoperative pulmonary complications. Future trainings based on evidence as it emerges may contribute to nursing practice that has a positive impact on patient outcomes related to the use of IS for perioperative patients for prevention of pneumonia.

Lastly, recommendations and implications for advanced practice will be discussed.

Recommendations and Implications for Advanced Nursing Practice

The advanced practice registered nurse (APRN) is in a unique position to enact a myriad of roles that improve patient outcomes. APRNs act as change agents in the important research needed for evidence-based practice regarding IS. Certified Adult Gerontology Acute Care Nurse Practitioners have the opportunity to function as local researchers, scholars, educators, health care providers, role models, influencers of quality improvement, administrators and business leaders.

Local researchers in healthcare facilities and academic centers of excellence in New England, and Providence, Rhode Island have received funding for cutting-edge research to determine factors associated with costs, effectiveness, compliance as well as roles and responsibilities of nurses in patient care delivery associated with IS. In addition, APRNs can lead research or participate with other researchers in receiving funding for new research related to IS and participate in the critical review and revision of manuscripts, which disseminate research findings (Eltorai, Szabo, et al., 2018).

In the translation of research to practice, faculty, nurse researchers and scholars can participate in the academic education of entry-level nurses and APRNs, on the clinical application of IS and bundles of care for prevention of postoperative pulmonary complications. Presentation of evidence-based educational sessions aimed at changing attitudes, knowledge, or practice to nurses via on-line continuing education sites, live conferences, orientation, in-service and annual competencies on agency policy and procedures, may further enhance healthcare to adult and geriatric hospitalized operative

patients. Patient educators can design a standardized format for nurses to efficiently educate patients on the most effective use of IS.

APRNs providing healthcare as members of interdisciplinary teams are responsible to triage and diagnosing a diverse patient population. According to primary prevention, the APRN is responsible for identifying patients at risk for pneumonia, monitoring vaccine status, surveying for signs of postoperative atelectasis, observing changes in health status, ordering appropriate diagnostic exams, and assist in tertiary prevention for complex critically ill patients diagnosed with NV-HAP. The balance between missed care and overtreatment must be maintained. Treatment such as IS has low level of evidence for the prevention of postoperative pneumonia and may be considered a costly overtreatment.

APRN can solicit nurses' views on important topics such as IS use and interpret findings that improve patient outcomes. For example, in this survey 23/23 respondents indicated that pain hindered patients' compliance with the use of IS. APRN optimizes pain management to achieve pulmonary hygiene. In addition, quality improvement projects, such as the use of IS, should be implemented with cost-effective parameters identified and monitored for control of spending. The utilization of the logic model may facilitate implementation of future improvement-based programs.

Another example of quality improvement related to IS use and nurses' roles may include a survey completed following the nurses' shifts. Both nurses' estimations of times and bias in reporting should be a consideration if implementing a post-shift survey related to nurses reporting times of reminding or educating patients in the use of

IS. APRNs would facilitate as a member of a leadership team implementing organizational change.

The APRN's influence in changing the electronic medical record (EMR) to include valuable data regarding care provided as it relates to IS use would be instrumental. Documentation access related to IS for RTs, healthcare providers, and nurses according to who is responsible to set the metrics needs to be identified. The frequency of IS use, breaths per session, ideal breath hold duration, initial target inspiratory volume, daily improvement in inspiratory volume and expected duration of the use of IS could begin by commencing the use of IS in the preoperative period, when the target volume is identified. The addition of a checkbox to indicate that the patient was reminded to use their IS or the patient was educated to use their IS would validate these activities. This allows for continuous monitoring and documentation throughout hospitalization. This data could contribute to prospective research to determine data points for cohorts of patients. In addition, a change in policy and procedures would require an improvement model such as the logic model to guide implementation.

