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Predictors of Postoperative Respiratory Failure in Patients Receiving Anesthesia

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PREDICTORS OF POSTOPERATIVE RESPIRATORY FAILURE IN PATIENTS RECEIVING ANESTHESIA

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EXECUTIVE SUMMARY

- **Abstract:** Postoperative Respiratory failure has been identified as a prevention quality indicator by The Agency for Health Research and Quality (AHRQ). Respiratory complications are is associated with increased length of stay, increased costs and increased morbidity and mortality. This retrospective case control study was conducted to determine if the various tools of evaluation of risk currently available are predictive of the risk of developing postoperative respiratory failure. No significant differences were found with age, gender, body mass index, diagnosis of obstructive sleep apnea, ASA Score, Surgical Apgar score or narcotic dosing. A logistic regression analysis was performed found a statistically significant relationship MEWS 12 and 24 hour score, also postoperative PCA use and post operative respiratory failure.
- **Introduction:** The patient safety indicator of postoperative respiratory failure has not undergone analysis at Charleston Area Medical Center (CAMC). At CAMC in 2009 and first quarter 2010 there were 98 cases of postoperative respiratory failure. If predictive factors for this postoperative condition can be identified, it may help health care providers place a safety net around those how are at most risk of respiratory complications and guide them safely through the surgical experience.
- **Literature Review:** Various tools exist for risk stratification of patients undergoing surgery. Research shows that several methods have been used to try to predict post operative complications.
- **Methodology:** The research design was a retrospective case control study conducted at a non-profit, level 1 trauma, Joint Commission accredited, research, and teaching facility in Charleston, West Virginia. Sample population contained 111 patients who met the criteria for inclusion and underwent a surgical procedure at CAMC between January 1, 2009 and March31, 2010. The hypothesis was analyzed using a t-test. A logistic regression analysis was performed.
- **Results:** There were no differences in age, gender, BMI, ASA score, surgical apgar score and narcotic dosing between patients who experienced no postoperative respiratory failure and patients who did experience respiratory failure. A logistic regression analysis found a statistically significant relationship between respiratory failure and 12 and 24 hour MEWS score and postoperative use of Morphine PCA.
- **Discussion:** Previous study findings were compared to the results found in this retrospective review. Several study limitations were discovered throughout the review.
- **Conclusions:** MEWS is a useful tool to identify the deteriorating patient and allow appropriate interventions to take place in a timely fashion to prevent respiratory failure.
- **Implications and Recommendations:** MEWS scoring should be incorporated in the nursing documentation to give nurses a tool to alert the medical staff of the deteriorating patient condition preventing respiratory failure. Morphine PCA merits closer scrutiny in post operative monitoring.

ABSTRACT

Introduction: Postoperative Respiratory failure has been identified as a prevention quality indicator by The Agency for Health Research and Quality (AHRQ). Postoperative Respiratory Failure is associated with increased length of stay, increased costs and increased morbidity and mortality. Unfortunately, current research is limited regarding scoring methods which are predictive for postoperative respiratory failure. This retrospective case control study was conducted to determine if the various tools of evaluation of risk currently available and to determine if any are predictive of the risk of developing postoperative respiratory failure.

Methodology: The design of this research was a retrospective case control study conducted at CAMC. The population included a convenience sample of 111patients: 54 patients in the postoperative respiratory failure group and 57 patients in the group without postoperative respiratory failure.

Results: There were no differences in age, gender, BMI, ASA score, Surgical Apgar Score and narcotic dosing between patients who experienced no postoperative respiratory failure and patients who did experience respiratory failure. A logistic regression analysis found a statistically significant relationship between respiratory failure and 12 and 24 hour MEWS score and also Morphine PCA use postoperatively for pain control.

Discussion/Conclusion: The available risk assessment scoring systems used today, ASA score and Surgical Apgar Score are not specific enough to predict postoperative respiratory failure. In addition, neither is the diagnosis of obstructive sleep apnea or elevated BMI. Narcotic dosing during anesthesia and in the PACU did not play a significant role in the development of postoperative respiratory failure, although Morphine PCA was found to be statistically significant and these patients merit closer scrutiny in post operative monitoring. MEWS is a useful tool to identify the deteriorating patient and allow appropriate interventions to take place in a timely fashion to prevent respiratory failure. MEWS scoring should be incorporated in the nursing documentation to give nurses a tool to alert the medical staff of the deteriorating patient condition preventing respiratory failure.

