Electronic Health Record Documentation: Is it an accurate indicator of quality of care for mechanically ventilated patients?

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Electronic Health Record Documentation:

Is it an accurate indicator of quality of care for mechanically ventilated patients?

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Master’s Health Informatics Information Management

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Abstract

Background: Ventilator associated pneumonia is one of the leading hospital acquired infections associated with increased mortality and lengths of stay in mechanically ventilated patients.

Hypothesis: It is hypothesized that the introduction of chlorhexidine gluconate will show reduction in the incidences of ventilator associated pneumonia and a greater reduction with tooth brushing vs oral swabbing. It is also hypothesized that the electronic health record will provide more evidence of quality of care than an external EHR sources.

Methods: The non-randomized, non-sampled population included 98 patient records that met the inclusion criteria. The external tool, Automated Vent Bundle tool provided information as to which patients were mechanically ventilated in the Surgical Intensive Care Unit during years 2011 and 2012 day to day during each month. Each EHR was searched for the documentation of CHG during periods of mechanical ventilation.

Results: There was not any significant difference noted in the reduction of VAP during years 2008 and 2009 in which swabs and tooth brushing were utilized. In 2010, significant decrease was noted in the rate of VAP from years 2009 and 2010 with a reduction of VAP by 27% from 4.1 in 2009 to 1.1 in 2010.

Conclusion: VAP rates and ventilator days were reduced as a direct result of implementation of CHG. External data sources provided more information than the data collected from the EHR. More research is needed in the evaluation of quality of care concerning electronic clinical documentation.
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**Definition of Terms**

BCMA- Barcode Medication Administration
CHG- CHG gluconate
CPIS- clinical pulmonary infection score
COL- colistin
eCQMs- electronic clinical quality measure
HIE-health information exchange
ICU-intensive care unit
IDICU-Idealized Design of the Intensive Care Unit Initiative
IHI- Institute for Healthcare Improvement
IPEC-Inpatient Evaluation Center
MU-Meaningful Use
MV- mechanically ventilated
NHSN-National Healthcare Safety Network
ONC- Office of the National Coordinator for Health Information Technology
RCT-randomized controlled trial
RN- Registered Nurse
SICU- Surgical Intensive Care Unit
VAP- ventilator associated pneumonia
Chapter 1 - Introduction

Statement of the Problem

Introduction

The hospital acquired infection, ventilator associated pneumonia (VAP), has accounted for nearly 25% of the second most common infection in Intensive Care Unit (ICU) patients. Ventilator associated pneumonia has been linked to increased costs, morbidity, mortality, and lengths of stay. Ventilator associated pneumonia (VAP) has been recognized as one of leading causes of mortality and morbidity within intensive care units. It is also associated with increased lengths of stay and increased costs of medical treatments (Torres, Ferrer & Badia, 2010, p. 48).

In 2001, the Institute for Healthcare Improvement (IHI), a not-for-profit organization leading improvement in healthcare around the world, collaborated with 13 other healthcare institutions to improve outcomes for mechanically ventilated intensive care unit patients in the Idealized Design of the Intensive Care Unit Initiative (IDICU). After a review of clinical processes, medical literature and debates, the IHI developed the ventilator bundle. The bundle consisted of small evidence based interventions reduce adverse events for ventilated patients and not solely for the purpose of preventing VAP though a reported compliance rate $\geq 95\%$ has shown a reported 44.5% reduction in VAPs in 35 reporting networked ICUs (Resar, Griffin, Haraden, & Nolen, 2012, p. 9).

The small evidence based interventions include: deep vein thrombosis and peptic ulcer disease prophylaxis, sedation vacation for assessment of readiness to wean, head of bed
Elevated 30 degrees or greater and oral care, and in May 2010, the addition of chlorhexidine gluconate (CHG) oral solution.

**Background of the Problem**

Ventilator associated pneumonia rates greater than those benchmarked by the National Healthcare Safety (NHSN) for 2007 and only about one percent below National Healthcare Safety Network (NHSN) Benchmarks two years afterwards, 2008-2009, which prompted the Interdisciplinary Team within a 15 bed Surgical Intensive Care Unit (SICU) to take action in order to decrease mortality and decrease increased costs associated with increased lengths of stay.

After reviews of literature and an immediate need for an effective evidence based practice approach, the Interdisciplinary Team consisting of bedside and Infection control Registered Nurses (RNs), Infectious disease physicians, respiratory therapist and anesthesiologists initiated the vent bundle protocol in fiscal year 2008.

Though no formal training was provided in administration of oral care, oral cleansing is vital in preventing ventilator associated pneumonia. Within the scope of nursing practice, documentation of interventions and prevention of ventilator associated pneumonia is seen as a primary nursing responsibility in caring for mechanically ventilated patients.

**Purpose of Study**

The purpose of this study is to examine the effectiveness of CHG in mechanically ventilated (MV) ICU patients and also to indicate whether or not electronic health records (EHRs) indicate quality of care for the evidence based vent bundle intervention, CHG, in mechanically ventilated patients. It is hypothesized that the introduction of CHG will show
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reduction in the incidences of VAP and a greater reduction with tooth brushing versus oral swabbing. It is also hypothesized that the EHR will provide more evidence of quality of care than an external source outside the EHR.

**Significance of Study**

This research is significant to the scope of practice of bedside RNs utilizing the components of the ventilator bundle with a specific focus on caring for mechanically ventilated patients. The significance of this study will validate the oral care practices provided by direct care nurses within ICU settings and the significance of their clinical documentation within the EHR.

Many research studies validated the necessity of oral decontamination with or without CHG in mechanically ventilated patients, a nursing intervention; though no standard oral care training programs or clinical documentation specific for oral care interventions exist.

