IMPLEMENTING A CLINICAL PRACTICE GUIDELINE ON THE USE OF CAPNOGRAPHY IN MONITORING FOR OPIOID-INDUCED RESPIRATORY DEPRESSION ON MEDICAL-SURGICAL UNITS

by

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As members of the Practice Inquiry Committee, we certify that we have read the practice inquiry prepared by Heather Lynn Carlisle entitled ‘Implementing a Clinical Practice Guideline on the Use of Capnography in Monitoring for Opioid-Induced Respiratory Depression on Medical-Surgical Units’ and recommend that it be accepted as fulfilling the practice inquiry requirement for the Degree of Doctor of Nursing Practice.

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SIGNED: Heather Lynn Carlisle
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DEDICATION

To med-surg nurses everywhere who monitor patients with astute clinical observation, critical thinking, a touch of intuition, and the latest technology. They work hard to keep their patients safe in a very demanding practice environment.
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ABSTRACT

Background: Opioid-induced respiratory depression (OIRD) is a life-threatening complication of opioid analgesia. Failure to recognize and respond to OIRD may result in respiratory arrest, anoxic brain injury, and death. Measuring end-tidal carbon dioxide through the use of capnography has been shown to detect early signs of OIRD. Early detection of OIRD facilitates the timely rescue of patients on medical-surgical units where critical patient events are less likely to be witnessed.

Purpose: The goal of this quality improvement project was to enhance patient safety by decreasing the incidence of OIRD. The aim was to design, implement, and evaluate a multifaceted intervention to improve patient monitoring for OIRD on medical-surgical units through the use of capnography. The intervention included an updated nursing protocol, an electronic order trigger, improved access to capnography monitors, and education to nurses about OIRD and the use of capnography.

Methods: The project was conducted over twelve months on ten medical-surgical units at a 489-bed academic medical center in Southern Arizona. Outcomes were measured using pre- and post-intervention point prevalence surveys. Indicators included the number of patients being monitored with capnography and the number of cases of OIRD. A survey of medical-surgical RNs was also conducted to gather their perceptions on the ease of use and effectiveness of capnography.

Results: Twelve months after introducing the intervention, there was a statistically significant increase in monitoring frequency, with 2.56 times more patients at high risk for OIRD being monitored with capnography than at baseline \((p = .006)\). Of the 167 RNs
surveyed during this project, 99% perceived the portable capnography monitors as easy to use and interpret. However, 71% reported systems issues in obtaining the monitoring equipment, and 65% reported problems with patient adherence. Preliminary data suggest that the incidence of OIRD decreased after one year, although not by a statistically significant amount (p = .876).

Implications for Practice: The intervention succeeded in increasing the number of high-risk patients being monitored with capnography, though the increased monitoring did not improve patient outcomes. The RN survey highlighted areas in need of further improvement, such as the supply of monitors and patient education.
CHAPTER ONE: BACKGROUND AND SIGNIFICANCE

“It may seem a strange principle to enunciate as the very first requirement in a hospital that it should do the sick no harm” (Nightingale, 1863 p.iii).

Pain is the most common presenting symptom among hospital patients, and opioids are the most commonly used treatment. The ubiquitous nature of opiate medications, however, has not reduced the risks associated with their use. Opioid-induced respiratory depression (OIRD) remains a serious complication of opioid analgesic therapy. It is also one of the leading causes of preventable death in the acute care setting. Moreover, it significantly increases the length of hospital stay and the cost of hospitalization (Gan, Odera, & Robinson, 2012). For clinicians it is the most feared outcome of pain treatment, because of the risk of fatality. The Anesthesia Patient Safety Foundation (APSF) calls for OIRD to be a “never” event (Weinger & Lee, 2011).

This Practice Inquiry describes a quality improvement project that will reduce OIRD by improving inpatient monitoring practices among registered nurses (RNs) at an academic medical center. This chapter explains the background and significance of OIRD, framing it as a failure to rescue, and situating it within the context of pain management and patient satisfaction.

Opioid-Induced Respiratory Depression (OIRD)

Opioid-induced respiratory depression is generally defined as a decrease in baseline ventilatory function after opioid administration, with a respiratory rate between 8 to 10 breaths per minute, oxygen saturation less than 90%, and end tidal carbon dioxide less than 30 mmHg or greater than 50mmHg (Jarzyna et al., 2011). Severe respiratory
depression occurs when the respiratory rate falls below 8 breaths per minute, with an oxygen saturation below 85% for a sustained period of at least 6 minutes (Dahan, 2007). It is worth noting, however, that these thresholds are not exact, and there have been reported cases of OIRD with vital signs outside these parameters. OIRD is usually preceded by marked sedation, which is a common side effect of opioids particularly during the first 24-hours of therapy, or after a dose escalation (Jungquist, Karan, & Perlis, 2011).

Opioids work by binding with mu1, mu2, kappa, and delta opioid receptor sites that regulate analgesia, sedation, and respiratory depression (Boom et al., 2012; Burke & Dunwoody, 1990). Opioid-induced respiratory depression begins with sedation, and then proceeds to interfere with the ventilatory centers in the brainstem that affect respiratory drive and rhythm. Opioids also decrease pharyngeal muscle tone, making it more difficult for patients to maintain a patent airway (Boom et al., 2012; Koo & Eikermann, 2011). The resulting irregular, decreased respiratory rate leads to a lower volume of air being moved in and out of the lungs, which in turn leads to a build-up of carbon dioxide (CO2) in the lungs. As CO2 rises, the body begins to suffer the effects of CO2 narcosis and respiratory acidosis. Ordinarily, increasing CO2 levels would be detected by chemoreceptors within the body that would arouse a ventilatory response (i.e. a breath). However, opioids dampen that process. The rising CO2 competes with oxygen for space in the alveoli in the lungs, resulting in lower oxygen saturation. Patients receiving supplemental oxygen, however, are able to maintain oxygen saturation levels above 90%, masking the effects of hypercarbia. Prolonged CO2 narcosis may progress to respiratory arrest and death (Dahan, 2007; Lynn & Curry, 2011).
If OIRD is detected early, non-pharmacologic interventions such as sitting the patient upright, shaking the patient, encouraging breathing, and talking to the patient may be sufficient to arouse the patient and stimulate breathing (Koo & Eikermann, 2011). If not detected early, then naloxone must be administered to reverse the respiratory depressant effects of the opioid medications (Burke & Dunwoody, 1990; Dahan, Aarts, & Smith, 2010). However, this also reverses the analgesic effects, leading to severe pain and distress (Koo & Eikermann, 2011). Naloxone is short-acting, so multiple doses may be required depending on the duration of action of the opioids that were ingested (Boland, Boland, & Brooks, 2013; Dahan et al., 2010). Naloxone rescue has been shown to be required in about 0.2%-to-0.7% of patients receiving post-operative opioids (Weinger & Lee, 2011). In the United States, this accounts for approximately 20,000 patients annually (Weinger & Lee, 2011).

