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## Comparison of Pain Management Modalities in the Development of Postoperative Respiratory Failure

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Comparison of Pain Management Modalities in the Development of Postoperative  
Respiratory Failure

Amanda Carney, BSN, RN, CCRN

University of Kentucky

College of Nursing

Spring 2017

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## Dedication

This project is dedicated to my friends and family. I want to thank each of you for understanding my limitations as I dedicated so much time to earning this degree. I want to also dedicate this to the many nurses, educators, and physicians who have contributed to my professional development over the years. I hope to impact others as you have impacted me.

## Acknowledgements

I would like to acknowledge my advisor Dr. Carol Thompson for all of her encouragement and direction both personally and professionally. You have looked out for my well-being even when

I didn't realize I needed it. I want to thank Dr. Chizimuzo Okoli for your patience and perseverance with me as we analyzed data. Dr. Lacey Buckler you have pointed me in the right direction to find the right people and the right equipment for this project. Dan Cleland, I appreciate your skill set for compiling data and cannot thank you enough for your help through this process. I also want to acknowledge Dr. Amanda Green for her willingness to guide me through the process of data collection. And, finally to my friends who have stood beside me through the doctoral process. Doreen, you have peeled me off the ceiling numerous times and kept me from completely losing my mind. Jennifer, you have kept me grounded and I can always count on you for a good laugh to keep my perspective straight. Alyssa, Geri, and Sarah, we have studied together, laughed a lot, and kept telling each other to, "Just keep swimming." I would not have completed this program without you. We did it ladies!

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Introduction to Final DNP Project

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Spring 2017

## **Abstract**

**BACKGROUND:** This paper outlines the steps taken for a quality improvement study that investigated the development of postoperative respiratory failure (PORF) at University of Kentucky Chandler Medical Center (UKCMC). The first paper describes the influence of an interprofessional education (IPE) pilot program on doctoral nursing students and the experiences gained while working on a process improvement project. The second paper is a literature review on predictors for PORF. The third paper is a case control study that investigated the effects of pain management modalities on the development of PORF.

**OBJECTIVES:** To outline the process for developing a practice improvement project. The purpose of the practice improvement project is to understand factors associated with PORF among surgical patients. Specifically the goal of the study was to understand if the type of postoperative pain management provided to surgical patients is associated with the development of PORF. There are four objectives to this project report: 1. To compare demographic, type of surgery, type of pain management, and discharge disposition differences between patients with and without PORF; 2. Among those who develop PORF to examine differences in demographic, type of surgery, and discharge disposition by type of pain management; 3. Examine the relationship between cause for reintubation and pain management type; 4. To determine the predictors of mortality in those with PORF.

**METHODS:** First a practice improvement project was completed using the skills gained during and IPE pilot program. Then a search of the literature was completed to determine the risk factors involved with the development of PORF. Then a retrospective chart review of PORF cases (n=108) matched to controls (n=107) was done at the University of Kentucky Chandler Medical Center for the years 2010-2015.

FINDINGS: The skills learned in IPE and the knowledge gained during the literature review culminated in a process improvement project with the following findings. As compared to controls, cases were significantly more likely to be smokers (36.1% vs 21.5%), to use intermittent intravenous dosing (IID) (47.2% vs 16.8%) and intravenous patient controlled analgesia (IVPCA) (26.9% vs 15.9%), have abdominal surgery (42.6% vs 29.9%), and to have longer lengths of surgery (mean length =334.6min vs 256.8min) and were less likely to be discharged home (42.6% vs 88.8%). Abdominal surgeries were more likely to receive IVPCA (47.8%) and epidural patient controlled analgesia (EPCA) (19.6%). Genitourinary surgery patients were more likely to receive IID (78.6%); head/neck and neuro/spine only received IDD (66.7%) or oral (PO) pain medication (33.3%); orthopedic surgery patients were most likely to receive IVPCA (37.5%); and thoracic and vascular surgery were primarily likely to receive IDD (63.6%). Individuals who expired were most likely to receive IID (42.9%). Primary causes for reintubation were atelectasis (34.3%) and fluid overload/pulmonary edema (25.0%). There were no statistically significant differences in causes for reintubation by pain management type. The only salient predictor of mortality was American Society of Anesthesia score  $\geq 3$ .

CONCLUSION: Interprofessional education (IPE) is a valuable tool that should be incorporated in the curriculum of doctoral education. The literature review is an essential step to guide scholarly inquiry into evidence-based practice. An investigation of the association of pain management modalities on the development of PORF at UKCMC found that there is a need for a multi-disciplinary approach to decrease the risk associated with PORF. Enhanced recovery after surgery (ERAS) pathways incorporate multidisciplinary strategies to address the primary variables associated with PORF. By implementing these multidisciplinary strategies, UKCMC can decrease the risk of PORF in abdominal surgery patients.

# Comparison of Pain Management Modalities in Patients Who Develop Postoperative Respiratory Failure

## Introduction

Postoperative respiratory failure (PORF) is a costly complication for patients and providers. Although the incidence of PORF is low, from 0.41%-5%, (Brueckmann et al., 2013; Canet et al., 2010) it is linked to significantly increased mortality and length of stay. Due to the severity of PORF the agency for Healthcare Research and Quality developed a patient safety indicator (PSI11) to track PORF across healthcare facilities. Many studies determined risk factors for developing PORF with the intention of targeting interventions for its prevention in vulnerable populations.

There are few research studies that have investigated the effect of pain management modalities on the development of PORF. High quality pain management is essential to postoperative recovery, and the most common method of pain management is opioid medications. However there are respiratory-related risks associated with opioids and the variation in delivery of the medication such as intermittent intravenous dosing (IID), intravenous patient controlled analgesia (IVPCA), epidural patient controlled analgesia (EPCA), and oral (PO) medications. There are also non-opioid pain management options such as peripheral nerve block (PNB) and a variety of oral medications.

The purpose of this practice improvement project is to evaluate the effects of pain management modalities on the development of PORF and reintubation among surgical patients at the University of Kentucky Chandler Medical Center (UKCMC) with the aim of developing

strategies to decrease the incidence of PORF. There are three manuscripts associated with this project:

1. Manuscript 1 explores the development of a pilot program on interprofessional education (IPE) from the perspective of doctorate of nursing students. A practice improvement project was completed using the LEAN process while simultaneously learning the tenants of IPE. The skills gained in this process were invaluable and applied to all aspects of the final DNP project.
2. Manuscript 2 is a literature review of the risk factors associated with postoperative respiratory failure. The literature review became the basis for the study variables and projected outcomes of the final project.
3. Manuscript 3 is the culmination of a retrospective chart review of a case control study at University of Kentucky Chandler Medical Center. The primary variable of interest was pain management modalities and the development of PORF. The results are reported in this manuscript.

Manuscript 1

Developing Interprofessional Education:

A Nursing Perspective

University of Kentucky

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## **Abstract**

**BACKGROUND:** Interprofessional education (IPE) is necessary for successful development of interdisciplinary healthcare teams. The University of Kentucky in collaboration with University of Kentucky Chandler Medical Center developed a pilot program to introduce students to the components of IPE and multidisciplinary team building through identifying a fractured process for improvement.

**PARTICIPANTS:** Three doctorate of nursing practice students, 2 resident physicians, and 1 pharmacy resident engaged in a quality improvement project.

**METHOD:** The participants were simultaneously introduced to the principles of interprofessional education and application of the LEAN process to engage in a practice improvement project. Didactic on emotional intelligence (EQ), conflict resolution, personality profiles, communication, and leadership was presented by specialists in their respective fields, and the students were guided by an expert through the LEAN process.

**CONCLUSION:** Interprofessional education should be incorporated into the curriculum of doctoral nursing students to promote effective collaboration across disciplines with a focus on quality and efficiency in the delivery of safe patient care.

## Developing Interprofessional Education: A Nursing Perspective

Collaborative care teams for the delivery of safe patient care were the motivation behind some important Institute of Medicine recommendations (Kohn, Corrigan & Donaldson, 2000). However, widespread adoption of interprofessional education (IPE) as a means to deliver collaborative care has been slow and often unrealized in academic or patient care environments. Representatives from the American Association of Colleges of Nursing took part in the Interprofessional Education Collaborative Expert Panel (2011) to improve IPE implementation. Core competencies for IPE were established and included: 1) values and ethics for interprofessional practice, 2) roles and responsibilities for collaboration, 3) interprofessional communication and 4) interprofessional teamwork. The Patient Protection and Affordable Care Act (2010) further supported IPE adoption by mandating IPE and interprofessional collaborative practice (IPCP, Zorek & Raehl, 2013), yet the law provides no formal structure for implementation. The adoption of IPE in academic and clinical training programs has been slow because of existing barriers from complex and fragmented health care delivery education systems. The purpose of this paper is to describe the experience of a group of doctor of nursing practice (DNP) acute care nurse practitioner students' participation in an IPE pilot program.

### **What is IPE?**

Preparation for purposeful IPE is necessary for nurse practitioners to approach team-based care (Foret Giddens et al., 2014). However, collaborative, interprofessional care is not intuitive and necessary skills must be taught. Established curricula with formal expectations must be introduced during academic preparation. A major bottleneck in the implementation of IPE and collaborative initiatives occur within the academic institutions (Zorek & Raehl, 2013). Specifically, because accrediting bodies lack standards and guidelines regarding the incorporation of IPE, academic institutions are not required to offer structured programs



introducing and applying IPE concepts (Zorek & Raehl, 2013). As innovative healthcare institutions and providers, the University of Kentucky's (UK) colleges of medicine and college of nursing doctorate of nursing (DNP) program developed a pilot program to introduce IPE to their students as an elective course. This pilot program intended to engage participants in a quality improvement project using the components of IPE and applicable skills to arrive at a collaborative solution for a fractured process.

The UK pilot program consisted of a didactic portion and a group project involving application of course concepts for quality improvement. Two resident physicians, one pharmacy resident and three DNP students made up the pilot group. Didactic concepts and skills for effective IPE included: emotional intelligence (EQ), conflict resolution, personality profiles, communication, and leadership. Experts in their respective fields introduced these skills and additional activities were arranged to foster learning and application of a quality improvement process. Students identified a problem and using IPE skills, applied the Lean process to develop a solution.

### **Quality Improvement Process**

Lean, an eight-step quality improvement process (Kaplan, 2012), is not new to healthcare (Glasgow, 2011), but its use within coursework at an academic institution is novel. Students participated in a oneday workshop to learn the Lean process. A key component of Lean is that frontline providers, such as physicians, nurses and managers are pivotal when discussing process flow (Kaplan, 2012). Similarly, IPE functions by engaging providers from all disciplines to collectively discuss and provide care. The pilot group of students unanimously chose turnaround time of laboratory results in obstetrics triage as a process in need of quality improvement.

The group learned to work together to overcome barriers such as scheduling conflicts, division of assigned work, and engaging with various departments within the hospital. Collaboration and communication with other disciplines fostered an appreciation of each persons' role in a project, keeping patient centered care at the forefront. Mutual respect, positive and negative feedback, as well as consensus building were core concepts derived from IPE learning.

### **Recommendations**

Recommendations to improve the program would be to incorporate the concepts and skills introduced in the pilot IPE course and to place an emphasis on collaborative care. This pilot project spanned nine months and scheduling meetings was a major barrier. It would be beneficial to have one day per month prearranged by academic faculty so that all students could plan to attend face-to-face meetings. Students learned from this pilot program that even in its early stages, IPE curricula within an academic setting can facilitate the development of mutual exchange and respect among disciplines with a patient-centered focus on improving healthcare system outcomes.

Through this pilot course, students gained an appreciation of necessary skills and expectations to successfully apply and implement IPE in a university healthcare setting. Competencies in the Lean process and IPE should be required in DNP curricula to promote effective collaboration across disciplines with a focus on quality and efficiency in the delivery of safe patient care. Skills gained through coursework facilitated these exchanges. These recommendations are consistent with the Interprofessional Education Collaborative Expert Panel's (2011) needs assessment and help meet provisions under the ACA (2010). Lobbying for IPE mandates by accrediting bodies for academic programs should also be considered (Zorek &

Raehl, 2013). What an amazing experience to be at the leading edge in the provision of safe, high quality, efficient and patient-centered care by being a part of the quality improvement process through interprofessional education!