Key Words: Postoperative, Respiratory Failure, Anesthesia, CRNA, Case Control

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INTRODUCTION

Background and Significance of the Problem

When a patient enters the hospital for treatment of a medical problem, they do not expect to leave with additional injuries, infections or other serious conditions that occur during the course of their hospitalization. Since October 1, 2007, Medicare has taken steps to improve the quality of care by selecting conditions that are reasonably preventable. To encourage hospitals to avoid hospital-acquired conditions, defined as conditions not present on admission, in 2008, Medicare no longer paid hospitals at a higher rate for the increased cost of care resulting from selected conditions (CMS 2009; Premier, 2010).

Post operative respiratory failure has been identified as a prevention quality indicator by The Agency for Health Research and Quality (AHRQ, 2009). The National Surgical Quality Improvement Program (NSQIP) found that the longest and most costly length of stay was attributed to postoperative pulmonary complications (Pederson, 1994).

The patient safety indicator of post operative respiratory failure has not undergone analysis by Charleston Area Medical Center (CAMC). Respiratory failure is significant because it increases length of stay resulting in increased hospital costs and increases morbidity and mortality (Smetana, 2010). At CAMC in 2009 there were 619 cases of respiratory failure not present on admission identified through abstracted data. The adjusted length of stay was 18.8 days with a mortality rate of 28.6%. For the calendar year 2009 and first quarter 2010, 98 cases of postoperative respiratory failure have been identified (Mimnaugh, 2010).

The definitions of postoperative respiratory failure complications encompass atelectatsis, Acute Respiratory Distress Syndrome (ARDS), post operative pneumonia, and the inability to be extubated 48 hours after surgery (Arozullah, Daley, Henderson, Khuri, 2000). There is much variability in the literature surrounding this complication in the perioperative arena, due to procedure related risk factors, patient selection criteria, patient related risk factors and many proposed definitions of respiratory complications (Smetana, 2010).

Literature Review

Post operative patients are a great risk of adverse drug events with administration of opioids to control operative pain. Opioids have the ability to cause significant respiratory depression due to over sedation. Computer surveillance of naloxone administration has been recommended as a monitoring tool for identifying adverse drug events in the post operative population to mitigate patient harm (Gordon, 2005; Eckstrand, 2009). High risk groups have been identified which include the morbidly obese, obstructive sleep apnea, the elderly and those receiving supplemental oxygen (Weinger, 2007).

Obstructive Sleep Apnea (OSA) is a common sleep disorder affecting approximately 10 % of adults in the United States (CDC, 2008; Sondik, 2008). It is a condition characterized by episodic airway obstruction during sleep. Perioperative guidelines have been established to protect this high risk group to reduce the likelihood of adverse outcomes. Post operative management focuses on analgesia, oxygenation, patient positioning and monitoring. This is a high risk group for developing post operative respiratory depression and failure (American Society of Anesthesiologists Task Force on Perioperative Management of Obstructive Sleep Apnea, 2006).

In 2007-2008, the prevalence of obesity, defined by a Body Mass Index (BMI) of 30 or over in the general population of the United States, was greater than 30%. Obesity is a risk factor for a variety of chronic conditions and higher grades of obesity are associated with increased mortality rates. These patients bring many challenges to anesthesia providers and are at greater risk of pulmonary complications (CDC, 2008; Flegal, Carroll,Ogden, Curtin, 2010). BMI is determined by the weight in kilograms divided by the square of the height in meters (km/m^2) (World Health Organization, 2010).

There are many risk stratification methods in place today. The American Society of Anesthesiologists (ASA) Physical status was instituted in 1941and revised in 1963. It was instituted to provide a basis of statistical data comparison in anesthesia and risk assessment of patients. The correlation between postoperative mortality and ASA classification was confirmed by a retrospective study in 1996 (Wolters, 1996). This is an input variable, the condition the patient presents for surgery. The ASA score is a subjective assessment of the patient's overall health status, defined by classes I, II, III, IV or V. Class one being healthy through class five being moribund. An Emergency (E) was included to denote an emergency operation (ASA, 2010).

The Modified Early Warning System (MEWS) is a simple scoring system that can quickly be used to quickly identify patients who are quickly deteriorating and need urgent intervention. Once the deteriorating patient has been identified, appropriate interventions should take place (Patterson, 2006). The MEWS incorporates five simple physiologic parameters; respiratory rate, heart rate, systolic blood pressure, temperature and (APVU) Alert, Voice, Pain, and Unresponsive level of consciousness score. The Standardized Early Warning System (SEWS) incorporates oxygen saturation. Since oxygen saturation is not a standardized assessment on all patients, the MEWS score will be utilized in this study. The

MEWS score will be calculated at 12 hour and 24 hours following discharge from the anesthesia stop time.