Naloxone was once thought to have only minor side effects, such as nausea and vomiting that were attributed to increased pain. There is increasing evidence, however, that naloxone administration may lead to cardiovascular complications such as pulmonary edema, cardiac arrhythmias, hypertension, and cardiac arrest (Burke & Dunwoody, 1990; Dahan et al., 2010; Jarzyna, 2005).

Incidence and Prevalence of OIRD

The incidence of OIRD reported in the scientific literature is highly variable due to the lack of consensus on a definition of OIRD, differences in study designs, diverse patient populations, and different opioid regimens (Dahan, 2007; Jarzyna et al., 2011). In a national survey of monitoring practices for OIRD, respondents reported considerable variation in OIRD definitions, ranging from 8 to 12 breaths per minute, with or without
other criteria such as apneic breathing, high sedation levels, or shallow respirations (Willens, Jungquist, Cohen, & Polomano, 2013), or hypercarbia (Koo & Eikermann, 2011). Despite the challenges, some figures are available for comparison. In postoperative patients receiving opioid analgesia, the incidence of OIRD has been reported as high as 17% (Cashman, 2004) and as low as 0.038% (Ramachandran et al., 2011). Estimates not limited to postoperative patients range from 0.5% to 0.005% (Dahan et al., 2010). However, rates in patients with multiple risk factors are believed to be higher (Jarzyna et al., 2011).

Hospital incident-reporting systems rely on different methodologies for tracking OIRD cases. Some review naloxone administration records; others use rapid response team reports; still others utilize the University Hospital Consortium’s (UHC) Patient SafetyNet™ system (Masimo Corporation, Irvine, CA). Forty-seven percent of respondents to a national survey of monitoring practices reported that they used naloxone rescue analysis to determine rates of OIRD (Willens et al., 2013). Unfortunately hospital incident-reporting systems do not capture all adverse events in a consistent manner (Levinson, 2010). When rates are reported, they may be calculated either as the number of events per hospital beds per year, or as the number of events per number of patient admissions. This makes comparison between healthcare organizations challenging.

OIRD incidents may result in cardiopulmonary arrest, and are therefore often embedded in data about rapid responses or code blue events. Approximately one-third of the 750,000 cardiac arrests occurring annually in hospitals list respiratory depression as a precipitating factor, with the worst outcomes occurring in medical-surgical units (Carr, Kahn, Merchant, Kramer, & Neumar, 2009; DeVita et al., 2010; Sandroni, Nolan, Cavallaro, &
In 50% of Code Blue events, the patient was receiving opioid medications (Fecho, Freeman, Smith, & Overdyk, 2009). Between 2006 and 2009, post-operative respiratory failure was the third highest occurring safety incident in American hospitals, affecting an estimated 600,000 patients per year, at a cost of $1.5 billion (HealthGrades, 2010). In general, mortality for in-hospital cardiopulmonary arrest may be as high as 80%, with worse outcomes on medical-surgical units (Jones, DeVita, & Bellomo, 2011; Sandroni et al., 2006).

Failure to Rescue

Many deaths and permanent disabilities could be avoided if hospitals adopted safe practices and implemented systems that facilitate patient safety. When a patient suffers an adverse outcome (such as death or disability) because of a complication (from the disease or treatment) that was not recognized in a timely manner, or was not treated appropriately once recognized, the event is considered to be preventable, and is called “Failure to Rescue” (Agency for Healthcare Research and Quality, 2013).

Failure to rescue may reflect deficiencies in the quality of patient monitoring (Koo & Eikermann, 2011). According to The Joint Commission (TJC), between 2004 and 2011, 20% of opioid-related sentinel events resulted from improper monitoring (The Joint Commission, 2012). In their Sentinel Event Alert from September 2012, TJC cite three causes of adverse events related to opioids: (a) lack of knowledge of the potency of medications; (b) improper prescribing, including the improper use of multiple opioids; and (c) inadequate monitoring (The Joint Commission, 2012). Improved monitoring practices are cited as one of the most important strategies in preventing opioid-related sentinel
events in a perioperative setting (Pasero, 2013).

Preventing OIRD is a shared responsibility between: (a) the providers who assess patients and prescribe pain medications, and (b) the nurses who assess patients, administer medications, and monitor patient response.

The Prescribing Side: Opioids and Pain Management

Effective pain management is considered a patient right (The Joint Commission, 2011a); indeed it is considered by many to be a human right (Brennan, Carr, & Cousins, 2007; Lohman, Schleifer, & Amon, 2010). The protection of patients’ rights with regard to pain management has broad implications for clinical practice and patient safety.

Fifth Vital Sign Campaign

According to TJC, pain is the fifth vital sign to be assessed and managed at regular intervals, alongside with blood pressure and heart rate (Phillips, 2000). The Fifth Vital Sign campaign arose in 2000 in response to concerns that patients were reporting undertreated acute pain in the hospital setting (Frasco, Sprung, & Trentman, 2005). Inadequately controlled pain is associated with negative patient outcomes, such as immobility (Pasero & McCaffery, 2010), longer hospital stays (Overdyk, 2012), and the development of chronic pain syndromes (Macrae, 2008).

Given these consequences of unrelied acute pain, this added attention to pain care has not been unwarranted (White & Kehlet, 2007). The treatment of pain as a vital sign, however, often results in the administration of pain medications in a formulaic manner, rather than relying on the critical thinking and clinical judgment of nurses in partnership
with patients (Institute for Safe Medication Practices, 2012; Vila et al., 2005; Weinger, 2006). For example, when a numerical scale for pain intensity is used, medication doses are often tied with the patient’s “pain number,” where the result may be over-medication (Institute for Safe Medication Practices, 2012; Lorenz et al., 2009). Assigning a number to pain severity distorts the fact that this is a subjective measure of pain. One patient’s seven on a scale of zero to ten may be another patient’s three, and will result in the administration of a higher dose of medication regardless of other patient criteria, such as degree of opioid tolerance or co-administration of other sedating medications. This distortion has been an unintended consequence of the Fifth Vital Sign campaign (Gordon, Pellino, Higgins, Pasero, & Murphy-Ende, 2008; Taylor, Kirton, Staff, & Kozol, 2005; Taylor, Voytovich, & Kozol, 2003).