### **Application to Final DNP Project**

Through this process I learned that it is necessary to develop a common language to understand the strengths and limitations of different disciplines. My communication skills have improved and I learned how to ask the right questions and collaborate across the care continuum. The pilot program began the practice of networking and inquiry that led to the discovery of what became my practice improvement project. While serving on a unit based council, a physician colleague discussed her concerns for perioperative respiratory complications with me in hope that the council would work with her to develop some strategies to prevent those complications. We collaborated with her to improve preoperative screening processes and I continued to investigate postoperative respiratory failure. After a variety of committee meetings and discussion with multiple disciplines, I decided to investigate pain management modalities and the effect that they may have on postoperative respiratory failure.

Furthermore, the poster presentation that we developed and presented at University of Kentucky Chandler Medical Center reinforced the need to disseminate findings to improve care across the enterprise. The paper that the DNP students wrote was published (Carney, Sipe, Clark, Hardin-Pierce, 2016) and that experience was beneficial to my professional growth and development as a doctoral student. The skills I learned through the IPE coursework and the professional development that resulted from the experience have been invaluable as I have progressed through this practice improvement project.

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## An Inter-professional Analysis of OB Triage Influenza Notification Rate

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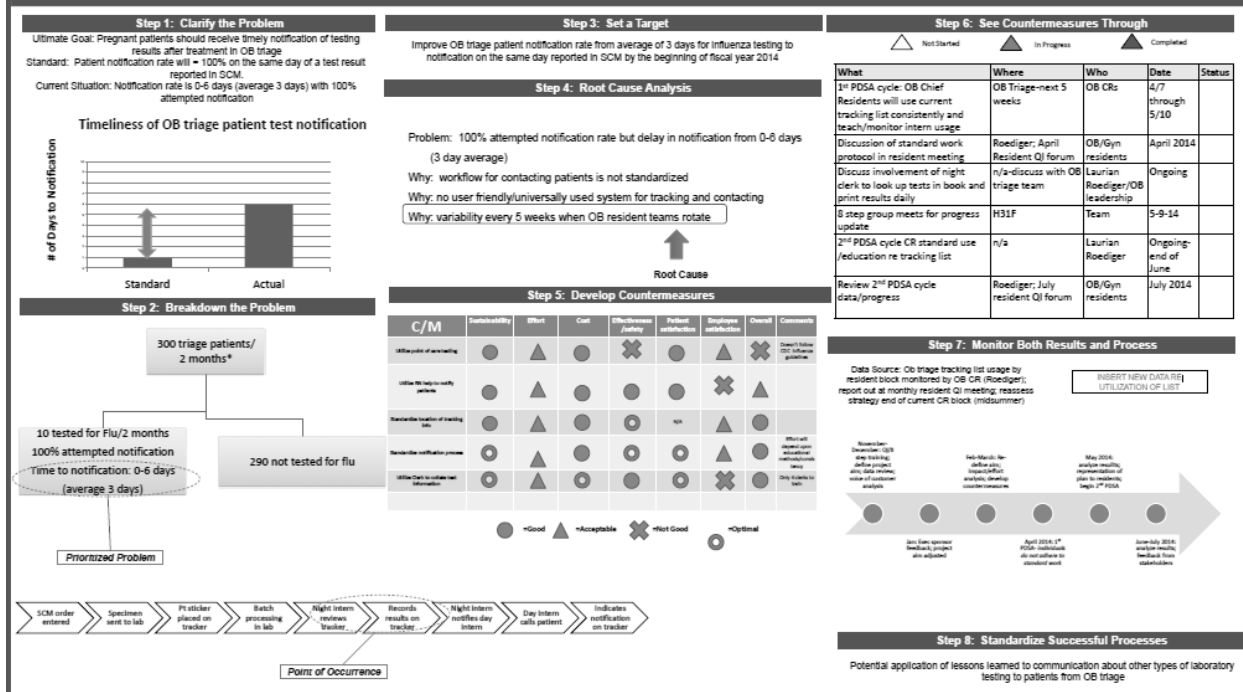


Figure 1-IPE Process Improvement Poster

Manuscript 2

Predictors of Post-Operative Respiratory Failure:

A Systematic Review

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University of Kentucky

## Abstract

**PURPOSE:** The purpose of this review is to identify risk factors that predict postoperative respiratory failure (PORF) and identify the most frequent triggers for reintubation so that they can be targeted for preventative nursing interventions.

**METHODS:** A search of the Cumulative Index to Nursing and Allied Health (CINAHL) and Pubmed databases using combinations of the following terms: post-operative, respiratory failure, complications, perioperative, PSI 11, predictors, nursing, prevention, trigger, adverse effects and re-intubation.

**FINDINGS:** The most common predictors of PORF include age greater than 65, length of surgery, American Society of Anesthesiology class greater than 2, type of surgery, and emergency surgery. Mortality for those who develop PORF ranges from 15-32%. Length of hospital stay is longer by 12-28 days. Reintubation happens most often within the first 3 days after surgery, and the primary reasons for reintubation are pulmonary edema, pneumonia, atelectasis, and aspiration.

**CONCLUSIONS:** Several studies have examined the predictors of PORF but few studies examine interventions to address the problem. The profile of patients at high risk for PORF needs to be studied further and nursing specific interventions evaluated in outcomes. The identification of atelectasis, pneumonia, and aspiration as risk factors for reintubation are within the framework of nursing's abilities to assess and intervene.

## Predictors of Post-Operative Respiratory Failure: A Systematic Review

### Background

Postoperative respiratory failure (PORF) is an infrequent but costly complication for patients and providers. The estimated incidence of PORF is from 0.41%-5% (Brueckmann et al., 2013; J. Canet et al., 2010). It has been linked with increased mortality and hospital length of stay resulting in higher healthcare costs. Patients with PORF are less likely to be discharged home (Thornlow, Anderson, & Oddone, 2013) which may also increase cost of care. PORF patients are intubated and mechanically ventilated which increases utilization of intensive care resources. In the United States, care of the mechanically ventilated patient costs approximately \$27 billion annually (Wunsch et al., 2010). In response, the Agency for Healthcare Research and Quality (AHRQ) developed a patient safety indicator (PSI 11) to track PORF in healthcare facilities. PSI 11 criteria have been independently validated as sensitive to predicting PORF (Borzecki et al., 2011; Utter et al., 2010).

The definition of PORF varies by researcher, but the AHRQ PSI 11 inclusion and exclusion criteria are clearly outlined to help facilities determine the rate of PORF (2015). AHRQ uses coding criteria to determine the number of cases per hospital discharge. An ICD-9 code for acute respiratory failure, mechanical ventilation for 96 consecutive hours zero or more days postoperatively, mechanical ventilation for less than 96 consecutive hours 2 or more days after surgery, or reintubation that occurs one or more days after surgery are included as cases in the numerator. There are several ICD-9 codes that exclude cases in the denominator based on the type of surgery or pre-existing conditions of the patient (AHRQ, 2015). This definition of PORF can be applied to multiple healthcare centers with consistency.



## **Purpose**

The purpose of this review is to identify the risk factors that predict PORF and identify the most frequent triggers for reintubation so that they can be targeted for preventative nursing interventions.

## **Methods**

A search was conducted in the Cumulative Index to Nursing and Allied Health (CINAHL) and Pubmed databases using combinations of the following terms: post-operative, respiratory failure, complications, perioperative, PSI 11, predictors, nursing, prevention, trigger, adverse effects and re-intubation. Ancestral searches were also conducted on each included article. The search was narrowed to the timeframe of 2005-2015. Inclusion criteria were articles published in the English language, adult population, post-operative respiratory failure defined by intubation and mechanical ventilation after extubation in the operating room, and those using the AHRQ PSI 11 guidelines. Exclusion criteria are articles in languages other than English, population younger than 18 years old, surgeries or conditions included in the exclusion criteria of AHRQ PSI 11. A total of 10 articles met the inclusion criteria.

The identified research articles are comprised of 1 retrospective cohort study, 4 prospective cohort studies, 2 retrospective observational studies, one prospective observational, one case control study and one retrospective cross-sectional study. A summary of the methods, design, and findings of the included studies can be found in Table I.

## **Findings**

### **Identified Risk Factors**

There are several identified risk factors that predict PORF. The most consistent include age (Canet et al., 2010; Hua, Brady, & Li, 2012; Johnson & Arozulla, 2007; McAlister, Bertsch,

Man, Bradley, & Jacka, 2005), length of surgery (Canet et al., 2010; Hua et al., 2012; McAlister et al., 2005; Thornlow et al., 2013), type of surgery (Canet et al., 2010), American Society of Anesthesia (ASA) class (Brueckmann et al., 2013; Hua et al., 2012; Johnson & Arozulla, 2007; Ramachandran et al., 2011), and emergency surgery (Brueckmann et al., 2013; Canet et al., 2010; Gupta et al., 2011; Johnson & Arozulla, 2007; Ramachandran et al., 2011). Four studies determined that older patients, age greater than 65 years, developed PORF more often than patients younger than 60 (Canet et al., 2010; Hua et al., 2012; Johnson & Arozulla, 2007; McAlister et al., 2005). Four of the included studies also associated longer time in surgery as well as higher ASA risk, defined as greater than II, with PORF (Brueckmann et al., 2013; Hua et al., 2012; Johnson & Arozulla, 2007; Ramachandran et al., 2011). Smoking (McAlister et al., 2005; Ramachandran et al., 2011; Utter et al., 2010), alcohol use (Ramachandran et al., 2011), and the existence of comorbidities such as congestive heart failure (Brueckmann et al., 2013), sepsis (Gupta et al., 2011), and lung diseases (Brueckmann et al., 2013; Gupta et al., 2011; Johnson & Arozulla, 2007; Ramachandran et al., 2011) are also identified in the included studies as high risk candidates for PORF; however, the authors determined that the comorbidities could be accounted for in the ASA scoring . Other risk factors such as functional status (Gupta et al., 2011) and irregular laboratory results (Canet et al., 2010; Johnson & Arozulla, 2007) were identified in the literature but not considered independent factors.

### **Mortality and Morbidity**

There is a significantly higher risk for all 30 day mortality associated with PORF. All cause thirty day mortality ranged from 15%-32% in those who experienced PORF versus 0.5%-1.9% in those who did not develop PORF (Borzecki et al., 2011; Brueckmann et al., 2013; Canet et al., 2010; Gupta et al., 2011; Hua et al., 2012; Johnson & Arozulla, 2007; Ramachandran et

al., 2011; Thornlow et al., 2013; Utter et al., 2010). Length of stay is also significantly longer for those who have developed PORF and varies from 12-28 days more than those who do not develop PORF (Canet et al., 2010; McAlister et al., 2005; Thornlow et al., 2013); furthermore, Thornlow et al. (2009) found that patients with PORF were less likely to be discharged home but more often discharged to long term care facilities. Increased length of stay contributes to the potential to develop hospital acquired infections and pressure ulcers which may impact the quality of life for patients and increase their financial burden. Being discharged to a long term care facility significantly influences the patient's independence.

### **Reintubation**

Brueckmann et al. (2013) identified the primary reasons for reintubation as pulmonary edema, pneumonia, atelectasis, and aspiration. These findings are supported by Borzecki (2011) and Thornlow et al. (2009). However, Thornlow et al. (2009) also identified delirium and oversedation as triggers for reintubation. In most of the included studies, there was more than one contributing reason cited for reintubation. Aspiration and delirium were also associated with more frequent reintubation by Thornlow et al. (2009).

Two studies found that half of reintubations occurred within the first 3-7 days postoperatively (Brueckmann et al., 2013; Hua et al., 2012). Hua et al. (2012) determined that 50% of reintubations happened within three days of surgery and 70% occurred within 7 days of surgery. The three day timeframe was also associated with increased risk for in-hospital death (Brueckmann et al., 2013). For inpatient surgery, the risk of PORF peaks during the first 3 days and continues to be at highest risk for the first 7 days.

The primary limitation of the literature is that respiratory failure has varied definitions throughout the studies. Some studies defined PORF by the AHRQ criteria, but others did not.

Some authors used parts of the AHRQ criteria to define respiratory failure. The National Surgical Quality Improvement Program (NSQIP) database was used to define the population in several studies (Gupta et al., 2011; Hua et al., 2012; Johnson & Arozulla, 2007; Ramachandran et al., 2011). NSQIP is a voluntary database that may not capture a diverse population. Some studies had relatively small sample sizes and findings may not be generalized to a larger population (Borzecki et al., 2013; Thornlow et al., 2013). Only one study addressed the nursing interventions used to prevent PORF (Thornlow et al., 2013).

