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# Quality Improvement Project: A Comparison of Daily Routine Chest Radiography Versus Clinically-Indicated Chest Radiography in Preventing Ventilator-Associated Pneumonia in Adult ICU Patients on Ventilators: An Evidenced Based Practice Project

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QUALITY IMPROVEMENT PROJECT:  
A COMPARISON OF DAILY ROUTINE CHEST RADIOGRAPHY VERSUS  
CLINICALLY- INDICATED CHEST RADIOGRAPHY IN PREVENTING  
VENTILATOR-ASSOCIATED PNEUMONIA IN ADULT ICU PATIENTS ON  
VENTILATORS: AN EVIDENCED BASED PRACTICE PROJECT

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## **ABSTRACT**

Ventilator-associated pneumonia is one of the critical complications identified by a chest x-ray (CXR). However, there is a controversy about the use of CXRs. Overuse of the CXR has also identified concern among the ICU patient population. The purpose of this evidenced-based practice project was to determine if there were differences in patient outcomes when receiving daily routine CXRs as compared to clinically-indicated CXRs. Patient outcomes measured were: ICU length of stay, complications while on the ventilator and ICU mortality, number of ventilator days, diagnostic efficacy, therapeutic efficacy, costs, and radiation exposure

The author identified 30 articles in the search process. These articles were reduced to 15 after identifying duplicates and applying the inclusion and exclusion criteria. Analysis was performed using an evidence table according to the process developed by Melynk and Fineout-Overholt. Analysis of the research findings from 15 studies that included randomized clinical trials, observational studies, cohort study, cluster randomized crossover study, meta-analysis, blind-peer reviews, and expert opinions revealed moderate support for the use of clinically-indicated CXRs for patients in the ICU on a ventilator. Following the analysis of the literature a retrospective chart audit was performed to determine if practice patterns in my institution matched the recommendations in the literature.

A sample of 60 patient records was drawn from 234 records of patients who were admitted to the medical ICU between June 1, 2014 and August 31, 2014.

The sample was equally divided between men and women who were primarily Caucasian with a mean age of 59.3. The most common admitting diagnoses were: ventilator dependent respiratory failure, sepsis, and chronic obstructive pulmonary disease. Patient outcomes were measured using a researcher developed chart audit tool. Analysis of the chart audit data revealed that in a three month period only one patient was treated with the clinically-indicated CXR regimen. The recommendation is that the professional practice group should begin discussion regarding the development of a policy and procedure in order to differentiate between patients who need daily routine versus clinically-indicated CXRs for improved outcomes and adherence to the current evidence.

## TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	ii
ABSTRACT.....	iii
LIST OF TABLES.....	vii
LIST OF FIGURES.....	viii
LIST OF ABBREVIATIONS.....	ix
CHAPTER I: – INTRODUCTION.....	1
Description of Clinical Problem.....	2
Scope of Problem.....	5
Analysis of Current Practice Guidelines/ Documented Need for Change.....	7
Discussion of Practice Innovation/Best Practice to Address Problem.....	9
Statement of Problem/Purpose.....	9
Summary.....	12
CHAPTER II: - REVIEW OF THE LITERATURE.....	13
Search Process.....	13
Analysis of the Evidence.....	14
ICU Length of Stay.....	15
Complications While on the Ventilator & ICU Mortality.....	19
Number of Ventilator Days.....	21

Diagnostic Efficacy.....	25
Therapeutic Efficacy.....	28
Costs.....	30
Radiation Exposure .....	31
Synthesis of Findings.....	33
Discussion of Potential Barriers/Supports for Adoption of Practice Innovation.....	34
CHAPTER III: - METHODS.....	35
Design .....	35
Participants & Setting.....	35
Instruments.....	37
Procedure .....	37
Protection of Human Subject Health Information .....	38
Data Analysis .....	39
Summary.....	41
CHAPTER IV: - RESULTS .....	41
Description of Sample.....	41
Analysis of the Evidence-Based Practice Question .....	43
Summary.....	44
CHAPTER V: - DISCUSSION .....	45
Introduction.....	45
Recommendations for Practice .....	45
Recommendations for Policy Development .....	46
Recommendations for Research .....	46
Recommendations for Education.....	47



Summary .....	47
REFERENCES .....	48
APPENDIX A: EVIDENCED TABLE .....	51
APPENDIX B: Hierarchy of Evidence –Rating System .....	55
APPENDIX C: CITI Training .....	56

## LIST OF TABLES

Table 1.1 PICOT Definitions.....	10
Table 2.1 Hierarchy of Evidence .....	15
Table 2.2 Quality Level of the Articles Measuring Length of ICU Stay.....	16
Table 2.3 Quality Level of Articles Measuring Complications While on the Ventilator .	19
Table 2.4 Quality Level of the Articles Measuring Number of Ventilator Days .....	22
Table 2.5 Quality Level of the Articles Measuring Diagnostic Efficacy .....	26
Table 2.6 Quality Level of the Articles Measuring Therapeutic Efficacy.....	28
Table 2.7 Quality Level of the Costs .....	30
Table 2.8 Quality Level of the Radiation Overexposure .....	32
Table 2.9 Final Synthesis of the Literature .....	34
Table 3.1 Data Analysis.....	41
Table A.1 Evidence Table.....	51
Table B.1 Hierarchy of Evidence – Rating System .....	55

**LIST OF FIGURES**

Figure 1.1 VAP Pathogenesis Factors .....4

## LIST OF ABBREVIATIONS

APRN.....	Advanced Practice Registered Nurse
CDC .....	Center For Disease Control And Prevention
CXR.....	Chest X-Ray
ICU.....	Intensive Care Unit
LOS.....	Length of Stay
MV.....	Mechanical Ventilation
NHSN.....	National Healthcare Safety Network
OR.....	Odds Ratio
USC.....	University of South Carolina
RCT.....	Randomized Clinical Trial
SBT .....	Spontaneous Breathing Trial
SD .....	Standard Deviation
WMD.....	Weighted Mean Difference

## **CHAPTER 1- INTRODUCTION**

Eighty-six percent of nosocomial pneumonias are associated with mechanical ventilation and are termed ventilator-associated pneumonia (VAP). According to the Center for Disease Control and Prevention (CDC) (2014) more than 300, 000 patients receive mechanical ventilation in the United States every year. These patients are at high risk for complication and poor outcomes, including death (CDC, 2014). Complications of VAP can lead to longer stays in the Intensive Care Unit (ICU) and hospital, longer duration of mechanical ventilation, increased risk of disability and death, and increased healthcare costs (CDC, 2014). Mortality in patients with acute lung injury on mechanical ventilation has been estimated to range from 24% in persons 15-19 years of age up to 60% for patients 85 years and older (CDC, 2014).

The National Healthcare Safety Network (NHSN) is the nation's most widely used healthcare-associated infection (HAI) tracking system (CDC, 2014). CDC (2014) further reports that NHSN provides facilities, states, regions, and the nation with data needed to identify problem areas, measure progress of prevention efforts, and ultimately eliminate HAIs. The Centers for Medicaid and Medicare (CMS) has partnered with the NHSN in an effort to report and track such a hospital inpatient quality reporting program. For the year 2010, NHSN facilities reported more than 3,525 VAPs, and the VAP incidence for various types of hospital units ranged from 0.0-5.8 per 1,000 ventilator days (CDC, 2014).

Chest Radiographs (CXR) are a common intervention used in the ICU to visualize and diagnose VAP. However, there has always been a concern about the overuse of diagnostic studies such as the CXR for patients who are mechanically ventilated in the ICU setting secondary to various adverse outcomes including costs (Oba & Zaza, 2010). There has also been a concern regarding the dose of radiation that is associated with the overuse of CXRs (Oba & Zaza, 2010). This problem is of special concern in the ICU because current standard practice is for patients to receive a CXR routinely on a daily basis (Prat, 2009).

The purpose of this evidenced-based practice project is to compare daily routine CXR versus clinically-indicated CXR in preventing VAP in adult ICU patients' on ventilators. The goal of this project is to determine if daily routine CXRs produce better patient outcomes than clinically-indicated CXRs. Chapter 1 presents a description of the problem, scope of the problem, documented need for analysis of current practice guideline (i.e. documented need for change), discussion of practice innovation (i.e. best practice to address the problem), statement of the problem/ purpose, and summary.