Nursing administrators are responsible to ensure that nurses have safe therapeutic policies and procedures to guide care. For example, a majority of nurses in this survey reported that patients didn't receive their IS. Responsibility of initial IS assessment described above ensures that the patient receives the IS. The RT or RNs role delineations and the documentation requirements contribute to standards of care. Materials managers working with nursing leaders can ensure a delivery system of devices to patient care units. Changes in policies and procedures would again be led by APRNs in leadership, clinical, educational and health care provider roles.

APRNs can positively affect change for patient care delivery while advocating for only those interventions that are evidence-based. Quality improvement projects should be aimed at all members of the health care team that interface with issues related to IS, using validated tools such as the logic model, and survey tools such as the one presented in this project. Patient use of IS has not been entered in standardized format in the EMR. Published research which reflects actual patient IS use and its effectiveness in prevention of NV-HAP is a recommendation for future research to determine the role of IS in preventing postoperative pulmonary complications. The APRN can identify evidence while actively participating in the care to ensure improved outcomes of patients.

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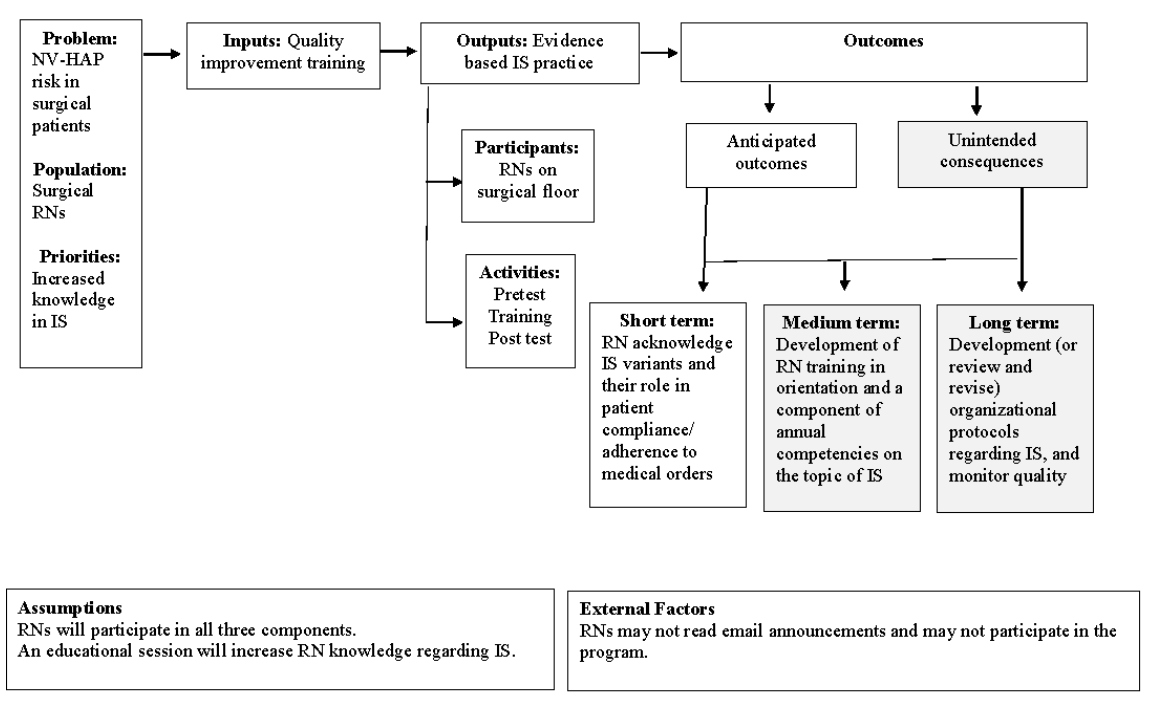
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Figure 1

Figure 1. Logic Model: Evaluating RN knowledge related to incentive spirometry



(Templates, Examples, Bibliography, 2018)

Appendix A

September 5, 2018

Melissa Gaffney, BSN,
RN363 Highland Ave
Fall River, Massachusetts 02720

RE: Implementing Incentive Spirometry in Adult Hospitalized Postoperative Patients: A Quality Improvement Project

Dear Ms. Gaffney:

The Clinical Research Office of Southcoast Health received the request for the above referenced project that you would like to conduct within the Southcoast Health System. The Clinical Research Office (CTO) reviewed the information submitted with the Nursing Administration and has endorsed this clinical trial.