The reviewed literature offered many tools to predict the development of respiratory failure, but did not specify interventions for prevention. Thus, a major gap in the literature on PORF is the identification of interventions, specifically nursing related, to prevent PORF. The studies included in this review are primarily focused on identification of risk factors.

### **Discussion**

By identifying patients who are at high risk for PORF, clinicians can target modifiable risk factors in the perioperative period. Many of the risk factors such as age, ASA score, type of surgery, and emergency surgery cannot be changed. However, focusing on the prevention of pneumonia, atelectasis, and aspiration could reduce the development of PORF and are well within the scope of nursing practice. Thornlow et al (2009) suggest that nursing care strategies to prevent aspiration could impact the development of PORF. Furthermore, the American Society of Anesthesiology recommends the use of pulmonary exercises and incentive spirometry in high risk patients (Qaseem et al., 2006). These are nursing related activities that could significantly impact the development of PORF.

The mortality and morbidity associated with PORF requires clinicians to be vigilant in preventing this condition. Since reintubation occurs most often in the first three days after

surgery, it is imperative that clinicians develop strategies to prevent deterioration in this time period. Preventing reintubation is the primary goal, and maintaining adequate respiratory muscle function is the first step toward the goal (Sasaki, Meyer, & Eikermann, 2013). What can nurses do in the first three days postop to prevent reintubation? The dynamics of respiratory muscle function can change with general anesthesia (Canet & Gallart, 2014) and may contribute to the development of PORF in high risk patients. Interventions that target high risk patients are needed to improve muscle function and prevent reintubation.

In 2006 the clinical guidelines for risk assessment and strategies to reduce perioperative pulmonary complications were released. The recommendations for reducing postoperative pulmonary complications are coughing, deep breathing, and incentive spirometry (Qaseem et al., 2006). The other recommendations focus on the preoperative timeframe to identify patients at risk. Although coughing, deep breathing, and incentive spirometry are recommended interventions, there are mixed reviews on the usefulness of these interventions to prevent PORF (Rupp, Miley, & Russell-Babin, 2013; Zubkoff et al., 2014). The postoperative nursing assessment and recognition of respiratory deterioration in high risk patients is paramount to rapid intervention. Further research is needed concerning the nursing interventions that significantly decrease the development of PORF.

### **Conclusion**

Although PORF develops in a small percentage of patients, its impact is significant. Not only does it increase the mortality of the patients affected, it also leads to longer length of stay in the hospital and utilizes substantially more resources. Several studies have examined the predictors of PORF but few studies have assessed interventions to address the problem. The first 3-7 days post operatively is the timeframe that may need more focused assessment and

intervention to prevent reintubation. Research on interventions to prevent PORF within the first three days after surgery is necessary to improve PORF outcomes.

It is apparent that there is a need for more research surrounding the prevention of PORF, especially regarding nursing assessment and intervention. The identification of atelectasis, pneumonia, and aspiration are within the framework of nursing's abilities to assess and intervene. The profile of patients at high risk for PORF needs to be studied further and nursing specific interventions evaluated in outcomes. Early ambulation and head of bed elevation have been studied for the prevention of pneumonia (Vollman, 2013), but not specifically related to PORF prevention. Bedside swallow evaluations on high risk patients may also be valuable to the prevention of PORF due to aspiration. These interventions need further study specific to PORF to determine if they are valuable to the deterrence of reintubation. Prevention is the key and nursing has an important role to play in protecting this high risk population.

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Table 1—Evidence Table for PORF

Authors, Year	Title, Journal, reference	Sample	Method	Study Design	Findings	Level
Borzecki, A.M., Kaafarani, H.M., Utter, G.H., Romano, P.S., Shin, M.H., Chen, Q., Itani, K.M., and Rosen, A.K. (2010)	How valid is the AHRQ patient safety indicator postoperative respiratory failure? <i>Journal of the American College of Surgeon</i> , 212(6), 935-945.	112	Random selection of 4 PRF cases from 28 hospitals. Categorized cases at true positives and false positives. T-tests and chi-square.	Retrospective observational study	PPV of PSI-11 by coding criteria is 94%. PPV of PSI-II by coding and clinical criteria 67%. Patient related risk factors included pre-existing high risk condition for respiratory failure, 1 cardiac risk factor, 1 substantial co-morbidity. Provider identified contributing factors include fluid overload, pneumonia, atelectasis.	II-2
Brueckmann, B., Villa-Urbe, J.L., Bateman, B.T., Grosse-Sundrup, M., Hess, D.R., Sclett, C.L.,	Development and validation of a score for prediction of postoperative respiratory complications.	33,769	Chart reviews with multivariable logistic regression analysis.	Retrospective cohort	0.41% required reintubation. Reintubation within 3 days post-op is highly associated with	II-2

Eikermann, M. (2013)	<i>Anesthesiology</i> , 118(6), 1276-1285				increased risk of in-hospital death. Independent predictors for post-op reintubation are ASA score > 3, emergency procedure, high-risk service, history of CHF and COPD. Primary reasons for reintubation include pulmonary edema, pneumonia, atelectasis, pneumonia.	
Canet, J., Gallart, L., Gomar, C., Paluzie, G., Valles, J., Castillo, J., Sabate, S., Mazo, V., Briones, Z., Sanchis, J. (2010)	Prediction of postoperative pulmonary complications in a population-based surgical cohort. <i>Anesthesiology</i> 113(6), 1338-1350.	2,464	Chi-square, Fisher exact test, bivariate odds ratios, 95% CI, Cramer V test, Kendal tau coefficient, logistic regression models	Prospective multicenter, observational	5% developed postoperative pulmonary event. Seven independent risk factors: low preoperative arterial oxygen saturation, acute respiratory infection during the previous month, age, preoperative anemia, upper abdominal or	II-2

					intrathoracic surgery, surgical duration of at least 2 hours, and emergency surgery	
Gupta, H., Gupta, P.K., Fang, X., Miller, W.J., Cemaj, S., Forse, R.A., Morrow, L.E. (2011)	Development and validation of a risk calculator predicting postoperative respiratory failure. <i>CHEST</i> , 140(5) 1207-1215.	211,410 257,385	Pearson $X^2$ , Fisher exact test for categorical variables. T or F test for continuous variables. Multivariate logistic regression	Prospective cohort	3.1% developed PRF. Death within 30 days in PRF group 25.62% vs 0.98% in non-PRF. Pre-op variables associated with increased risk PRF=ASA class, dependent functional status, emergency procedure, pre-op sepsis, type of surgery. Predictive model validated.	II-2
Hua, M., Brady, J.E., & Li, G. (2012)	A scoring system to predict unplanned intubation in patients having undergone major surgical procedures. <i>Anesthesia and</i>	407,579	$X^2$ , Cox proportional hazards model, logistic regression model	Prospective cohort 231	2.7% developed postoperative pulmonary complications. 4 variables most predictive of unplanned intubation: age, ASA physical status,	II-2

	<i>Analgesia</i> , 115(1) 88-94.				preoperative sepsis, and total operative time.	
Johnson, R.G., Arozullah, A.M., Neumayer, L., Henderson, W.G., Hosokawa, P., Khuri, S.F. (2007)	Multivariable predictors of postoperative respiratory failure after general and vascular surgery: Results from the patient safety in surgery study. <i>Journal of the American College of Surgery</i> . 204(6) 1188-1198.	5,389	Logistic regression analysis to develop a predictive model of postoperative RF.	Retrospective observational	3% of patients developed respiratory failure. Characteristics: older males, co-morbidities, ASA class 4/5, abnormal lab values, in-patients, general anesthesia, emergency surgery, high complexity surgery. Significant increase in 30-day mortality of those with respiratory failure 26.5% vs 1.4%.	II-2
McAlister, F.A., Bertsch, K., Man, J., Bradley, J., Jacka, M. (2005)	Incidence of and risk factors for pulmonary complications after non-thoracic surgery. <i>American Journal Respiratory Critical Care</i>	1,055	Chi-square, Fisher's exact test for dichotomous variables and t-test for continuous variables. Multivariate logistic	Prospective cohort	2.7% suffered post-op pulmonary complication. LOS 27.9 vs 4.5d. Identifies variables independently associated with increased risk of post-op pulmonary complication.	II-3

	<i>Medicine</i> . 171, 514-517		regression analysis			
Ramachandran, S.K., Nafiu, O.O., Ghaferi, A., Tremper, K.K., Shanks, A., Kheterpal, S. (2011)	Independent predictors and outcomes of unanticipated early postoperative tracheal intubation after nonemergent, noncardiac surgery. <i>Anesthesiology</i> , 115(1) 44-53.	222,094	Statistical analysis of American College of Surgeons-National Surgical Quality Improvement Program	Prospective cohort	0.9% incidence of UPEI. Of UPEI 49.4% were within 3 days of surgery. UPEI independent predictor of all cause 30 day mortality. Multiple independent predictors of UPEI identified	II-2
Thornlow, D.K., Oddone, E., Anderson, R. (2014)	Cascade iatrogenesis: A case-control study to detect postoperative respiratory failure in hospitalized older adults. <i>Research in Gerontological Nursing</i> , 7(2) 66-77.	28 cases 28 control	Descriptive statistics, t tests, chi-square tests	Retrospective, descriptive, case-control pilot study	Cases had more minutes under anesthesia, returned to OR more often, were in ICU more, aspirated more, required more rapid response calls, and had higher rates of pneumonia, mortality, longer length of stay than controls. Trigger events: oversedation, delirium,	II-1

					atelectasis, aspiration, fluid overload.	
Utter, G.H., Cuny, J., Sama, P., Silver, M., Zrelak, P., Baron, R., Drosler, S., Romano, P. (2010)	Detection of postoperative respiratory failure: How predictive is the agency for healthcare research and quality's patient safety indicator?	609	Analysis of the PPV of PSI 11. Descriptive analysis of those cases.	Retrospective cross-sectional	23% mortality rate in confirmed PORF. 83% true instances of PORF.	II-2

U.S. Prevention Services Task Force. Quality of Evidence: I.-Evidence obtained from at least one properly randomized controlled trial, II-1.-Evidence obtained from well-designed controlled trials without randomization, II-2.-Evidence obtained from well-designed cohort or case control analytic studies preferably from more than one center or research group, II-3.-Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments could also be regarded as this type of evidence, III- Opinions of respected authorities, based on clinical experience; descriptive studies, and case reports; or reports of expert committees (U.S. Preventive Services Task Force, 1996).

Manuscript 3

Final DNP Project Report

Comparison of Pain Management Modalities in Patients Who Develop Postoperative Respiratory  
Failure

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## Abstract

**PURPOSE:** The purpose of this study is to understand factors associated with postoperative respiratory failure (PORF) among surgical patients. Specifically, the goal of the study was to understand if the type of postoperative pain management provided to surgical patients is associated with the development (PORF). There are four objectives to this project report: 1. To compare demographic, type of surgery, type of pain management, and discharge disposition differences between patients with and without PORF; 2. Among those who develop PORF to examine differences in demographic, type of surgery, and discharge disposition by type of pain management; 3. Examine the relationship between cause for reintubation and pain management type; 4. To determine the predictors of mortality in those with PORF.

**METHODS:** A retrospective chart review of PORF cases (n=108) matched to controls (n=107) was done at the University of Kentucky Chandler Medical Center for the years 2010-2015. Demographic data was collected as was type of surgery, type of pain management, reason for reintubation, and discharge disposition.

**RESULTS:** As compared to controls, cases were significantly more likely to be smokers (36.1% vs 21.5%), to use intermittent intravenous dosing (IDD) (47.2% vs 16.8%) and intravenous patient controlled analgesia (IVPCA) (26.9% vs 15.9%), to have abdominal surgery (42.6% vs 29.9%), and had longer lengths of surgery (mean length =334.6min vs 256.8min) and were less likely to be discharged home (42.6% vs 88.8%). Abdominal surgeries were more likely to receive IVPCA (47.8%) and epidural patient controlled analgesia (EPCA) (19.6%). Genitourinary surgery patients were more likely to receive IID (78.6%); head/neck and neuro/spine only received IDD (66.7%) or oral (PO) pain management (33.3%); orthopedic

surgery patients were most likely to receive IVPCA (37.5%); and thoracic and vascular surgery patients were primarily likely to receive IDD (63.6%). Individuals who expired were most likely to receive IDD (42.9%). Primary causes for reintubation were atelectasis (34.3%) and fluid overload/pulmonary edema (25.0%). There were no significant differences in causes for reintubation by pain management type. The only salient predictor of mortality was American Society of Anesthesia (ASA) score  $\geq 3$ .