Since VAP has been recognized as a leading cause of increased mortality, lengths of stay, and cost associated with hospitalization, it necessary to utilize capabilities within electronic health records to monitor compliance and/or modify existing interventions to reduce the occurrence of VAP in mechanically ventilated patients.

**Research Questions**

- Does CHG reduce VAP rates in mechanically ventilated ICU patients and which method, swab vs tooth brushing or swab & tooth-brushing, has the greatest impact in the reduction of VAP?
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• Does the documentation of oral compliance with the administration of CHG in the electronic health record indicate quality of care for mechanically ventilated patients in the SICU?

Chapter 2-Review of Literature

Overview of Section

A review of literature provides evidence of varying outcomes of oral care utilizing the evidence based practiced vent bundle protocol, CHG gluconate. The literature evaluates the outcomes of placebo vs intervention and oral swabs vs tooth brushing in mechanically ventilated patients. It also evaluates the quality of data abstracted from electronic health records.

Electronic databases searched includes: CAVHS Pubmed, BMJ Journals Collection, EBSCOhost databases, MD Consult, CINAHL (Cumulative Index to Nursing and Allied Health), JAMA Network Journals, New England Journal of Medicine, Ovid Online, Science Direct, Cochrane Central Register of Controlled Trials and Wiley Online Library. The searches were limited primary sources published in 2006 to present date, in English, and involving patients in adult intensive care units and electronic health records. No restrictions were placed on the study designs. Studies selected for inclusion were primary research studies examining utilizing CHG as evidence based oral care intervention in mechanically ventilated patients and performance measures of EHRs, published in 2006 to the present. Systematic literature reviews and studies specific to pediatrics and ICU sub-specialties such as cardiac and neurosurgery ICUs were excluded and EHRs performance measures specific to outcomes in specific specialties were excluded.
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A total $n=86$ articles were related to the subject. Of the 86 related articles, which included systematic literature reviews, editorials, quasi-experimental studies, and historical control studies, only 13 studies, including a paper and a testimony, were chosen and utilized to answer the research questions. The study design similarities and differences are further described in frequency and application of oral care and also in research blinding. To identify relevant sources, key words were used in the search terms which included: CHG, documentation, EHR, evidence based practice, ICU, interoperability, notes, nursing, oral care, outcomes, performance measures, quality, and vent bundle.

Articles that met inclusion criteria contained the following:

1. Assessed the outcome of implementing CHG and measuring its effects as related to the incidence of ventilator associated pneumonia, pre and post implementation.
2. Compared the incidence of ventilator associated pneumonia by comparing oral care utilizing CHG vs a placebo utilizing swabs and toothbrushes.
3. Discussed the significance of interoperability and semantics in EHRs for data aggregation to compare and/or measure clinical performance based electronic documentation.

Review of Literature

1. Does chlorhexidine gluconate reduce ventilator associated pneumonia rates in mechanically ventilated ICU patients?

Cutler et al. (2013) conducted a clinical audit review of oral care with a control group of 528 patients and an intervention group of 559 patients. Ninety-one percent compliance was noted in the control group, 0.2% CHG, and 90% compliance, after the practice change using 1% CHG, was noted in the intervention group for documented oral. Though no formal
diagnosis of VAP was considered other than by recommendation of a microbiologist and an intensivist, outcomes showed a VAP rate of 8.9% with 0.2% CHG and a VAP rate of 4.1% post implementation of 1% CHG. Within this study, there is full implementation of the vent care bundle with 0.2% CHG and the mention of routine oral care. It does not state the frequency of “routine” oral care so it is difficult to attribute the full 50% reduction rate of VAP to the increase in strength of the CHG. Cutler et al. (2003) shows that compliance with an oral care regimen, that VAP rates can be cut by at least 50%. A reduction in VAP was also noted in a randomized control, double blind placebo controlled study by Koenman et al. (2006).

Koenman et al., conducted a randomized controlled trial (RCT) utilizing a placebo, CHG, and a CHG/Colistin (COL) combination administered four times a day in attempts to reduce the incidence of VAP. The study included 385 patients that were expected to have mechanical ventilation for 48 hours or more. Of the 385 patient, 52 developed VAP with 23 in the placebo group, 13 in the CHG group and 16 in the CHG/COL group. During the study, it was noted that the combination drug, CHG/COL, reduced early onset of VAP by 55%, whereas CHG reduced VAP by 65% when compared to the placebo drug. COL/CHG was more effective in reducing gram negative colonizations but even when administered separately, the two medications were almost equally as effective.

Unlike the Cutler et al. study, Koenman et al. utilized CPIS which included chest x-ray, sputum cultures and prescribed antibiotic therapy in order to diagnose VAP. Grap et al. (2011) also defined VAP utilizing cultures and scores based on the parameters within the CPIS. In the Grap et al. study, subjects were included if enrolled in the study at 12 hours of intubation but not greater than 48 hours post intubation, excluding the edentulous and those
extubated and reintubated within 48 hours. Of 145 patients enrolled, 60 patients CPIS scores >6 were evaluated at admission, at 48 and at 72 hours for to assess the effectiveness of early administration of CHG. With early administration of CHG, within the first 24 hours of intubation, patients without pneumonia, indicated by a CPIS <6, of 39 patients, 55.6% (10/18) of the control group developed VAP by 48 or 72 hours versus 33.3% (7/21) in the intervention group that developed VAP. Grap et al. conclude that the early intervention of CHG reduced the oral contaminants which led to an overall reduction of VAP in the intervention group.

2. Which method of CHG administration (swab vs tooth brushing vs tooth-brushing/swab) has the greatest impact the reduction of VAP in ICU patients?