### **Description of the Problem**

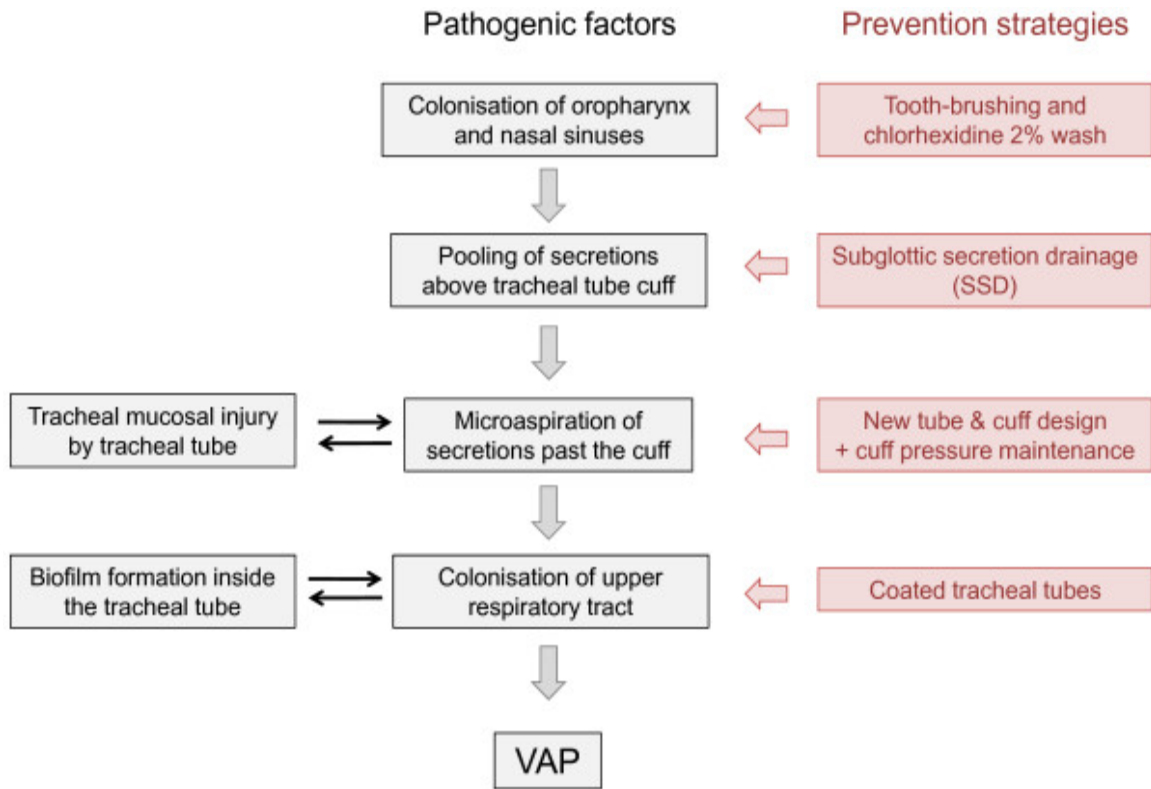
Ventilator-associated pneumonia is defined as an airway infection that develops more than forty-eight hours after a patient is intubated (Ibrahim, Hill, Fraser, & Kollef, 2001). Ventilator-associated pneumonia arises when there is bacterial invasion of the pulmonary parenchyma in a patient receiving mechanical ventilation (Coffin, et al., 2008).

There are common diagnostic tests such as a CXR that are performed in acute care settings to help visualize and manage a patient's pulmonary status.

Patients that require intubation and mechanical ventilation in the ICU are especially in need of diagnostic test such as the CXR. The CXR has allowed intensivists healthcare providers to directly assess endotracheal tube positioning for adequate oxygenation and ventilation via the pulmonary system (Siela, 2002). A daily CXR may also provide a non-invasive internal visualization of the pulmonary tree including the trachea, right and left lung fields, cardiac silhouette, mediastinum, diaphragm, pulmonary arteries, bony structures, and line placement (Siela, 2002).

Ventilator-associated pneumonia is one of the critical complications identified by a CXR. This evidenced-based practice project will focus on identifying assessment variables and or outcomes that determine clinical significance of daily routine CXRs, and to also identify the best practices for prevention of VAP with use of the CXR.

The clinical characteristics that lead to VAP include: inoculation of the formerly sterile lower respiratory tract (typically arising from aspiration of secretions), colonization of the aero-digestive tract, or use of contaminated equipment or prescribed medications (Coffin, et al., 2008). Risk factors for VAP also affect the incidence of ventilator-associated events (VAE) in the adult medical ICU patient population. Therefore complications of VAP are termed (VAEs). See Figure 1.1 below which illustrates the pathogenesis factors for VAP:



*Figure 1.1.* VAP Pathogenesis Factors. Reproduced with permission from Zolfaghari and Wyncoll  
*Critical Care* 2011 15:310 doi:10.1186/cc10352,  
<http://ccforum.com/content/15/5/310/figure/F1?highres=y>:



Coffin et al. (2008) reported risk factors for VAP to include prolonged intubation, enteral feeding, witnessed aspiration, paralytic agents, underlying illness, and extremes of age such as the older adult. Other risk factors of concern identified for VAP risk factors included: overall health status and comorbid health conditions. Pre-existing conditions that increase the risk for VAP in intubated and mechanically ventilated patients include smoking and various microbial pathogens including *pseudomonas* species and other highly resistant *gram-negative bacilli*, *staphylococci*, *enterobacteriaceae*, *streptococci*, and *haemophilus* species (Park, 2005). Antibiotic-resistant pathogens such as *pseudomonas* and *acinetobacter* species and methicillin-resistant strains of *staphylococcus aureus* are much more common after prior antibiotic treatment or prolonged hospitalization or mechanical ventilation, and when other risk factors are present (Park, 2005). The bacterial pathogens responsible for VAP also vary depending on patient characteristics and in certain clinical circumstances, such as in acute respiratory distress syndrome (ARDS) or following tracheotomy, traumatic injuries or burns (Park, 2005).

Another variable contributing to the debate about daily routine versus clinically-indicated CXRs is radiation overexposure. Radiation overexposure not only affects the patient but also staff members in the surrounding areas. All may be inadvertently exposed to dosages of overdoses of radiation (Prat, 2009).

### **Scope of the Problem**

Pneumonia is the second-most-common hospital-acquired infection (HAI) in the United States accounting for 17.8% of all hospital-acquired infections and 40,000 to 70,000 deaths per year (Iregui & Kollef, 2001). Healthcare-associated pneumonia (HAP) and VAP are the second-most-common cause of nosocomial infection overall (Rostein et al., 2008).

Also, both HAP and VAP are the most common causes documented in the intensive care unit (Rotstein et al., 2008).

In the adult ICU patient population, the incidence of VAP for various types of hospital units ranged from 0.0-5.8 per 1,000 ventilator days (CDC, 2014). Ventilator-associated pneumonia, sepsis, ARDS, pulmonary embolism, barotrauma, and pulmonary edema are among the complications that can occur in patients receiving mechanical ventilation (CDC, 2014). Such complications can lead to longer duration of mechanical ventilation, longer stays in the ICU and hospital, increased healthcare costs, and increased risk of disability and death.

In the past 20 years, the overall incidence of HAIs in the United States has increased by 36% (Stone, 2009). Annually, approximately 2 million patients suffer from a HAI and an estimated 90,000 of these patients die (Stone, 2009). This statistic ranks HAI as the fifth leading cause of death in acute care hospitals settings (Stone, 2009). CDC (2014) estimated that more than 300,000 patients receive mechanical ventilation every year. Given this staggering statistic referencing VAP mortality, the need for better source control of this clinical phenomenon is critically important.

The Center for Medicaid and Medicare Services (CMS) outlined various indicators for quality healthcare outcomes for patients' in acute care facilities. In addition, and in the interest of promoting high-quality, patient-centered care and accountability CMS (2013) and the Hospital Quality Alliance (HQA) began publicly reporting VAP in June 2008. Publicly reporting these measures increases the transparency of hospital care, provides useful information for consumers choosing care, and assists hospitals in their quality improvement efforts (CMS, 2013).

Ventilator-acquired pneumonia is such a prevalent and important issue that now CMS and HQA are tracking and reporting these events for consumers.

The direct relationship that affects the consumer (i.e. patient) is that of costs. Therefore, another important aspect associated with scope of the problem included identifying the effects of costs associated with ventilated patients with VAP. Factors influenced by VAP included addressing the costs of the daily CXR versus clinically-indicated, costs associated with antibiotic therapy, and average costs of ventilated patients with VAP versus those who do not have VAP.

### **Analysis of Current Practice Guidelines**

#### **Documented Need for Change**

Ganapathy et al. (2012) argued that many providers in the intensive care setting are concerned about the severity of cardiopulmonary illness and complexity of medical intervention. One of the biggest concerns of providers with the consideration of transition to clinically-indicated CXR included risk of patient complications and the risk for mortality in the ICU.

A common mortality indicator scale utilized within the ICU setting is that of the Acute Physiology and Chronic Health Evaluation (APACHE II) score (Kager et al., 2010). This scale can be used to predict a patients' risk for mortality given the patient's chronic medical history, admission diagnosis, and current clinical status. Ganapathy et al. (2012) stated that the frequency of complications such as device malpositioning, pneumothoraces, and cardiac arrhythmias have led to recommended daily routine CXRs for all patients with acute cardiopulmonary problems or receiving mechanical ventilation. Ganapathy et al. (2012) outlined the advantage of daily routine CXR to include prompt detection of complications, and thus, earlier treatment of clinically unsuspected abnormalities, documentation of disease progression or response to therapy, and educational value for trainees.

The use of daily routine versus clinically-indicated CXRs to prevent ventilator associated events such as VAP in ICU patients prompted further investigation by this author. Furthermore, CDC (2013) evidence suggested that CXR findings alone do not accurately identify VAP. CDC (2013) further stated that the subjectivity and variability inherent in CXR technique, interpretation, and reporting make chest imaging ill-suited for inclusion in a definition algorithm to be used for the potential purposes of public reporting, inter-facility comparisons, and pay-for-performance programs.

In contrast, there were various pieces of evidence that supported forgoing the daily routine CXR approach and focusing on a clinically-indicated CXR. First, Prat (2009) stated that radiology departments likely have little incentive to abandon the practice of daily routine CXRs as each radiograph taken generates revenue for the radiology department and the radiologist interpreting it. Second, there is a strongly engrained practice culture of the daily CXR in the ICU (Oba and ZaZa, 2010). Critical care providers are ordering daily CXR as a precaution to assure that potential complications are not missed. However, an abundance of authors argued that outcomes are the equitable for patients who receive daily routine CXRs or clinically-indicated CXRs (Clec ‘h et al., 2008; Fishman & Primack, 2005; Ganapathy, et al., 2012; Graat, et al., 2005; Graat, et al., 2006; Gratt et al., 2007; Kager et al., 2010; Krivopal et al., 2003; Kroner et al.,2008; Hejblum et al., 2009; Hendriksen,2007; Magill, et al., 2013; Oba & ZaZa, 2010; Prat, 2009; Siela, 2002; and Siegel, 2009).