CONCLUSION: Many of the findings of this study support results from previous studies and emphasizes the need for multiple interventions to prevent PORF and associated outcomes. Prevention of atelectasis and fluid overload may reduce the development of PORF. Increased utilization of the pain management team for multimodal pain management options may also impact the development of PORF. Interventions such as pulmonary hygiene as well as conservative fluid management are nursing related activities that could improve the incidence of PORF.

## Comparison of Pain Management Modalities in Patients Who Develop Postoperative Respiratory Failure

### Background

Postoperative respiratory failure (PORF) is an infrequent but costly complication for patients and providers. The estimated incidence of PORF is from 0.41%-5% (Brueckmann et al., 2013; Canet & Gallart, 2013). It has been linked with increased mortality and length of stay resulting in higher healthcare costs. All cause thirty day mortality ranges from 15%-32% (Borzecki et al., 2011; Brueckmann et al., 2013; Canet et al., 2010; Gupta et al., 2011; Hua, Brady, & Li, 2012; Johnson & Arozulla, 2007; Ramachandran et al., 2011; Thornlow, Anderson, & Oddone, 2013; Utter et al., 2010) and length of stay increases 12-28 days (Canet et al., 2010; McAlister, Bertsch, Man, Bradley, & Jacka, 2005; Thornlow et al., 2013). Patients with PORF are less likely to be discharged to home (Thornlow et al., 2013) which may also increase cost of care. Patients with PORF are intubated and mechanically ventilated which increases utilization of intensive care resources. In the United States, care of the mechanically ventilated patient costs approximately \$27 billion annually (Wunsch et al., 2010). In response, the Agency for Healthcare Research and Quality (AHRQ) developed a patient safety indicator (PSI 11) to track PORF in healthcare facilities. PSI 11 criteria have been independently validated as sensitive to predicting PORF (Borzecki et al., 2011; Utter et al., 2010).

The definition of PORF varies by researcher, but the AHRQ PSI 11 inclusion and exclusion criteria are clearly outlined to help facilities determine the rate of PORF (See Appendix 1). AHRQ uses coding criteria to determine the number of cases per hospital discharge. An international classification of diseases 10<sup>th</sup> edition code (ICD-10) for acute respiratory failure, mechanical ventilation for 96 consecutive hours zero or more days postoperatively, mechanical ventilation for less than 96 consecutive hours 2 or more days after

surgery, or reintubation that occurs one or more days after surgery are included as cases in the numerator. Several ICD-10 codes exclude cases in the denominator based on the type of surgery or pre-existing conditions of the patient (AHRQ, 2015). According to the AHRQ Quality Indicators, version 5.0, PORF is reported as the number of cases per 1,000 elective surgical discharges for patients age greater than 18. This definition of PORF can be applied to multiple healthcare centers with consistency.

Several studies focus on developing tools to predict the development of PORF. There are numerous identified risk factors that predict PORF. The most consistent include age (Canet et al., 2010; Hua et al., 2012; Johnson & Arozulla, 2007; McAlister et al., 2005), length of surgery (Canet et al., 2010; Hua et al., 2012; McAlister et al., 2005; Thornlow et al., 2013), type of surgery (Canet et al., 2010), American Society of Anesthesia (ASA) class (Brueckmann et al., 2013; Hua et al., 2012; Johnson & Arozulla, 2007; Ramachandran et al., 2011), and emergency surgery (Brueckmann et al., 2013; Canet et al., 2010; Gupta et al., 2011; Johnson & Arozulla, 2007; Ramachandran et al., 2011). Three studies (Brueckmann et al., 2013; Gupta et al., 2011; Hua et al., 2012) validated scoring systems that include the frequent risk factors for PORF in order to predict its development. Although several studies emphasize the importance of predicting and identifying PORF, few investigate preventative measures.

In 2006 the clinical guidelines for risk assessment and strategies to reduce perioperative pulmonary complications were released. The recommendations for reducing postoperative pulmonary complications are coughing, deep breathing, and incentive spirometry (Qaseem et al., 2006). Further recommendations focus on the preoperative timeframe to identify patients at risk. Although coughing, deep breathing, and incentive spirometry (IS) are recommended interventions, there are mixed reviews on the usefulness of these interventions to prevent PORF

(Rupp, Miley, & Russell-Babin, 2013; Zubkoff et al., 2014). Incentive spirometry was not considered more effective than any other pulmonary techniques such as coughing, deep breathing or the use of non-invasive positive pressure ventilation in preventing pulmonary decline (Freitas, Soares, Cardoso, & Atallah, 2012). Rupp, Miley, and Russell-Babin (2013) found that IS was only as effective as coughing and deep breathing in preventing pulmonary complications and that no one technique is superior to another in preventing pulmonary failure. However, some type of pulmonary prophylaxis is better than none. When IS was paired with a respiratory bundle that included head of bed elevation, oral care, and repositioning, a 13% decrease in respiratory distress was achieved (Lamar, 2012). Pasquina, Tramèr, Granier, & Walder (2006) reviewed 35 trials and found that 4 studies reported improvement in respiratory complications as a result of combinations of IS, coughing and deep breathing, or postural drainage. These studies suggest that a multimodal approach may influence the development of PORF.

High quality postoperative pain management may modify postoperative complications (Liu & Wu, 2007). Postoperative pain control enables patients to perform adequate pulmonary hygiene. Without adequate pain control it becomes difficult to cough, deep breathe, mobilize or use incentive spirometry to help prevent pulmonary complications (Sachdev & Napolitano, 2012). There is a fine balance between adequate pain management and drug related side effects. Opioids have side effects such as nausea, vomiting, sedation, respiratory depression, confusion and constipation (Colfer, Wolo, & Viscusi, 2013). Sedation and respiratory depression are factors that could lead to the development of PORF. Peripheral nerve blocks (PNB) have side effects of peripheral nerve irritation, chondrolysis, and residual motor weakness (Golembiewski & Dasta, 2015) as well as a rare systemic reaction which results in cardiovascular collapse,

seizures, and death (Colfer et al., 2013). The primary side effects of PNB are not associated with risk for PORF. PNBs only last approximately 16-24 hours which may require the patient to also use opioids for pain control.

Opioids delivered by patient controlled analgesia (IVPCA) pumps are associated with lower pain intensity scores than intermittently dosed opioids, however, there was a similar incidence of adverse events in the two groups (McNicol, Ferguson, & Hudcova, 2015). In a review of studies conducted by Liu and Wu (2007), IVPCA was associated with fewer pulmonary complications than conventional intermittent opioid administration. From these studies it seems that the use of IVPCA opioid administration is safer for patients than intermittent opioid administration.

There is very little research available that compares the use of PCA versus PNB for postoperative pain management and the development of PORF. Peripheral nerve blocks are not systemic and have less potential to contribute to respiratory depression. Local anesthetics block nerve conduction on peripheral nerves at the site of injury whereas, opioids work on the central nervous system to block opioid receptors and transmission of pain receptors (Golembiewski & Dasta, 2015). Peripheral nerve blocks do not use narcotics for pain control; IVPCAs do use narcotics. Narcotic overuse contributes to hypercapnic respiratory failure due to loss of central ventilation (Sachdev & Napolitano, 2012). A review of the literature comparing PNB to systemic opioids found minimal evidence that PNB contributed to morbidity or mortality (Liu & Wu, 2007), furthermore, PNB provided superior pain control and fewer side effects than opioid PCA (Chan, Fransen, Parker, Assam, & Chua, 2016); furthermore, Boekel et al. (2016) compared EPCA, continuous infusion PNB, and IVPCA and found that patients with EPCA and PNB had lower reported pain scores and less postoperative opioid induced respiratory depression than

IVPCA. A Cochrane Review of the use of PNB versus systemic analgesia in major knee surgeries provides evidence that PNB as an adjunct reduced pain intensity (Xu, Chen, Ma, & Wang, 2014). A small study with 60 patients having unilateral maxillary surgery found that patients receiving maxillary nerve block had better pain control, hemodynamic stability and lower side effects when compared to IVPCA (Niazi & Shoukat, 2015). These studies have determined that the use of PNB in specific patient populations results in better pain control and fewer side effects than systemic opioids.

Patient controlled analgesia is superior to intermittent delivery of opioids in controlling pain and reducing postoperative complications (Lawrence, Cornell, & Smetana, 2006). A recent study compared the use of IVPCA to an IVPCA with continuous infusion rate and found that the continuous infusion resulted in a superior pain control however, there was a 5% incidence of respiratory insufficiency (Jelezcov et al., 2016). The 2016 guidelines for managing postoperative pain recommend the use of IV PCA when the parenteral route is needed and the patient is cognitively appropriate for the use of the device (Chou et al., 2016). The guidelines also recommend that clinicians adjust pain management plans on the basis of adequate pain control and the presence of adverse events (Chou et al., 2016) and encourage the use of local anesthetic when appropriate.

In summary, both opioid IVPCA and PNB have superior pain control to intermittent dosing of medications. However, there are few definitive studies comparing the type of pain management and the development of PORF. This gap in the literature defines a need for further research. The question for this inquiry project is: Does the type of postoperative pain management affect the development of PORF?

## **Conceptual Framework**

This is a quality improvement project focused on understanding the factors that contribute to the development of PORF at UKCMC. A fishbone diagram (Appendix B) was completed to define the relationships among the variables to be studied and to then define potential interventions for prevention.

## **Purpose**

The purpose of this inquiry project is to understand the relationship between postoperative pain management and the development of PORF and causes for reintubation. The specific aims of the study are:

1. To compare demographic, type of surgery, type of pain management, and discharge disposition differences between patients with and without PORF
2. Among those who develop PORF to examine differences in demographic, type of surgery, and discharge disposition by type of pain management.
3. Among those who develop PORF to determine the relationship between cause for reintubation and pain management type.
4. To determine the predictors of mortality among those with PORF.

## **Methods**

A retrospective chart review was conducted on all PORF cases from 2010-2015. Permission was gained through the University of Kentucky Institutional Review Board.



## Setting

The University of Kentucky Chandler Medical Center (UKCMC) is a 900 bed, Level I trauma center located in Lexington, Kentucky. It is an academic center servicing all of Kentucky, northern Tennessee, western areas of West Virginia, and southern Ohio and is a multi-organ transplant center for these areas. Good Samaritan Hospital (GSH) is also a part of the University of Kentucky enterprise. There are a total of 44 operating rooms and an average of 114.7 cases performed daily at UKCMC and GSH.

## Sample

A sequential sample was taken from the University Healthcare Consortium (UHC) database. The UHC database houses all reported PORF cases for UKCMC and GSH. Cases are determined by the AHRQ inclusion and exclusion guidelines (Appendix A). The sample of PORF cases from 2012-2015 was matched to controls by age  $\pm 5$  years, ASA score, and sex. These three variables have consistently been identified in the literature as predictors of PORF. The controls were further matched by procedure length  $\pm 15$  minutes, diagnosis related group (DRG) weight, year, and type of surgery. Of the 110 matched controls, 3 controls had incomplete data resulting in 107 controls and 108 cases.

## Data Collection

Upon completion of matching the cases to controls, the data was de-identified and recorded in a spreadsheet format on a password protected, Endpoint encrypted computer. Descriptive data was collected such as body mass index (BMI), history of respiratory disease, history of smoking, and history of heart failure. History of respiratory disease was defined by the ICD codes in Figure 1. History of smoking was collected from documentation in the electronic

medical record from the contact at time of surgery and any prior documented contact with UKCMC. Heart failure history was collected from all past and present documentation in the electronic medical record for UKCMC.

Type of surgery was divided into the following categories: 1. Abdominal- any surgery done on the gastrointestinal tract and abdominal cavity excluding the esophagus, 2. Genitourinary—any surgery done on the reproductive organs or urinary tract, 3. Head and neck/ neuro/spine—any surgery done on the head and neck excluding tracheostomy as well as any surgery done on the brain or spinal column 4. Orthopedic—any surgery done on the bones excluding facial bones, 5. Thoracic and vascular—any surgery done on the heart, lungs, esophagus, or the arteries and veins. If a patient had more than one type of surgery then the type of surgery was based on the last surgery prior to discharge or developing PORF. The types of surgeries either included or excluded were determined by the AHRQ definition of PSI 11 (AHRQ 2015).

