

Prevention of Hospital-Acquired Pneumonia: An Integrative Review

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Abstract

Background: Hospital-acquired pneumonia (HAP) not only brings about physical challenges to patients that can lead to death, it also involves financial burdens. Research on how to prevent HAP is a necessity; however, a deficit exists in research concerning prevention of non-ventilator hospital-acquired pneumonia (NV-HAP). The purpose of this study is to synthesize the current research on the nurse's role in prevention of NV-HAP, identify where additional research is needed, and suggest clinical standards of care to prevent pneumonia in hospitalized patients.

Methods: Data for this integrative review was collected from the following databases: PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), GoogleScholar, Cochrane Register of Controlled Trials, MEDLINE, and OneSearch. An interview with a local hospital registered nurse was conducted.

Results: Four different categories of interventions were researched and the results were synthesized. Oral care, the early mobility bundle and isolation rooms were found to significantly decrease the occurrence of NV-HAP. Incentive spirometry, on the other hand, was not found to effectively decrease NV-HAP.

Discussion: While oral care, early mobility and isolation rooms were all found to significantly reduce the occurrence of NV-HAP, these interventions are most effective when the health care workers carrying them out are educated on properly performing each intervention.

Conclusion: Enhanced oral care and enhanced mobility should be primary interventions for the prevention of NV-HAP, while incentive spirometry should be considered a secondary intervention. More research is needed to be conclusive on the effectiveness of incentive spirometry and isolation rooms.

Prevention of Hospital-Acquired Pneumonia: An Integrative Review

The Center for Disease Control and Prevention (CDC) estimates that about 1 in 25 patients has or will acquire a healthcare-associated infection (HAI) during their hospital stay (“Healthcare-associated Infections,” 2014). In 2011, it was estimated by the CDC that there were 721,800 cases of HAI in the United States of which approximately 75,000 of those patients died while in the hospital (“Healthcare-associated Infections,” 2014). Pneumonia and surgical site infection are the leading types of HAI, and pneumonia alone accounted for approximately 157,000 of HAI cases in 2011 (“Healthcare-associated Infections,” 2014). According to Quinn (2013), there are no current requirements for monitoring occurrences of non-ventilator hospital-acquired pneumonia (NV-HAP). This suggests that the statistics of NV-HAP reported could be much lower than actual cases experienced. Hospitals are responsible to absorb the cost of treatment for HAI’s, since the infection is presumed to be a result of negligence. HAI’s cost U.S. hospitals approximately \$28.4 to \$33.8 billion U.S. dollars per year (Scott, 2009). Pneumonia is also associated with indirect costs to the patient such as lost wages, short and long term morbidity and mortality (Scott, 2009). Families also experience the indirect costs of time and income due to frequent hospital visits (Scott, 2009). Due to the large financial burden as well as the injury HAP causes patients and hospitals, knowledge about prevention of HAP must be obtained. A large pool of research exists investigating the prevention of ventilator-acquired pneumonia (VAP); however, there is a deficit in research regarding prevention of NV-HAP.

This study will address the question, in hospitalized patients (P), how do oral care, early mobility, incentive spirometry and isolations rooms (I) compare to current standards of care (C) in effectively preventing NV-HAP (O)?

Purpose

The purpose of this integrative review is to synthesize the current research about the nursing role in NV-HAP prevention, identify areas where additional research is needed, and suggest evidence-based clinical standards of care to successfully prevent pneumonia in hospitalized patients.