Surgical APGAR (Activity, Pulse, Grimace, Appearance, Respiration) Score is the newest measure of intraoperative performance as it relates to surgical outcomes. Apgar score was first used as a numerical expression of an infant's condition, 60 seconds after birth. It was later adapted from data derived from the Surgical Quality Improvement Center, to create as a simple method of evaluation that would be applicable throughout all fields of surgery. Studies have validated its usefulness in predicting post operative risk (Gawande, 2006; Regenbogen, 2008). Poor scoring patients were 16 times more likely to experience postoperative complications (Regenbogen, 2008). This is a useful tool because it is easy to calculate using scoring system looking at intraoperative blood loss, heart rate and blood pressure. This score, unlike a preoperative risk assessment, adds the evaluation of intraoperative care. It can be used as a decision support tool for postoperative care. The surgical APGAR score is a 10-point scoring system that is based on assessing three variables intraoperatively: lowest heart rate, estimated blood loss in milliliters and lowest mean arterial pressure.

Statement of the problem and research purpose

Postoperative respiratory failure is multifaceted and costly in terms of mortality and dollars spent to recover from this deadly event. There is no tool presently available that is specific to the prediction of postoperative respiratory events. The anesthesia provider is pivotal in placing the patient in the correct postoperative level of care to help prevent, identify or manage this serious complication.

This retrospective case control study seeks to identify risk factors associated with unfavorable surgical outcomes due to postoperative respiratory failure. As patients descend from the highly monitored environment in the operating room to the unmonitored nursing floor, patients may develop respiratory depression that goes unrecognized. Respiratory depression is the decrease of the rate and depth of respirations. The combination of patient's chronic illnesses and pain medication administration after surgery potentially will place patients at risk for respiratory depression. Despite past research, there is no tool available to identify respiratory risk in the general surgical population.

The purpose of this retrospective case control study is to explore the various tools of evaluation of risk currently available and to determine if any are predictive of the risk of developing postoperative respiratory failure. The aim of this study is to specifically examine narcotic dosing to find if total dosing is attributed to respiratory failure, taking into account the patient risk stratification.

METHODOLOGY

Research Hypothesis

The working hypothesis will test that BMI, OSA diagnosis, ASA physical status, MEWS, Surgical Apgar score and narcotic dosing will be predictive of the risk of developing post operative respiratory failure.

Research design and setting

The research design was a retrospective case control study. This research design was chosen in order to describe the association between ASA Score, Surgical Apgar Score, MEWS 12 and 24 hour after anesthesia end time, OSA diagnosis, BMI category and narcotic total dose intraoperative and in the PACU and the incidence of developing post operative respiratory failure. The retrospective design was chosen because all data is included in standard documentation and easily accessible through electronic patient records.

CAMC, being one of two, tertiary referral centers in West Virginia, experiences some of the highest acuity operative cases in the state. Approximately, 35,000 operative cases are performed annually, including a Level One Trauma Center (CAMC, 2010). The validation of predictors in patients with postoperative respiratory failure would support the use of tools to maximize patient safety. This could lead to change in policy at CAMC requiring the anesthesia team to use the valid predictors to determine the appropriate level of post operative care and nursing care management.

The research setting was the operating room, the Post Anesthesia Care Unit (PACU) and the postoperative nursing units in CAMC in 2009 and first quarter of 2010.

Sample population and Description

Postoperative respiratory failure is a Premier quality indicator at CAMC. Premier is a health care alliance consisting of more than 2,500 U.S. hospitals. Premier is dedicated to improving health of communities by collecting and analyzing clinical and financial data. Their aim is to reduce costs, improve quality and safety and manage risk. The Electronic Medical Record (EMR) was used to extract the charts for review and data collection (McKesson Corporation, 2008).

The sample population used for this retrospective study included patients undergoing surgery and experienced postoperative respiratory failure from January 1, 2009 through March 31, 2010 at CAMC. One hundred and eleven who met criteria for inclusion were selected for this study. The convenience sample included 54 patients who experienced post operative respiratory failure and 57 patients who did not have post operative respiratory failure. All subjects included in the sample were identified by and a control group of 57 similar cases with no postoperative respiratory failure from post operative patients experiencing respiratory depression from the *International Classification of Diseases*, 9th revision, Clinical Modification (ICD-9-CM) codes (U.S. Department of Health and Human Services, 1989) and the Major Disease Category (MDC) codes (Medicare Claims Processing Manual, 2010) code Acute Respiratory Failure (518.81) was used to pull the sample population through the Premier database. Included were all elective surgical discharges age 18 and over defined by specific DRGs and an ICD-9-CM code for an operating room procedure.