Type of pain management is the primary variable of interest to this inquiry. Type of pain management was defined as 1. Epidural patient controlled analgesia (EPCA), 2. Intermittent dosing of intravenous medications (intermittent), 3. Intravenous patient controlled analgesia (IVPCA), 4. Medications given by mouth (PO), 5. Peripheral nerve block (PNB). Some cases received more than one type of pain management modality and were placed in a category according to the modality used within 48 hours of reintubation. Some controls also received more than one type of pain management modality and were placed in the category that represented the most frequently used modality.

The reason for reintubation was determined by the first chest radiograph done after reintubation as read by the radiologist. If the radiology report was not definitive then the critical care provider's interpretation of the radiograph was used to determine the reason for reintubation. The following categories were identified: 1. Aspiration, 2. Atelectasis, 3. Fluid overload/pulmonary edema, 4. Obstruction including pulmonary embolism and over sedation, 5. Pneumonia.

The final variable studied was discharge disposition. The following categories were used: 1. Expired-the patient died in the hospital, 2. Acute rehabilitation-includes inpatient rehabilitation facilities, nursing homes, Veteran Affairs hospital, and long term acute care facilities, 3. Home-with or without home health assistance.

### **Data Analysis**

Descriptive statistics including demographic (age, sex, BMI, smoking history, respiratory illness history, heart failure history), ASA score, length of surgery, type of surgery, and type of pain management by cases and controls was examined using Chi square analyses for categorical data and independent sample t-test (with Levene's test for equality of variance) for categorical variables. A Chi square analysis or independent sample t-test (with Levene's test for equality of variance) as appropriate, was conducted to determine the differences in demographic, type of surgery, and discharge disposition by type of pain management among those who develop PORF. A Chi square analysis was used to assess the relationship between cause for reintubation and pain management type among those who develop PORF. Finally, because no one among the controls expired a logistic regression analysis among those who develop PORF was conducted to

determine the predictors of mortality by regressing mortality on type of pain management controlling, demographic, ASA score, length of surgery, and type of surgery.

## Results

### Sample characteristics

Table 1 depicts the sample characteristics. The sample was primarily male (56.3%) with a mean age of 58.6 (sd=14.6) years and obese (mean BMI=31.0, sd=14.8). The majority of participants had an ASA score of 3 (60.9%) which demonstrated severe systemic disease. Nearly one third had a current history of tobacco use, nearly half had a history of respiratory illness and one sixth had a history of heart failure. The main type of surgery was abdominal (36.3%) followed by head/neck and neuro/spine (20.9%) and the main source of pain control was intermittent (32.1%) followed by PO (28.4%). On average surgeries lasted for about 5 hours. In the sample 9.8% expired, 24.7% were discharged to a rehabilitation facility or the VA and the majority (65.6%) were discharged home. There were significant differences between cases and controls (see Table 1) such that cases had a significantly higher proportion of smokers (36.1% vs 21.5%), were significantly more likely to use intermittent (47.2% vs 16.8%) and IVPCA (26.9% vs 15.9%), were significantly more likely to have abdominal (42.6% vs 29.9%) and thoracic/vascular (20.4% vs 6.5%), had longer lengths of surgery (mean length =334.6min vs 256.8min) and were less likely to be discharged home (42.6% vs 88.8%). There were no other differences in demographic or main outcomes between cases and controls.

## **Differences in demographic, type of surgery, and discharge disposition by type of pain management among those who develop PORF**

Table 2 presents differences in demographic variables, type of surgery, and discharge disposition by type of pain management among those who developed PORF (n=108). There were no significant differences in demographic features by type of pain management. However, there were significant differences in type of surgery with individuals who underwent abdominal surgery more likely to receive IVPCA (47.8%) and EPCA (19.6%); individuals who underwent genitourinary surgery were more likely to receive intermittent (78.6%); individuals who underwent head/neck and neuro/spine only received intermittent (66.7%) or PO (33.3%); individuals who underwent orthopedic surgery were most likely to receive IVPCA (37.5%); and individuals who underwent thoracic and vascular surgery were primarily likely to receive intermittent (63.6%). In addition individuals who expired were most likely to receive intermittent (42.9%), those who were discharged to acute rehab and VA were also most likely to receive intermittent (61.0%) and those who were discharged home were most likely to receive IVPCA (43.5%). There were no deaths in the control group but 19.4% of the cases expired. The majority of controls were discharged home (88.8%) and over three times more cases than controls were discharged to acute rehabilitation centers (38.0% vs 11.2%).

## **Relationship between cause for reintubation and pain management type among those who develop PORF**

Table 2 also presents causes for reintubation by pain management type. Among those with PORF the primary causes for reintubation were atelectasis (34.3%) and fluid

overload/pulmonary edema (25.0%). However, there were no significant differences in causes for reintubation by pain management type.

### **Predictors of mortality among those with PORF**

Table 3 presents the results of a regression analysis to identify salient predictors of mortality from our sample. We found that ASA score was the only salient predictor of mortality with individuals with an ASA score of 3 or greater being nearly 6 times more likely to expire as compared to those with an ASA score less than 3. In addition, males as compared to females, smokers, those with a history of respiratory illness, those with IVPCA (as compared to PO), and older patients were more likely to expire but these relationships failed to reach statistical significance. There were no other predictors of mortality among our sample.

### **Discussion**

The purpose of this study was to examine the relationship between postoperative pain management and the development of PORF and causes for reintubation among surgical patients. We found that there were particular characteristics that were significantly different between those who developed PORF and those who did not; specifically ASA score, smoking history, abdominal surgery, use of intermittent and IVPCA pain management and discharge disposition. Moreover, among those who developed PORF, we found that type of pain management significantly differed by type of surgery. In addition, there were no differences for causes for reintubation by pain management type. Finally, the only significant predictor of mortality was ASA score. These findings are important to understanding the development of PORF and warrant detailed discussion.

The fishbone diagram depicted in Figure 1 shows the relationship of the variables studied to the development of PORF. The sample was obese with a mean BMI of  $31\text{kg/m}^2$  which is class I obesity according to the National Institute of Health. It has the lowest risk in the obesity classification, but obesity is considered to be high risk for developing hypertension, type II diabetes and cardiovascular disease. There were 18 cases of Class I obesity (16.6%), 16 cases of Class II obesity (14.8%) and 12 cases of Class III obesity (11.1%) in the study sample. The Centers for Disease Control and Prevention (2012) reported that 21.5% of men and 17.8% of women in the United States are in the Class I obesity classification so the sample of this study is comparable to the national statistics. All classifications of obese patients are at higher risk of postoperative complications than overweight or ideal weight patients including perioperative airway management and obstructive sleep apnea (American Society of Anesthesiologists, 2014b). This is consistent with a study conducted by Goode, Phillips, DeGuzman, et al., (2016) that suggests that a BMI in the overweight to obese category is associated with increased postoperative complications and particularly postoperative respiratory failure. Ramachadran et al. (2011) also found BMI to be an independent predictor of unintended postoperative intubation. Khavanin et al. (2013) found that a  $\text{BMI} > 30\text{kg/m}^2$  had higher incidence of unplanned reintubation.

Obesity is not included in ASA risk stratification, but some of the comorbidities associated with obesity would increase ASA scoring. The obese patient is scored ASA 2 and with any comorbidity goes up to at least an ASA 3 (Bluth, Pelosi, and Gama de Abreu, 2016). The cases in my study were also more likely to have an ASA of 3 or greater and were six times more likely to die than those with an  $\text{ASA} < 3$ . Since UKCMC is a level I trauma center that serves a large geographical area, this may be a reflection of the region, but it could also be a

reflection of the obesity of the population. However, ASA scores greater than 2 have been associated with development of PORF in larger sample sizes from national databases (Borzecki et al., 2011; Gupta et al., 2011). It is reasonable that the severity of risk for surgery should predict potential postoperative complications.

In order to address the potential for postoperative pulmonary complications in the obese population, Alvarez, Singh, and Sinha (2014) support the use of opioid sparing multimodal pain management strategies. The American Pain Society (2016) also supports the use of multimodal pain management for postoperative pain. Therefore, it would be beneficial for UKCMC to develop multimodal pain management protocols that institute the recommendations mentioned above and utilize adjunctive pain management options such as non-opioid analgesia medications, local anesthesia and PNB, PO pain medications, and IVPCA or EPCA over intermittent dosing to manage postoperative pain. The multimodal approach is patient specific and requires a change in the culture of providers. But, it could potentially improve the outcomes in this patient population.

Other unique sample characteristics of cases include smoking, respiratory illness, longer lengths of surgery, abdominal surgery, use of intermittent and IVPCA for pain management, and the cases were less likely to be discharged home. Smoking and history of respiratory illness have been associated with PORF (Ramachadran et al. 2011, Johnson et al., 2007; McAlister et al., 2005) as have longer lengths of surgery (Canet et al., 2012; Hua et al., 2012) abdominal surgery (Canet et al., 2010), and discharge disposition (Thornlow et al., 2013). In our study 19.4% of the patients who developed PORF expired which is also consistent with the literature.



The cases that were discharged home were more likely to have received IVPCA for pain management (43.5%) prior to developing PORF. This differs from the findings of Thornlow, Oddone, and Anderson (2013) who found that patients with IVPCA were less likely to be discharged home. The difference could be attributed to the difference in number of cases (108 vs 28) or the type and amount of opioid used in each study. This was an unexpected finding, however, IVPCA may have been discontinued after the development of PORF and alternative pain management modalities may have been used. Our study did not investigate the possibility of changes in pain management modalities prior to discharge. Furthermore, the additional monitoring of the pain management team at UKCMC for patients receiving IVPCA may have influence discharge disposition.

In the patients who experience PORF, twenty one patients expired; nine of those patients received intermittent pain medication. Additionally, 49.0% of PORF patients receiving intermittent dosing of opioids were discharged to a rehabilitation facility. These findings are significant because there is very little literature that compares pain management modalities and discharge disposition in PORF patients. Thornlow, Oddone, and Anderson (2013) studied PORF patients that received IVPCA for pain management and found that over half of the cases either died or were discharged to long term care facilities. Perhaps there is an association between type and amount of pain management and discharge disposition. At UKCMC there is a pain team of nurses and physicians that follow patients receiving EPCA and IVPCA. The pain team evaluates each patient receiving EPCA and IVPCA patient daily while receiving therapy. Furthermore, the pain team manages all pain medications for the patient while on EPCA or IVPCA and makes adjustments according to patient response. Intermittent dosing of IV medications is dependent on nursing evaluation of pain score and patient response and has a variable onset and duration of

action. It is possible that more than one type and/or dose of medication may be available and multiple opioid pain medications may be used at the same time. Although this study did not investigate the specific medications or amount of medication received by each patient, further research to determine if discharge disposition is dose or medication dependent is warranted. A post hoc analysis of our study to investigate the type of pain medications and dosages in the PORF patients who expired or were discharged to rehabilitation is an efficient step to determine if a relationship exists between type of pain management and discharge disposition.

Postoperative pain management type is highly influenced by type of surgery. The type of surgery may limit the type of pain management available to the patient. For instance, this study found that head/neck and neuro/spine types of surgery only received intermittent or PO for pain management. Epidural PCA and PNB would not be appropriate choices for these types of surgery. As this study shows, the majority of patients who developed PORF had abdominal surgery (42.6%) and most frequently received intermittent opioid pain control (47.2%). Of the five types of surgery investigated in this study, three types (genitourinary, head/neck, and thoracic/vascular) most frequently used intermittent dosing for pain management and two (abdominal and orthopedic) most frequently used IVPCA. However, in the entire sample, abdominal surgery patients were more likely to receive IVPCA (47.8%) and EPCA (19.6%). In prior studies from a national database, the sample sizes were much larger than our study and intermittent dosing and abdominal surgery were most often associated with PORF (Ramachadran et al., 2011; Bruekeman et al., 2013). This study is consistent with those findings. The findings of Liu and Wu (2007) showed IVPCA to be safer than intermittent opioid dosing. In order to reduce the use of intermittent dosing of opioid medications at UKCMC, it would be beneficial to employ multiple pain management options as outlined in the American Pain Society and

American Society of Anesthesiology guidelines for postoperative pain management for patients at high risk for PORF who have abdominal surgery.