Conceptual Framework

Table 1. Conceptual Definitions of Interventions Researched

Intervention	Conceptual Definition
Oral Care	Mouth care including but not limited to brushing of the teeth, swabbing of the mouth, and rinsing with an oral rinse
Early Mobility Bundle	Patient's activity level is progressively increased. Exercise activity time and distance are increased during treatment. Includes education of staff to promote intervention
Isolation Rooms	Private room that does not share ventilation with hospital
Incentive Spirometry	Device used to encourage deep breathing and improve lung function

Table 2. Definitions of Terms and Acronyms Used

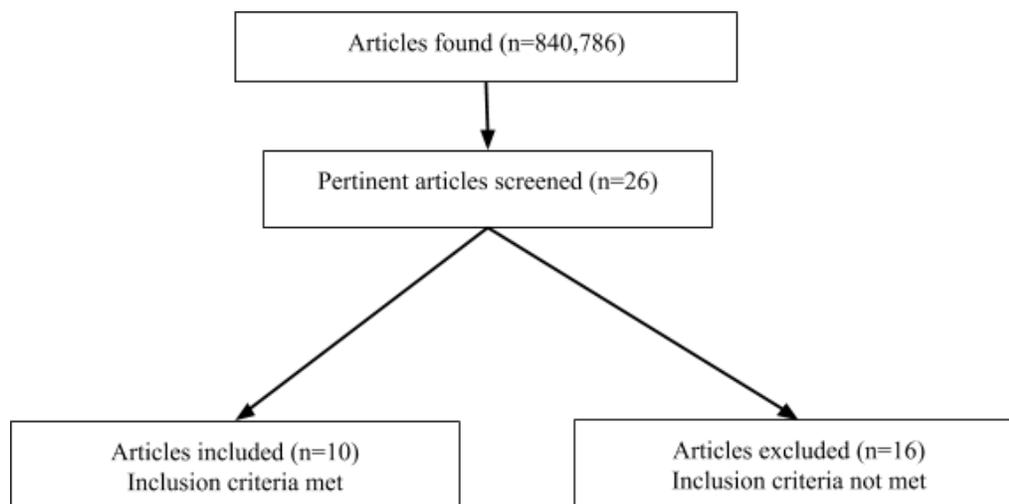
APACHE II	Acute Physiology and Chronic Health Evaluation II
Aspiration pneumonia	Pneumonia that occurs from breathing in bacteria that has colonized on the teeth
Bundle	Multiple specific interventions that are grouped together
HAP	An infection of the lungs that occurs within 48 hours of admission to the hospital

Nosocomial	Hospital-acquired
Post-operative pulmonary complications	Includes pneumonia, atelectasis, pulmonary function, and oxygenation

Methods

Databases searched for this review included PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), GoogleScholar, Cochrane Register of Controlled Trials, MEDLINE, Center for Disease Control (CDC), and OneSearch. Keywords used included various forms of “prevention”, “hospital-acquired”, “pneumonia”, “deep-breathing”, “nosocomial”, and “pulmonary function.” The inclusion criteria set for this integrative review were: articles published between 2009-2014, and a focus on NV-HAP. Exclusion criteria were: articles published before 2009, and a focus on community-acquired pneumonia or VAP. Figure 1 below outlines how research was narrowed down to ten articles by relevancy.

Figure 1. Article Search Process Diagram



Nursing Interview

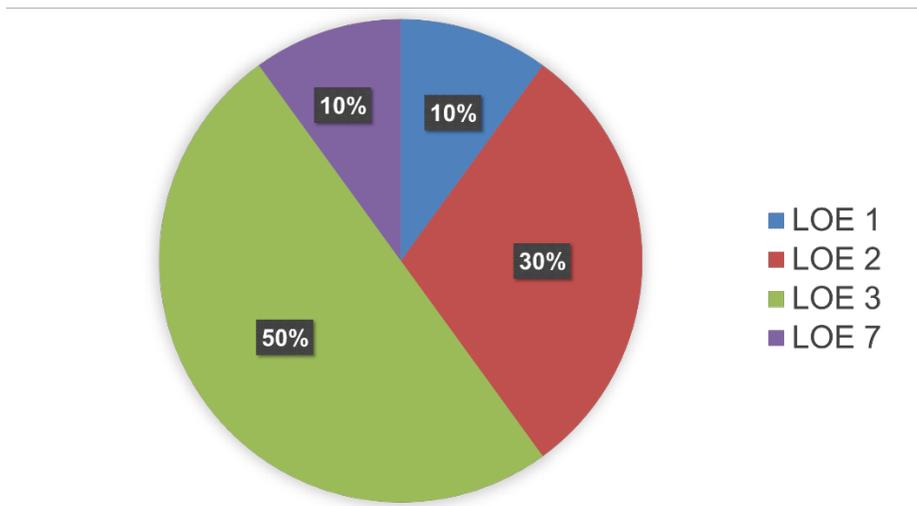
A local registered nurse at Springfield Regional Hospital was interviewed concerning existing hospital protocol for preventing NV-HAP (A. Gillaugh, personal communication,