### **Discussion of Practice Innovation/ Best Practice to Address the Problem**

Intensivist health care providers have remained divided over this best practice clinical quandary for many years. There is evidence to support utilization of diagnostic tests to guide the clinician’s interventions and management of intubated and mechanically ventilated patients.

This evidenced-based practice project aims to evaluate both daily routine and clinically-indicated CXR best practice in the prevention of VAP for adult ICU patients on ventilators.

### **Statement of the Problem/ Purpose**

The purpose of this evidenced-based practice project is to determine if daily routine CXRs produce better patient outcomes than clinically-indicated CXRs. The evidence-based practice question is: In the adult ICU patient on the ventilator, is there a difference between daily routine CXRs and clinically-indicated CXRs on patient outcomes of ICU length of stay, complications while on the ventilator, ICU mortality, and number of ventilator days, costs, and radiation exposure? Table 1.1 contains the definitions of population, intervention, comparison, and outcomes as defined by Melynck & Fineout-Overholt.

Table 1.1 PICOT Definitions

Population of Interest	Adult ICU Intubated and Mechanically Ventilated Patient's
Intervention or Issue of Interest	Daily Routine CXRs
Comparison of Interest	Clinically-Indicated CXRs
Outcome Expected	ICU Length of Stay Complication(s) while on the Ventilator & ICU Mortality Number of Ventilator Days Diagnostic Efficacy Therapeutic Efficacy Costs Radiation Exposure
Time for the Intervention to Achieve the Outcome	Time During Hospitalization of The Patient

Definitions

Comparison of Interest: Clinically-indicated CXR in the intubated and mechanically ventilated patient.

Diagnostic Efficacy: The number of CXRs with new or progressive major predefined findings divided by the total number of CXRs obtained.

Intervention or Issue of Interest: Daily routine CXR in the intubated and mechanically ventilated patient.

ICU: Intensive Care Unit

Outcome Expected: Expected outcomes to be evaluated for adult intubated and mechanically ventilated patients' include: ICU length of stay, complications while on the ventilator & ICU mortality, number of ventilator days, diagnostic efficacy, therapeutic efficacy, costs, and radiation exposure.

## Outcome Definitions

ICU length of stay: The total number of patient days in the intensive care unit.

Complications while on the ventilator and ICU mortality: Ventilator complications can lead to longer duration of ICU stay, increased risk of disability and death, tube dislodgement, and increased healthcare costs.

Number of ventilator days: The total number of days the patient is mechanically ventilated.

Diagnostic efficacy: Is used as an indicator of the value of the CXR to assist in the development of a diagnosis by a clinician. Diagnostic efficacy includes the total number of CXRs with new or progressive predefined findings divided by the total number of CXRs obtained (Kager et al. (2010).

Therapeutic efficacy: Is any intervention that includes changes in antibiotic therapy, bronchoscopy, administration or change in diuretic therapy, thoracentesis, and repositioning of endotracheal tube and lines (Clec 'h et al (2008).

Costs: The total monetary amount billed for each ICU patient CXR.

Radiation exposure: The total amount of radiation associated with CXR.

Population of Interest: Adult ICU intubated and mechanically ventilated patient > 18 years of age. The gender includes male or female patients' requiring continuous ventilation for a specific health problem.

Time for intervention to achieve the outcome: Includes the amount of time the patient requires for the hospitalization.

Mechanical Ventilation: A form of continuous ventilation for extrinsic oxygenation as measured by breaths per minute, volume in CC of breath per breath, and percent of oxygen per breath.

## Summary

The next step in the evidenced-based practice process is the literature search to obtain the evidence to answer the evidenced-based practice question. The evidence will be organized using an evidence table. This process is explained in detail in chapter II. Also, the evidence will be analyzed by the author.

In conclusion, the goal of this evidenced-based practice project is to determine the best method for preventing VAP in mechanically ventilated patients regarding the utility of daily routine versus clinically-indicated CXRs in patients on ventilators. Complications such as ventilator-acquired events (VAE) and subsequent VAP can be fatal and are of major concern for the adult ICU intubated and mechanically ventilated patient. This evidenced-based practice projects aim is to compare, contrast and determine the best practice for use of daily routine versus clinically-indicated CXRs for preventing VAP in adult ICU patients on ventilators. Chapter II will provide a review of the literature in an attempt to answer the evidenced-based practice question.



## **CHAPTER II - REVIEW OF THE LITERATURE**

The evidenced-based practice project began with the development of a clinical question using the PICOT format as defined by Melnyk & Fineout-Overholt (2011). Chapter II presents the search process, evidence table, analysis of the literature, and synthesis of the evidence. The purpose of this evidenced-based practice project is to determine if daily routine CXRs produce better patient outcomes than clinically-indicated CXRs. The evidence-based practice question is: In the adult ICU patient on the ventilator, is there a difference between daily routine CXRs and clinically-indicated CXRs on patient outcomes of ICU length of stay, complications while on the ventilator, ICU mortality, number of ventilator days, costs, and radiation exposure?

### **Search Process**

The search process began with seven electronic databases appropriate for this project. The databases were CINAHL, University of South Carolina (USC) Powersearch, MEDLINE OVID, PUBMED, Web of Science, Cochrane Database, and National Guidelines Clearinghouse. The search used the concepts from the PICOT definitions: critical care, daily routine, clinically-indicated, CXR, intensive care unit, patient outcomes, financial impact, mechanical ventilation, diagnostic efficacy, therapeutic efficacy, and radiation exposure. The search process used an expanded version of the PICOT definitions to find the broadest possible literature that might contain information pertinent to this evidenced-based practice question. These terms included: intensivist, adverse effect, and patient safety.

The author identified a number of selection criteria in order to determine literature that would answer the evidenced-based practice question. All articles were in English and within the last 10 years, 2003-2013. Articles were excluded if they pertained to children or did not meet the PICOT definitions. The next step in the search process involved a systematic search to identify the best evidence to answer the evidence-based practice question. The search revealed a combination of thirty randomized clinical trial articles, observational studies, cohort study, cluster randomized crossover study, meta-analysis, blind-peer reviews, and expert opinion articles. Patient outcomes measured were: ICU length of stay, complications while on the ventilator and ICU mortality, number of ventilator days, diagnostic efficacy, therapeutic efficacy, costs, and radiation exposure. CINAHL produced the most relevant articles. The articles were reduced from 30 to 15 by eliminating duplicates and applying the inclusion and exclusion criteria.

### **Analysis of the Evidence**

The first step in analysis was to organize and analyze the evidence. The evidence was organized using an evidence table described by Melnyk & Fineout-Overholt (Appendix A). The categories on the evidence table were reference, quality rating, method, threats to validity / reliability, findings, and conclusion. They proposed a hierarchy of evidence rating system that rated research quality from I-VII with I being the highest quality of evidence and VII being the poorest quality of evidence. The articles were placed in the evidence table in descending order of quality with Level I studies listed first and Level VII studies listed last. Table 2.1 displays the levels and their definitions.

Table 2.1 Hierarchy of Evidence

Level I	Evidence from a systematic review or meta-analysis of all relevant randomized clinical trials (RCT)
Level II	Evidence obtained from well-designed (RCT)
Level III	Evidence obtained from well-designed controlled trials without randomization
Level IV	Evidence from well-designed case-control and cohort studies
Level V	Evidence from systematic reviews of descriptive and qualitative studies
Level VI	Evidence from single descriptive or qualitative studies
Level VII	Evidence from the opinion of authorities and /or reports of expert committees

Melnyk & Fineout-Overholt (2011). *Evidenced-Based Practice in Nursing & Healthcare. A Guide to Best Practice.*

The second step in organizing the articles was to identify specific outcomes measured in the research studies. The outcomes measured included ICU length of stay, ventilator complications and ICU mortality, number of ventilator days, diagnostic efficacy, therapeutic efficacy, costs, and radiation overexposure. The analysis began by focusing on patient outcomes from studies that compared daily routine to clinically-indicated CXRs.

## ICU Length of Stay

Four studies, one level I, one level II, and two levels III, compared daily routine CXR with clinically-indicated CXR on length of stay in ICU for patients on mechanical ventilation. All studies found that elimination of daily routine CXRs did not alter length of stay in the ICU.

Table 2.2 Quality Level of the Articles Measuring ICU Length of Stay

	Level I	Level II	Level III	Level IV	Level V	Level VI	Level VII
<b>Brief Citation</b>	-Oba & ZaZa, (2010)	-Hejblum et al., (2009)	- Gratt et al., (2007) - Hendrikse (2007)				

Oba & ZaZa (2010) conducted a meta-analysis which included eight studies with a total of 7078 identified patients. This study aimed to determine whether abandoning daily routine CXR versus utilization of clinically-indicated CXR would affect patient outcomes such as ICU length of stay. This study was rated a level I. Of the 7078 adult patients, 3429 underwent daily routine CXRs and 3649 had the clinically-indicated CXRs. The authors concluded that there was no statistically significant difference in ICU length of stay with the daily routine versus clinically-indicated CXR group. The weighted mean difference was 0.19 days (95% confidence interval: -0.13, 0.51; p = 0.25). Ultimately, the researchers found that daily routine CXR could safely be eliminated without compromising patient care or increasing length of stay in the ICU.