Since the introduction of the Fifth Vital Sign campaign, there has been an increase in OIRD in hospitalized patients nationwide (Frasco et al., 2005; Vila et al., 2005). In one study of adverse drug events before and after the implementation of the new TJC standards, opioid-related adverse drug events more than doubled (Vila et al., 2005). However the methodology used in that study has been criticized for using one intermittent respiratory rate from each patient in a retrospective chart review (Overdyk, Carter, & Maddox, 2006). The Institute for Safe Medication Practices, however, also reports that OIRD is increasing as a result of more aggressive pain treatment based on the TJC standards (Institute for Safe Medication Practices, 2012).
Opioid Tolerance

Multiple factors influence whether a patient will be more or less likely to suffer an episode of OIRD. If a patient becomes opioid tolerant from long-term opioid therapy for chronic pain, he or she is likely to require significantly higher doses of opioid medications for acute pain in a hospital setting (Koo & Eikermann, 2011; Patanwala, Jarzyna, Miller, & Erstad, 2008). Though chronic opioid use provides some protection against OIRD at stable doses, a dose escalation can put that patient at risk (Jarzyna et al., 2011; Jungquist et al., 2011). A study conducted at The University of Arizona Medical Center (UAMC) showed that the incidence of OIRD among opioid tolerant patients was higher than among opioid naive patients (Abbott et al., 2012). Opioid tolerance may develop in as little as one week, where the dose rate is the equivalent of 30 mg of morphine per day (Patanwala et al., 2008). Consumption of illegal opiates such as heroin also leads to opioid tolerance, and creates added challenges for pain control in the hospital setting.

The Monitoring Side: OIRD Risk Factors

Detecting Patient Risk Factors for OIRD

The American Society for Pain Management Nursing (ASPMN) has identified several high risk patient groups for OIRD: patients suffering from renal dysfunction, chronic obstructive pulmonary disease (COPD), heart failure (HF), obstructive sleep apnea (OSA), and obesity (Jarzyna et al., 2011). Obstructive sleep apnea (OSA), in which the upper airway may become occluded during sleep, places hospitalized patients at greater risk for respiratory depression, because opioids can relax pharyngeal tone and increase the airway occlusion already found in people with OSA (Koo & Eikermann, 2011; Littleton & Mokhlesi,
Epidemiologic data indicates that the prevalence of OSA may now be as high as five percent of the population, with only fifteen percent of those sufferers having a confirmed diagnosis (Finkel et al., 2009; Hutchison & Rodriguez, 2008). The high rate of undiagnosed OSA means that healthcare providers may not recognize their patient’s risk. A body mass index greater than 30 and a neck circumference of 17.5 inches are parameters used as proxy indicators for OSA, and are therefore considered risk determinants for OIRD (Jarzyna et al., 2011; Park, Ramar, & Olson, 2011). There is growing evidence of improved patient outcomes when patients receive enhanced monitoring as a result of a high score on the STOP-BANG assessment tool for obstructive sleep apnea (Dolezal, Cullen, Harp, Mueller, 2011; Lakdawala, 2011).

Iatrogenic Risk Factors for OIRD

Iatrogenic factors also place patients at high risk. According to The Joint Commission (TJC), between 2004 and 2011, 11% of opioid-related sentinel events were the result of excessive dosing, medication interactions, and adverse effects (The Joint Commission, 2012). Patients who receive both benzodiazepines and opioids, or who are on continuous opioid infusions, or who are within the first 24-hours after surgery with general anesthesia, are all at greater risk (Jarzyna et al., 2011). On the other hand, even for young and otherwise healthy patients, there is still a low-frequency yet unpredictable risk of opioid-induced respiratory depression (Weinger & Lee, 2011).

OIRD occurs not only with continuous opioid drips and continuous infusions on patient-controlled analgesia devices (PCA), but also with intermittent parenteral injections of opioid analgesics. An analysis of OIRD cases at UAMC during 2011 showed that only 20%
of OIRD cases involved continuous opioid infusions. The rest were related to intermittent intravenous bolus injections or orally-administered opioids (or concurrent use of both oral and parenteral opioids) (Abbott et al., 2012). This observation has major implications for understanding where high-risk patients tend to be located in hospital settings. Continuous opioid infusions are generally administered on critical care units where continuous monitoring is standard practice. RN-administered intermittent parenteral opioids and oral opioids are commonly ordered on medical-surgical units, where only intermittent bedside monitoring is the norm.

**Challenges of Medical-Surgical Units**

Opioid-induced respiratory depression can arise quickly, and is not always recognized at an early stage (Fecho et al., 2009). In intensive care units, both the higher level of general monitoring and the smaller patient loads for each nurse mean that incidents of OIRD are more likely to be witnessed and immediately addressed. Capnography is usually standard in every patient’s room, facilitating the nurse’s ability to evaluate trends in EtCO2, oxygenation, and respiratory rate. Data from UAMC for 2012 indicate that 90% of the incidents of OIRD occurred on medical-surgical units (D. Jarzyna, personal communication, May 3, 2013).

As noted above, many of the respiratory arrests reported in the literature occur among post-operative patients receiving opioid analgesics and sedatives (Carr et al., 2009; Jones et al., 2011). Post-operative patients are frequently transferred to general medical-surgical units, particularly in high acuity facilities such as UAMC (Overdyk & Guerra, 2011). Overdyk (2011) stresses the dangers in the postoperative patient on the general medical
floors, compared to those in intensive care units, noting that preventable cardiopulmonary arrests are five times more likely on general medical-surgical units. In this case, the worst outcomes occur on general medical-surgical units because of less frequent monitoring, resulting in crucial delays in recognizing patient deterioration (Carr et al., 2009). Rapid response teams were developed in part to address the problem of patients who deteriorate rapidly in areas of the hospital that are further away from critical assistance (DeVita et al., 2006; Jones et al., 2011). However, rapid response teams are still under-utilized by most nursing staff (Massey, Aitken, & Chaboyer, 2010).