Berry et al. (2010) conducted a single blind RCT in efforts to test the effects of oral care regimens on dental plaque. Data was collected on 109 participants who required ventilation > 48 hours, with qualifiable data collected only 60 participants. This study utilized intensive oral care regimens which included: sterile water, sodium bicarbonate, CHG and toothpaste. The study intended to assess the change in microbial dental plaque or gums in edentulous patients and also assess the effectiveness of the oral care regimen in reducing the incidences of VAP. The diagnosis of VAP relied on results of white blood cell counts, body temperature, consistency of bronchial secretions, and oxygenation requirements. Patients enrolled amongst groups A, B, and C, nine patients (4%) developed VAP with one in group A, the control, and four each for groups B and C, the intervention groups by the eighth day. With all three sets of interventions requiring oral brushing three times a day, the study does not mention any set parameters on the length of brushing time. It is possible that less time may have been devoted to groups B and C because other cleansing
agents were utilized besides just toothpaste. Group A may have received more time with brushing due to only using just sterile water and toothpaste. The results are conclusive but methods of oral care administration are not.

Lorente et al. (2012) performed an RCT to evaluate the efficacy of tooth brushing vs not tooth brushing both utilizing CHG 0.12% in patients mechanically ventilated for >24 hours. In this study, the control group received gauze with 20mL CHG 0.12% used for cleaning all surfaces of the oral mucosa, teeth and tongue followed by a 10mL 0.12% injection in the oral cavity, then suctioning for 30 seconds to the oropharyngeal surfaces. The intervention group received the same oral care plus 90 seconds of brushing to each tooth on both surfaces, tongue and gum line. This study excluded edentulous patients as did Grap et al. study. Specific criteria was utilized to determine a diagnosis of VAP for 21 of 217 (9.7%) in the no CHG -brushing group versus 24 of 219 (11%) in the tooth brushing group. No statistical differences were found in either group in early prevention based on findings related to gram positive/negative bacterium, or in either early or late onset VAP in any patients without VAP at baseline before intubation.

Munro et al. (2009) conducted an RCT which enrolled 547 patients within 24 hours of the intubation period, excluding those extubated post 48 hours, edentulous and with preexisting pneumonia. Patients were assigned to one of the four treatment regimens which included a CHG 5ml swab twice a day in 12 hour intervals, plain tooth brushing three times a day 4 to 5 hours apart, tooth brushing three times a day with CHG every 12 hours and the control group, routine oral care. This study specified the pattern of tooth brushing by dividing the mouth into quadrants and brushing each tooth a specified number of strokes.
Though tooth brushing is an effective method in removing dental plaque, in this study, tooth brushing did not make any significant difference in the reduction of CPIS scores incidences of VAP. CHG reduced incidences of VAP by reducing CPIS scores on day three for patients who had CPIS <6 at baseline. Munro et al. concluded that tooth brushing dislodge plaque which could have travel form the mouth to the lungs and more investigation is needed for risks of tooth brushing in mechanically ventilated patients.

Tantipong et al. (2008) conducted an RCT study and compared the results of their study with similar studies. One hundred and two participants received CHG 2%, intervention group, and 105 participants in the placebo group received normal saline. Due to the high rate of VAP within the population within the setting in Bangkok, Tantipong et al presumed that because VAP was reduced with lower doses of CHG (0.2%-1%) that if a stronger dose of CHG were used, it would greatly reduce the rate of VAP. From a rate of 14 episodes per 1000 ventilator days to 7 per 1000 with the use of CHG and 21 per 1000 ventilator days with NS, Tantipong et al. concluded that CHG effectively reduce the incidence of VAP in mechanically ventilated patients. Though this study lacked rigorous inclusion criteria by including patient 18 years of age or older, not specification of minimal intubation time and not allergic to CHG, but there was specific criteria to diagnose VAP. Some patient developed irritation to the oral mucosa but that was attributed to the vigorousness of the decontamination process and not the fact that this study utilized 2% CHG which was 2 times greater in strength than what was used in other studies.

Of the seven chosen studies, oral care regimens existed in the forms of frequent oral rinses every 2 hours either with sterile water, sodium bicarbonate, or sterile water and CHG and manual tooth brushing three times a day for all treatment options. This particular study
revealed less instances of VAP in the non CHG group. The remaining six studies all showed a reduction of VAP with the use of CHG. Of the six studies in which measurement of VAP may have been effected by either using a swab or toothbrush or administration of CHG with a swab or toothbrush, no significant measurements in reduction of VAP were noted.

With conflicting outcomes with the use of the same intervention, it is necessary to further investigate if the use of CHG reduces the occurrence of VAP in MV patients. It is also necessary to investigate whether or not electronically documented compliance in the administration of CHG correlates with the occurrence or reduction of VAP in mechanically ventilated patients. See Table 1 for the details of each study.

3. Does the electronic documentation of oral compliance with the administration of CHG in the electronic health record indicate quality of care for mechanically ventilated patients in the SICU?

There were not any articles specifically related to this research question but several articles and studies discussed the importance of EHRs capabilities in data retrieval to effectively evaluate the quality of care patients receive based on the documentation of interventions provided. Information regarding this subject was presented in the form of studies, journal articles, and government White Papers.

Edwards, Neri, Volk, Schiff and Bates (2013) performed a cross sectional study evaluating the quality of 239 physicians notes and the indicators of quality of care within the notes. The authors evaluated the quality of the notes utilizing a documentation tool and comparing it to disease-specific clinical quality scores from data extracted from the EHR. Data integrity was undermined by the inappropriate use of copy/paste functions which led to
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redundancy, poor note quality and increased length. Edwards et al. also noted that note quality was of higher quality when it was organized and had clinical usefulness versus noting the documentation of quality markers.