Hendrikse (2007) conducted a prospective observational study in an adult 10-bed mixed medical surgical ICU of a teaching hospital. This study was rated a level III. He investigated the effects of eliminating daily routine CXR on ICU length of stay. The sample population included data on 1780 daily routine CXRs in 559 hospital admissions. The study period lasted 1-year and was divided into two parts.

The first part of the study focused on other outcomes variables. However the second part of the study focused on ICU length of stay (LOS). The second part of the study revealed 433 CXRs that were obtained in 274 admissions. Of the 559 hospital admissions 486 patients were evaluated. The researcher learned that of the 79 (4.4%) daily routine CXRs versus the 138 (15.2%) of clinically-indicated CXRs only 33 (1.9%) of the daily routine CXRs versus the 162 (17.9%) clinically-indicated CXRs led to a change in ICU length of stay.

The author defined length of stay (LOS) into three different categories. These three categories were: short stay (1-2 days), intermediate stay (3-14 days), and long stay (>14 days). The sample population included 589 patients. According to the author of the 589 patients 349 (61%) had a 1-2 days ICU stay, 179 (32%) had a 3-14 day stay, and 39 (8%) had a greater than or equal to 15 day stay (p-value = <0.001). In conclusion, there was found to be no change in the ICU length of stay between patients who had daily versus clinically-indicated CXRs to prevent VAP.

Hejblum et al. (2009) conducted a cluster-randomized, open-label crossover study where 21 intensive care units from 18 hospitals in France searched to find out if the use of a daily routine or clinically-indicated strategy for CXR was more beneficial. This study was rated level II.

The studies included 967 patients but of those 118 were excluded because they had been receiving mechanical ventilation for less than 2 days. Overall, 424 patients had 4607 daily routine CXRs and 425 patients had 3148 clinically-indicated CXRs. The age range for the daily routine CXR group was 51-74 with a mean age of 61, and the clinically-indicated CXR group ages ranged from 49-74 with a mean of age 63.

The reasons for mechanical ventilation for both sample groups included thoracic diseases such as: acute respiratory distress syndrome (ARDS) or acute lung injury (ALI), pneumonia, acute on chronic respiratory insufficiency, cardiogenic edema, asthma, coma, shock, and postoperative care.

The results of the study supported clinically-indicated CXRs versus daily routine were safe and did not reduce patient quality of care. The study also demonstrated that there were no statistically significant differences between patient lengths of stay to improve with clinically-indicated (13.21%) versus daily routine (13.96%) CXRs for mechanically ventilated patients ( $p < 0.28$ ).

Gratt et al. (2007) performed a 5-month prospective, nonrandomized, controlled study with patients in a 28-bed ICU. The study was divided into two phases. This study was rated a level III. A total of 3894 CXRs were obtained from 754 patients in phase one which included 2457 daily routine CXRs and 1437 clinically-indicated CXRs (Gratt, 2007). A total of 1267 CXRs were obtained from 622 patients in phase two. The study involved 2,457 participants who received daily routine CXR and 1,437 participants who received clinically-indicated CXR (Gratt, 2007). In phase 1, patient outcomes were measured for 5 months before the CXR intervention was implemented.

Phase 2 began one month after phase 1 concluded. In phase 2, participants received either daily routine CXRs or clinically-indicated CXRs as determined by their healthcare providers over 5 months.

The researchers found that not only did the number of CXRs per patient per day decline from 1.1 days +/-0.3days to 0.6 days+/-0.4 days (p<0.05), but also there was no statistically significant difference in the phase one versus phase two participants on length of stay in ICU. Overall, daily routine CXRs did not reduce length of ICU stay as an effective patient management in the prevention of VAP.

### **Complication While on the Ventilator and ICU Mortality**

Three studies, two level I and one level III, compared daily routine CXR with clinically-indicated CXR on complications and ICU mortality for patients on mechanical ventilation. All studies found that elimination of daily routine CXRs did not change complication rate or ICU mortality.

Table 2.3 Quality Level of the Articles Measuring Complications While on the Ventilator and ICU Mortality

	<b>Level I</b>	<b>Level II</b>	<b>Level III</b>	<b>Level IV</b>	<b>Level V</b>	<b>Level VI</b>	<b>Level VII</b>
<b>Brief Citation</b>	- Ganapathy, et al., (2012) - Oba & ZaZa, (2010)		- Kagere et al., (2010)				

Ganapathy, Adhikari, Spiegelman, and Scales (2012) presented a meta-analysis on the necessity of routine CXR in the intensive care unit. This study was categorized at the highest rating of I. The purpose of this meta-analysis was to review the utility of one of the most frequent radiological diagnostic tests performed in the intensive care setting. The meta-analysis determined potential patient risks and complications for mechanically ventilated patients.

Ganapathy et al. (2012) argued that many providers in the intensive care setting are concerned about the severity of cardiopulmonary illness and complexity of medical intervention. One of the biggest concerns of providers included mechanically ventilated patient complications and the risk for mortality in the ICU.

Ganapathy et al. (2012) stated that the frequency of complications such as device malpositioning, pneumothoraces, and cardiac arrhythmias have led to recommended daily routine CXRs for all patients with acute cardiopulmonary problems or receiving mechanical ventilation. Ganapathy et al., (2012) outlined the advantage of daily routine CXR to include prompt detection of complications and thus earlier treatment of clinically unsuspected abnormalities, documentation of disease progression or response to therapy, and educational value for trainees.

In this meta-analysis, nine studies were included for a total of 39,358 CXRs conducted on 9,611 patients from the United States, Canada, France, The Netherlands and Germany (Ganapathy et al., 2012). Pooled data showed that the primary outcome of ICU mortality did not demonstrate a statistical significance between clinically-indicated and daily routine CXR groups on ventilator complications and ICU mortality (95% CI 0.84 to 1.28), (p value = 0.72).



Results were also similar between groups for hospital mortality (95% CI 0.68 to 1.41), (p value = 0.91). Ganapathy et al. (2012) concluded that the meta-analysis did not detect any statistically significant differences in mortality between daily routine CXRs and clinically-indicated CXRs.

Oba & ZaZa (2010) conducted a meta-analysis which included eight studies with a total of 7078 patients. This study aimed to determine whether abandoning daily routine CXR versus utilization of clinically-indicated CXR would affect patient outcomes such as ICU mortality. This study was rated a level I. Of the 7078 patients 3429 underwent daily routine CXRs and 3649 had the clinically-indicated CXRs. The study found that there was no statistically significant difference in ICU mortality in the daily routine versus clinically-indicated CXR group pooled analysis of 0.92 odds ratio (OR) with a 95% (confidence interval: 0.76, 1.11; (p =0.4) for this outcome. The study found that elimination of daily routine CXR did not affect ICU mortality.

Kager, et al. (2010) conducted a prospective nonrandomized controlled study regarding the value of routinely obtained radiographs for a medical-surgical ICU. The study was rated a level III. The study took place over a 10 month period in a 28-bed mixed medical-surgical ICU. The sample population included a total of 1081 patients of which 854 were daily routine and 227 were clinically-indicated. The study found that complications such as loss of orotracheal tubes or indwelling catheters may cause hemodynamic deterioration and in fact may induce more pain and anxiety of critically-ill patients (Kager et al., 2010).

## Number of Ventilator Days

There were three level II and one level III study that compared routine daily CXR and clinically-indicated CXR on days of mechanical ventilator. In patients on ventilators, both of these studies had no statistically significant difference between groups on days of mechanical ventilation. One level III study drew the same conclusion. The researcher cautioned that the sample was too small to conclude anything.

However, the finding is consistent with the two level II studies. All studies found that elimination of daily routine CXRs did not change number of ventilator days.

Table 2.4 Quality Level of the Articles Measuring Number of Ventilator Days

	Level I	Level II	Level III	Level IV	Level V	Level VI	Level VII
<b>Brief Citation</b>		<ul style="list-style-type: none"> <li>- Clec "h et al., (2008)</li> <li>- Krivopal et al., (2003)</li> <li>- Hejblum et al., (2009)</li> </ul>	-Graat, et al., (2006)				

Clec'h, et al. (2008) conducted a level II randomized controlled trial comparing daily routine CXR with clinically-indicated CXR on days of mechanical ventilation. The randomized study population included 165 patients who were mechanically ventilated for 48 hours or more. The sample included 372 patients. 191 patients were deemed eligible and the remaining 26 were excluded because of: length of mechanical ventilator days less than 48 hours, reintubation, therapeutic limitation and tracheostomy (Clec'h, et al. 2008).

After meeting the selection criteria 165 patients were selected to participate in the study. Eighty-four patients were assigned to the daily routine CXR group and 81 were assigned to the clinically-indicated CXR group. The number of days of mechanical ventilation of those receiving daily routine CXRs was approximately 9.7 days versus 9.8 days for those patients in the clinically-indicated CXR group.

Clec'h et al. (2008) found no statistically significant difference in the number of ventilator days when comparing daily routine versus clinically-indicated CXR ( $p = 0.94$ ). The author recommended that a rational use of CXRs be based on clinical judgment and evaluation by the clinical provider.

Krivopal et al. (2003) performed a level II randomized observational study comparing daily routine CXR and clinically-indicated CXR on length of mechanical ventilation. There were 94 participants who were hospitalized in medical ICU. 94 patients were evaluated over a 10-month period. A total of 293 CXRs were obtained from 43 patients in the routine arm of the study (Krivopal et al. (2003). These included 200 daily routine CXRs and 93 clinically-indicated CXRs.