Inclusion Criteria:

1. Discharges with ICD-9-CM codes for acute respiratory failure (518.81) or acute and chronic respiratory failure (518.84) in any secondary diagnosis field.
2. Discharges among cases meeting the inclusion and the exclusion rules for the denominator with an ICD-9-CM procedure codes for intubation procedures : (96.04) intubation one or more days after a major operation, (96.70 or 96.71) intubation two or more days after the major operation, (96.72) zero or more days after a major operation.

Exclusion Criteria:

1. ICD-9-CM codes for admission diagnosis of acute respiratory failure.
2. ICD-9-CM diagnosis code for admission diagnosis of a neuromuscular disorder
3. If a procedure for tracheostomy is the only operating room procedure or tracheostomy occurs before the first operating room procedure

4. MDC 14 (any patient presenting during pregnancy, childbirth, and puerperium)
5. MCD 4 (any patient with diseases/disorders of the respiratory system)
6. MCD 5(any patient with diseases/disorders of the circulatory system)

In addition, the patients who remained intubated from surgery were also excluded since anesthesia personal had determined that these patients would experience respiratory failure. The reason this group was excluded is to evaluate the patients at risk for developing unrecognized post operative respiratory failure. The comparison group had the same exclusion criteria, including matching with controls of age and gender, DRG, and comorbidty categories.

Procedure and Protocol

A retrospective medical chart review was carried out on patients who underwent surgery at CAMC from January 1, 2009 to March 31, 2010. The independent variables in this study included: age, gender, race, Body Mass Index (BMI), ASA physical status, OSA diagnosis, Surgical Apgar Score, MEWS score 12 and 24 hours post anesthesia end time, and total narcotic dosing intraoperatively and in the PACU. The dependent variable analyzed was postoperative respiratory failure and no postoperative respiratory failure.

Data Collection and Instruments

Data collection was conducted using existing data from each patient's individual Electronic Medical Record (EMR). The specific data used was collected from the anesthesia record, the PACU record, nursing administration database and the vital sign graphic sheets and nursing assessment sheets.

The anesthesia record is used for every patient who undergoes surgery at CAMC and contains information including: physical status scoring, medications received, important times during the anesthetic, vital sign trends and other patient surgical data. The postoperative nursing unit is any nursing unit that a patient is sent to upon discharge from the PACU.

The PACU at CAMC cares for the patient's needs immediately after surgery until the patient is stable and able to be transferred the appropriate level of care defined by the patient condition. The PACU flow sheet was used to record patient data during the time the patient was in the recovery room after surgery. The PACU flow sheet contains information that was collected in the study included: administered narcotics and patient disposition. The postoperative nursing unit is any nursing unit that a patient is sent to upon discharge from the PACU.

The nursing admission data base supplied the basic patient statistics such as age, weight, height, and BMI. The nursing graphic sheets and the nursing assessment/ nursing note sheets were used to record patient data during their hospitalization. The graphic sheet contains information collected in this study including: blood pressure, heart rate, respiratory rate, and temperature. The nursing assessment/ nurses notes contain information collected in this study including: mental status assessment.

Data collection worksheets were developed to aid in collection and organization of patient data. Data Collection Worksheet #1 was used to assign each patient a study participant number that was linked to each patient's medical record number and account number in order to protect patient identification (Appendix A). Data collection worksheet #2 served to organize data for all collected patient information including: surgical procedure, anesthesia end time, intraoperative mean arterial blood pressure, intraoperative lowest heart rate, intraoperative estimated blood loss, intraoperative total narcotic dose, PACU total narcotic dose, patient disposition after PACU, and post recovery B/P, heart rate, respiratory rate, temperature and Alert, Voice, Pain, Unresponsive (APVU) collected at the 12 and 24 hour calculated from the anesthesia end time (Appendix B). This data collection worksheet also served to organize patient demographic data including: gender, age, ASA physical status, BMI and a diagnosis of Obstructive Sleep Apnea (OSA). Surgical Apgar score was calculated utilizing the Surgical Apgar scoring sheet (Appendix C). Modified Early Warning Score (MEWS) 12 and 24 hours postoperatively was collected and calculated using the MEWS score sheet (Appendix D). The MEWS 12 and 24 hour score was calculated from the anesthesia end time from the first surgical procedure of each patient.