Southcoast does not have an internal IRB and therefore an external Central IRB listed on our Federal Wide Assurance (FWA) must be used. Southcoast Hospitals Group assurance number is FWA00009571.

You have chosen to use the Rhode Island College (RIC) Review Board as your governing IRB. Please submit a copy of this letter from the Southcoast Clinical Trials Office along with your study submission forms to RIC for their approval of the trial.

Rhode Island College Review
Board 600 Mount Pleasant Ave.
Providence, RI. 02903

Please provide the Clinical Trials Office with a copy of the RIC approval/disapproval letter for the study when it is received. If you have any questions, please contact me at 508-973-7428 / isdaled@southcoast.org

Sincerely,

debra Isdale

Debra G. Isdale
Clinical Research Program Director
Southcoast Health

CHARLTON MEMORIAL HOSPITAL

ST. LUKE'S HOSPITAL

TOBEY HOSPITAL

363 Highland Avenue, Fall River MA 02720 101 Page Street, New Bedford MA 02740 43 High Street, Wareham MA
02571 508-679-3131 508-997-1515 508-295-0880

Appendix B

Greetings,

The proposal for the project referenced below has been determined to be NOT HUMAN SUBJECTS RESEARCH BUT A QUALITY IMPROVEMENT PROJECT BY the Institutional Review Board (IRB).

Project title: Registered Nurses' Knowledge of Pneumonia Prevention Implementing Incentive Spirometry in Adult Hospitalized Postoperative Patients: A Quality Improvement Project

Approval #: 1819-1739

Type of review: Not Human Subjects Research

Proposal type: Original

Principle Investigator: Hodne, Melinda

Fees received: 1. No fees -- RIC supervised or sponsored

Funding status:

Click here to access the protocol:

<https://ric.topazti.net/RIC/SL/Default.aspx?linkParms=NPqkQNfZcnV14LxrX%2b9WGg%3d%3d>

Do not reply to this "RIC_Elements" email address because it will not be received by the IRB. Send all correspondence to IRB@ric.edu.

Best Regards,

Emily Cook, Ph.D.
Associate Professor
Chair, IRB
Rhode Island College
IRB@ric.edu

Appendix C

Email Announcement

Hello,

As many of you may know, I am matriculating in the Adult Acute Care/Geriatric Nurse Practitioner program at Rhode Island College. Part of my course work includes the proposal and development of a master's major project, and completion during my final semester. I am excited to inform you that I have selected the use of incentive spirometer (IS).

I plan to perform a quality improvement project, my intention is to determine the RN's level of knowledge of IS, followed by an educational session of effective patient education and interventions aimed at the prevention of postoperative pneumonia. I will administer a pretest and a posttest to measure. Please find attached a letter of intent.

I plan on presenting the following dates:

1/13/19 @ 11:00

1/13/19 @ 19:00

1/14/19 @ 03:00

1/19/19 @ 03:00

1/19/19 @ 11:00

1/19/19 @ 19:00

Thank you in advance for participating.

Thank you,

Melissa Gaffney, BSN, RN

508.340.0088

Appendix D

Informational letter

Dear Atwood 3 Surgical Nurses,

You are being asked to participate in a quality improvement project. The purpose of this project is to evaluate and educate RNs' related to IS in the prevention of NV-HAP postoperatively. The RN who has the knowledge, skills and ability to implement IS, may facilitate pulmonary care interventions for adults undergoing surgery.