As a result, nurses working on general medical-surgical units face additional challenges when it comes to monitoring patients at high risk for OIRD. Medical-surgical nurses tend to have higher numbers of patients, so that the amount of time spent at each patient’s bedside is lower. If OIRD occurs, it is less likely to be witnessed immediately, and a rapid-response team may not be able to reach the patient quickly. The continuous monitoring and early detection afforded by capnography makes it a potentially valuable tool to help nurses ensure patient safety. However, most nurses are less familiar with capnography than with pulse oximetry (Maddox & Williams, 2012).

*End-tidal Carbon Dioxide Monitoring*

Capnography is a noninvasive method of measuring end tidal (exhaled) carbon dioxide (EtCO2) that provides an indication of ventilation. Ventilation and oxygenation are two separate physiologic processes. Pulse oximetry measures oxygenation but not ventilation, and therefore cannot substitute for end-tidal CO2 monitoring. Decreased oxygen saturation is also a late sign of respiratory depression (Pasero, 2013). This is
especially true in patients who are receiving supplemental oxygen, as the additional oxygen can mask the signs of OIRD by showing artificially elevated oxygenation (Burton, Harrah, Germann, & Dillon, 2006). Relying on pulse oximetry, therefore, can be misleading and even dangerous, as it may provide nurses with a false sense of security, that in turn may lead to delayed recognition and rescue of a deteriorating patient (Lynn & Curry, 2011).

In capnography, a nasal cannula captures exhaled breath and measures ventilation, including end-tidal carbon dioxide (target range thirty-five to forty-five mmHg), apneic events (pause in breathing for more than 10 seconds), and respiratory rate (<8-10 breaths per minute) (Soto, Fu, Vila, & Miguel, 2004). Placing the capnography cannula on the patient’s face is similar to initiating a nasal cannula for supplemental oxygen. Breath samples are obtained through both nostrils, and oxygen may be delivered through small pin holes. Some types of tubing have extensions in front of the mouth, which can be used to obtain readings if the patient breathes through the mouth instead of the nose—as is often the case in patients with sleep apnea, a high-risk group for OIRD. Figure 1 shows an Alaris Portable EtCO2 monitor, the type most commonly used at UAMC.

Numerous studies have shown that capnography detects signs of respiratory depression earlier and more effectively than visual respiratory assessments and/or pulse oximetry (Burton et al., 2006; Cacho, Pérez-Calle, & Barbado, 2010; Hutchison & Rodriguez, 2008; Maddox & Williams, 2012; Tran, Ciarkowski, Wagner, & Stevenson, 2012; Waugh, Epps, & Khodneva, 2011). McCarter et al. also demonstrated that end-tidal CO2 monitoring
is more effective than pulse oximetry in detecting early signs of OIRD in patients that are receiving supplemental oxygen (McCarter, Shaik, Scarfo, & Thompson, 2008).

Some end tidal CO2 monitors can be integrated with patient-controlled analgesia (PCA). So if the respiratory rate drops below the programmed parameter, the PCA will be shut off, and the patient will not be able to administer any more opioid medication. This set-up is commonly used with basal rates (continuous infusions) on PCA pumps, since continuous infusions incur higher risk for patients (George et al., 2010).

The evidence for the risk of OIRD in cases with patient-controlled analgesia is equivocal. It can be considered low risk due to the fact that, if the patient becomes sedated and falls asleep, he or she is unable to push the button to administer additional doses of medication (Craft, 2010; Dahan et al., 2010; Koo & Eikermann, 2011). Some authors, however, cite PCA as high risk (Hagle, Lehr, Brubakken, & Shippee, 2004; Weinger & Lee, 2011; Willens et al., 2013). Indeed several of the facilities that mandate EtCO2 monitoring for the prevention of OIRD do so specifically on patients using PCA (Henriksen et al., 2008; Maddox & Williams, 2012; McCarter et al., 2008; Overdyk et al., 2007). There is a lack of distinction in the literature between PCAs with continuous infusions versus PCAs with only incremental bolus doses. Continuous infusions effectively eliminate any built-in safety mechanism that occurs when the patient becomes too sedated to push the button. Other risks associated with PCAs are the risk of programming errors, or PCA-by-proxy (Koo & Eikermann, 2011). Evidence from cases of OIRD at UAMC did not find PCAs to be of higher risk than RN-administered intermittent parenteral bolus opioids (Abbott et al., 2012).
In a national survey of monitoring practices to prevent OIRD, only 2.2% of institutions used EtCO2 for patients undergoing epidural therapy (6% if they were high risk patients), and 1.5% used it on patients with patient-controlled analgesia devices (8.1% if considered high risk). There were no institutions that used EtCO2 monitors based on an overall OIRD risk assessment regardless of the method of opioid administration. Seventy-five percent of respondents stated that they did not have EtCO2 monitors available at their institutions (Willens et al., 2013).

Capnography is a reliable method of measuring exhaled carbon dioxide and respiratory rate. It is used in critical care units, postanesthesia care units, during procedural sedation, and during resuscitations (Kodali, 2013; Whitaker, 2011). EtCO2 monitoring is likely to catch hypercarbia before it progresses to respiratory depression and arrest, e.g., before the administration of naloxone is required (Kodali, 2013). The value of EtCO2 monitoring outside the operating room is increasingly being recognized, and several professional associations have issued guidelines recommending its use, including the American Society of Anesthesiologists, the Association of Anaesthetists of Great Britain and Ireland, and the American Heart Association (Kodali, 2013), and the American Society of Pain Management Nursing (Jarzyna et al., 2011).
Public awareness and interest in capnography is growing. For example, in August 2011, National Public Radio ran a story about a man who was resuscitated during a cardiac arrest after 96 minutes of continuous chest compressions (Cuda-Kroen, 2011). The capnography readings for this patient indicated the compressions were of high quality and circulation was still occurring. Then there is the “Promise to Amanda” website that was set up by the parents of a teenager who died of OIRD while being treated in the hospital for an infection (Promise to Amanda Foundation, n.d.). This website is devoted to promoting the use of capnography for all patients that are using patient-controlled analgesia. Finally, there is the Physician-Patient Alliance for Health and Safety, an advocacy group focused on spreading the use of capnography (Wong, n.d.).
In September 2011, the ASPMN Expert Consensus Panel published “Nursing Guidelines on Monitoring for Opioid-Induced Sedation and Respiratory Depression” (Jarzyna et al., 2011). The Panel agreed that the “frequency, intensity, and duration of sedation monitoring should be based on the type of opioid therapy, patient and iatrogenic risk factors, and response to treatment.” (p. 144). The panel recommended the use of capnography for monitoring end-tidal carbon dioxide (referred to in the literature as EtCO2 or end-tidal CO2) in patients determined to be at high risk of OIRD, based on a thorough assessment of the patient’s risk factors as described above.