Statistical Design and Analysis

The purpose of this retrospective case control study is to explore the various tools of evaluation of risk currently available and to determine if any are predictive of the risk of developing postoperative respiratory failure. The aim of this study is to specifically examine narcotic dosing to find if total dosing is attributed to respiratory failure, taking into account the patient risk stratification. The data was analyzed assuming normality. All surgical cases in which the patient remained intubated after surgery were eliminated from the analysis to test the specificity of the independent variables to predict postoperative respiratory failure. Comparison between the groups for age was done using a T-test. Mean postoperative days to respiratory failure was calculated. Comparison of patient variables between groups including age, gender and BMI was done using cross tabulation.

The hypothesis that ASA score, OSA, Surgical Apgar score, BMI category, total narcotic dose intraoperatively and in the PACU, MEWS 12 and 24 hour score post anesthesia end time are predictive of postoperative respiratory failure was analyzed using logistic regression. Logistic regression method was used to analyze the dependent variable, respiratory depression, in relation to the independent variables: ASA score, OSA, Surgical Apgar score, BMI category, Mews 12 and 24 hour post anesthesia end time, and total narcotic dosing intraoperatively and in the PACU. Statistical Package for the Social Sciences (SPSS) Version 17 was used to analyze the study data (SPSS IBM Company, 2010). The value, $p<.05$, was the level of significance used during the study analysis.

Ethical Considerations

This study was approved by CAMC and West Virginia University/ Charleston Division Institutional Review Board on July 1, 2010.

RESULTS

Presentation, Analysis and Interpretation of the Data

The study sample contained 111 patients who underwent surgery at CAMC between January 1, 2009 and March 31, 2010. The convenience sample included 57 patients who experienced respiratory failure and 54 patients who did not experience respiratory failure. The sample population included 51% male and 49% female, a range of 21-88 years of age (60.66±14.48), BMI ranging 15-61 (31.42±9.52) and ASA mean of 3.26. Sample characteristics are described in Table 1.

Table 1: Sample Characteristics

	No Respiratory Failure (n=54)	Respiratory Failure (n=57)
Age (mean)	61.02	62.49
Gender		
Male	56.1%	50.5%

Female	43.9%	49.4%
Race		
Caucasian	100%	87.3%
Black	0%	11.4%
Oriental	0%	1.3%
BMI (mean)	30.4	31.46
ASA Score		
ASA1	0	0
ASA2	0	0
ASA3	8	6
ASA4	25	29
ASA5	24	19
OSA Diagnosis		
Yes	52	44
No	5	10
Surgical Apgar Score		
Low Risk	11	4
Medium Risk	35	40
High Risk	10	8
Severe Risk	1	2
12 Hour Mews (mean)	1.77	2.41
24 Hours Mews (mean)	1.67	2.44
Intraoperative Narcotics (mean)		
Total Fentanyl Dose (mcg)	258.77	313.61
Total Remifentanyl Dose(mg)	.07	.20
Total Morphine Dose (mg)	.86	1.26
Total Dilaudid Dose (mg)	.288	.315
Total Demerol Dose (mg)	.53	.00
PACU Narcotics (mean)		
Total Fentanyl Dose (mcg)	33.86	19.44
Total Morphine Dose (mg)	3.63	3.70
Total Dilaudid Dose (mg)	0.258	0.178
Total Demerol Dose (mg)	1.58	1.96
Patient Receiving PCA in PACU		
Fentanyl PCA	0	1
Morphine PCA	9	18

Dilaudid PCA	8	4

Table#2: Mean age per Group T-test

	Respiratory Failure	N	Mean	Std. Deviation	Std. Error Mean
Age	No Respiratory Failure	57	61.02	15.223	2.016
	Respiratory Failure	54	60.28	13.779	1.875

A T-test showed that there was no significant difference in age between the groups (Table 2). The means are 61.02 for no respiratory depression and 60.28 for the respiratory depression group.

Demographic characteristics: BMI, gender did not differ between the two groups. Cross tabulation showed that there were no statistical differences between the two groups demonstrated, (Table 3 & 4).