All volunteers must be employed on the surgical unit as per-diem, part time and full-time registered nurses who have completed orientation. If you wish to participate, you will be asked to attend a 15-minute educational program, along with the completion of both a twenty-five question pre-test and post-test, anticipated to take 5 minutes each to complete.

There are no questions which should cause you discomfort. Taking part in this project is completely voluntary, if you do not want to complete either test or attend the educational program, you are free to choose not to and may withdraw participation at any time. If you do choose to participate, this project may increase your knowledge regarding incentive spirometer in the postoperative patient. The questionnaires from this project will be kept confidential and anonymous, and none of the information you provide will have your name or other identifying information on it. You will only be asked to indicate your mother's maiden name initials and father's birth month, which will be used for data collection. The tests will be placed in an envelope and test responses will be kept anonymous. The program developer, Melissa Gaffney will be the only one to have access to the test results.

Should you have any questions about this quality improvement project, please feel free to contact Melissa Gaffney, mgaffney_6819@email.ric.edu or 508-340-0088. You may also contact the principal investigator Melinda Hodne at mhodne@ric.edu or 401-456-9041.

Thank you for your consideration in participating in this program.

Sincerely,

Melissa Gaffney, BSN, RN

Master's Student Program Developer

Rhode Island College

Appendix E

Perspectives on Incentive Spirometry

Pre test
mother's maiden name initials
and father's birth month: _____

Perspectives on Incentive Spirometry

We are interested in understanding nurses' perspectives on the use of incentive spirometry in their clinical practice. The purpose of this research is to explore nurses' understanding of incentive spirometry, how incentive spirometry impacts workload and barriers to patient adherence to incentive spirometry use. Your feedback is important and will enable us to develop a deeper understanding regarding incentive spirometry use in patient care. All responses will remain anonymous. The survey should not take more than 5 minutes to complete. Thank you for your time and participation.

Please indicate your position

- Nurse
- Respiratory Care Practitioners

reset

Years in practice

Primary practice location

Please mark one box indicating your level of agreement with the following statements:

	Strongly agree	Agree	Somewhat agree	Somewhat disagree	Disagree	Strongly disagree	
Incentive spirometers (ISs) are essential for patient care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
ISs improve pulmonary function	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs improve inspiratory capacity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs help prevent atelectasis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs help reverse atelectasis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs help prevent pneumonia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs help reverse pneumonia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs should be used routinely preoperatively	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset

Perspectives on Incentive Spirometry

ISs should be used routinely postoperatively	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
In general, ISs are as effective as early ambulation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, ISs are as effective as deep breathing exercises	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, ISs are as effective as directed coughing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
My education and training regarding ISs was adequate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, patient IS use compliance is poor.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, patient IS use compliance should be improved.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset

Ideally, how frequently should a patient use their IS?

Ideally, how many breaths should a patient take per session?
Please enter number

Please enter a number 0-100 breaths

What is the ideal breath hold duration? (seconds)

0-180 seconds

What is the initial target inspiratory volume? (mL)

0- 4000 mL

What is the ideal daily improvement in inspiratory volume? (mL)

0- 4000 mL

Perspectives on Incentive Spirometry

Which is the most important factor for successful IS use?

- Achieving target inspiratory flow
- Achieving target inspiratory volume
- Breath hold

reset

What is the target inspiratory flow rate?

- As slow as possible
- As quick as possible
- Piston hovers in the target range (i.e., in the "smiley-face" zone)
- Not incredibly important

reset

In an average 8-hour shift, how many times do you typically remind a patient to use their IS? Please give number.

0-480 times

In an average 8-hour shift, typically how much time do you spend educating or reminding a patient to use their IS? Please report in minutes.

0-480 minutes

- ... patients not understanding how to use their ISs
- patients not receiving ISs
 - patients not using their ISs frequently enough
 - patients not using their ISs effectively
 - patients not using their ISs long enough
 - patients being unable to reach their ISs
 - patients having too much pain
 - sleep interference
 - providers not having enough time to work with patients on IS use
 - providers having too limited resources to work with patients on IS use
 - having too few staff to work with patients on IS use
 - patient cognitive status
 - patient language barrier
 - other: _____

Comments?