In summary, the two key advantages of capnography are that it is continuous and it detects signs of OIRD at an early stage. Both of these advantages are vitally important on medical-surgical units.

Purpose of the Practice Inquiry Project

The purpose of this Practice Inquiry Project was to design, implement, and evaluate the effectiveness of a multifaceted intervention that will improve patient monitoring for OIRD on medical-surgical units. The intervention promotes the adoption of the Clinical Practice Guideline (CPG), as prepared by the American Society of Pain Management Nursing (ASPMN) (Jarzyna et al., 2011). The CPG recommends the use of capnography for detecting early signs of OIRD on high-risk patients.

The specific objectives of this project were to:
1. Assess the feasibility of implementing the CPG
2. Design a multifaceted intervention to improve monitoring practices
3. Implement (i.e., introduce and sustain) the intervention
4. Monitor the implementation through audits and feedback processes
5. Evaluate outcomes via pre- and post-intervention data analyses

Significance of This Project to Nursing

*Nurses’ Role in Quality and Safety*

The Institute of Medicine (IOM) defines quality of care as “the degree to which health services to individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge” (Institute of Medicine, 2001). In “Crossing the Quality Chasm: A New Health System for the 21st Century,” the IOM recommends that patients receive care based on the best scientific knowledge, and that care should not vary widely from clinician to clinician (Institute of Medicine, 2001). Clinical Practice Guidelines have the potential to improve the consistency of care and improve quality and safety.

Because of their direct bedside experience and their education in evidence-based practice, nurses are ideally suited to help develop and implement Clinical Practice Guidelines for the assessment and monitoring of patients (Davies, Edwards, Ploeg, & Virani, 2008; Wallin, Profetto-McGrath, & Levers, 2005). As the largest professional group in healthcare, nurses are well-placed to influence practice change (Leeman, Baernholdt, & Sandelowski, 2007).
Nurses’ Role in Preventing Opioid-Induced Respiratory Depression

The Agency for Healthcare Research and Quality (AHRQ) defines safety as practices that “reduce the risk of adverse events related to exposure to medical care across a range of diagnoses or conditions” (Shojania, Duncan, McDonald, Wachter, & Markowitz, 2001). Nurses are critical to the delivery of high quality, safe healthcare in hospitals, even though efforts to measure their impact are underdeveloped (Emanuel et al., 2008; Needleman & Hassmiller, 2009). Because their clinical duties place them directly at the bedside 24 hours a day, nurses can play a critical role in ensuring safety by monitoring for respiratory depression (Jarzyna et al., 2011). Nurses and nurse’s aides are often the first responders when it comes to recognizing early warning signs of OIRD, calling for a rapid response, or administering rescue medication.

Nurses also play an important role in the identification and evaluation of patients with risk factors for OIRD. They can help in the development of safe plans of care for pain management, and in preventing adverse events from side effects of pain medicines (Jarzyna et al., 2011). This project therefore recognizes the value of nursing presence at the bedside. It also supports nurses by recommending that they have greater access to the appropriate tools, education, and overall institutional support for keeping patients safe. This project also relies on input from the nurses about their perceptions of OIRD and the use of capnography. Note: No studies were identified in the literature that have taken nurses’ perceptions into account when assessing the use of capnography in general medical-surgical areas. There has, however, been one study on nurses’ perceptions of the use and effectiveness of capnography in the emergency department (Payne, 2010).
Nurses’ Role in Achieving Effective Pain Management

Patient satisfaction with their pain management regime is a Nurse-Sensitive Indicator of quality of care (Patrician, Loan, McCarthy, Brosch, & Davey, 2010). Nurse Sensitive Indicators are indicators that capture the process of patient care or that capture the patient outcomes that are most affected by nursing care (Beck, Weiss, & Ryan-Wenger, 2013). Interest in evaluating Nurse-Sensitive Indicators has increased over the last ten years, partly in recognition of the importance of: (a) measuring nurses’ contributions to patient outcomes, (b) improving care delivery, and (c) rewarding high performance (Beck et al., 2013).

By virtue of their 24-hour presence at the bedside, nurses are at the front lines in advocating for effective, safe pain management for their patients (Jowers-Ware, Bruckenthal, Davis, & O’Conner-Von, 2011). They assess patients’ pain, interpret range orders, administer medications, and monitor for effect. Nurses and their delegates monitor pulse oxygenation, end-tidal CO2, and respiratory rate and quality. They evaluate this objective data together with subjective data from patients’ self-reports about pain. Nurses also educate patients about pain, medication, side-effects, and the importance of wearing monitors consistently and correctly (Beck et al., 2010; Gordon et al., 2010).

Significance to Advanced Practice Nursing

A growing body of evidence demonstrates the benefits of an advanced-practice, nurse-led, pain management consultation service in the acute care setting (Jarzyna, 2012). Advanced-practice nurses with specialty certification in pain management have been shown to incur lower rates of naloxone rescue for their patients, increased patient
satisfaction with pain management, and positive revenue streams (Jarzyna, 2012; Proud, 2009). Because of their clinical expertise, advanced education, and training in the appraisal of evidence, these advanced practice nurses are well-placed to develop and implement Clinical Practice Guidelines for the assessment and monitoring of patients during opioid administration for pain management (D'Arcy, 2009; Schneider, 2008).

Summary

This chapter described the problem of opioid-induced respiratory depression (OIRD), situating it in the context of acute pain management in the hospital setting. It also provided the rationale for addressing the issue of opioid-induced respiratory depression in the medical-surgical setting. Finally, it justified the project in terms of its value to advanced practice nursing.
CHAPTER TWO: CONCEPTUAL FRAMEWORK

A well-known, persistent challenge in the provision of high quality healthcare is the gap between what is known and what is actually practiced (Institute of Medicine, 2001). Multiple sources have estimated that it takes an average of seventeen years for the evidence resulting from research studies to be applied in clinical practice (Morris, Wooding, & Grant, 2011). Meanwhile, approximately 30% to 40% of patients do not receive healthcare consistent with current scientific evidence (Eccles, Foy, Sales, Wensing, & Mittman, 2012). Part of the problem is the sheer volume and raw format of scientific literature that the average clinician simply does not have the capacity to acquire, read, and integrate into his or her own knowledge base (Grimshaw, Eccles, Lavis, Hill, & Squires, 2012; Grimshaw et al., 2006). Even if clinicians were able to keep pace with current literature, increased knowledge does not always lead to improvements in practice (Gurses et al., 2010; Shojania & Grimshaw, 2005).