Only five patients received PNB in this study so there was not enough data to compare PNB to other pain management modalities. The five patients who did receive PNB were in the control group and were subsequently discharged home. The use of PNB for postoperative pain management is supported by postoperative pain management clinical practice guidelines (Chou et al., 2016; Cooney, 2016).

At UKCMC the primary cause for reintubation was atelectasis (34.3%) followed by fluid overload/pulmonary edema (25.0%) which is consistent with the findings of Brueckmann et al. (2013) and Borzecki et al. (2011). This is a significant finding and supports interventions for managing atelectasis and fluid overload. The most frequent type of surgery to develop PORF in our study was abdominal surgeries. So, strategies to reduce atelectasis and fluid overload in patients who have abdominal surgery may have the greatest impact on PORF. A study investigating the incidence of postoperative pulmonary complications in high risk abdominal surgery patients found that there was an association between delayed postoperative mobilization and postoperative pulmonary complications (Haines, Skinner, and Berney, 2013). Silva, Li, and Rickard (2012) concluded that mobility alone can reduce pulmonary complications such as atelectasis in abdominal surgery patients. Furthermore, Pashikanti and Von Ah (2012) conducted a review of nine empiric studies and found that early mobility protocols maintained or improved functional status of postoperative patients.

There have been several intensive care unit (ICU) based mobility programs that have had varying success at UKCMC, but I think that a structured mobility program should be considered

on a medical surgical unit at UKCMC. The Cardiovascular Thoracic ICU, Surgical Trauma ICU, and Medicine ICU have encouraged early mobility in their patient populations for the last 5 years. UKCMC has a mobility scale that is applied to all patients (See Appendix B). Hopkins et al. (2012) found that 55% of the patients transferred from the ICU to a medical floor had a decrease in ambulation the first day of transfer despite having physical therapy or nursing orders for ambulation. Since abdominal surgeries can go to the medical surgical floor from the post-anesthesia care unit and the ICU, a nurse driven structured mobility protocol for a medical surgical unit could benefit this patient population. A review of the successes of current ICU mobility programs that are ongoing at UKCMC would be a good starting point to begin the process of building an ambulation program for a medical surgical floor. Pashikanti and Von Ah (2012) suggest utilizing clinical nurse specialists in the role of developing medical surgical unit based protocols for ambulation.

At UKCMC fluid overload was the second most common reason for reintubation however; having a history of heart failure was not statistically significant in the development of PORF. Therefore, it is reasonable to consider perioperative fluid management practices as a potential source of fluid overload. Conservative perioperative fluid management such as those associated with enhanced recovery after surgery (ERAS) programs have been associated with lower rates of postoperative pulmonary complications (Gustafsson, 2013). In November, 2016 several pathways of ERAS were implemented at UKCMC for colorectal surgeries. The anesthesia team started running all the IV fluids via pump and monitoring volume status in the operating room to maintain normovolemia. Thacker et al. (2016) suggest that the conservative fluid strategy of ERAS could be applied to other abdominal surgeries as well as orthopedic surgeries.

UKCMC also implemented many of the other pathways of ERAS in November, 2016 such as preoperative education, multimodal pain management, minimization of invasive tubes and encouraging early mobilization (Rebel, 2017) in colorectal surgery patients. The implementation of ERAS at UKCMC was not in place when the data for my study was completed. Moore, Conway, Thomas, Cummings and Atkinson (2017) found that full implementation of ERAS in multiple major surgery categories significantly decreased the incidence of postoperative pulmonary complications. Greco et al. (2013) also found that respiratory complications in ERAS programs were very low due to the multimodal approach to patient care. The next step at UKCMC is to study the impact of ERAS on the development of postoperative respiratory complications and based on the outcomes in colorectal surgery to consider applying ERAS pathways to other types of surgery.

Pain management type did not appear to significantly impact causes for reintubation. This is an interesting finding because Cashman and Dolin (2004) reviewed the evidence and found that intermittent opioid pain management was associated with a higher incidence of respiratory depression but Liu and Wu (2007) found no sufficient evidence that postoperative analgesic techniques affected postoperative mortality or morbidity. Both of the aforementioned reviews state that their conclusions are affected by the varying sample sizes in their studies. There may not have been a sufficient number of patients in each pain management modality to reach an association in our study which may explain why pain management type did not impact causes for reintubation. Furthermore, UKCMC has a pain management team that manages all IVPCA, EPCA, and PNB, The extra monitoring of these patients may also explain this finding. More studies that investigate the effects of pain management modalities on the cause for reintubation in the development of PORF are needed.

The only identified predictor of mortality in the study was ASA score greater than or equal to three. This is an expected predictor of mortality because ASA scoring includes severity of systemic disease. This is also consistent with the literature that associated mortality with higher ASA scores (Brueckmann et al., 2013; Hua et al., 2012; Johnson & Arozulla, 2007; Ramachandran et al., 2011). The only pain management modality to be associated with mortality was IVPCA, however it was not statistically significant and is contradictory to the finding that the cases that expired were more likely to receive intermittent pain medication.

### **Limitations**

A limitation to this study is that UKCMC has an acute pain management team that places all PNBs and follows all EPCA and IVPCAs that are started in the hospital. They are the only practitioners that can order these types of pain management. This may skew the data or limit the applicability of the findings to other centers without pain management teams. The sample for the study was obtained from one institution and therefore is not generalizable to all hospitals. The data collected for history of respiratory illness was dependent on medical coding. Therefore, it may not represent all types of respiratory illness (see Appendix D).

### **Future Quality Improvement**

This study highlights the need for utilization of multimodal pain management, mobility protocols on the medical surgical unit and further study of implementing ERAS for abdominal surgeries. This can be accomplished through further study and execution of ERAS pathways. The Enhanced Recovery (ERAS) after Surgery Society recommendations are comprehensive and evidence based. They offer pathways for most types of abdominal surgeries, information and assistance with implementing the pathways, and continuous utilization review of the process.

Utilizing the Plan, Do, Study, Act model for quality improvement, we can address future steps to improve outcomes in PORF.

The planning phase would begin by evaluating the outcomes of ERAS on PORF in the colorectal population at UKCMC. At UKCMC, ERAS was started after the results of this study were completed, so its impact is not reflected in our results. The ERAS Society recommendations provide a comprehensive perioperative plan that is evidence based (Gustafsson, 2017) and incorporates many of the suggestions made by this investigator to improve PORF outcomes such as multimodal pain management, early mobilization and perioperative conservative fluid management. The pathways also address other non-pulmonary complications associated with surgery. A task force is in place at UKCMC for implementing ERAS in colorectal surgeries, so a presentation of the data from our study would inform the task force and support using ERAS pathways for all abdominal surgeries. The key stakeholders are included in the task force such as surgeons from differing disciplines, anesthesiologists, physical therapy, pharmacists, and respiratory therapy. Other stakeholders that should be included are perioperative nursing staff, and medical surgical floor nursing staff. Inclusion of nursing staff in ERAS implementation would increase compliance with aspects of ERAS that could be nurse driven such as preoperative teaching, early mobilization, and optimizing nutrition. The [erassociety.org](http://erassociety.org) website offers educational resources for bedside providers to facilitate adoption of the pathways.

After the planning phase, the task force should review the results of ERAS in the colorectal surgery population to decide if significant improvement in patient outcomes has been achieved. If so, the task force could then build a plan to apply the ERAS pathways to all abdominal surgeries which was the type of surgery most associated with PORF in this study.

Significant attention should be placed on including nursing staff in the adoption of ERAS pathways to ensure that the nurses caring for these patients understand the importance of their role in preventing postoperative pulmonary complications and providing them with the resources to execute the pathways.

After executing the ERAS pathways, a prospective study of the development of PORF in abdominal surgeries would then guide future evidence based practice. Auditing ERAS compliance and clinical outcomes such as complication rates, readmission rates and length of hospital stay are quality metrics that can improve practice and guide further change (Gustafsson et al, 2013). Furthermore, ERAS implementation has decreased cost associated with abdominal surgeries (Greco et al., 2014; Lassen et al., 2005). In the current climate of healthcare reform, cost effective strategies to improve patient outcomes, prevent costly complications and enhance patient satisfaction are needed to stay competitive and relevant. The use of ERAS pathways for abdominal surgery patients could meet those needs.

### **Conclusion**

Several findings from this study support results from previous studies and emphasizes the need for multiple interventions to prevent PORF and associated outcomes. The comorbidities related to obesity may increase the ASA risk stratification score which is associated with increased incidence of PORF. Use of multimodal pain management as suggested by the American Pain Society and the American Society of Anesthesiology could improve outcomes in the obese population. Although there was no relationship between pain management modality and reasons for reintubation, there appears to be a relationship between pain management modality and discharge disposition. Further analysis is required to determine whether discharge disposition is dose or medication dependent.



Delayed mobility has been linked to postoperative pulmonary complications. UKCMC has several mobility programs in place in their ICU's but medical surgical units do not have structured mobility plans. We propose that we investigate the successfulness of the ICU programs and incorporate a mobility program for medical surgical units. Enhanced recovery after surgery programs are evidence based and incorporate multiple aspects of patient care to decrease postoperative complications. UKCMC has already adopted ERAS for colorectal surgery patients, and depending on the outcomes associated with the program, we should also consider implementing ERAS pathways for all abdominal surgeries and evaluate the effects of ERAS on PORF.

Upon conclusion of the doctoral defense process for this project, suggestions were proposed to further investigate the effects of pain management modalities on discharge disposition and to discuss the relationship between history of heart failure and fluid overload to the reasons for reintubation. There appears to be an association between pain management and discharge disposition in this study, however due to time constraints a full investigation into the potential relationship will not be completed at this time. The data from this study will be presented to the PORF patient safety committee at UKCMC and the benefit of further study can be considered at that time. I have been invited to share the findings of this study with the ERAS task force at UKCMC. Understanding the primary reasons for reintubation in PORF patients will support the goal of the task force which is to prevent postoperative complications in colorectal surgery patients. I have learned that the ERAS task force also wants to apply the pathways to other surgery types such as genitourinary and expand to include most abdominal surgeries. The findings of this study will support their endeavors and give them specific information about

PORF at UKCMC. Going forward as a nurse practitioner, I will continue to apply the findings of this study to my practice and remain involved in the prevention of PORF at UKCMC.