November 10, 2014). The nurse reported that Springfield Regional Hospital protocol did not specifically address NV-HAP. Protocol for VAP prevention included oral hygiene, mobility, cough and deep breathing, and use of incentive spirometry.

Results and Findings

Our search yielded many articles, of which we narrowed it down to ten that fit the study criteria. The majority of articles included had a level of evidence of 3 or greater as indicated by Figure 2 below. Reference the table in Appendix A for synthesis of research findings.

Figure 2. Level of Evidence (LOE) of Articles Cited



Oral Care

Oral care was found to be a beneficial treatment in four studies. Robertson and Carter (2013) found that there was a significant reduction in HAP with the patients who received Enhanced oral care (EOC) as compared to those that received standard oral care (SOC). EOC for this study involved: changing mouth suction equipment every 24 hours, mouth assessment every 2-4 hours, brushing teeth every 12 hours, oral rinse solution every 2-4 hours as well as a few other protocols. The researchers found that the percentage of HAP in hospitalized patients dropped by more than three-quarters from 25.5% to 6.3% with EOC.

In their randomized control trial, Seegers, Speekenbrink, Ubbink, van Ogtrop and de Mol (2006) found that consistent cleansing of the nasopharynx and oropharynx with chlorhexidine gluconate significantly reduced the incidence of nosocomial infection. Lower respiratory tract infections, such as pneumonia, were found to have one of the greatest reductions in occurrence dropping from 15.8% to 9.3% with treatment. The length of hospital stay for patients who received consistent application of chlorhexidine gluconate was reduced to 9.5 days as compared with that of those who did not receive the routine treatment who had a 10.3 day average hospital stay.

In a third research article, Quinn et al (2013) found that education of staff on oral hygiene and thus implementation of enhanced basic oral nursing care decreased the occurrence of NV-HAP per 1000 patients from 1.25 to 0.81, or by 35.2%. In 100 patient days, the rate of NV-HAP decreased from 0.49 days to 0.30 days, or by 38.8%. The researchers found that 1.6 million dollars were saved through avoidance of costs associated with the development of pneumonia.

Barnes (2014) found that aspiration pneumonia and the colonization of oral bacteria in dental plaque are directly linked. The more bacteria that colonizes, the higher the risk of the patient breathing in that bacteria and developing pneumonia as a result. According to Barnes (2014), aspiration pneumonia is one of the leading causes of mortality and morbidity in nosocomial infections. It was also found that if a patient is taking more than three medications per day, they have a 60% chance of developing xerostomia (dry mouth). If this occurs, mucous membranes have a high chance of deteriorating during hospital stay due to change in saliva and high levels of medication; therefore, this places the patient at a higher risk for developing NV-HAP.

Early Mobility Bundle

One study by M. Stolbrink, McGowan, Saman, Nguyen, Knightly, Sharpe, Reilly, Jones, and Turner was conducted on high-risk patients who were elderly or on a respiratory floor (2013). This study used a bundle intervention focusing on enhanced mobility through walking aids, provision of occupational therapy equipment, adding mobility charting, and staff wide notices of patient capabilities (Stolbrink et al, 2013). No studies of this nature existed before this study was carried out (Stolbrink et al, 2013). Researchers found mobility did not significantly decrease the length of hospital stay because the data was skewed due the number of patients discharged quickly (Stolbrink et al, 2013). Stolbrink et al reported a statistically significant finding at $p < 0.05$ with increasing mobility minutes per day and increasing steps (2013). Patients who did not receive treatment had an NV-HAP occurrence rate of 10.0% while those that received early mobility treatment had a NV-HAP rate of 3.6% (Stolbrink, 2013).