Table 3: Gender * Respiratory Failure Cross tabulation

			Respiratory Failure		
			No Respiratory Failure	Respiratory Failure	Total
Gender	Female	Count	25	29	54
		Expected Count	27.7	26.3	54.0
	Male	Count	32	25	57
		Expected Count	29.3	27.7	57.0
Total		Count	57	54	111
		Expected Count	57.0	54.0	111.0

Table 4: BMI Category * Respiratory Failure Cross tabulation

			Respiratory Failure		
			No Respiratory Failure	Respiratory Failure	Total
BMI Category	< 18.5 Kg	Count	3	3	6
		Expected Count	3.1	2.9	6.0
	18.5 - 24.99 Kg	Count	9	11	20
		Expected Count	10.3	9.7	20.0
	25 - 29.99 Kg	Count	16	6	22

		Expected Count	11.3	10.7	22.0
	30 - 34.99 Kg	Count	14	13	27
		Expected Count	13.9	13.1	27.0
	35 - 39.99 Kg	Count	6	8	14
		Expected Count	7.2	6.8	14.0
	> or = 40 Kg	Count	9	13	22
		Expected Count	11.3	10.7	22.0
Total		Count	57	54	111
		Expected Count	57.0	54.0	111.0

Step-wise Logistic regression was used to analyze the independent variable to determine their ability to predict respiratory failure. The results show that the only variable statistically significant is 24 MEWS ($p<.05$), (Table 5).

Table 5: Predictor for Postoperative Respiratory Depression Logistic Regression

			Score	df	Sig.
Step 0	Variables	ASA	.099	1	.752
		Emergency	.263	1	.608
		OSA	2.254	1	.133
		Surgical APGAR	1.186	1	.276
		BMI category	.936	1	.333
		MEWS12hr	5.695	1	.017
		MEWS24hr	9.864	1	.002
	Overall Statistics		14.414	7	.044

The logistic regression analysis showed that total narcotic dose was not significant in predicting respiratory depression. However, Morphine PCA was statistically significant, ($p<.05$), (Table6).

Table6: Intraoperative and PACU Total Narcotic Dose Logistic Regression

			Score	df	Sig.
Step 0	Variables	IntraopFentanylTotaldose	2.365	1	.124
		IntropRemifentanilTotaldose	.688	1	.407
		IntraopMorphineTotaldose	.642	1	.423
		IntropDilaudidTotaldose	.037	1	.848
		IntraopDemerolTotaldose	1.328	1	.249
		PACUFentanylTotaldose	1.304	1	.254
		PACUMorphineTotaldose	.005	1	.941
		PACUDilaudidTotaldose	.298	1	.585
		PACUDemerolTotaldose	.067	1	.796
		FentanylPCA	1.065	1	.302
		MorphinePCA	4.637	1	.031
		DilaudidPCA	1.263	1	.261
	Overall Statistics		12.655	12	.395

The postoperative day to respiratory failure following surgery was a mean of 4.61 with a standard deviation of 5.32.

Table 7:Postostop Days to Respiratory Failure

N	Valid	54
	Missing	0
Mean		4.61
Std. Deviation		5.318

DISCUSSION

Discussion of Study Results

Widespread consensus exists that healthcare organizations can reduce patient injuries by improving the environment of safety by improving staff awareness of patient safety risks. Patient Safety Indicators (PSIs) which are based on computerized hospital discharge abstracts from the AHRQ's Healthcare Cost and Utilization Project (HCUP). Analysis of these inexpensive and readily available data sets may provide a screen for potential medical errors and also a trend for monitoring trends over time. The Postoperative Respiratory Failure indicator is intended to flag cases of postoperative respiratory failure for analysis and improvement in Premier hospitals. The National Surgical Quality Improvement Program (NSQIP) found that postoperative pulmonary complications were the most costly of major postoperative complications. The rate of postoperative pulmonary complications in all types of surgery was 6.8% in a systematic review of studies. (Smetana, 2010).

Some of the factors influencing postoperative respiratory failure include lung volumes with a vital capacity reduced by 50 to 60 percent for up to one week post surgery and the functional residual capacity (FRC) is reduced by about 30 percent lead to respiratory failure. Dysfunction of the diaphragm due to postoperative pain and splinting are also factors. Reduction of the FRC contributes to the risk of atelectasis, pneumonia and ventilation/perfusion mismatching. The microatelectasis results in areas of the lung that is perfused but not ventilated. This leads to impaired gas exchange and postoperative hypoxemia. In addition, decrease in tidal volume, loss of sighing breathes, and increased respiratory rate, especially after abdominal and thoracic surgery, contribute to the risk of complications. The residual effects of anesthesia and postoperative opioids both depress the respiratory drive. In this study, it was determined that total intraoperative narcotic dose in addition to the total PACU dose did not affect the incidence of postoperative respiratory failure, although morphine PCA was found to contribute to postoperative respiratory depression.