Expand

Submit

Post test
mother's maiden name initials
and father's birth month: _____

Perspectives on Incentive Spirometry

We are interested in understanding nurses' perspectives on the use of incentive spirometry in their clinical practice. The purpose of this research is to explore nurses' understanding of incentive spirometry, how incentive spirometry impacts workload and barriers to patient adherence to incentive spirometry use. Your feedback is important and will enable us to develop a deeper understanding regarding incentive spirometry use in patient care. All responses will remain anonymous. The survey should not take more than 5 minutes to complete. Thank you for your time and participation.

Please indicate your position

- Nurse
- Respiratory Care Practitioners

reset

Years in practice

Primary practice location

Please mark one box indicating your level of agreement with the following statements:

	Strongly agree	Agree	Somewhat agree	Somewhat disagree	Disagree	Strongly disagree	
Incentive spirometers (ISs) are essential for patient care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
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ISs help prevent atelectasis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs help reverse atelectasis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs help prevent pneumonia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs help reverse pneumonia	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
ISs should be used routinely preoperatively	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset

Perspectives on Incentive Spirometry

ISs should be used routinely postoperatively	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
In general, ISs are as effective as early ambulation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, ISs are as effective as deep breathing exercises	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, ISs are as effective as directed coughing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
My education and training regarding ISs was adequate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, patient IS use compliance is poor.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset
In general, patient IS use compliance should be improved.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	reset

Ideally, how frequently should a patient use their IS?

**Ideally, how many breaths should a patient take per session?
Please enter number**

Please enter a number 0-100 breaths

What is the ideal breath hold duration? (seconds)

0-180 seconds

What is the initial target inspiratory volume? (mL)

0- 4000 mL

What is the ideal daily improvement in inspiratory volume? (mL)

0- 4000 mL

Perspectives on Incentive Spirometry

Which is the most important factor for successful IS use?

- Achieving target inspiratory flow
- Achieving target inspiratory volume
- Breath hold

reset

What is the target inspiratory flow rate?

- As slow as possible
- As quick as possible
- Piston hovers in the target range (i.e., in the "smiley-face" zone)
- Not incredibly important

reset

In an average 8-hour shift, how many times do you typically remind a patient to use their IS? Please give number.

0-480 times

In an average 8-hour shift, typically how much time do you spend educating or reminding a patient to use their IS? Please report in minutes.

0-480 minutes

Perspectives on Incentive Spirometry

Please mark all boxes that apply to the following statement.
Patient IS use compliance is hindered by

- patients forgetting to use their ISs
- patients not knowing when to use their ISs
- patients not understanding how to use their ISs
- patients not receiving ISs
- patients not using their ISs frequently enough
- patients not using their ISs effectively
- patients not using their ISs long enough
- patients being unable to reach their ISs
- patients having too much pain
- sleep interference
- providers not having enough time to work with patients on IS use
- providers having too limited resources to work with patients on IS use
- having too few staff to work with patients on IS use
- patient cognitive status
- patient language barrier
- other: _____

Comments?