A randomized controlled trial was done by Soares, Nucci, Silva, and Campacci (2013) to test the effects of physical therapy integrated into patient care both pre-operatively and post-operatively, and how it affected the occurrence of postoperative pulmonary complications (PPC). Patients in the treatment group were given physical therapy 2-3 weeks before surgery. Both the control and treatment group were then assessed postoperatively at 24 hours, the 7th day, and the 30th day. No significant differences were found between the groups at baseline; however, there were statistically significant findings between the groups post-operatively. Eleven PPCs occurred in the control group, while only 5 occurred in the intervention group ($p=0.03$). This suggests that physical therapy decreased the occurrence of PPC in surgical patients. (Soares, Nucci, Silva, 2013)

Incentive Spirometry

A systematic review conducted by Carvalho, Paisani, and Lunardi (2013) evaluated the usefulness of incentive spirometry (IS) in the clinical setting, and how well it prevented postoperative pulmonary complications. Thirty studies were assessed independently by two reviewers. Fourteen of the studies included were abdominal surgeries, 13 cardiac, 2 thoracic, and 1 that included both thoracic and abdominal surgery. Both of the reviewers concluded that IS was not beneficial in preventing PPCs in patients undergoing surgery (Carvalho, Paisani, and Lunardi, 2013).

In a randomized control trial done by Bergin et al. (2014), 140 patients who received knee and hip total joint replacements were split into two groups. The control group was provided standard care while the intervention group also received preoperative incentive spirometry education (POISE). The main goal of Bergin et al.'s study was to determine whether or not the intervention group (Group 1) returned to postoperative IS baseline volume before the control group (Group 2). The results reported Group 1 with an average time of 15.8 hours before returning to postoperative IS baseline volume, and Group 2 with an average of 11.8 hours. Other relevant findings include Group 1 had only 1 PPC, whereas Group 2 had 3 PPCs.

Isolation Rooms

Placing patients with presumptive pneumonia in private isolation rooms is an effective measure in preventing the spread of pneumonia to the rest of the hospitalized patients (Ucgun, Dagli, Kiremitci, Yildirim, Ak & Aslan, 2013). One study, investigating the effects of remodeling an ICU ward from open to separate isolation rooms found that the prevalence of HAP decreased from 22.9% of patients to 17.4% of patients (Ucgun, Dagli, Kiremitci, Yildirim, Ak & Aslan, 2013). In this study, patients being treated empirically and patients who met

definitive diagnostic criteria for pneumonia were placed in isolation rooms. This produced the reduction in the appearance of HAP.

Discussion

Appendix B includes a diagram outlining the method in which research was carried out following the IOWA Model of Evidence-Based Practice to Promote Quality Care (Titler et al, 2001) using a problem based approach. Once the problem was identified, research was conducted to determine if solving the problem could be effective and efficient. A team was then formed and research was carried out. Research was narrowed down and then summarized, leading into an evidence based practice recommendation.

Oral Care

Oral care has been found to significantly reduce the occurrence of hospital-acquired pneumonia; thus it is important not only to administer consistent enhanced oral care, but also to educate nurses and aides who will be performing the care. One main problem with adherence to proper oral care is education. The task of completing oral care is typically delegated to nursing aides or medical technicians, who may have less education about the benefits of oral care. In addition, RNs are taught oral care as patient comfort rather than an essential tool to prevent infection, specifically hospital-acquired pneumonia. Barnes (2014) discusses this topic and comes to the conclusion that the better the education, the better the adherence due to the fact that those offering the oral care will understand the benefits of it. Inter-professional communication between dental hygienists and nurses is also extremely important so that they are both aware that the oral care is being done properly.