The study concluded with a discussion about key information missing from notes, lack documentation from physicians’ notes to support quality of care the patients received and if that information were notated, it was found in other areas within the EHR. See Table 1 for greater details of this study.

In the Executive Summary: A Study of the Impact of Meaningful Use Clinical Quality Measures (2013), authors Eisenberg et al. conducted four case studies at four different hospital sites well versed in EHR implementation from various vendors. The study evaluated the each hospitals experience with the implementation of Medicare EHR Incentive Program’s Meaningful Use (MU) Stage 1 electronic clinical quality measure (eCQMs).

The goals of each hospital were to generate quality data in efforts to improve care by data sharing amongst clinicians, and utilize the EHR for clinical decision support for care delivery consistent with eCQMs guidelines. In order to achieve these goals, each facility performed a “gap analysis” in order to realize shortcomings within the EHRs. The gap analysis compared the measure requirements against the data captured from the EHRs from the clinical workflow by utilizing the eCQMs tool.

As a result of the analysis and study, organizations were able to identify gaps in structured data and data documented as narrative (free text) notes. Also, data was not in a specific location for extraction by eCQMs tools and the lack of interoperability with the eCQMs tool and the EHR did not help the situation. To fix the problem, 20% of vendors
would have to modify EHR software and 80% of hospitals would have to change their workflow to accommodate eCQMs data capture. After the changes and modifications, the lack of interoperability would still pose a continued problem in data capture perpetuated by a non-standardized vocabulary between the EHR and the eCQMs tool. Until that problem is fixed, organizations utilizing the eCQMs tool will not meet MU criteria due to inaccurate reporting of clinical measures.

The American Health Information Management Association (2013) discusses the importance of quality electronic health records in which the quality of the data resulting from poor documentation and poor data collection can result in adverse reactions, sentinel events, poor performance measures and increased costs in healthcare delivery.

In order for an electronic health records to meet the criteria for the (MU) EHR incentive program initiatives, the EHR needs the capability of accurate data collection for the purposes of sharing and reporting. Without standardized clinical documentation sources, data capturing and encoding, EHRs will never reach full potential in producing quality data. Without reaching full potential concerning data capture, EHRs are setup for possible failures and legalities.

The quality and integrity of data collected from EHRs is not only a concern for local healthcare entities, this issue has gained the attention of the federal government. In a testimony to the Office of the National Coordinator for Health Information Technology (ONC) concerning legalities associated with clinical documentation, Michelle Daugherty, director of research and development for the American Health Information Management Association (AHIMA) foundation, along with the professional opinions of 67k other HIM professionals implied that one of the main concerns for EHRs were a need for greater focus in the quality
and integrity of data and a good source of documentation for the implementation of widespread health information exchanges (HIEs). Quality data and integrity cannot occur without the standardization of vocabulary in non-standardized clinical documentation sources.

In the standardization of clinical documentation, it is necessary to standardized vocabulary within clinical documentation. For example: MCA can mean Mid Cerebral Artery or mean cell area, AFBG can mean aortofemoral bypass graft or average of fasting blood glucose. Non standardized abbreviations can have a plethora of meanings. Without human reasoning ability or artificial intelligence, it is virtually impossible for an EHR synthesize or parse meaning of characters within a free text notes to produce quality data or reports for meaningful use within an organization.

Until vendors are able to not only meet the requirements of (MU) but also the standards to electronically disseminate and report with the guidelines of the eCQM tools. According to the testimony of Michelle Daugherty, it is imperative to prioritize data quality and information integrity to adhere to the concept of “collect once and use many.” The one time collection reduces redundancy, volume of excess data, and saves time when processing data.

**Summary**

The studies and articles in the review of literature evaluating outcomes of compliance with CHG, tooth brushing versus swabbing and the quality of data extractable from EHRs have shown consistency in outcomes. Most studies confirmed each other in the reduction of VAP as evidenced by the use of CHG but without any difference noted in tooth brushing
versus oral swabbing. Literature also confirms the difficulty of evaluating quality of care based on the quality of data extracted and data non-extractable from EHRs.

Healthcare professionals from clinicians to HIM specialist agree that electronic health records help to organize patient records and provide accessibility to data from in house or remote locations. Clinicians sometimes face difficulty in the data entry process when utilizing EHRs and Informatics Specialist face challenges extracting the same data from the EHR necessary to build reports that show quality of care based on the clinical documentation provided. In order to improve the quality of clinical documentation and improve the quality of extracted data, standardization of EHRs and collaboration with clinicians and IT specialists are needed in the development and deployment of EHRs.

Chapter 3- Methodology

Methodology

The methods utilized and data collection analyses are described in the following section. The study contains data made available in the Surgical Intensive Care Unit Automated Vent Bundle tool spreadsheet and data from individual patient records in the Computerized Patient Records System. The Automated Vent Bundle tool and the EHR each provided data to validate compliance with the on the use of the evidence based practice, “Vent Bundle.”

Research Design

This study uses a cross sectional research design to compare the quality of patient outcomes at different points in time. The study shows the rates of VAP, in 2007, before introduction of the vent bundle in 2008. The first analysis of the incidences of VAP rates are evaluated during the years of 2007 before the vent bundle, and 2008-2009 before the
introduction of CHG as part of the vent bundle. After the introduction of CHG, in January 2010, the second analysis examines VAP rates, during years 2011 and 2012.