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Table 1. Sample Characteristics

	Total (N=215)		Cases (n=108)		Controls (n=107)		Differences Chi square (df), p-value
	N	%	N	%	n	%	
<b>Sex</b>							.00 (1), p=.952
Male	121	56.3	61	56.5	60	56.1	
Female	94	43.7	47	43.5	47	43.9	
	Total (N=215)		Cases (n=108)		Controls (n=107)		Differences Chi square (df), p-value
<b>ASA score</b>							
1	2	0.9	1	0.9	1	0.9	
2	41	19.1	21	19.4	20	18.7	
3	131	60.9	63	58.3	68	63.6	
4	39	18.1	22	20.4	17	18.1	
5	0	0.0	0	0.0	0	0.0	
6	2	0.9	1	0.9	1	0.9	
<b>Smoker</b>							5.60(1),p=.018
Yes	62	28.8	39	36.1	23	21.5	
no	153	71.2	69	63.9	84	78.5	
<b>History of respiratory illness</b>							.04(1),p=.834
Yes	100	46.5	51	47.2	49	45.8	
no	115	53.5	57	52.8	58	54.2	
<b>History of heart failure</b>							.95(1),p=.330
Yes	33	15.3	14	13.0	19	17.8	

no	182	84.7	94	87.0	88	82.2	
<b>Type of pain control</b>							41.5(4),p<.0001
EPCA	34	15.8	13	12.0	21	19.6	
Intermittent	69	32.1	51	47.2	18	16.8	
IVPCA	46	21.4	29	26.9	17	15.9	
PO	61	28.4	15	13.9	46	43.0	
PNB	5	2.3	0	0.0	5	4.7	
<b>Type of surgery</b>							18.1(4), p=.001
Abdominal	78	36.3	46	42.6	32	29.9	
Genitourinary	37	17.2	14	13.0	23	21.5	
Head/neck and neuro/spine	45	20.9	18	16.7	27	25.2	
Orthopedic	26	12.1	8	7.4	18	16.8	
Thoracic/vascular	29	13.5	22	20.4	7	6.5	
<b>Discharge disposition</b>							53.9(2), p<.0001
Expired	21	9.8	21	19.4	0	0.0	
Rehab/VA	53	24.7	41	38.0	12	11.2	
Home	141	65.6	46	42.6	95	88.8	
	m	sd	m	sd	m	sd	Differences t-test (df), p-value
Age	58.6	14.6	58.9	14.7	58.3	14.6	.30(213),p=.761
Body mass index	31.0	14.8	31.0	14.8	31.0	14.8	.03(213), p=.975
Length of surgery (in minutes)	295.9	159.7	334.6	167.5	256.8	141.9	3.68(213), p<.0001

\*differences were calculated using chi square analyses for categorical data and independent sample t-test (with Levene's test for equality of variance) for categorical variables. EPCA=epidural patient controlled analgesia, IVPCA=intravenous patient controlled analgesia, PO=by mouth, PNB=peripheral nerve block

Table 2. Differences in demographic, type of surgery, and discharge disposition by type of pain management among those who develop PORF

	Total (N=108)		EPCA (n=13)		Intermittent (n=51)		IVPCA (n=29)		PO (n=15)		Differences Chi Square (df), p-value
	N	%	n	%	n	%	n	%	n	%	
<b>Sex</b>											1.29 (3), p=.731
Male	61	56.5	6	46.2	31	60.8	15	51.7	9	60.0	
Female	47	43.5	7	53.8	20	39.2	14	48.3	6	40.0	
<b>ASA score</b>											12.54 (12), p=.403
1	1	0.9	0	0.0	1	2.0	0	0.0	0	0.0	
2	21	19.4	5	38.5	8	15.7	7	24.1	1	6.7	
3	63	58.3	7	53.8	29	56.9	19	65.5	8	53.3	
4	22	20.4	1	7.7	12	23.5	3	10.3	6	40.0	
5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
6	1	0.9	0	0.0	1	2.0	0	0.0	0	0.0	
<b>Smoker</b>											4.57(3), p=.206

Yes	39	36.1	3	23.1	16	31.4	15	51.7	5	33.3	
no	69	63.9	10	76.9	35	68.6	14	58.3	10	66.7	
	N	%	n	%	n	%	n	%	n	%	
<b>History of respiratory illness</b>											3.24(3), p=.356
Yes	51	47.2	4	30.8	24	47.1	17	58.6	6	40.0	
no	57	52.8	9	69.2	27	52.9	12	41.4	9	60.0	
<b>History of heart failure</b>											.83(3),p=.841
Yes	14	13.0	1	7.7	8	15.7	3	10.3	2	13.3	
no	94	87.0	12	92.3	43	84.3	26	89.7	13	86.7	
<b>Reason for intubation</b>											7.47 (12), p=.825
Aspiration	22	20.4	1	7.7	14	27.5	4	13.8	3	20.0	
Atelectasis	37	34.3	5	38.5	18	35.3	9	31.0	5	33.3	
Fluid overload & pulmonary edema	27	25.0	4	30.8	11	21.6	9	31.0	3	20.0	
Obstruction, pulmonary embolism & oversedation	6	5.6	0	0.0	2	3.9	3	10.3	1	6.7	
Pneumonia	16	14.8	3	23.1	6	11.8	4	13.8	3	20.0	
<b>Type of surgery</b>											42.03 (12), p<.0001

Abdominal	46	42.6	9	69.2	12	23.5	22	75.9	3	20.0	
	N	%	n	%	n	%	n	%	n	%	
Genitourinary	14	13.0	2	15.4	11	21.6	1	3.4	0	0.0	
Head/neck and neuro/spine	18	16.7	0	0.0	12	23.5	0	0.0	6	40.0	
Orthopedic	8	7.4	1	7.7	2	3.9	3	10.3	2	13.3	
Thoracic/vascular	22	20.4	1	7.7	14	27.5	3	10.3	4	26.7	
<b>Discharge disposition</b>											18.12 (6), p=.006
Expired	21	19.4	1	7.7	9	17.6	6	20.7	5	33.3	
Rehab/VA	41	38.0	6	46.2	25	49.0	3	10.3	7	46.7	
Home	46	42.6	6	46.2	17	33.3	20	69.0	3	20.0	
	m	sd	m	sd	m	sd	m	sd	m	sd	Differences f- statistic (df), p-value
Age	59.9	14.7	56.7	11.2	60.8	15.1	55.0	14.2	61.8	16.2	1.3 (3,104), p=.285
Body mass index	31.0	14.8	31.1	7.3	31.3	20.1	30.0	8.2	32.1	6.9	.1(3,104), p=.973
Length of surgery (in minutes)	334.6	167.5	398.4	182.7	330.2	156.7	312.1	165.3	338.0	196.3	.8(3,104), p=.490

\*differences were calculated using chi square analyses for categorical data and one way ANOVA (with Levene's test for homogeneity of variance) for categorical variables. EPCA=epidural patient controlled analgesia, IVPCA=intravenous patient controlled analgesia, PO=by mouth.

Table 3. Predictors of mortality among those who develop PORF

	OR	95% CI
<b>Sex</b>		
Male	2.2	.7-7.3
Female (referent)	1.0	--
<b>ASA score *</b>		
1-2 (referent)	1.0	--
3-6	5.9	1.3-27.0
<b>Smoker</b>		
Yes	1.6	.4-6.2
No (referent)	1.0	--
<b>History of respiratory illness</b>		
Yes	2.9	.8-10.7
No (referent)	1.0	--
<b>History of heart failure</b>		
Yes	.7	.1-4.1
No (referent)	1.0	--
<b>Type of pain control</b>		
EPCA	.2	.0-3.1
Intermittent	.3	.1-1.7
IVPCA	1.8	.2-15.3
PO (referent)	1.0	--
<b>Type of surgery</b>		
Abdominal	.4	.1-2.6
Genitourinary	1.9	.2-17.3

Head/neck and neuro/spine	2.3	.3-19.0
Orthopedic	2.6	.2-29.4
Thoracic/vascular (referent)	1.0	--
Age	1.0	1.0-1.1
Body mass index	1.0	.9-1.0
Length of surgery (in minutes)	1.0	1.0-1.0

\*OR= Odds Ratio; 95% CI=95% Confidence limits



# Post-Operative Respiratory Failure

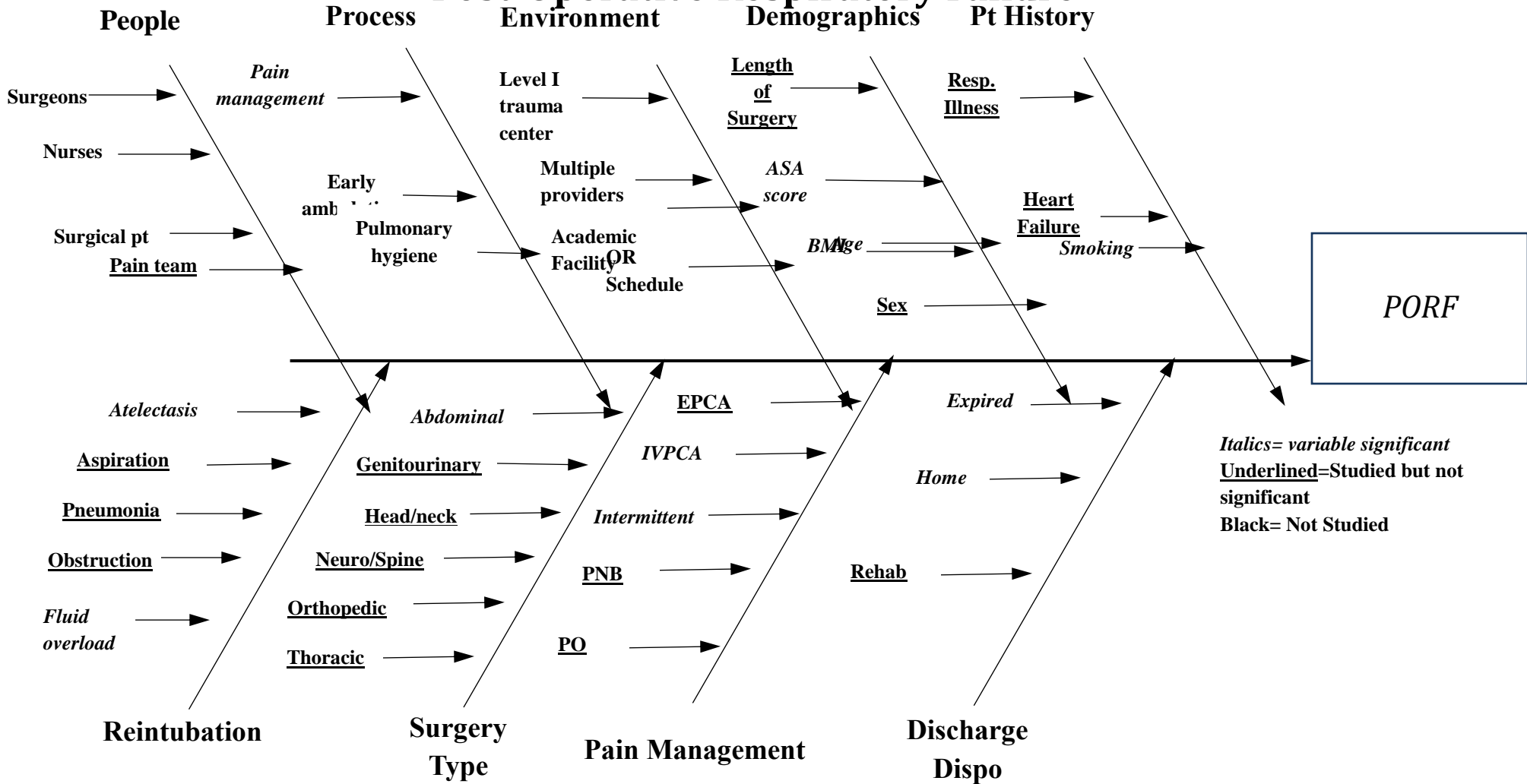


Figure 1--Fishbone diagram

Conclusion to Final DNP Project Report

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## Conclusion to Final DNP project

Interprofessional education (IPE) is a valuable tool that should be incorporated in the curriculum of doctoral education. It can facilitate the development of mutual exchange and respect among disciplines with a focus on patient-centered outcomes. Furthermore, it serves as a gateway to generate open dialogue and inquiry into improving nursing practice and professional development. The role of IPE in this practice improvement project has been invaluable as it has provided the ability to effectively communicate with multiple disciplines and understand how to work within systems to achieve measurable results.

The literature review is an essential step to provide evidence-based practice. Although the risk factors associated with postoperative respiratory failure (PORF) have been well studied, gaps remain in the literature about the effect of pain management on the development of PORF. An investigation of the association of pain management modalities on the development of PORF at University of Kentucky Medical Center found that there is a need for a multi-disciplinary approach to decrease the risk associated with PORF. There was a 19.4% mortality rate among the cases and less than half of the cases were discharged home. Those findings place a burden on the healthcare system. With the cost of \$27 billion annually associated with mechanical ventilation (Wunsch et al., 2010) and the rising cost of healthcare it is fiscally prudent to determine ways to prevent PORF.

Further findings from the study show that intermittent dosing was associated with those who died from PORF, yet there was no pain management modality that was a statistically significant predictor of mortality. The primary causes for reintubation were atelectasis and fluid overload. Therefore practice changes concerning strategies to decrease atelectasis and conservative fluid management would be beneficial to UKCMC in the prevention of PORF.

Enhanced recovery after surgery (ERAS) pathways incorporate strategies to address atelectasis, fluid overload, early mobilization and pain management which are all needed to prevent PORF in abdominal surgery patients. Although UKCMC has adopted ERAS for colorectal surgery patients, I think that it prudent to develop a strategic plan to adopt the pathways of ERAS for all abdominal surgeries, which was the type of surgery most associated with PORF from my study. Furthermore, the multimodal pain management strategies of ERAS encourage less intermittent intravenous opioid administration which was associated with the patients with PORF who expired. By implementing these multidisciplinary strategies, UKCMC can decrease the risk of PORF in abdominal surgery patients.