Early Mobility Bundle

Stolbrink et al.'s research shows that early mobility decreases the rate of HAP (2013). However, Stolbrink et al. suggested further research on the early mobility bundle to increase evidence based clinical practice preventing NV-HAP (2013). Stolbrink et al. suggested that early mobility is a cost efficient intervention that should become widely used (2013). Stolbrink et al's study on surgical patients with a low risk of acquiring pneumonia indicated that precautionary intervention measures significantly and effectively decrease the rate of NV-HAP (2013). A randomized control trial conducted by Soares, Nucci, Silva, and Campacci (2013) also found that early and consistent mobility significantly decreased the number of PPCs in surgical patients. Hospital staff should be educated on this effective intervention, and nurses specifically should be encouraging ambulation and patient adherence to any exercises the physical therapist may assign them.

Incentive Spirometry

As the studies by Carvalho, Paisani, and Lunardi (2011), and Bergin et. Al (2014) found, there is no current evidence to support the use of incentive spirometry for the prevention of NV-HAP or PPCs in the clinical setting. There is a greater need for research in this area to support this practice as being evidence-based and not simply tradition.

Isolation Rooms

The decrease in NV-HAP after isolation measures were taken is encouraging. This is a preferred nursing practice when possible; however, in clinical practice it often is not ideal. In the circumstance of preventing NV-HAP, there should be no difference between practice and the ideal. The reduction of pneumonia by 5.5% is significant and thus isolation should be a priority.

It is important to note that the study by Ucgun, Dagli, Kiremitci, Yildirim, Ak, and Aslan (2013) also concluded that rates of pneumonia mortality with isolation showed non-significant changes. Isolation has not been found to improve outcomes for pneumonia patients; however, it has been found to decrease the incidence.

Limitations

More definitive research is needed in the area of effectiveness of pulmonary function tests and isolation rooms. While the studies supporting these interventions presented their findings reputable, more evidence is needed to make a strong recommendation.

Conclusion

Current research recommends that enhanced oral care and early mobility be added as primary interventions for HAP prevention. In addition, incentive spirometry should be considered a secondary intervention. Nurses and nursing aids should be educated about the changes in preventative measures for NV-HAP. For patients who present with high risk for pneumonia development, dental hygienist consultations could be helpful. In units, such as the ICU when pneumonia rates are high, patients being treated empirically or definitively should be isolated from other patient populations.

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Appendix A: Synthesis of Research Findings

Author(s) and Year	Purpose	Sample	Measurement	Treatment	Results	Findings	LOE
Barnes (2014)	To determine the effectiveness of oral hygiene in preventing HAP, and ways in which healthcare workers should adhere better to this intervention	Patients were selected from an outpatient digestive specialist clinic for a randomized controlled trial	No information regarding databases given	N/A	N/A	Inter-professional collaboration between nurses and dental hygienists is important. Patients who do not have their teeth brushed or flossed on a regular basis have a high risk of obtaining aspiration pneumonia due to bacteria on their dental plaque biofilm.	3
Bergin, Speroni, Travis, Sheridan, Kelly, Daniel (2014)	To determine if POISE would return patients back to postoperative IS baseline volume faster than those who did not receive the education.	Patients were selected from one hospital over a two year period.	Group 1 participants were asked to keep a 7-day post-operative record of pain and highest volume reached on IS.	Patients in the experimental group were given 15 minute training on POISE, and were asked to keep a preoperative and postoperative diary.	Group 1 had an average of 15.8 hours before return to preoperative IS baseline volume. Group 2 had an average of 11.8 hours. Group 1 had 1 PPC, and Group 2 had 3 PPCs.	Group 1 had less PPCs, but there was no significant difference between the groups regarding return to postoperative IS baseline volume.	2
Carvalho, Paisani, Lunardi (2011)	To determine whether or not incentive spirometry is effective in preventing postoperative pulmonary complications and reducing recovery time.	Databases Medline, Embase, Web of Science, PEDro and Scopus were searched to find randomized controlled trials dealing with incentive spirometry used pre and post operatively	The quality of each study was reviewed independently by two people using the PEDro scale	N/A	The majority of RCTs reviewed had a PEDro score of >5/10.	Almost every study reviewed found that incentive spirometry alone did not improve lung function after surgery, and that positive pressure had better benefits. More research is needed in this area to confirm this information.	1