In the non-routine arm of the study there were 226 CXRs acquired from 51 patients (Krivopal et al. (2003). The mean age for the routine arm was 64.3 years and non-routine arm 61.5 years of age (Krivopal et al. (2003). Major co-morbidities for the routine arm group included: cardiac (35), pulmonary (13), renal (7), endocrine (14), and neurologic (11) (Krivopal et al. (2003). Major co-morbidities for the non-routine arm included: cardiac (35), pulmonary (15), renal (9), endocrine (13), and neurologic (11) (Krivopal et al. (2003). The mean time on the ventilator for the daily routine CXR group was 7.93 days +/-5.64 days in comparison to 6.76 days +/-4.03 days of the clinically-indicated CXR group. The difference was not statistically significant ( $p=0.2606$ ). The researchers concluded that it would be more prudent to use clinically-indicated CXRs as this approach was equitable in outcomes on number of ventilator days (Krivopal et al., 2003).

Hejblum et al. (2009) conducted a cluster-randomized, open-label crossover study where 21 intensive care units from 18 hospitals in France searched to find out if the use of a daily routine or clinically-indicated strategy for CXRs was more beneficial. The study was rated a level II. The study included 967 patients but of those 118 was excluded because they had been receiving mechanical ventilation for less than 2 days. Overall, 424 patients had 4607 daily routine CXRs and 425 patients had 3148 clinically-indicated CXRs. The age range for the daily routine CXR group was ages 51-74 with a mean of 61, and the clinically-indicated CXR group ages ranged from 49-74 with a mean of 63. The reasons for mechanical ventilation for both sample groups included thoracic diseases such as: acute respiratory distress syndrome (ARDS) or acute lung injury (ALI), pneumonia, acute on chronic

respiratory insufficiency, cardiogenic edema, asthma, coma, shock, and postoperative care. The study demonstrated that patients with clinically-indicated CXRs in the ICU versus daily routine CXRs were found to have fewer days of mechanical ventilation (p value = 0.009).

In addition, Graat et al. (2006) performed a prospective observational study in a 28-bed, mixed medical-surgical ICU of a university hospital. This study was rated a level III. The purpose of the study was to determine if daily routine CXRs could be replaced with clinically-indicated CXR. The study period was over 5 month duration, and 2,457 daily routine CXRs were completed in 754 consecutive ICU patients. Demographic data for the 754 patients included an average age of 59.8 years, and the reason for admission to the ICU included: large atelectasis (>2 lobes), large infiltrates (>1 lobe), severe pulmonary congestion, severe pleural effusion, pneumothorax/pneumomediastinum, and malposition of the orotracheal tube. The researchers found that days of mechanical ventilation was not influenced by the elimination of daily routine CXRs. The data revealed that of 754 patients a total of 3,894 CXRs were completed.

Of these 3,894 CXRs 2,457 were categorized as daily routine (63.1%) and the remaining as clinically-indicated (Graat et al. (2006). Graat et al. (2006) went on to show that the sensitivity and specificity of the clinicians in predicting changes on daily routine CXR were 2.1% (3/145) and 99.3% (2296/2312) respectively. In addition, Graat et al. (2006) stated that “although sensitivity improved with those CXRs that were categorized as clinically-indicated CXRs (21% [8/38]), specificity dropped to 59% (167/283). However, the study population was small and; therefore,

the researchers expressed caution about drawing any conclusions. Gratt et al. (2006) stated that there is a need for not only additional studies, but also additional studies with a different case-mix before results can be generalized to all types of ICU settings and ICU patients.

### **Diagnostic Efficacy**

Two studies, one level II and one level III, compared daily routine CXR with clinically-indicated CXR on diagnostic efficacy for patients on mechanical ventilation. One of these studies was randomized which increased confidence in the findings. Both studies found that elimination of daily routine CXRs did not change diagnostic efficacy. The researcher cautioned that the samples were too small to conclude anything.

Table 2.5 Quality Level of the Articles Measuring Diagnostic Efficacy

	Level I	Level II	Level III	Level IV	Level V	Level VI	Level VII
<b>Brief Citation</b>		-Clec'h et al., (2008)	-Kager et al.,(2010)				

Clec'h et al. (2008) also conducted a randomized control trial to determine if daily routine CXRs are useful in mechanically ventilated patients. 191 patients were deemed eligible and the remaining 26 were excluded because of: length of mechanical ventilator days less than 48 hours, reintubation, therapeutic limitation and tracheostomy (Clec'h, et al. 2008. After meeting the selection criteria 165 patients were selected to participate in the study. Eighty-four patients were assigned to the daily routine CXR group and 81 were assigned to the clinically-

indicated CXR group. As stated in a previous outcome, this study was categorized as a rating of level II. Clec'h et al. (2008) aimed to compare the diagnostic efficacy of a clinically-indicated CXR with that of a daily routine CXR. The diagnostic findings of the daily routine group revealed that most daily CXRs were not helpful with diagnostic efficacy. Of 885 CXRs obtained, only 64 revealed new findings. New diagnostic findings on daily routine CXRs accounted for 66% versus clinically-indicated CXRs 7.2% ( $p < .0001$ ). In conclusion, the researcher found that clinically-indicated CXRs in mechanically ventilated patients were associated with better diagnostic efficacy without impairing patient outcomes.

Kager et al. (2010) conducted a prospective nonrandomized study. This study was categorized as a level III. The study included patients from a 28-bed mixed medical-surgical university-affiliated ICU setting.

The demographics of the sample population included an average of 62 (Kager et al. (2010). Further demographics of the patient population included medical patients (including cardiology and pulmonary disease patients), surgery patients (including trauma patients), orthopedic surgery and urology patients), cardiothoracic surgery patients, and neurology patients (including patients after neurosurgery) (Kager et al (2010). Throughout the study, diagnostic efficacy of daily routine versus clinically-indicated use of CXRs was assessed.

Diagnostic efficacy included the number of CXRs with new or progressive major predefined findings divided by the total number of CXRs obtained. Diagnostic efficacy was also used as an indicator of the value of the CXR to assist in development of a diagnosis either by the intensivist clinician or the radiologist.

Examples of diagnostic efficacy documented in the study included: large atelectasis, large infiltrates severe pulmonary congestion, massive pleural effusion, pneumothorax or pneumo-mediastinum or malposition of invasive devices (Kager et al., 2010).

The findings revealed that during the 10-month period, 5067 CXRs were obtained in 1330 patients. Of these CXRs, 1081 were admission CXRs within 6 hours of admission to the ICU. Major abnormalities were defined as: large atelectasis, large infiltrates severe pulmonary congestion, massive pleural effusion, pneumothorax or pneumo-mediastinum, and malposition of invasive devices. Kager et al, (2010) showed that the majority of routinely obtained CXRs did not reveal any new predefined major abnormalities. Kager et al. (2010) defined major abnormalities as large atelectasis (>2 lobes) 5 (0.6%), large infiltrate (>1 lobe) 10 (1.2%), severe pulmonary edema 18(2.1%), massive pleural effusion 11 (1.3%), pneumothorax or pneumomediastinum 11 (1.3%), or malposition of invasive device 70 (8.2%). Of 854 routine CXRs, 14% or 117 CXRs demonstrated a major abnormality. This researcher went on to illustrate that the incidence of potentially clinically relevant abnormalities on routinely obtained admission CXRs was low.

### **Therapeutic Efficacy**

Two studies, one level II and one level III, compared daily routine CXR with clinically-indicated CXR on therapeutic efficacy for patients on mechanical ventilation. All studies found that elimination of daily routine CXRs did not change therapeutic efficacy in the ICU. One of these studies was randomized.



Table 2.6 Quality Level of the Articles Measuring Therapeutic Efficacy

	Level I	Level II	Level III	Level IV	Level V	Level VI	Level VII
<b>Brief Citation</b>		-Clec ‘h et al., (2008)	-Kager et al., (2010)				

Clec ‘h et al. (2008) also presented data on the therapeutic efficacy of daily routine CXRs versus clinically-indicated CXRs. This study was rated at level II. 191 patients were deemed eligible and the remaining 26 were excluded because of: length of mechanical ventilator days less than 48 hours, reintubation, therapeutic limitation and tracheostomy (Clec’ h, et al. 2008). According to Clec’ h, et al. (2008) there was no statistical difference with regard to age, gender, severity source, and reason for intubation. After meeting the selection criteria 165 patients were selected to participate in the study. Eighty-four patients were assigned to the daily routine CXR group and 81 were assigned to the clinically-indicated CXR group. Clec’ h et al. (2008) aimed to compare the diagnostic efficacy of a clinically-indicated CXR with that of a daily routine CXR.

According to the study by Clec ‘h et al. (2008) of the 94 clinically-indicated CXRs, 53 revealed new findings important enough to prompt therapeutic intervention. Therapeutic intervention included changes in the following: antibiotic therapy, bronchoscopy, administration or change in diuretics/ dobutamine, thoracentesis, and repositioning of endotracheal tube and lines. Of the 885 CXRs obtained in the daily routine group, only 49 revealed a new finding important enough to prompt therapeutic intervention. Therapeutic intervention statistical data for the daily routine CXR group included: antibiotic therapy (34), bronchoscopy (9),

administration or change in diuretics/ dobutamine (5), and thoracentesis (5). Clec'h et al. (2008). Statistical data for the clinically-indicated group included a total of 94 studies with 53 new findings which include: antibiotic therapy (29), bronchoscopy (11), administration or change in diuretics/ dobutamine (5), and thoracentesis (4).