This Practice Inquiry Project aims to change clinical practice by implementing a multifaceted intervention to improve the way nurses monitor patients for opioid-induced respiratory depression. This chapter presents the conceptual framework that has guided the design, implementation, and evaluation of the project.

ACE Star Model of Knowledge Transformation

The Academic Center for Evidence-based Practice (ACE) Star Model of Knowledge Transformation (Stevens, 2004) was selected for this project due to its applicability to the problem being addressed. Knowledge Transformation is defined as “the conversion of research findings from primary research results, through a series of stages and forms, to
impact on health outcomes by way of evidence-based care” (Stevens, 2004, p. 1). The ACE Star Model provides an intuitive framework for synthesizing evidence and translating it into practice. The ACE Star Model is shown in Figure 2.

Using a five-point star as an illustration, the model represents the ways that voluminous, broad knowledge from research is transformed into a concise format that can be utilized in clinical practice so as to impact patient outcomes. Point One is Discovery, representing primary research studies; Point Two is the Evidence Summary, which is the synthesis of knowledge into a single document, such as a systematic review; Point Three is Translation, often taking the form of evidence-based Clinical Practice Guidelines; Point Four, Integration, where guidelines are put into practice; and Point Five, Evaluation of outcomes (Stevens, 2012). The cyclical nature of the model indicates the value of integrating information regarding outcomes (a form of evidence that can also constitute new knowledge) back into the knowledge cycle (Stevens, 2012).
Star Point 1: Discovery Research

In this first stage, new knowledge is generated through systematic research and scientific inquiry using quantitative and qualitative methods. Research is conducted, reported in scientific journals, and reviewed by peers. Research on patient outcomes after the implementation of an innovation (such as the introduction of a new clinical practice guideline) may also be captured here, to become part of the knowledge base for future transformations (Stevens, 2004).

Star Point 2: Evidence Summary

In this phase, the body of research on a particular topic is synthesized to create a summary statement about the current state of knowledge, including the identification of
any gaps in knowledge. This synthesis process is approached as a scientific inquiry, involving question formulation, literature search, literature appraisal following standardized criteria, statistical analysis of results, and conclusions. The result of this process may generate knowledge by uncovering bias and identifying chance effects. It also increases the power and validity of causal relationships identified in research studies (Stevens, 2004).

Outputs from this process take the form of meta-analyses, systematic reviews (Cochrane Collaboration), evidence syntheses (Agency for Healthcare Research and Quality), literature reviews, and state of the science reviews. Documents such as these may be used to make clinical decisions, guide future research design, and inform overall policy decisions (Stevens, 2012; Stevens, 2004). After this process is completed, the volume of literature on any given topic is more manageable for clinicians.

*Star Point 3: Translation to Guidelines*

During the translation phase, the evidence summary is used to generate practical recommendations, or Clinical Practice Guidelines (CPGs). Clinical Practice Guidelines are tools for practitioners that help them adopt evidence-based practices (Dodek, Cahill, & Heyland, 2010; Lugtenberg, Burgers, & Westert, 2009). The Institute of Medicine (IOM) describes CPGs as “systematically developed statements to assist practitioner and patient decisions about health care for specific clinical circumstances” (Graham, Mancher, Wolman, Greenfield, & Steinberg, 2011, p. 3). The successful implementation of CPGs reduces inconsistencies in practice, and provides instructions for clinical decision-making to improve patient safety. It also improves patient outcomes, and promotes cost effective,
high quality care (Grimshaw et al., 2012). The use of CPGs can significantly increase the extent to which patients receive recommended therapies (Jeffs et al., 2012).

Star Point 4: Practice Integration

Clinical Practice Guidelines must be put into practice in order for the benefits of the knowledge to accrue to the patient. The mere existence of CPGs is not sufficient for them to be put into practice (Grimshaw et al., 2012). Implementation science examines the approaches that are used for promoting the uptake of CPGs into practice.

Implementation Science

Implementation science is the “study of methods, interventions, and variables that promote the uptake and use of research findings and other EBPs by individuals and organizations to improve clinical and operational decision-making in health care with the goal of improving health care quality” (Newhouse, Bobay, Dykes, Stevens, & Titler, 2013, p. S32). There are multiple terms describing the concepts related to implementation science: knowledge translation, implementation research, adoption (innovation or knowledge), quality improvement, dissemination, improvement science (McKibbon et al., 2012).

The strategies employed to implement CPGs often suffer from the lack of an evidence base (Groene, 2011; McIntyre & Shojana, 2011). There is also a lack of a theoretical framework guiding the selection of implementation strategies (Foy et al., 2011). Mazza et al. (2013) define implementation strategy as “a purposeful procedure to achieve clinical practice compliance with a guideline recommendation.” (Mazza et al., 2013, p. 1). Leeman, Baernholdt & Sandelowski (2007) conducted a content analysis of forty three guideline implementation studies to link the implementations strategies to theoretical
constructs. They identified the Theory of Planned Behavior as a theoretical foundation for interventions targeting individual clinicians, while Diffusion of Innovation theory underpins many interventions targeting organizations or work processes (Leeman et al., 2007).

Implementation of evidence-based practice impacts—and is impacted by—the social, cultural, and economic context in which the practice takes place (Eccles et al., 2012). Factors that either support or thwart change should be identified, so that strategies to overcome barriers and build on supports can be devised. Efforts to change practice have a low likelihood of success unless these barriers are addressed (Baker et al., 2010). Successful implementation of CPGs works best with multifaceted approaches targeting multiple barriers simultaneously (Grimshaw et al., 2004; Mazza et al., 2013). Active strategies are more likely to be effective than passive ones (Mazza et al., 2013; Shojania & Grimshaw, 2005).

*Star Point 5: Process, Outcome Evaluation*

The final stage of the ACE Star Model is the evaluation of outcomes. Evaluation should occur at multiple levels and may be focused on clinicians, organizations, or patients. Evaluation results contribute to a growing knowledge base of what types of interventions work and under what circumstances (Dy et al., 2011; Foy et al., 2011).