Expand

Submit

Appendix F

▶ Incentive Spirometer Evidence-Based Practice

- ▶ Melissa Gaffney, BSN, RN
 - ▶ Rhode Island College
 - ▶ Adult-Gerontology Acute Care
 - ▶ Nurse Practitioner Student
-
- ▶ All volunteers must be employed on the surgical unit as per-diem, part time and full-time registered nurses who have completed orientation. If you wish to participate, you will be asked to attend a 15-minute educational program, along with the completion of both a twenty-five question pre-test and post-test, anticipated to take 5 minutes each to complete.
 - ▶ There are no questions which should cause you discomfort. Taking part in this project is completely voluntary, if you do not want to complete either test or attend the educational program, you are free to choose not to and may withdraw participation at any time. If you do choose to participate, this project may increase your knowledge regarding incentive spirometer in the postoperative patient. The questionnaires from this project will be kept confidential and anonymous, and none of the information you provide will have your name or other identifying information on it. You will only be asked to indicate your mother's maiden name initials and fathers birth month, which will be used for data collection. The tests will be placed in an envelope and test responses will be kept anonymous.
-
- ▶ **Background**
 - ▶ Pneumonia: lung infection caused by bacteria or viruses
 - ▶ 2011: CDC \approx 157,500 cases of hospital-acquired pneumonia (HAP)
 - ▶ Nonventilator hospital-acquired pneumonia (NV-HAP) \approx 61% of HAP
 - ▶ \uparrow Costs due to \uparrow LOS, morbidity and mortality associated with NV-HAP and ventilator-associated pneumonia (VAP) compared to nonhospital pneumonias.
 - ▶ PA: NV-HAP \approx \$156 million; VAP \approx \$86 million for VAP
 - ▶ Mortality: 13.9% -30 % for NV-HAP

- ▶ ↑ incidence of NV-HAP but disproportionate and limited research on prevention on NV-HAP

▶ **Prevention of Postoperative NV-HAP**

- ▶ Oral care
- ▶ ↑ HOB 30-40 degrees
- ▶ Mobility
- ▶ Use of incentive spirometry
- ▶ Deep breathing and coughing exercises
- ▶ Research demonstrated these interventions alone do not prevent NV-HAP, however together as a bundle may have greater effect on prevention of postop pneumonia.

▶ **Postop Pulmonary Complications**

- ▶ Postop pulmonary complications: 2–39%
- ▶ Atelectasis
- ▶ Pneumonia
- ▶ Respiratory failure
- ▶ Thoracic surgery and abdominal surgery associated with increased risk
- ▶ Preop and postop respiratory therapy goals: prevent or reverse atelectasis; improve airway clearance
- ▶ Risk and severity: reduced by therapy that increases lung volume
- ▶ IS: routine periop respiratory therapy strategies to prevent or treat complications
- ▶ IS: designed to mimic natural sighing or yawning by encouraging the patient to take long, slow, deep breaths
- ▶ Effect: decreased pleural pressure, increased lung expansion and better gas exchange
- ▶ IS exercise: repeat regularly to prevent or reverse atelectasis
- ▶ **IS: clinical efficacy remains controversial of routine clinical periop prophylactic and therapeutic regimen**

▶ **IS Recommendations**

Grading of Recommendations Assessment, Development, and Evaluation (GRADE) scoring system

- ▶ Alone NOT recommended routinely in preop/postop to prevent postop pulmonary complications (1B)
- ▶ IS with deep breathing techniques, directed coughing, early mobilization, & optimal analgesia to prevent postop pulmonary complications (1A)
- ▶ Similar benefits as deep breathing exercises in the preop/postop setting to prevent postop complications (2C)
- ▶ NOT recommended for postop upper-abdominal surgery to prevent atelectasis (1B)
- ▶ NOT recommended for postop coronary artery bypass graft surgery to prevent atelectasis (1A)
- ▶ IS device: volume-oriented device (2B)

▶ **Patient use of volume incentive spirometer**

- ▶ Sit on the edge of the bed if possible, or sit up as far as possible in the bed
- ▶ Hold IS in an upright position
- ▶ Place the mouthpiece in mouth and seal lips tightly around it
- ▶ **Breathe in slowly** and as deeply as possible; observe the rising indicator toward the top of the column. The indicator should reach the goal-outlined area.
- ▶ Hold breath as long as possible, exhale slowly, allow the indicator to fall to the bottom of the column
- ▶ **Rest for a few seconds**, repeat above steps at least 10 times every hour
- ▶ Position the indicator on the left side of the spirometer to show best effort, use the indicator as a goal to work toward during each slow deep breath
- ▶ Cough after each set of 10 deep breaths to clear lungs
- ▶ If applicable: splint incision with a pillow when coughing
- ▶ OOB order: safely get out of bed, take frequent walks, practice the cough