Author(s) and Year	Purpose	Sample	Measurement	Treatment	Results	Findings	LOE
Quinn, Baker, Cohen, Stewart, Lima, & Parise. (2013)	To document the number of NV-HAP occurrences and to determine if basic oral care would decrease NV-HAP occurrence rate.	Convenience sampling in three hospitals with 11 units hosted the quasi-experimental testing. 110 patients a month for a two year period. The first year's data was collected from charts. The second year was the 12 month intervention period. Electronic records were checked for all cases of NV-HAP.	Rate of NV-HAP occurrences in the hospital.	New and better supplies was stocked. Education of 100 nursing aids and 1000 RN (90% of the staff) on the importance of oral hygiene was conducted. New protocols were written.	NV-HAP per 1000 patients decreased from 1.25 to 0.81 (35.2%); NV-HAP per 100 patient day lower to 0.3 from 0.49 (or by 38.8%); 1.6 million dollars was saved in avoidance saving.	Educating nursing staff is critical for care implementation. Oral care reduces the NV-HAP.	3
Ribertson and Carter (2013)	To determine if enhanced oral care reduces the occurrence of nosocomial pneumonia in hospitalized, care-dependent, neurosurgical patients.	Patients from an acute neurosurgical unit at a tertiary care trauma hospital who were 19 years or older, non-intubated, care-dependent and a primary diagnosis of neurologic injury/insult	Confirmation of HAP included a positive chest x-ray and two of the following three criteria: elevated WBC count, pyrexia, and positive sputum culture.	Standard oral care (SOC) or Enhanced oral care (EOC). EOC included changing mouth suction equipment every 24 hours, mouth assessment every 2-4 hours, brushing teeth every 12 hours, oral rinse ever 2-4 hours as well as moisturizing mouth/lips.	There was a significant reduction in HAP with the patients who received EOC as compared to the SOC group. The percentage of HAP dropped by more than three-quarters from 25.5% to 6.3%.	Use of enhanced oral care (EOC) greatly reduces the occurrence of HAP in hospitalized patients. Improving oral hygiene in care-dependent patients can reduce the risk of NV-HAP.	3

Author(s) and Year	Purpose	Sample	Measurement	Treatment	Results	Findings	LOE
Segers, Speekenbrink, Ubbink, Ogtrop, de Mol (2006)	To determine if application of chlorhexidine gluconate would decrease the occurrence of nosocomial infection in patients returning from cardiac surgery.	Patients over 18 who were hospitalized and having cardiac surgery more than two days after their admission to the hospital. Patients were excluded if they had a preoperative infection or were using antimicrobials prior to surgery.	Patients were watched to determine if they obtained a nosocomial infection.	The treatment consisted of 0.12% chlorhexidine gluconate solution that came in the form of an oral rinse (10mL) to cleanse the oropharynx and a nasal gel to cleanse the nasopharynx. Immediately after surgery, patients were administered the rinse and gel; however half received a placebo. The products were administered for 30 seconds, four times daily.	Lower respiratory tract infections, including pneumonia, were found to have one of the greatest reductions in occurrence dropping from 15.8% to 9.3% with treatment. The length of hospital stay for patients who received consistent application of chlorhexidine gluconate was reduced to 9.5 days as compared with that of those who did not receive the routine treatment who had a 10.3 day average hospital stay.	Consistent cleansing of the Nasopharynx and Oropharynx with chlorhexidine gluconate significantly reduced the incidence of nosocomial infection. Lower respiratory tract infections, such as pneumonia, were found to have one of the greatest reductions in occurrence.	2
StolbrinkMcGowan, Saman, Nguyen, Knightly, Sharpe, Reilly, Jones, Turner	To determine the effectiveness of mobilization on reducing NV-HAP by increasing physical therapy and	A cluster design was used: one hospital association with three sites and two wards (elderly and respiratory).	Length of stay, fall rate, pressure sores, rate of NV-HAP with regard to risk factors, which include age, co-morbidity, and	Less than 10 minutes/day of moderate activity in the experimental group. Less than 5 minutes/day of activity in the	Physical activity level m questionnaires, and . Length of stay was not necessarily a cause-effect relationship in	Future studies should have an inclusion criteria for length of hospital stay to clarify results. Randomized studies should be conducted to discover cost effectiveness and clinical effectiveness of the	2