**Population and Sample Design**

The population in this study was limited to the patients that were included in the SICU Automated Vent Bundle tool in the form of a password protected spreadsheet (Microsoft Excel). The non-randomized, non-sampled population included patients that met the following: non-intubated prior to admission, intubated for at least 48 hours, pneumonia not pre-existing prior to intubation, and CHG not a prior home medication. In total, there were 98 out of 114 total patients that met criteria for inclusion for this study.

**Data Collection Procedure**

Data extraction from an electronic database, SICU Automated Vent Bundle tool, allowed data capture of all monthly recorded encounters of ventilated patients that met criteria for this study. The Automated Vent Bundle tool provided information as to which patients were mechanically ventilated in the SICU during years 2011 and 2012 day to day during each month. VAP rates from the first Quarter of 2011 were utilized in comparison of yearly VAP rates. The first quarter of 2011 (Oct 2011- Dec 2011) was not utilized when discussing CHG or CHG ordering compliance due to incomplete data. Data obtained from Inpatient Evaluation Center (IPEC) provided monthly information regarding the number of vent days, number of infections and VAP rates by (VAP/ventilator days x 1000). The data was analyzed and comparisons made to identify trends.

**Summary of Methodology**

In summary, data collected and imported into Microsoft Excel was used to construct tables and graphs to identify trends in the data obtained from the SICU Automated Vent
Chapter 4- Results

Overview of Results

This chapter will include an overview of the correlations between incidences of VAP in the patient population and the practice changes noted during a specified time frame. Charts and graphs will display ventilator associated pneumonia rates along with reported frequency of oral care will provided and reported documented use of CHG versus actual electronic documented use of CHG.

Results Analysis

The present study analyzes the rates of VAP in SICU during years 2007-2012. Before 2007, the SICU did not utilize all components of the vent bundle but all patients did receive oral decontamination. During years 2008 and 2009, the ICU fully implemented all components of the ventilator bundle. Oral care consisted of six packets for oral care every four hours.

In 2008, the first device, for 9am medication administration, contained a suction swab, application swab, sodium bicarbonate solution and antiplaque solution. The remaining five kits contain suction swab, application swab, and 0.12% hydrogen peroxide solution. In 2009, the first device in the oral care packet contained all of the same items as the packets in 2008 with the change of a suction toothbrush instead of a suction swab. In 2010, the
Interdisciplinary Team convened and under the advisement of Infection Control practitioners, CHG oral solution was added as a part of oral decontamination.

There was not any significant difference noted in the reduction of VAP during years 2008 and 2009 in which swabs and tooth brushing were utilized. In 2008, only swabs were used every four hours during a 24 hour period versus a toothbrush used once and swabs thereafter ever four hours within a 24 hour period. So there was no difference in incidence in VAP using a swab or toothbrush (Figure 1). To see which months had the greatest rates of VAP during the pre/post implementation of the vent bundle and pre/post implementation of CHG, see Figure 2.

Even after 2009 and with the continued use of tooth brushing and swabbing, in 2010, significant decrease was noted in the rate of VAP from years 2009 and 2010 with a reduction of VAP by 27% from 4.1 in 2009 to 1.1 in 2010. The rates stayed non-significant during years 2010-2011 and decreased to zero in 2012 (Figure 1).

When comparing the number of patients to the number of orders for physicians orders for oral care and CHG, the results showed that of 98 patients included in the study, 71 or 72.4% of patients had orders for oral care every four hours whereas 35 or 35.7% of patients had orders for CHG once every 12 hours. There were also 49% less orders for CHG than routine oral care with the oral cleaning device. The infrequency of oral care orders may have led to the increase in VAP rates (Figure 3).

In analyzing the CHG compliance versus ventilator days and VAP rates, the results show that as oral care compliance increased and maintained near 100% compliance, ventilator days decreased and VAP rates stayed decreased or at zero percent (Figure 4).
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Significant difference resulted in clinical documentation of CHG in nursing, physician, and the Automated Vent Bundle tool. Throughout the two fiscal years, CHG was documented only one time in a free text note in May 2011 but documented 31 times in physicians’ progress notes between Jan 2011-September 2012. In the physicians’ progress notes, CHG was documented as an active medication depicting the route and frequency of administration (Figure 5).

Summary of Results

Based on the results from the study, the electronic health record was not a quality indicator of patient outcomes for mechanically ventilated patients receiving oral care with CHG. Compliance with oral care using CHG was not captured in the nursing record as an intervention and only evidence of the medication order remained, after discharge, as part of the physicians’ notes. As far as vent bundle interventions are concerned, the sedation vacation, head of bed elevated 30 degrees, DVT and GI prophylaxis were all documented as nursing interventions with >95% compliance, in the Automated vent bundle tool with oral care with CHG at an average of 98% of the time (Table 3).
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Figure 1.

![VAP Rates 2007-2012](image1)

Note: Adapted from Infection Control Department.

Figure 2.

![Monthly VAP Rates 2007-2012](image2)

Note: Adapted from Infection Control Department.
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Figure 3.

![Graph of Oral Care Orders vs VAP Rates 2010-2012](image)

Note: Adapted from Infection Control Dept and ICU Department.

Figure 4.

![Graph of CHG Compliance vs Vent Days vs VAP Rates 2010-2012](image)

Note: Adapted from Infection Control Dept and SICU Department.
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Figure 5.

![Graph: Clinical Documentation of CHG vs VAP Rates 2010-2012](image)

Note: Adapted from Infection Control Dept and ICU Dept.
Chapter 5-Summary, Discussion, and Limitations

Overview of Section

The conclusions reached can be viewed as mixed results with respect to whether or not EHRs are quality indicators of patient outcomes. The summary will, in more details, explain the outcomes of the results as it relates to the incidences of VAP and the EHR as an indicator of quality of care. The conclusion, will compare this study to other studies in the literature review, answer the research questions and provide suggestions for future research. The study was conducted as a cross sectional design, which investigated whether or not the vent bundle intervention, CHG, in the ICU were effectively employed to reduce a leading hospital acquired infection, VAP.