*Process Outcomes (Practitioner/Organization)*

When the interventions target practitioners or organizations with the aim of promoting a change in practice, then measurements are made of the actual change in health practices (for example, the compliance with guidelines, or changes in prescribing rates).
Evaluation of knowledge and attitudes of healthcare practitioners can provide a surrogate measure of the effectiveness of the intervention. Indicators of change at the organizational level may include the health system, policies, workflows, or costs (Hakkennes & Green, 2006). Evaluations of outcomes should also examine the unintended outcomes or changes in processes that occurred as a result of the intervention (Foy et al., 2011).

**Patient Outcomes**

Interventions targeting clinicians can also be measured by improvements in patient outcomes, such as measurements of change in the health status of the patient (such as the patient's pain, depression, mortality, and quality of life). Measures of patient adherence, attitudes, or length of stay in the hospital can also provide a surrogate measure of the effectiveness of the intervention (Hakkennes & Green, 2006).

**Summary**

This chapter presented the ACE Star Model of Knowledge Transformation as the conceptual model that guided the design, implementation, and evaluation of a multifaceted intervention to improve monitoring of patients at risk for OIRD. The next chapter will describe the design and implementation of the intervention, and will explain how the outcomes were measured.
CHAPTER THREE: METHODS

This chapter describes the design and implementation of the multifaceted intervention to improve patient monitoring for OIRD. It also describes the methodology for the outcomes evaluation.

Background of the Practice Inquiry Author

The author is a Master’s-prepared Doctor of Nursing Practice (DNP) student in the College of Nursing at The University of Arizona. She is also an Adult Nurse Practitioner, certified in Pain Management Nursing, employed by the Acute Pain Service at UAMC. The author’s professional role includes providing direct patient care through individual consults on issues related to complex pain management. The author also provides for physician and nurse education on pain-related topics, staff coaching on pain management, and individual quality improvement initiatives. This Practice Inquiry Project was undertaken as part of a larger quality improvement project spearheaded by the author.

Sections of this chapter describe the implementation of this project as a chronological account. The author was a participant-observer in the decision-making process of an interprofessional working group. Documentary evidence used in this report includes hospital protocols, minutes of meetings, the author’s personal meeting notes, and correspondences.

Setting

This Practice Inquiry Project was conducted at The University of Arizona Medical Center, University Campus (UAMC-UC). UAMC-UC is a 489-bed Level One Trauma Center, Magnet certified by the American Nurses Credentialing Center (ANCC) (The University of
Arizona Health Network, 2013). UAMC-UC is part of The University of Arizona Health Network (UAHN) that includes a second hospital and multiple out-patient clinics. UAHN’s mission is “Advancing health and wellness through education, research and patient care” (The University of Arizona Medical Center, 2013a, p. 1).

UAHN engages in a number of quality and safety initiatives to promote a safety culture. Through the Quality & Safety First Program, the health network integrates error prevention and quality improvement into its hospital systems and processes (The University of Arizona Medical Center, 2013b). UAHN participates in the University Hospital Consortium’s Patient SafetyNet™ system for reporting adverse events and near misses (Masimo Corporation, Irvine, CA). UAHN reports Core Measures performance on Heart Attack/Acute Myocardial Infarction, Heart Failure, Pneumonia, Surgical Care Improvement Project, and Children’s Asthma Care (The University of Arizona Medical Center, 2013b).

Upon patients’ admission to the hospital, UAMC-UC staff provide patients with a safety brochure from The Joint Commission on how they can be partners for safety in their own care by asking questions about tests, treatments, and medications (The Joint Commission, 2011b). More specific to this project, UAMC-UC was recently rated “better than average” for respiratory failure following surgery according to data from the Centers for Medicare and Medicaid Services as reported by HealthGrades (HealthGrades, 2012).

Nurses for this project were targeted from the following types of Adult Health units: medical, surgical, combined medical-surgical, and intermediate care (step-down) units. Due to the overall high patient acuity at UAMC and the hospital’s capacity to utilize telemetry monitoring on every unit, all of the Adult Health medical-surgical units are rated as

Ten units were included in the project: 3E, 3NE, 3NW, 4NE, 4W, 5E, 6E, 7W, D2N, and D3N. Each of the ten units has a sub-specialty (for example, cardiology, orthopedics, neurology, transplant), yet each unit can be considered a medical-surgical unit. Each of these units manages patients with acute pain (and often acute-on-chronic pain) with co-morbidities and iatrogenic risk factors placing them at high risk for OIRD. None of the patient rooms on these units has a built-in capnography wall-unit. Each unit relies solely on portable EtCO2 monitors. To maintain consistency for this Practice Inquiry project, the following types of units were excluded from the project: intensive (critical) care units, labor and delivery, post-partum, post-anesthesia care, pediatrics, and the emergency department.

Nurses on the medical-surgical units may carry a patient load of three, four, or five patients, depending on acuity. They are assisted by Patient Care Technicians (PCTs) who each attend to eight to ten patients. The PCTs check vital signs of their patients at regular intervals, per protocol or per physician-specified parameters. RNs can delegate more frequent vital sign checking if they consider it necessary, based on the patient’s condition.

End-tidal CO2 monitoring, when ordered, is ordered continuously, rather than intermittently. Once it is in place, both RNs and PCTs check it when they are in the room, and both listen for alarms when they are out of the room.

Ethical Considerations

The University of Arizona College of Nursing Departmental Review Committee and The University of Arizona Institutional Review Board both reviewed the survey project and,
as a component of a quality improvement activity, considered that it was exempt from a full review. The signature page can be found in Appendix A. UAMC’s Site Review Authority (SRA) was informed of the project, but no written approval process was required since this project is a quality improvement project. There were no regulatory, ethical, or cultural concerns that needed to be addressed.

There was, however, a concern expressed from Nursing Administration about survey fatigue, as multiple RN-targeted surveys were planned around the same time as this project’s survey. Through careful scheduling, the investigator avoided direct competition with other active surveys, though general survey fatigue may have negatively affected the response rate.

Applying the ACE Star Model to OIRD

*Star Points 1-3: ASPMN Guidelines on Monitoring for OIRD*

This section describes how the American Society for Pain Management Nursing guidelines were developed, using the first three points of the ACE Start Model of Knowledge Transformation. The ASPMN reviewed the research-based knowledge about opioid-induced respiratory depression (Point One: Discovery) and performed the evidence summary (Point 2) that led to the translation of the evidence into guidelines (Point Three).