This retrospective case control revealed the hypothesis, that of all currently used scoring systems used today, the12 and 24 hour MEWS score was predictive of postoperative respiratory depression. This current study showed that total narcotic dose during anesthesia and in the PACU did not influence post surgical respiratory complications. However, the use of postoperative Morphine Patient Controlled Analgesia (PCA) was statistically significant in the development of post operative respiratory depression. The operational protocol, in October of 2010, was changed to have every patient on any PCA be placed on pulse oximetry for the duration of the opioid therapy. This safety net and protocol is supported by this research.

The influence of age as an independent risk factor of postoperative pulmonary complications has been questioned in research. Early studies indicated an increased risk of pulmonary complications with advanced age but subsequent studies did not reliably demonstrate age as a predictor of pulmonary complications (Moller, 2001). The results of the current study did not substantiate the correlation between age and increased incidence of postoperative pulmonary complications.

Physiologic changes that occur with morbid obesity include reduction of lung volume, ventilation/ perfusion mismatch and relative hypoxemia (Pasullka,1986). One would expect these finding to accentuate the affects of anesthesia and postoperative opioids administration. However obesity has not consistently been shown to be a risk factor for postoperative pulmonary complications. A systematic review found that, among eight studies using multivariate analysis, only one identified obesity as an independent predictor (Smetana, 2006). This finding was verified in the current study where BMI category was not statistically significant in predicting postoperative respiratory failure.

Obstructive sleep apnea is an emerging risk factor and is well appreciated in anesthesia literature. OSA increases the risk of critical respiratory events immediately after surgery, including early hypoxemia and unplanned reintubation (American Society of Anesthesiologists Task Force on Perioperative Management of Obstructive Sleep Apnea, 2006). Although this study found no statistical difference between OSA and associated postoperative respiratory failure, research suggests that patients should be screened for OSA prior to elective surgery. The increased risk for difficult intubation alone is enough concern to identify this patient population. As of October 2009 at CAMC, the OSA risk assessment is completed on every patient and anyone of identifiable OSA risk, receiving a narcotic PCA is placed on an oxygen saturation monitor. OSA has been proven to be a predictor of improved survival at CAMC in 2010 because of all the safety nets put around that population. These safety nets include identification of the patient as a possible difficult airway and postoperative SAO2 monitoring on the patient population. The mortality index had decreased about 50% in 2010. Cost and length of stay didn't decrease however. Rescuing people as opposed to pronouncing them outside of the ICU (i.e. failed code) is costly but the return on investment is the patient lives (Mimnaugh, 2011).

In one study, the major causes of 'suboptimal care' prior to transfer from the nursing floor include failure of organization, lack of knowledge, failure to appreciate clinical urgency, lack of supervision and failure to seek advice (Subee, Kruger, Rutherford, Gemmel, 2001). The logistic regression analysis in this study showed that showed no significant relationship between postoperative respiratory depression and the ASA score, Surgical Apgar score. However 12 and 24 hour MEWS show significance in sensitivity to identify those who have deteriorating respiratory function. Once an unwell patient is identified, with a MEWS of 5 or greater, urgent interventions can take place. The Emergency Response Team (MET) notified to intervene can treat and move, if necessary, the patient to a higher level of care within the institution. Other physiologic parameters have also been suggested to be added to the scoring system, such as oxygen saturation and urinary output, in addition to respiratory rate, heart rate, systolic BP, temperature and APVU. Ideally, with the adoption of electronic charting, the MEWs would be automatically calculated so the nurse can utilize her time for patient care and not calculating risk scores. With the 5.3 mean days and standard deviation of 4.9 days to postoperative days to failure in this study, it would be wise to continue MEWs scoring during the entire postoperative stay.

While the MEWS has not been adopted at CAMC, it is gaining acceptance in hospitals nationwide. The concerns surround balancing the specificity and the sensitivity of the scoring to identify the patient in true need of medical attention versus another annoying alarm. As hospital systems are financially stressed, nurse to patient ratios suffer. We must be able to utilize the EMR to allow us to work smarter to insure patient safety.

Study Limitations

Study limitations should be discussed prior to drawing conclusions. Several limitations are the result of the retrospective nature of this study. Study limitations exist at all areas of the patient evaluation process: preoperative, in the PACU and on the nursing unit. The ASA score is entirely subjective and varies with each practitioner.

OSA needs to be well defined by the organization and in the history and physical. Screening does not occur on everyone. In addition, vital signs in the medical record at CAMC are not organized in a manner where one can look at trends and track changes in patient condition. There did not seem to be an organized approach to vital signs with many missing recordings, so the MEWS calculations had to be computed with the closest vital signs to the 12 and 24 hour post anesthesia time.