Ventilator associated pneumonia rates are measured as quality nursing sensitive indicators by the National Healthcare Safety Network (NHSN). Implementation of the vent bundle is primarily regarded as a nursing responsibility to aid in the reduction of VAP. With the utilization of EHRs as an effective means to reduce clinical errors, improve patient safety, support improved outcomes and document care provided to patients, the study was conducted to validate whether or not the EHR effectively captures the quality of care administered the mechanically ventilated patients in the ICU by determining if the EHR is a quality indicator of care.

Summary of Findings

The goal of all hospitals is to attain and maintain a zero percent goal of VAP. Some facilities have managed to significantly reduce VAP within their ICUs, but total elimination of
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VAP may be unrealistic due to the pre-existing comorbidities and predisposition associated with patients and their diagnoses.

Since 2008, the eradication of VAP has been one the main priorities in the ICUs when caring for mechanically ventilated patients. In order to try to achieve a 0% VAPs rate, the hospital implemented the evidence based practice “Vent Bundle Protocol” modeled by the Institute for Healthcare Improvement also with the addition of CHG 0.12%.

The analysis of oral care before and after the implementation of CHG showed significant difference from 2007 to 2010 and from 2010 to 2012 with continued use and documentation of compliance. Figure 1 displays VAPs at the highest rates before the implementation of the Vent Bundle. Years 2007 to 2008 displayed a trending down of VAP but without significant change between years 2008 and 2009 with the only change noted as tooth brushing once a day with the oral care cleansing device. Without any significant reduction in VAP with either oral swabs and tooth brushing in years 2008-2009, evidence shows dramatic reduction in VAP from 2009 to 2010, with sustained reduction of VAP in years 2011 and 2012.

It is also noted that as the order frequency for CHG increased and compliance maintained near 100%, the number of ventilator days reduced and monthly VAP rates maintained zero percent incidences or stay to a very low minimum. Though compliance was documented outside the EHR, in the Automated Vent Bundle tool, incidences of nursing documentation remained at only one instance throughout the 2011-2012 years. Physicians’ notes only revealed the presence of the order but not the actual administration of the medication.
Discussion

Ventilator associated pneumonia remains a leading clinical problem associated with critically ill mechanically ventilated patients. Critically ill patients run the risk of VAP at the moment of intubation. Due to the risk of VAP, efforts have been put in place in attempts to safeguard patients from one of the most prevalent hospital acquired infections. The interventions, vent bundle, enacted by the IHI have been adopted by several healthcare facilities in efforts to prevent VAP. The interventions have led to several studies investigating the effectiveness of CHG and the effectiveness of oral swabs versus tooth brushing with and without the use of CHG.

This study compared the VAP rates within the SICU pre and post implementation of CHG as an addition to the ventilator bundle. Prior to the implementation of the vent bundle in 2007, VAP rates were as high as 7.9% for the year. After the implementation of the vent bundle in 2008, the rate reduced to 3.8% for year 2008 and 2009. After the addition of CHG, in 2010, to the vent bundle, the VAP rate declined by 27% from 4.1% in 2009 to 1.1% in 2010, during the first year of the practice change.

In RCTs published by Grap et al. (2011) and Koenman et al. (2006), both studies showed significant reductions in VAP with the implementation of CHG. In the study by Grap et al. (2011) 39 patients, 55.6% of patients developed VAP with the usual oral care and only 33.3% of patients developed VAP within 48 or 72 hours with the use of a single CHG swab within 12 hours of intubation, which attributed to the reduction of VAP.
Koenman et al. (2006) utilized CHG and CHG/COL in oral care applications four times a day. Of 385 patients enrolled in the study, CHG reduced the rate of VAP by 55% and the use of CHG/COL together as a single oral care component reduced the daily rates of VAP by 65%.

Cutler et al. (2013) conducted a historical control study of 1085 patients. A change in oral care regimen, CHG 0.2% to CHG 1% every 6 hours and the addition of toothpaste twice a day reduced the VAP rates by 50%. The implementation of CHG has proven effective in reducing VAP but the debate remains whether or not tooth brushing or swabbing to remove dental plaque significantly affect incidences of VAP.

In this study, there were not any noted differences in the rates of VAP in years 2008 to 2009 from the use of all swabs in 2008 to the use of a single use toothbrush in 2009 as part of the oral care regimen. Because the oral care kits remained the same from 2010 to the present the significant reduction is attributed to the implementation of CHG in Jan 2010. In four RCTs by Berry et al. (2011), Lorente et al (2009), Munro et al (2009), and Tantiapong et al. (2008), tooth brushing versus swabs and oral rinses were studied to determine the effectiveness of tooth brushing over other oral care administration techniques. All the studies revealed a decrease in the rates of VAP when utilizing CHG but none of the studies conclusively revealed any significant decline in VAP associated with tooth brushing techniques.

Numerous literature reviews, RCTs, meta-analyses, historical control studies and cross sectional studies have been performed to measure the efficacy of CHG in mechanically ventilated patients. The majority of the results have determined that
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CHG is effective in reducing VAP either in early, within 12 hours of intubation or at least by 24 hours and swabbing vs tooth brushing had no significant effect on the outcomes of VAP. Based on the results of this study and the comparisons of other studies performed by prior authors, CHG has been shown effective in reducing the rate of VAP whereas tooth brushing has not had any significant or direct correlation in the reduction of VAP.