Kager et al. (2010) conducted a prospective nonrandomized study. This study was categorized at a rating of III. Demographics of the sample include a total of 854 patients. The average age was 62 years of age, and most patients had medical, general surgery, cardiothoracic surgery, or neurosurgery as an admitting diagnosis Kager et al. (2010). Study findings indicated that approximately one-third of routinely obtained admission CXRs with a new predefined major abnormality revealed clinically relevant information (i.e. atelectasis, infiltrate, pneumonia, pleural effusion, pneumothorax/ pneumomediastinum, or malpositioning of tubes or lines) Kager et al. (2010). Of the 40 CXRs, 4% of all admission CXRs, 5% of all routinely obtained CXRs, and 34% of routinely obtained chest x-rays with a predefined major abnormality resulted in a change in therapy. Kager et al. (2010) found that therapeutic efficacy resulted in a change in therapy very minimally out of the 854 daily routine CXRs. Incidence of change in therapeutic efficacy is due to: large atelectasis 1(0.1%), large infiltrate 6 (0.5%), severe pulmonary congestion 2 (0.2%), massive pleural effusion 4 (0.5%), pneumonthorax/ pneumomediastinum 5 (0.6%), malposition of invasive devices 30 (3.5%), and total number of CXRs with new abnormalities 40 (4.7%) Kager t al. (2010). While 40% is high, the research doesn't determine if those patients would have been diagnosed with a clinically-indicated CXR.

## Costs

Two studies, one level I and one level III, compared daily routine CXR with clinically-indicated CXR on costs of ICU patients on mechanical ventilation. All studies found that elimination of daily routine CXRs did decrease costs in the ICU.

Table 2.7 Quality Level of the Articles Measuring Costs

	Level I	Level II	Level III	Level IV	Level V	Level VI	Level VII
<b>Brief Citation</b>	-Oba & ZaZa, (2010)		- Hendrikse (2007)				

Oba & ZaZa (2010) highly debated use of daily routine versus clinically-indicated CXRs. The study by Oba & ZaZa was rated a level I because of its high quality rating. A total of 7078 ICU patients were included in the analysis. Of the 7078, patients 3429 underwent daily routine CXRs and 3649 had the clinically-indicated CXRs. Factors affecting costs included: length of days on mechanical ventilation, length of stay in the ICU, length of stay in the hospital, and risks of potential complications. The researchers concluded that an alternative strategy such as obtaining a CXR only when clinically-indicated would save healthcare costs (Oba & ZaZa, 2010). According to the Institute for Healthcare Improvement (2014), VAP as an estimated costs of \$40,000 to a typical hospital stay.

Hendriske (2007) conducted a prospective observational study in an adult 10-bed mixed medical surgical ICU. This study was rated a level III. This study collected 1780 daily routine CXRs. The sample population included data on 1780 daily routine CXRs in 559 hospital admissions. The study period lasted 1-year and was divided into

two parts. The first part of the study focused on outcome variables such as costs. However the second part of the study focused on other outcome variables. A total CXR volume reduction of 35% which equaled \$9,900 per bed per year was documented by the author of this study, however the total number of beds was not revealed. Conversely, they found a 50% decrease in the total number of CXRs per patient per day. In the study, a change of practice to clinically-indicated CXRs resulted in a savings of \$100,000/year.

### **Radiation Exposure**

Three studies, one level I, one level three, and one level IV, compared daily routine CXR with clinically-indicated CXR on radiation overexposure for patients on mechanical ventilation. All studies found that elimination of daily routine CXRs did change radiation overexposure in the ICU.

Table 2.8 Quality Level of the Articles Measuring Radiation Overexposure

	Level I	Level II	Level III	Level IV	Level V	Level VI	Level VII
<b>Brief Citation</b>	-Oba & ZaZa, (2010)		- Hendriske, (2007)	-Prat, (2009)			

In the meta-analysis by Oba and ZaZa (2010), the researchers sought to examine whether abandoning daily routine CXRs would adversely affect patient outcomes for missing VAP. Oba and Zaza (2010) examined a total of eight studies with a total of 7078 identified patients. The mean age for the patients was 62.8 years (62.5 for routine CXR group and 63.0 for the clinically-indicated group. The author goes on to say that 95 % of the patients selected were medial (i.e. nonsurgical) and

61% of these patients were mechanically ventilated. The authors did not include specific costs analysis information associated with daily routine versus clinically indicated CXRs. In turn, the researchers found that elimination of daily routine CXRs did not adversely affect outcomes and in terms for missing VAP but did show a decrease in radiation exposure Oba and ZaZa (2010) went on to say that there should be protocols in place to promote clinically-indicated rather than daily routine CXRs to reduce unnecessary radiation exposures for patients and staff.

Hendriske (2007) found a 50% decrease in the total number of CXRs per patient per day. Prat (2009) submitted data on radiation exposure in a retrospective comparative study. The author went on to say that although radiation exposure was decreased with clinically-indicated CXRs versus daily routine x-rays that the problem is likely multi-factorial.

### **Synthesis of Findings**

Of the 15 articles reported for this evidenced-based practice project, none of the studies found a decrease in quality of patient outcomes when using clinically-indicated CXRs versus daily routine CXRs for adult ICU patients on ventilators. The quality of the evidence is moderate and the most compelling findings show that instituting clinically-indicated CXR strategy would not produce adverse patient outcomes.

In other words using clinically-indicated CXRs would not increase patient risk for complication as measured by length of stay, number of ventilator days, complications and mortality. However, diagnostic efficacy and therapeutic efficacy are not as strongly supported in the literature. More research needs to be done on the

formula in accurately representing diagnostic and therapeutic efficacy, and there needs to be validation to measure diagnostic and therapeutic efficacy. Obviously, cost would be reduced if the number of CXRs were reduced.

Table 2.9 Final Synthesis of the Literature

Outcomes	Level I	Level II	Level III	Level IV	Level V	Level VI	Level VII
ICU Length Of Stay	1	2	1				
Complication(s) While on the Ventilator & ICU Mortality	2		1				
Number of Ventilator Days		3	1				
Diagnostic Efficacy		1	1				
Therapeutic Efficacy		1	1				
Costs	1		1				
Radiation Overexposure	1			1			

### **Discussion of Potential Barriers/ Supports for**

### **Adoption of Practice Innovation/ Best Practice**

Upon review of the literature the author of this evidenced-based practice project has identified potential barriers and or supports for adoption of practice innovation for best practice. A readiness assessment was not completed but the barriers identified here included the author’s foresight of various healthcare disciplines within the acute care setting.

These barriers for adoption of practice innovation included provider resistance to change as a daily CXR is routine and engrained into their current practice. Another barrier is staffing. Various healthcare disciplines including both nursing and respiratory therapies assumption that although a daily CXR is not ordered by the clinician the staff is also resistant to change and will order the CXR as they assume that provider would have wanted the diagnostic test. Although there is evidence to change to clinically-indicated CXRs intensivists providers may still be resistant to change current practice.

Support for adoption of practice innovation for best practice includes the effect on patient safety as unnecessary tests are not performed for those who may not need it, and also the cost effectiveness for not obtaining an unnecessary diagnostic test. Changing practice protocol to clinically-indicated CXRs seems promising. Before making this recommendation to ICU staff, the author will do a chart audit of patients in an ICU to determine if those outcomes are supported by the evidence. Outcomes include: ICU length of stay, complications while on the ventilator and ICU mortality, number of ventilator days, diagnostic efficacy, therapeutic efficacy, costs, and radiation exposure. Chapter III contains the description of the chart audit and the data collection process.

## **CHAPTER III - METHODS**

In order to gather more evidence, the author conducted a chart audit of mechanically ventilated patients in ICU practice population to determine if there were any differences in the outcome variables when comparing daily routine to clinically-indicated CXRs. The author also aimed to determine if these differences in the outcome variables affected the prevention of VAP. These outcomes include: ICU length of stay, complications while on the ventilator and ICU mortality, number of ventilator days, diagnostic efficacy, therapeutic efficacy, costs, and radiation exposure.

### **Design**

A descriptive study was used to collect and, improve data outcomes. The population includes medical and cardiovascular ICU patients from a level III trauma facility. More specifically, the descriptive study was done in the form of a retrospective chart audit. Pending IRB approval from the organization and the university the chart audit will commence September 1, 2014, with retrospective chart review.

### **Participants and Setting**

Medical records of patients with respiratory pathology on ventilators in the ICU will be reviewed. Charts were reviewed for 30 patients with daily routine CXRs and 30 patients who have had clinically-indicated CXRs for a total of 60 patients at a North Carolina medical center.



Patients with respiratory pathophysiology criteria inclusion are selected in order to compare patients with similar diagnosis. These patients are also the ones most likely to have ventilator complications such as VAP.

### **Instruments**

The author developed a chart audit tool based on the outcomes identified in the analysis of research findings in Chapter II. The chart audit tool is divided into eleven sections. Section one focuses on subject demographic information. Demographic information includes subject numbers, gender, age, and race. No identifiers will be linked to the patient's name or chart number, or medical record. The second section focused on the subject date of admission, and whether or not the patient was intubated on admission. The third section identified the respiratory pathology for the participant on admission. The fourth section reviewed ICU length of stay. Fifth, the audit tool focused on complications and mortality while on the ventilator in ICU. Sixth, the number of ICU ventilator days was documented. Seventh, diagnostic efficacy was reviewed. Eighth, therapeutic efficacy was obtained. Ninth, cost associated with the number of CXRs was identified. Tenth, the opportunity for radiation overexposure was identified. The final section includes the type of strategy used for the CXR, either daily routine or clinically-indicated.