## Appendix A-Inclusion and exclusion criteria for PORF

### **Patient Safety Indicators 11 (PSI 11) AHRQ Quality Indicators™, Version 5.0 March 2015**

#### **Provider-Level Indicator**

#### **Type of Score: Rate**

#### **Description**

Postoperative respiratory failure (secondary diagnosis), prolonged mechanical ventilation, or reintubation cases per 1,000 elective surgical discharges for patients ages 18 years and older. Excludes cases with principal diagnosis for acute respiratory failure; cases with secondary diagnosis for acute respiratory failure present on admission; cases in which tracheostomy is the only operating room procedure or in which tracheostomy occurs before the first operating room procedure; cases with neuromuscular disorders, laryngeal or pharyngeal surgery, craniofacial anomalies that had a procedure for the face, esophageal resection, lung cancer, or degenerative neurological disorders; cases with a procedure on the nose, mouth, or pharynx; cases with respiratory or circulatory diseases; and obstetric discharges.

*[NOTE: The software provides the rate per hospital discharge. However, common practice reports the measure as per 1,000 discharges. The user must multiply the rate obtained from the software by 1,000 to report events per 1,000 hospital discharges.]*

#### **Numerator**

Discharges, among cases meeting the inclusion and exclusion rules for the denominator, with either:

any secondary ICD-9-CM diagnosis code for acute respiratory failure; or  
any-listed ICD-9-CM procedure codes for a mechanical ventilation for 96 consecutive hours or more that occurs zero or more days after the first major operating room procedure code (based on days from admission to procedure); or  
any-listed ICD-9-CM procedure codes for a mechanical ventilation for less than 96 consecutive hours (or undetermined) that occurs two or more days after the first major operating room procedure code (based on days from admission to procedure); or  
any-listed ICD-9-CM procedure codes for a reintubation that occurs one or more days after the first major operating room procedure code (based on days from admission to procedure)

#### **Denominator**

Elective surgical discharges, for patients ages 18 years and older, with any-listed ICD-9-CM procedure codes for an operating room procedure. Elective surgical discharges are defined by specific DRG or MS-DRG codes with admission type recorded as elective (SID ATYPE=3).

See *Patient Safety Indicators Appendices*:

Appendix A – Operating Room Procedure Codes

Appendix D – Surgical Discharge DRGs

Appendix E – Surgical Discharge MS-DRGs

Exclude cases:

with a principal ICD-9-CM diagnosis code (or secondary diagnosis present on admission) for acute respiratory failure (see above)  
where the only operating room procedure is tracheostomy  
where a procedure for tracheostomy occurs before the first operating room procedure  
with any-listed ICD-9-CM diagnosis codes for neuromuscular disorder  
with any-listed ICD-9-CM procedure codes for laryngeal or pharyngeal, nose, mouth or pharynx surgery  
with any-listed ICD-9-CM procedure codes involving the face and any-listed ICD-9-CM diagnosis codes for craniofacial anomalies  
with any-listed ICD-9-CM procedure codes for esophageal resection  
with any-listed ICD-9-CM procedure codes for lung cancer  
any-listed ICD-9-CM diagnosis codes for degenerative neurological disorder  
MDC 4 (diseases/disorders of respiratory system)  
MDC 5 (diseases/disorders of circulatory system)  
MDC 14 (pregnancy, childbirth, and puerperium)  
with missing gender (SEX=missing), age (AGE=missing), quarter (DQTR=missing), year (YEAR=missing), or principal diagnosis (

## Appendix B-UK HealthCare Mobility Scale

### UK HealthCare Mobility Scale

Please reference General Mobility and Ortho/Trauma/Spine guidelines for specific instructions.

**Our Goal: Early Progression of Best Possible Mobility  
Based on Patients' Success with Previous Steps**

Score	Activity	Length of Time	How Often
<b>Patient Immobile</b>			
0	Patient completely immobile or prone	n/a	n/a
1	Turn depending on need. HOB less than 30 degrees	Every 1-2 hours	Every 1-2 hours
<b>Patient in Bed</b>			
2	HOB elevated 30 or greater and less than 45 degrees	5-10 minutes	2-3 times per day
3	Head of bed elevated 45 to 64 degrees; legs in dependent position.	10-20 minutes as tolerated	2-3 times per day
4	Head of bed elevated 65 degrees or greater; legs in dependent position (to be used when pt to chair with lift).	10-30 minutes, up to 1 hour as tolerated	2-3 times per day
<b>Patient - Sitting/ Standing</b>			
5	Patient positioned on edge of bed (EOB); legs dangling with assist for balance and safety. * (see note below)	5-15 minutes	1-2 times per day Note: Pt to sit on EOB with minimal assist (for balance) before advancing
6	Initiate standing/side stepping/ marching at EOB	1-5 minutes	1-2 times per day
7	Initiate stand-pivot or steps to chair (Reposition in chair every 30 min. Refer to #4 if using lift.)	2 hrs maximum	2-3 times daily as tolerated
<b>Patient Ambulating</b>			
8	Ambulation with assist as needed	Distance as tolerated	2-3 times daily as tolerated

\*Consider having 2 people to assist for scores/activities 3-6

DX1=missing)

## Appendix C--American Society of Anesthesiology Classification

ASA PS Classification	Definition	Examples, including, but not limited to:
<b>ASA I</b>	A normal healthy patient	Healthy, non-smoking, no or minimal alcohol use
<b>ASA II</b>	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Examples include (but not limited to): current smoker, social alcohol drinker, pregnancy, obesity (30 < BMI < 40), well-controlled DM/HTN, mild lung disease
<b>ASA III</b>	A patient with severe systemic disease	Substantive functional limitations; One or more moderate to severe diseases. Examples include (but not limited to): poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA < 60 weeks, history (>3 months) of MI, CVA, TIA, or CAD/stents.
<b>ASA IV</b>	A patient with severe systemic disease that is a constant threat to life	Examples include (but not limited to): recent (< 3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis
<b>ASA V</b>	A moribund patient who is not expected to survive without the operation	Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction
<b>ASA VI</b>	A declared brain-dead patient whose organs are being removed for donor purposes	

\*The addition of "E" denotes Emergency surgery: (An emergency is defined as existing when delay in treatment of the patient would lead to a significant increase in the threat to life or body part)

These definitions appear in each annual edition of the ASA Relative Value Guide®. There is no additional information that will help you further define these categories.



Appendix D—List of ICD 9 Codes Used to Define History of Respiratory Illness

ICD CODE	ICD_DX_DESCRIPTION
11505	, '11505' HISTOPLASM CAPS PNEUMON
11595	, '11595' Histoplasmosis, unspecified, pneumonia
1304	, '1304' Pneumonitis due to toxoplasmosis
4800	, '4800' PNEUMONIA DUE TO ADENOVIRUS
4801	, '4801' Pneumonia due to respiratory syncytial virus
4802	, '4802' Pneumonia due to parainfluenza virus
4808	, '4808' Viral pneumonia NEC
4809	, '4809' VIRAL PNEUMONIA, UNSPECIFIED
481	, '481' Pneumococcal pneumonia (Streptococcus pneumoniae pneumonia)
4820	, '4820' K. pneumoniae pneumonia
4821	, '4821' PSEUDOMONAL PNEUMONIA
4822	, '4822' PNEUMONIA DUE TO HEMOPHILUS INFLUENZAE (H. INFLUENZAE)
48231	, '48231' PNEUMONIA DUE TO STREPTOCOCCUS, GROUP A
48232	, '48232' Pneumonia due to Streptococcus, group B
48239	, '48239' PNEUMONIA OTH STREP
48240	, '48240' Pneumonia due to unspecified Staphylococcus
4824	, '4824' STAPHYLOCOCCAL PNEUMONIA
48241	, '48241' Pneumonia due to Staphylococcus aureus
48242	, '48242' Methicillin resistant pneumonia due to staphylococcus aureus
48249	, '48249' PNEUMONIA DUE TO STAPHYLOCOCCUS
48282	, '48282' PNEUMONIA E COLI
4829	, '4829' Bacterial pneumonia NOS
4830	, '4830' MYCOPLASMA PNEUMONIAE
4831	, '4831' PNEUMONIA DUE TO CHLAMYDIA
4838	, '4838' Pneumonia due to organism
4841	, '4841' Pneumonia in cytomegalic inclusion disease (manifestation)
4843	, '4843' PNEUMONIA IN WHOOP COUGH
485	, '485' BRONCOPNEUMONIA ORG NOS
486	, '486' PNEUMONIA, ORGANISM NOS
4870	, '4870' Influenza with pneumonia
48801	, '48801' Influenza due to identified avian influenza virus with pneumonia
48881	, '48881' Influenza due to identified novel influenza A virus with pneumonia
4957	, '4957' 'ventilation' pneumonitis
4958	, '4958' OTHER SPECIFIED ALLERGIC ALVEOLITIS & PNEUMONITIS
4959	, '4959' Unspecified allergic alveolitis & pneumonitis
504	, '504' PNEUMONOPATHY DUE TO INHALATION OF DUST

		BRONCHITIS AND PNEUMONITIS DUE TO FUMES AND VAPORS
5060	,5060'	
5070	,5070'	PNEUMONITIS DUE TO INHALATION OF FOOD OR VOMITUS
5071	,5071'	Pneumonitis due to inhalation of oils and essences
5078	,5078'	SOLID/LIQ PNEUMONIT NEC
51630	,51630'	Idiopathic interstitial pneumonia, not otherwise specified
51632	,51632'	Idiopathic non-specific interstitial pneumonitis
51633	,51633'	Acute interstitial pneumonitis
51636	,51636'	Cryptogenic organizing pneumonia
51637	,51637'	Desquamative interstitial pneumonia
5168	,5168'	Alveolar and parietoalveolar pneumonopathies
5169	,5169'	ALVEOL PNEUMONOPATHY NOS
V1261	,V1261'	Personal history of pneumonia (recurrent)
4660	,4660'	ACUTE BRONCHITIS
4661	,4661'	ACUTE BRONCHIOLITIS
46611	,46611'	Acute bronchiolitis due to respiratory syncytial virus (rsv)
46619	,46619'	ACUTE BRONCHIOLITIS DUE TO OTH INFEC ORG
4910	,4910'	SIMPLE CHRONIC BRONCHITIS
4911	,4911'	Mucopurulent chronic bronchitis
		OBSTRUCTIVE CHRONIC BRONCHITIS WITHOUT EXACERBATION
49120	,49120'	
		OBSTRUCTIVE CHRONIC BRONCHITIS WITH ACUTE EXACERBATION
49121	,49121'	
		OBSTRUCTIVE CHRONIC BRONCHITIS WITH ACUTE BRONCHITIS
49122	,49122'	
4918	,4918'	Chronic bronchitis
4919	,4919'	CHRONIC BRONCHITIS NOS
4940	,4940'	BRONCHIECTAS W/O AC EXAC
494	,494'	BRONCHIECTASIS
4941	,4941'	Bronchiectasis with acute exacerbation
		BRONCHITIS AND PNEUMONITIS DUE TO FUMES AND VAPORS
5060	,5060'	
51634	,51634'	Respiratory bronchiolitis interstitial lung disease
		EXTRINSIC ASTHMA, WITHOUT ACUTE EXACERBATION/STATUS ASTHMATICUS/UNSPECIFIED
49300	,49300'	
49301	,49301'	EXTRINSIC ASTHMA, WITH STATUS ASTHMATICUS
49302	,49302'	EXTRINSIC ASTHMA, WITH ACUTE EXACERBATION
49310	,49310'	Intrinsic asthma, unspecified
49311	,49311'	INT ASTHMA W STATUS ASTH
49312	,49312'	Intrinsic asthma, with (acute) exacerbation
49321	,49321'	Ch ob asthma w stat asth
49322	,49322'	Chronic obstructive asthma, with (acute) exacerbation
49382	,49382'	Cough variant asthma
49390	,49390'	ASTHMA W/O STATUS ASTHM

49391	,49391'	Asthma, unspecified type, with status asthmaticus
49392	,49392'	ASTHMA W ACUTE EXACERBTN
5130	,5130'	Abscess of lung
51631	,51631'	Idiopathic pulmonary fibrosis
51853	,51853'	Acute and chronic respiratory failure following trauma and surgery
51883	,51883'	Chronic respiratory failure
51884	,51884'	ACUTE AND CHRONIC RESPIRATORY FAILUR

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