The second research question sought to answer if the electronic health record indicated quality of care for MV patients in the SICU based on the clinical documentation of compliance with CHG as part of the evidence based practice vent bundle protocol. In this cross sectional designed study of 98 eligible patients between Jan 2011 and Sept 2012, CHG was documented only one time as a free text in a nursing note and 31 times as part of “Active Medications” in physicians’ progress notes. CHG was documented on 32 of 98 patients and remained undocumented 67% of the time from Jan 2011-Sept 2012. Edwards et al. (2013) experienced the same outcomes with their cross sectional study of 239 physicians notes. Indicators of quality of care were often found outside of physicians notes’ within the EHR. Also within this study, the clinical documentation was not the best representation of quality of care patients received.

Clinical text within an EHR documents decision making processes and interventions provided to and for patients. Free text data is usually the most abundant type of data but also remains the most difficult type of data to capture, mine and analyze. Free texting documentation allows flexibility and saves time in the documenting process but it is also
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riddled with non-standardized abbreviations, spelling and grammatical errors, and often
times, grammar that is structurally incorrect. Attempting to replace free text with structured
reporting formats or templates is time consuming. Until a solution has been found to solve
this analytic problem, EHRs may not ever fully be a quality indicator of outcomes for
patients.

Limitations of Study

There are several potential limitations to this study. First, the study was conducted in a
single surgical intensive care unit at a university teaching facility including medical intensive
care unit patient overflow, non-exclusive to postsurgical intensive care unit patients only.

Second, it is possible that all mechanically ventilated patients were added to the number
of patients in overall vent days even if not ventilated greater than 24 hours. There is also the
possibility that some patients, ventilated greater than 48 hours, were not included in the
Automated Vent Bundle due to human error and not accounted for in this cross sectional study
leading to Neyman bias. The bias is associated with the study selection which affected the
accuracy of the size of the population based on the availability of information. There is a
possibility that VAP rates could have been more or less for the studied years. Third, the
numbers of VAP infections were available but data was not available on which individual
patients developed VAP and if occurring within 48 hours of intubation or secondary to
prolonged intubation and neither was the date CHG was ordered as a medication due to
inability to see expired orders after discharge from SICU. Another limitation is possible that
clinical documentation may not accurately reflect the amount of oral care provided at the
bedside for ventilated patients.
Due to time constraints, the study was limited to patients within the surgical intensive care unit because of the availability of data containing information on patients ventilated during a specific time frame, not available in other ICU areas within the hospital, and also the lack of data mining capabilities available to the EHR end users requiring manual searching and data extraction.

Despite these limitations, this study will attempt to show whether or not the use of CHG has reduced the incidences of VAP and if the outcomes are representative of the clinical documentation in the EHR for mechanically ventilated patients in the Surgical Intensive Care Unit during years 2011 and 2012.

Chapter 6-Implications, Conclusion, and Recommendations

Implications of Study

The result of this study clearly shows inconsistencies in perceived quality of care patients received and the quality of the documented care. The quality of documented interventions was inversely proportionally related to the quality of care patients received based on the reduction of VAP after the implementation of CHG in January 2010.

Many studies have examined how adoption of electronic health records have improved patient care through the use of computerized physician order entry, barcode medication administration, and clinical decision support. Very few studies, Edwards et al., have examined the quality of data retrieved from EHRs when evaluating the quality of interventions provided for patients versus actual patient outcomes.
The results of this study show the importance of not only evaluating an EHR to meet the criteria for (MU), but to also evaluate the quality of the EHR in terms of data quality, integrity, and ease in retrieval from clinical documentation.

Without quality data abstraction from quality EHRs, healthcare institutions will not fully realize the potential to improve patient outcomes through data collection, sharing and research. Less than quality indicators also degrade the quality of care reported in the 15 Meaningful Use (MU) quality measures. This in turn will also lessen hospital reimbursements even if patients are receiving the best quality of care, all because the quality is not indicated in the data collected from the EHR.

**Conclusions**

Compliance with the vent bundle, with addition of CHG, proved effective with the reduction of VAP in 2010 and sustained reduction in years 2011 and 2012. The EHR was unsuccessful at recording the oral care intervention, CHG, as part of vent bundle interventions provided by nursing and not a quality indicator of care for MV patients in the ICU. Abstracting data related to clinical documentation of CHG was a daunting task to due to the lack of a standardization in charting formats. The lack of standardization within EHRs continues to make the evaluation of quality of care a formidable task.

**Recommendations**

Based on the literature reviews, findings, and results, and comparison of this study to others, more research is needed to understand the impact of clinical documentation as it is the only indicator of quality of care represented as sets of data in a digitized format when meeting, failing, or exceeding quality standards.
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From this study, healthcare organizations may consider implementing quality controls to verify, test, and analyze the amount and quality of data retrievable from their current EHRs. This analysis can indicate whether or not standards are being met due to actual quality of care delivered or due to the ability or lack of ability to retrieve data verifying performance one way or the other.

In the selection process of vendors for EHR implementation and when requesting information, it is important for institutions to focus on the organizational needs and the products functionality to meet those needs. After selection and a request for proposal, it is then necessary for healthcare organizations to know and understand how the product will support the needs of the organization, and based on the findings of this study, especially indicators of quality retrieved from clinical documentation.