### **Procedure**

The author collaborated with the Informatics Manager and Informatics Analyst at the institution to identify electronic patient records that met the requirements of the chart audit. After the selected electronic charts were provided from the Informatics Analyst, the author initiated and completed the data collection process.

The author obtained Institutional Review Board (IRB) approval from USC and the regional medical center to conduct the electronic chart review.

The author also worked with the Informatics Manager at her facility to generate a list of patients in the medical ICU that fit the inclusion sample criteria.

The data collected was placed on a secure and encrypted flash drive that was password protected. The password was only known by the author. Next, the author requested a total of 40 charts per day to review during each 8 hour chart audit day. No protected health information was removed from or transferred from the organizations electronic records. The author selected one chart at a time to review and data was extracted to complete according to the audit tool criteria. Next, the information was tracked electronically via the same secure and encrypted flash drive. The data collected was then placed into an excel spreadsheet created by the author. The excel spreadsheet was also maintained only by the author via a secure and encrypted flash drive. The chart audit began with ICU patients starting June 1, 2014 and ending August 31, 2014. No patient identifiers were collected except race, age, and gender.

The author collected, extracted, and trended data via the excel spreadsheet. The author continued to retrospectively collect data until there are 30 patients with daily routine CXRs and 30 patients with clinically-indicated CXRs for a total of 60 patients with similar pathophysiology.

### **Protection of Human Subject Health Information**

IRB approval was obtained from USC and CaroMont Regional Medical Center. This project is a quality improvement evidenced-based practice project and; therefore, organization IRB approval was expedited. Confidential patient health information was protected by collecting data electronically using a secure flash drive and auditing each chart individually and closing out charts immediately after data was collected. There were no patient identifiers on the chart audit tool. Patient names or identification numbers were never associated with data to the patients' electronic medical record. USC IRB committee approval was also expedited as this is retrospective chart audit evidenced-based practice project.

To ensure human subject protection, the CITI Certification (an ethical training program facilitator) was completed by the author (See Appendix C). As previously stated this evidenced-based practice project will be a retrospective chart audit method design. With use of this methodology therefore there was minimal to no harm to project participants.

Prior to undergoing the project, an approval to initiate the project was sought from the Institutional Review Board (IRB) at University of South Carolina. Furthermore, an approved IRB board was utilized prior to undergoing the project within the approved acute care facility at CaroMont Regional Medical Center. The IRB board reviewed the application and made a determination regarding the application. A compliance officer in the office of sponsored programs emailed to the author the approval and exempt status and gave permission to proceed with the

quality improvement project. A copy of the CITI training can be found in Appendix C.

### **Data Analysis**

After a total of 60 patients are audited that met the authors criteria for this evidenced based-practice project the data were analyzed via a statistical analysis system (SAS 9.4). The author took the chart audit tool and created an Excel spreadsheet that included the demographic information, outcome, and CXR variables. The demographic variables were analyzed using measures of central tendency. Descriptive statistics were calculated on the selected variables. Frequency distribution was used to describe for categorical variables. Continuous variables statistics included measure of central tendency (mean and median) and measure of spread (standard deviation and range). The descriptive statistics for main variables were conducted by group.

Simple inferential statistics were used to analyze the differences between groups by outcomes. The statistical procedures were based on the level of data. Table 3.0 displays the outcome variable, measurement from the chart audit, and statistical procedure.

Table 3.1 Data Analysis

Variable	Measurement From Chart Audit	Statistical Procedure
Length of Stay	Number of Days	1-way Anova (comparing 2 groups)
ICU Complication	Number of Complication	1-way Anova
ICU Mortality	Mortality: Yes/No	CHI Square Analysis
Number of Days of Ventilation	Number of Days	1-way Anova
Diagnostic Efficacy	Number of Complication Divided By Number of Days in ICU	Two-Sample Proportion Test
Therapeutic Efficacy	Number of Interventions	1-way Anova
Cost	Cost Facility Charges Per CXR	1-way Anova
Radiation	Number of CXRs	1-way Anova

### Summary

The evidenced based-practice project question was answered using a descriptive study with a chart audit tool. IRB approval from the data collection site and the academic institution were both obtained. Chapter 4 of this evidenced-based practice project will describe the findings of data collection.

## **CHAPTER IV - RESULTS**

### **INTRODUCTION**

The purpose of this project was to determine if there were any differences in patient outcomes with ICU patients on ventilators in the prevention of VAP between those who received daily routine CXRs and those who received clinically-indicated CXRs. The patient outcomes measured were ICU length of stay, complications while on the ventilator, ICU mortality, number of ventilator days, costs, and radiation exposure? Chapter 2 indicated that there were no differences in patient outcomes with VAP but there was significant financial costs savings with clinically-indicated CXRs. A retrospective chart audit of patients in the authors' practice site was conducted to see if those patient outcomes matched the literature findings. Chapter IV provides an analysis of the results from the evidenced-based practice project. Chapter IV is divided into the following sections: description of the sample, analysis of the evidenced-based practice question, additional analysis, and summary.

#### **Description of Sample**

The population of records from which the sample was drawn was generated by a regional hospitals informatics analyst. The hospital analyst, using the chart audit tool as a guide, generated a list of 234 patients admitted to the medical ICU from April 1, 2014 to September 1, 2014. The author began by examining the electronic charts in sequence and selected every chart that met the inclusion criteria.

The sample consisted of 60 records of patients who had been admitted and discharged from an 8-bed medical ICU in a North Carolina regional hospital. All of the patients were on ventilators. The sample was evenly divided between male (30) and females (30). The mean age the sample was 59.3 with a SD (Standard Deviation) of 16.6. The ethnicity in the sample consisted of 54 Caucasian, 5 African American, and 1 other.

The most common reasons for admission to the ICU were: ventilator dependent respiratory failure, sepsis, and chronic obstruction pulmonary disease exacerbation. The mean number of days in the ICU was 4.5 with a SD of 0.8. The mean number of days on the ventilator in the ICU was 4.7 with a SD of 1.6. Data were collected from records of patients hospitalized between June 1, 2014 and August 31, 2014. There were a total of 10 ICU deaths for patients on the ventilator for the duration of this data collection timeframe. The remaining 50 patients transferred either to the post-intensive care unit, another monitored bed unit, or the medical floor.

### **Analysis of the Evidenced-Based Practice Question**

Following the review of the 60 records the author discovered that CXRs for only one patient used the clinically-indicated method. The authors choose to stop data collection because it was clear that the current practice is for all ventilated patients to receive a daily CXR. If only one patient per every three months is ordered to get clinically-indicated CXRs the author would have to go back 20 months or almost two years to have any chance of accruing a clinically-indicated CXR group. The danger in this approach is that the patients would not be homogenous. Policy changes, practice changes, equipment changes, personnel changes, and disease prevalence patterns would make the threat of history inevitable. While the failure to accrue a clinically-indicated CXR group is disappointing the findings are illuminating.

The current accepted practice in the medical ICU does not conform to findings in the literature. This practice pattern is understandable because the following: fear of missing a potential patient complication, fear of a malpractice suit, profit benefit, cost of doing multiple CXRs, tradition, and clinician comfort levels. The challenge for medical ICU providers is to find a balance between excessive costs, radiation overexposure, and patient safety versus provider comfort.

### **Summary**

In the critical care setting the need for diagnostic imaging plays a crucial role in the assessment, and appropriate management of the ICU patient on a ventilator. The chart audit revealed that only one patient was treated using the clinically-indicated CXR approach. Therefore, there needs to be an ongoing discussion regarding the use of daily routine versus clinically-indicated CXRs for patients on ventilators as new knowledge is developed. Chapter five presents recommendations for clinical practice, policy development, research and education.



## **CHAPTER V - DISCUSSION**

### **INTRODUCTION**

The purpose of this project was to determine if there were any differences in patient outcomes with ICU patients on ventilators in the prevention of VAP between those who received daily routine CXRs and those who received clinically-indicated CXRs. The evidence-based practice question is: In the adult ICU patient on the ventilator, is there a difference between daily routine CXRs and clinically-indicated CXRs on patient outcomes of ICU length of stay, complications while on the ventilator, ICU mortality, number of ventilator days, costs, and radiation exposure? A retrospective chart audit of 60 patients on ventilators in the medical ICU was conducted. Only one patient was managed with clinically-indicated CXRs, making it impossible to compare the two groups. Chapter V presents recommendations and implications for practice, policy development, research and education.

#### **Recommendations for Practice**

There is evidence supporting the use of clinically-indicated CXRs for patients on ventilators in the ICU. The practice pattern in the medical ICU at the regional healthcare system did not match the current literature findings. The author reported findings of the retrospective chart audit to the medical ICU director who expressed support for decreasing the number of CXRs that patients on ventilators receive. Members of the intensivist staff were supportive in the reduction of the number of CXRs patients on ventilators receive.

Intensivist colleagues were supportive as well in the development of a practice algorithm. The author has determined that there is a need for practice protocol development for daily routine versus clinically-indicated CXRs. In addition there needs to be an ongoing discussion among critical care providers regarding the need for this change in practice.

Recommendation 1: There is currently enough evidence to change clinical practice.

Recommendation 2: Develop an ongoing dialogue among the professional staff concerning evidence for CXR use.