APVU needs further clarification before a useable MEWS score can be adopted in hospitals. APVU is subjective and hospitals would benefit from a standardized scoring system.

In addition, the limitation was the effect of versed sedation. In addition to postoperative pain, level of sedation was another factor identified as a possible variable in postoperative respiratory failure. Over sedation not only brings the danger of increased morbidity and mortality, but it also increases cost, prolongs mechanical ventilation and extends length of stay in the hospital. Patients in the current study may have received versed sedation preoperatively and this study did not examine the synergistic effects of sedation and narcotics. The response to versed sedation is patient dependence and may affect postoperative APVU scores.

CONCLUSIONS

Results from this study show that 12 and 24 hour MEWs scores were found to be predictive of respiratory depression in this sample. Therefore, the Mews scoring system should be adopted by CAMC to protect all postoperative patients, especially in light of the fact that current scoring systems available today do not have the specificity to predict postoperative respiratory failure patient populations at risk. The study also confirms the advantage of closely monitoring narcotic PCA patients in preventing respiratory complications.

IMPLICATIONS AND RECOMMENDATIONS

Respiratory failure after surgery is a life threatening and expensive complication. No single assessment tool is available today to predict postoperative respiratory failure. With CMS making this a reportable and avoidable complication, elevates the need for a predictive tool to help place a safety net around this patient population. Further study would be beneficial in early identification and prevention of this complication.

The MEWS score is a brief evaluation tool designed to alert health care workers that the patient condition is deteriorating. MEWS has great potential for an early warning system and would be of use for the nursing staff to alert the MET team to evaluate the patient condition. The addition of oxygen saturation monitoring and urinary output monitoring into the Mews score could increase the sensitivity in the prediction of the deteriorating condition. Chart reviews revealed deteriorating renal function, sepsis, new heart dysfunction, and low hematocrit levels at the time of intubation postoperatively. Further study utilizing these additional parameters would be beneficial. In addition, the ability to visually track and trend, not only vital signs but laboratory results would reveal trends otherwise overlooked by medical professionals. Redesigning the patient chart to enhance visual cues will help prompt faster recognition and medical treatment. While concepts and components of the early warning system are not yet widely adopted in the United States, health care improvement institutions are promoting adoption of the MEWS scoring system.

In this study, since intraoperative and PACU narcotics did not contribute to postoperative respiratory depression, the results from this study would benefit from further analysis of multiple narcotic dosing regimens on patients allowing maximum pain relief with minimized narcotic respiratory depression affects. Narcotic effects and narcotic clearance are patient dependent, enhances the need for further study in this area. Also the additional enhancing effects of Versed on sedation and level of consciousness, needs to be included in additional studies.

Ongoing evaluation of postoperative respiratory failure mandated by CMS and costly in terms of lives and resources will remain a challenge to medical institutions. With the advent of tools currently at use in CAMC: early sepsis recognition, OSA recognition and MEWS scoring we can help prevent this deadly complication. Work must be done in the surrounding hospitals to educate them about useful predictor tools and subsequent medical transfer to medical institutions with advanced care ability.

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APPENDICES

APPENDIX A: DATA COLLECTION WORKSHEET #1

Patient Medical Record #	PIN #	Study Participant #
		1
		2
		3
		4
		…..
		136

APPENDIX B: DATA COLLECTION WORKSHEET #2

Study Participant #	Gender	Age (yr)	BMI Category	ASA physical status I-IV	OSA Y vs N	Intra op Narcotic Total Dose	PACU Narcotic Total Dose	Surgical Apgar Score	12 hour MEWS	24 Hour Mews	Respiratory Failure Y/N
1											
2											
3											
4											
…..											
136											

Appendix C: Data Collection Worksheet #3						
Study Participant #		Procedure			Date of Service	
Surgical Apgar Score						
Points	0	1	2	3	4	Patient Score
Est. Blood Loss	>1000	601-1000	101-600	100 or less	N/A	
Lowest MAP*	<40	40-54	55-69	70 or more	N/A	
Lowest HR	>85	76-85	66-75	56-65	55 or less	

Appendix D: Data Collection Worksheet #4							
Modified Early Warning Score (MEWS)							
Score	3	2	1	0	1	2	3
Resp Rate		<9		9-14	15-20	21-29	>29
Heart Rate		<41	41-50	51-100	101-110	111-129	>129
Sys BP	<71	71-80	81-89	90-159	160-169	170-199	>199
Temp		<35		35-38.4		>38.4	
APVU				Alert	Voice	Pain	Unresponsive
A score of 5 or more is a marker for immediate transport							