▶ **Alternate Procedure**

- ▶ IS (aka sustained maximal inspiration): use of a device providing feedback of inhalation at a predetermined flow or volume, and sustained for at least 5 seconds
- ▶ Instruct patient to hold the IS in an upright position, exhale normally, place the lips tightly around the mouthpiece
- ▶ Next: a slow inhalation to raise the ball (flow-oriented) or the piston/plate (volume-oriented) in the chamber to the set target
- ▶ At maximum inhalation remove mouthpiece, hold breath and normal exhalation.
- ▶ Instruct health caregivers in IS use to facilitate appropriate use and compliance

▶ **ICOUGH**

- ▶ Southcoast Health ICOUGH bundle
- ▶ I- Incentive Spirometer
- ▶ C- Cough and breathe deeply
- ▶ O- Oral care
- ▶ U- Understand ICOUGH practices
- ▶ G- Get moving
- ▶ H- Head of bed elevation

▶ **IS limitation of evidence**

- ▶ IS: effectiveness dependent on patient selection, careful instruction, and supervision during respiratory training
- ▶ IS training and self-administration: may result in lack of resolution of postoperative complications
- ▶ IS: with or without respiratory therapy may have similar clinical outcomes
- ▶ IS: with or without preop and postop deep breathing exercises, directed cough, early mobilization, and optimal analgesia is effective in preventing or

reversing complications after **thoracic, cardiac, abdominal, and peripheral surgeries in obese adults**

- ▶ IS: evidence is lacking for benefits in reducing pulmonary complications and in decreasing the negative effects on pulmonary function in **CABG patients**
- ▶ IS: not associated with significant improvements of inspiratory capacity prior **to laparoscopic bariatric surgery**; may not be useful to prevent postop decrease in lung function
- ▶ IS: no significant difference between deep breathing with directed cough in prevention of postop pulmonary complications following **esophagectomy**
- ▶ IS: may not be as effective as intrapulmonary percussion ventilation in preventing atelectasis in patients with **neuromuscular disease**
- ▶ **IS evidence: strongly suggests that IS alone may be inappropriate to prevent or treat postoperative complications**

- ▶ **Contraindications for IS**
 - ▶ Cognitive: who cannot be instructed or supervised of appropriate use
 - ▶ Cooperative: uncooperating or unable to demonstrate proper use
 - ▶ Developmental: young patients or developmental delays
 - ▶ LOC: confused/delirious, heavily sedated or comatose

- ▶ **Clinical personnel competencies for IS**
 - ▶ Implement standard precautions per CDC
 - ▶ Effective use of evidence for clinical application of IS
 - ▶ Instruct patient in proper technique
 - ▶ Respond appropriately to adverse effects
 - ▶ Identify need for therapy, response to therapy, and need to discontinue ineffective therapy
 - ▶ Monitor patient use periodically

- ▶ **IS Frequency**

Evidence is lacking for a specific frequency for use of IS.

Clinical trials suggestions have included:

- ▶ 10 breaths every 1-2 hours while awake
- ▶ 10 breaths, 5 times a day
- ▶ 15 breaths every 4 hours
- ▶ After proper instruction and return demonstration, the patient should be encouraged to perform IS independently.