Recommendation 3: Collect literature regarding indicators for the signs and symptoms of CXRs for patients on ventilators.

Recommendation 4: Develop an algorithm.

### **Recommendation for Policy Development**

Currently the medical ICU has no policy on daily routine versus clinically-indicated CXRs for patients on the ventilator.

Recommendation 1: Develop a policy.

### **Recommendation for Research**

It is possible to have quasi- experimental studies comparing patient outcomes between these two methods of care.

Recommendation 1: Conduct more quasi-experimental studies comparing two methods of care.

Recommendation 2: Test the algorithm developed by the practice group.

## **Recommendation for Education**

Sensitizing the staff to the pros and cons of daily routine CXRs is important. Nursing and radiology staff would need to be included in the process development for identifying indicators for CXR use.

It is important to keep the conversation going between physicians, nurse practitioners, nurses, radiologist, and other staff members so that a transition towards clinically-indicated CXRs may be proposed.

Recommendation 1: Present findings of the evidenced-based practice project to the staff.

Recommendation 2: Involve staff members in the development of clinical indicators for the algorithm.

## **Summary**

The author has identified that there needs to be ongoing discussion regarding the use of daily routine versus clinically-indicated CXRs for patients on ventilators. The main limitation for this quality improvement project included identifying only a small number of patients in the authors practice site that receive clinically-indicated CXRs. Therefore, the evidenced-based practice question is currently unable to be answered. The analysis of the literature revealed that there is no advantage to daily routine CXRs in the prevention of VAP.

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**APPENDIX A**

**EVIDENCE TABLE**

**TABLE A.1 - EVIDENCE TABLE**

<b>Table A.1</b>						
<b>Evidence Table</b>						
<b>Level of Evidence</b>	<b>Reference</b>	<b>Methods</b>	<b>Type of Study/System</b>	<b>Threat to Validity/Reliability</b>	<b>Findings</b>	<b>Conclusion</b>
Level II	(Clec ‘h et al., 2008)	A questionnaire completed.	RCT	Rigorous search and multiple experts reviewing data	The rate of delayed diagnoses in restrictive prescription was 0.7%. Mortality was similar.	Restrictive use of CXR in mv pt’s was assoc. with diagnostic & therapeutic efficacies without impairing outcomes.
Level I	(Ganapathy et al., 2012)	Medline & Embase quantitative review.	Quasi-RCT	Quantitative review	Findings were unclear.	The study did not detect any harm associated with a restrictive CXR strategy
Level I	(Oba & Zaza, 2010)	Systematic review	Meta analysis	Literature Review	Transition to on-demand CXRs, but identify sub-pop’s	Daily routine CXRs could be eliminated without affecting outcomes.

Level II	(Hejblum et al., 2009)	Random assignment	Randomized Cluster- 2 Crossover	Literature Review	32% CXR Reduction w/clinically -indicated.	No reduction in quality of pt care.
Level III	(Hendrikse et al., 2007)	2 part study	Controlled Study	Journal provides strong evidence for practice	Most frequent unexpected abnormalities were: progressive infiltrates, and confirmation tube placem	Value is low and daily routine can safely be eliminated
Level II	(Krivopal et al., 2003)	Random selection	Random Observation Study	Literature Review	No Additional Benefits of Daily CXRs	No reduction in ICU stay, hospital stay or reduced mortality
Level III	(Gratt et al., 2006)	Random Selection	Prospective Observation Study	Not all daily routine CXRs revealed unexpected outcomes	Daily routine CXRs can be eliminated safely.	Daily routine CXRs rarely showed unexpected outcomes.
Level III	(Graat, et al., 2007)	Random Selection	Prospective non-randomized controlled	Study provided information support the research findings	Diagnostic & therapeutic efficacy Values were not increased with daily CXRs	Daily routine does not affect readmission rates, ICU and hospital rate
Level V	(Graat, et al., 2005)	Comparison of 2 groups	Systematic Review	A question was developed to determine a difference between 2 groups.	Found no difference in mean duration, hospital, or ICU length of stay b/t the two groups	Daily routine CXRs are safe, but larger studies need to be done



Level III	(Kager et al 2010)	Random Selection	Nonrandom controlled study	Rigorous search and multiple experts reviewing the evidence	Low incidence of diagnostic therapeutic efficacy of routinely CXRs	Study concluded efficacy of routinely ob admission CXRs is low
Level IV	(Kroner et al., 2008)	University study setting	Cohort study	Clear objective identified ar researcher	Recommend elimination daily routine strategy doesn't affect other diagnostic imaging.	Daily routine CXRs may not affect practice of thoracic imaging in t ICU
Level IV	(Prat, 2009)	Comparison of 2 groups	Comparativ study	Peer review article, however no distinct objective noted	Found reduction of testing i.e. daily routine CXRs had no adverse effect on outcomes	Pt. outcomes should not be affected; the push should be towards on-demand CXRs
Level VII	(Fishman, J, Primack, S.,2005)	Review of the literature	Expert Opinion	Unable to rate the evidence given the expert opinion	Found that CXRs can lead to a change in management	Use of clinically-indicated CXRs is indicated
Level VII	Magill, et al 2013	Tiered approach applied to VAP surveillance	Expert Opinion	Surveillance should be objective, & reliable.	Key stake holders proposed new approaches VAP surveillance adult pt's	Executive summary developed a national approach to surveillance Ventilator-Associated Events

Level VII	(Siela, 2002)	Literature Review	Expert Opinion	Researcher did provide adequate insight into thoracic imaging interpretation	CXRs should be read in a systematic method for accuracy	Important to understand anatomy & physiology in correct interpretation CXRs
Level III	(Siegel, 2009)	Random Selection	Randomized study	Researcher identified no difference in pt outcomes	On-demand CXRs yielded improved pt outcomes without adverse effects.	Forgoing routine CXRs is more beneficial to pt's & decreasing health care costs

**APPENDIX B**  
**RATING SYSTEM**

**Table B.1-HIERARCHY OF EVIDENCE**

Level I:	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCT)
Level II:	Evidence obtained from well-designed randomized controlled trials (RCT)
Level III:	Evidence obtained from well-designed controlled trials without randomization
Level IV:	Evidence from well-designed case-control and cohort studies
Level V:	Evidence from systematic reviews of descriptive and qualitative studies
Level VI:	Evidence from single descriptive or qualitative studies
Level VII:	Evidence from the opinion of authorities and /or reports of expert committees

Melnyk & Fineout-Overholt (2011). *Evidence-Based Practice in Nursing & Healthcare. A Guide to Best Practice.*

**APPENDIX C**

**CITI TRAINING CERTIFICATE**

**CITI Collaborative Institutional Training Initiative**

**Human Research Curriculum Completion Report**

**Printed on 3/31/2010**

**Learner:** Kimberly Howell-McKenney

**Institution:** Winston-Salem State University

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**Contact Information**

**WSSU IRB Members:**

**Stage 1. Basic Course Passed on 09/19/08 (Ref # 2115556)**

<b>Required Modules</b>	<b>Date Completed</b>	
Introduction	09/11/08	no quiz
History and Ethical Principles – SBR	09/11/08	6/7 (86%)
History and Ethical Principles	09/19/08	7/7 (100%)
Defining Research with Human Subjects - SBR	09/19/08	5/5 (100%)
The Regulations and The Social and Behavioral Sciences – SBR	09/19/08	5/5 (100%)
Basic Institutional Review Board (IRB) Regulations and Review Process	09/19/08	5/5 (100%)

Assessing Risk in Social and Behavioral Sciences – SBR	09/19/08	5/5 (100%)
Informed Consent – SBR	09/19/08	4/4 (100%)
Informed Consent	09/19/08	4/4 (100%)
Privacy and Confidentiality – SBR	09/19/08	4/4 (100%)
Social and Behavioral Research for Biomedical Researchers	09/19/08	4/4 (100%)
Records-Based Research	09/19/08	2/2 (100%)
Genetic Research in Human Populations	09/19/08	2/2 (100%)
Research With Protected Populations - Vulnerable Subjects: An Overview	09/19/08	4/4 (100%)
Research with Prisoners – SBR	09/19/08	4/4 (100%)
Vulnerable Subjects - Research with Prisoners	09/19/08	4/4 (100%)
Research with Children – SBR	09/19/08	5/5 (100%)
Vulnerable Subjects - Research Involving Minors	09/19/08	3/3 (100%)
Research in Public Elementary and Secondary Schools – SBR	09/19/08	4/4 (100%)
Vulnerable Subjects - Research Involving Pregnant Women and Fetuses in Utero	09/19/08	3/3 (100%)
International Research – SBR	09/19/08	4/4 (100%)
International Research	09/19/08	no quiz
Internet Research – SBR	09/19/08	5/5 (100%)
Group Harms: Research With Culturally or Medically Vulnerable Groups	09/19/08	3/3 (100%)
FDA-Regulated Research	09/19/08	5/5 (100%)

Human Subjects Research at the VA	09/19/08	3/3 (100%)
HIPAA and Human Subjects Research	09/19/08	2/2 (100%)
Workers as Research Subjects-A Vulnerable Population	09/19/08	4/4 (100%)
Hot Topics	09/19/08	no quiz
Conflicts of Interest in Research Involving Human Subjects	09/19/08	2/2 (100%)
Winston-Salem State University	09/19/08	no quiz
Winston-Salem State University MANUAL	09/19/08	no quiz

**For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.**

Paul Braunschweiger Ph.D.  
Professor, University of Miami  
Director Office of Research Education  
CITI Course Coordinator