EHR adoptions are still fairly new and cutting edge and some hospitals and small practice have and have yet to adopt. Research concerning the quality of care extracted from electronic health records has shown mixed results and more research is needed in the area of clinical documentation.
Table 1. Systematic Literature Review

<table>
<thead>
<tr>
<th>Author</th>
<th>Type of Study</th>
<th>Population</th>
<th>Oral Care</th>
<th>Findings</th>
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</table>
| Berry et al. (2011)     | Randomized Controlled Trial | Adult intensive care unit in a university hospital in Australia. Patients enrolled requiring mechanical ventilation more than 48 h were eligible. | (A) sterile water rinsed q 2 hr  
(B) sodium bicarbonate rinsed q 2 hr  
(C) twice daily irrigation with CHG 0.2% aqueous oral rinse and sterile water irrigation q 2 hr. All rinses applied with curved tip dental syringe, and tooth brushing with a soft, pediatric toothbrush three times a day for all treatment options | Patients (n=9) that developed VAP on day 8  
No significant changes noted until after day 4; The incidence of ventilator associated pneumonia was evenly spread between Groups B and C (5%) while Group A was only 1%. |
| Cutler et al. (2013)    | Historical control study | Patients (n=1087) adult ICU in England, VAP diagnosed within 48 hr post intubation | Pre Implementation: Routine oral care with CHG 0.2%  
Post Implementation with toothpaste (0600-1800)  
CHG gel 1% to oral mucosa (0800, 1400, 2000, 0200) | Pre-CHG 47 of 528 or 8.9% developed VAP  
Post chlorhexidine 24 of 599 or 4% developed VAP  
The practice changed showed a reduction of VAP and associated cost by 50% post CHG |
| Edwards et al. (2013)   | Cross sectional study  | Evaluation of patient records (n=239) written by 111 physicians; 110 notes were written by primary care physicians, 52 by cardiologists and 77 by endocrinologists. | No oral care as part of this study | Reason for visit absent in 10% of notes, medication list missing in 19.7% notes;  
Timing for follow-up absent in 18.0% of notes. 10.5% notes copy/paste  
Laboratory quality indicators were more often found in other EHR sections than in the physician note. |
### EHRs: Quality Indicator of Outcomes for MV Patients

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<tr>
<th>Study</th>
<th>Design</th>
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<th>CPIS Evaluation</th>
<th>Notes</th>
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<td>Grap et al. (2011)</td>
<td>RCT</td>
<td>145</td>
<td>control group and CHG (single swab) within 12 hrs of intubation</td>
<td>In 39 patients without pneumonia at baseline, Control group: 55.6%, CHG group: 33.3% within 48-72 hrs</td>
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<td>Koeman et al. (2006)</td>
<td>2RCT: Consecutive patients needing MV for 48 h or more were enrolled in a randomized, double-blind, placebo controlled trial with three arms: CHG, CHG/COL, and placebo</td>
<td>385</td>
<td>(A) CHG 2% in petroleum jelly (B) CHG 2% with COL 2% in Vaseline (C) Vaseline Oral cavity cleansed with 0.9% NaCl, 0.5GM of each gel administered four times a day with a gloved fingertip to both side of buccal cavity.</td>
<td>Patients that developed VAP 13 CHG (CHG) 16 CHG/Colistin 23 Placebo group Daily VAP rates reduced 65% with CHG and 55% CHG/COL; unable to determine efficacy between both groups</td>
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<tr>
<td>Lorente et. al (2009)</td>
<td>RCT</td>
<td>436</td>
<td>q 8 hours, Control: oral mucosa cleansed with gauze (20ml) 0.12% followed by 10ml of CHG Intervventional: same CHG injection followed by manual tooth brushing</td>
<td>No statistical difference or significance in development of VAP. 11% without brushing vs 9.7% with brushing</td>
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<tr>
<td>Munro et al. (2009)</td>
<td>RCT with a 2 × 2 factorial design</td>
<td>547</td>
<td>Patients were randomly assigned to 1 of 4 treatments: (A). 0.12% solution of CHG gluconate (CHG) 5 mL by oral swab twice daily (B) tooth brushing 3 times a day (C) combination care (tooth brushing 3 times a day and CHG every 12 hours),</td>
<td>Ventilator-associated pneumonia was determined by using the Clinical Pulmonary Infection Score (CPIS). Sixty or 24% of patients, who did not have VAP at baseline, developed it by day 3. No significant difference of outcomes for tooth brushing or CHG, though</td>
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<td>Tantipong et al. (2008)</td>
<td>RCT and meta analysis</td>
<td>Patients (n=207), &gt;18 yrs of age University hospital, Bangkok, Thailand</td>
<td>(A) CHG 4 times a day: teeth brushing, brushing the teeth, suctioning any oral secretions, and rubbing the oropharyngeal mucosa with 15 mL of a 2% CHG. (B) Normal saline: same regimen as above except with the use of NS.</td>
<td>CHG did reduce VAP on day 3 (CPIS =6) among patients who had CPIS &lt;6 at baseline. The incidence of VAP (A) 4.9% (5 of 102) in the CHG group VAP rate 7/1000 vent days (B 11.4% (12 of 105) in the normal saline group VAP rate 21/1000 vent days Oral decontamination with 2% CHG solution was effective at preventing pneumonia in patients who received MV</td>
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Table 2. Quarterly VAP Rates 2007-2012

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Table 3. CHG Compliance per Automated Vent Bundle vs Vent Days and VAP Rates

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<td>111</td>
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<td>0.0%</td>
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<td>41</td>
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Table 4. MD orders for Oral Care vs Order for CHG

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EHRs: Quality Indicator of Outcomes for MV Patients

References


EHRs: Quality Indicator of Outcomes for MV Patients


EHRs: Quality Indicator of Outcomes for MV Patients


Statistics Oral Care. (2014). *CHG compliance versus vent day versus VAP rates, 2010-2012.* [Table]. Retrieved from Infection Control Department, Automated Vent Bundle, and EHR.