▶ **Conclusion**

- ▶ There are discrepancies in the literature
- ▶ Further research is needed
- ▶ Evidence regarding patient adherence is not available

▶ **Thank you**

- ▶ Thank you for your participation.
- ▶ Question
- ▶ Comments
- ▶ Concerns

Appendix G

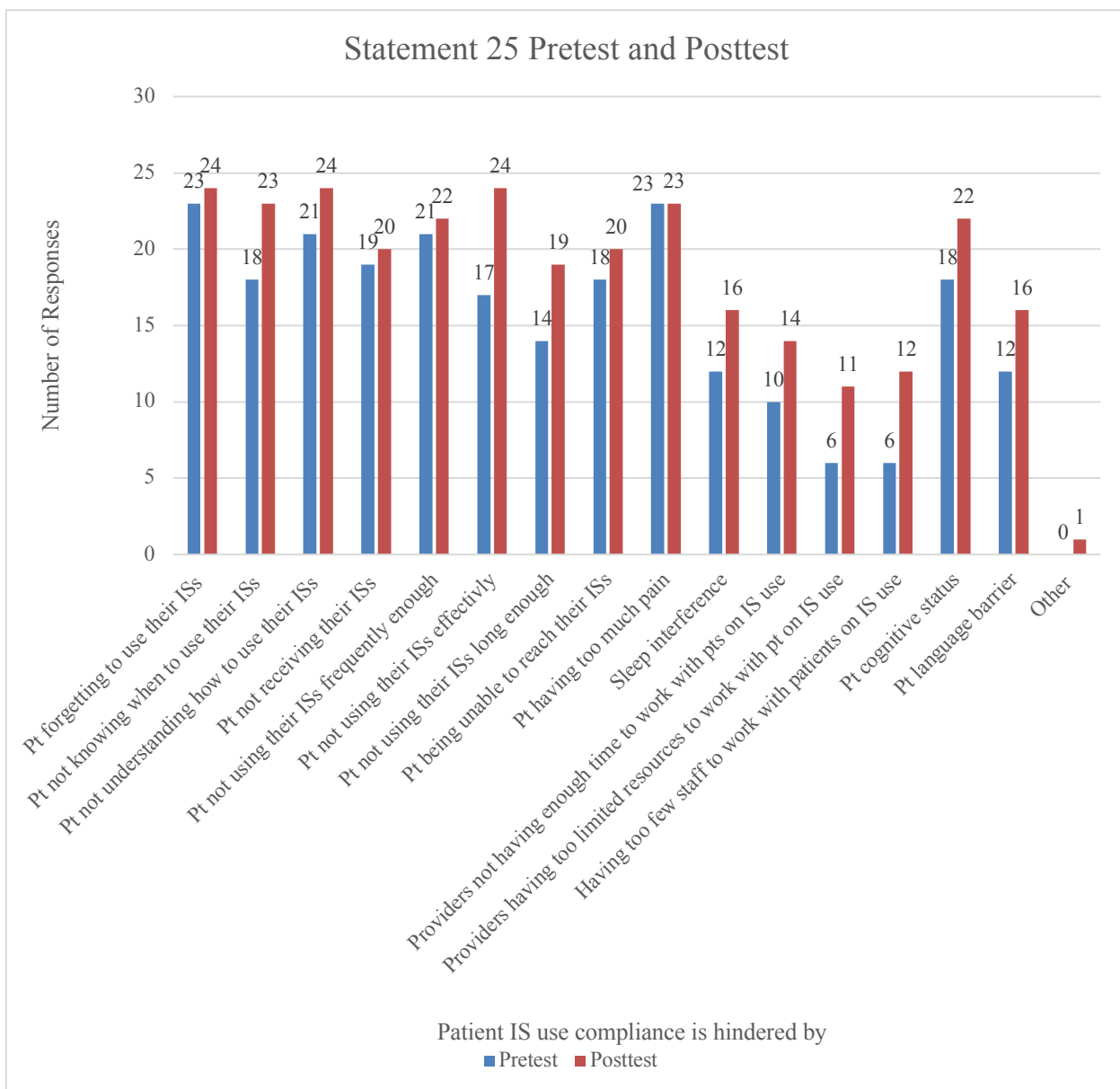


Figure 6. Pre/Post Test Statement 25 Completion Comparison