Author(s) and Year	Purpose	Sample	Measurement	Treatment	Results	Findings	LOE
	multidisciplinary staff jointly promoting the intervention.	Staff was selected to limit cross over between units. Surgical admission diagnosis is an exclusion criteria.	condition upon admission. Patient activity level measured by accelerometer daily. Falls and pressure sores data was collected from charting.	control group. Patient steps were counted. Staff was instructed to promote patient activity.	preventing NV-HAP. Intervention statistically significant at $p < 0.05$. 25 of 678 participants in the intervention group developed NV-HAP (3.6%). 50 of 501 participants in the control group developed NV-HAP (10.0%). No statistical significance found in other measurements	intervention.	
Soares, Nucci, Silva, Campacci (2013)	To determine how effective pre-operative physical therapy is in preventing postoperative pulmonary complications and reducing recovery time.	Patients were selected from an outpatient digestive specialist clinic for a randomized controlled trial	Patients received physical therapy for 2 weeks before their scheduled surgery and for 7 days after, and were assessed 24 hours, 7 days, and 30 days post-operatively.	The physical therapy consisted of two 50-minute sessions per week. Patients were trained on coughing as well as various respiratory muscle training.	11 (out of 16) patients in the postoperative control group and 5 (out of 16) in the treatment group had PPCs	Early ambulation is effective in preventing postoperative pulmonary complications. Nurses should be encouraging this with their patients and helping them understand why they should adhere to any exercises given to them.	2
Torres, Ewig, Lode & Carlet (2009)	To release a multidisciplinary European statement on the current knowledge, controversies, and areas where	Chairman from ERS, ESCMID, ESICM selected qualified members of their society, then members were randomly	Unanimous peer approval across ERS, ESCMID, and ESICM societies	N/A	N/A	1. Prevention of pneumonia should include identifying risk factors, including: sedation, curarization, coma, trauma, enteral nutrition, and surgery. 2. Pneumonia is highly associated with mortality,	7

Author(s) and Year	Purpose	Sample	Measurement	Treatment	Results	Findings	LOE
	further research is needed in the treatment and prevention of hospital acquired pneumonia	assigned to pairs and subjects, manuscripts was prepared and approved by the full committee, and finally the manuscript was peer-reviewed unanimous within each society.				but is attributed to the underlying conditions rather than new onset infection. Mortality rates are low in patients with reasonably good underlying condition and when therapy is started immediately. 3. More data is needed as to preventative benefits of 45 versus 30 degree patient inclination, but semi-recumbent position is unanimously an effective preventative measure. 4. Patients with high risk of HAP (increased age, structural lung disease, previous antimicrobial treatment, prior tracheobronchial colonization) selective digestive decontamination (SDD) can reduce incidence, but not mortality. Patients at high risk for pneumonia they should undergo SDD and prophylactic IV antimicrobial treatment.	
Ucgun, Dagli, Kiremitci, Yildirim & Aslan (2013)	To determine the effectiveness of isolation rooms on preventing HAP in the ICU over 4 years	532 patients; inclusion criteria: admission to the ICU, exclusion criteria: non-admission to the ICU	APACHE II and occurrence of HAP	Ward-type configuration with two isolation rooms	Incidence of pneumonia decrease from 22.9% to 17.4%	HAP is significantly decreased when patients who are showing signs of pneumonia or diagnosed with pneumonia are secluded from other patients	3

Appendix B: IOWA Model of Evidence-Based Practice to Promote Quality Care