According to the ASPMN Consensus Panel, in 2007 the ASPMN Board of Directors approved the formation of the panel to develop guidelines for the assessment and monitoring of patients at risk for OIRD. At the time the panel began its work, there were no universally accepted guidelines to direct bedside nurses towards safe and effective assessment and monitoring practices for patients receiving opioid medications for pain
(Jarzyna et al., 2011). There also appeared to be no consensus among professional organizations about the benefits of capnography in hospitalized patients receiving opioids for pain therapy (Weinger, 2006). At that point, there had not been any randomized clinical trials to provide high quality evidence of the value of capnography in detecting early signs of OIRD and preventing adverse outcomes (Jarzyna et al, 2011). In addition, a survey of clinicians conducted by the ASPMN Consensus Panel indicated that there was considerable variation in monitoring practices and screening for patient risk (Jarzyna et al, 2011; Pasero, 2012).

The Panel conducted their work over a three-year period, from the time they began their literature review until the time they developed their recommendations and submitted them for publication (D. Jarzyna, personal communication, January 9, 2012). These recommendations were to be based on the strength of existing evidence (using an evidence rating scale) and expert consensus of the panel members (Jarzyna et al., 2011).

As a result of their analysis, the following recommendation was made by the Panel: “At this time, the ASPMN Expert Consensus Panel recommends that the use of pulse oximetry and capnography to detect respiratory compromise in the ongoing care of patients who are receiving continuous opioid therapy be determined by patient risk factors, iatrogenic risk, and institutional policies” (Jarzyna et al., 2011, p. 144). More specifically, they wrote:

- The frequency, intensity, duration, and nature of monitoring (assessments of sedation levels and respiratory status and technology-supported monitoring) should be individualized based on a patient’s individual risk factors, iatrogenic risks, and pharmacologic regimen administered to treat pain.
- Technology-supported monitoring (e.g., continuous pulse oximetry and
capnography) can be effective for the patient at high risk for unintended advancing sedation and respiratory depression.
- Technology-supported monitoring should be directed by patient risk including preexisting conditions, response to therapy, overall clinical status, practice environment, and concurrent medication administration.
- The use of capnography in the postoperative period can be a useful indicator for respiratory depression in high-risk patients.

As a result of these recommendations, an interprofessional group of clinicians at UAMC decided to initiate the process that ultimately became this Practice Inquiry Project.

*Star Point 4: Integration of the CPG Into Practice*

This Practice Inquiry Project essentially began at Star Point Four of the ACE Star Model of Knowledge Transformation. This stage is Integration, when Clinical Practice Guidelines are put into practice. This stage requires a change in professional practice at multiple levels. More specifically, this stage “involves changing both individual and organizational practices through formal and informal channels” (Stevens, 2012, p. 19).

*Project Design*

The purpose of this Practice Inquiry Project was to design, implement, and evaluate the effectiveness of a multifaceted intervention to improve patient monitoring for OIRD on medical-surgical units. The specific objectives of the project were to:

1. Assess the feasibility of implementing the CPG
2. Design a multifaceted intervention to improve monitoring practices
3. Implement (introduce and sustain) the intervention
4. Monitor the implementation through audit and feedback processes
5. Evaluate outcomes via pre- and post-intervention data analyses
This project was a prospective implementation project, using a before and after design to evaluate outcomes. The intervention is aimed to change nursing practice by supporting the use of end-tidal CO2 monitors at the bedside. Therefore, the direct targets of the intervention were medical-surgical nurses. However, under the pre-existing system, physicians entered the orders for EtCO2 monitoring, so the project design included a consideration of physician practice.

The process outcome indicator was the number of patients monitored with EtCO2 monitors before and after the implementation of the intervention. In addition, nurses were surveyed about their perceptions of the use and effectiveness of capnography on medical-surgical units. The purpose of the survey was to identify barriers and supports that arose during the one-year period of the intervention. The information will also be used to guide future activities to promote the use of EtCO2 monitoring.

The indirect targets of the project intervention were the patients at risk for OIRD on medical-surgical units. The patient outcome indicator was the incidence of opioid-induced respiratory depression. OIRD incidence was measured before and after the implementation, by analyzing the number of cases in which naloxone administration was required over a one-year period.

Interprofessional Working Group

Two sentinel events related to respiratory arrests in patients on opioid therapy in 2011 prompted UAMC’s Quality and Safety Board (QSB) to investigate ways to (a) identify patients at risk for respiratory depression and (b) improve monitoring practices for those patients. The ASPMN guidelines on monitoring for OIRD had recently been published,
providing evidence-based recommendations for clinical practice. This author was asked to convene an interprofessional working group to do a rapid assessment of the issue and develop solutions (H. Costello, personal communication, December 5, 2011).

In January 2012, the interprofessional working group met for the first time. The following representatives were invited to participate, and all of them agreed.

1. Nursing: two pain-certified APRNs, a critical care nurse, and a medical-surgical nurse
2. Medicine: two anesthesiologists, one from the Acute Pain Service, and one with a particular interest and passion about respiratory monitoring
3. Respiratory Therapy
4. Pharmacy
5. Manager of Nursing Informatics (a nurse)
6. Information Systems Services specialist
7. Director of Adult Health Services (a nurse)
8. Quality Analyst (a nurse)

The group met three times over a ten-week period, communicating electronically in-between meetings. The group reviewed UAMC’s then-current end-tidal CO2 monitoring practices, the new ASPMN guidelines (Jarzyna et al. 2011), and the Anesthesia Patient Safety Foundation’s (APSF) Position Paper on Respiratory Depression (Weinger, 2011). Five members of the group had been involved in analyzing cases of OIRD at UAMC and were well-versed on the issue. Nurses from multiple levels of the organization comprised the majority of the group, including two bedside nurses.

The group at UAMC made a decision to adopt the ASPMN’s recommendations and incorporate them into the organization’s Nursing Protocol on monitoring for OIRD. The
decision-making process involved answering four questions as described in the Agency for Healthcare Research and Quality’s (AHRQ’s) framework “Will It Work Here? A Decision-maker’s Guide to Adopting Innovations” (2008). The four questions were: (a) Does this innovation fit; (b) Should we do it here; (c) Can we do it here; and (d) How can we do it here? (Agency for Healthcare Research and Quality, 2008).

In answer to the AHRQ’s questions, the working group discussed the following rationale (author’s meeting notes January – March 2012):

*Does this innovation fit?* Yes, the patient population at UAMC is characterized by multiple medical and iatrogenic risk factors for OIRD. UAMC is a high acuity facility treating the sickest of the sick. Capnography is an appropriate means for monitoring at this hospital. Nurses at UAMC are already skilled at monitoring patients with EtCO2, since it has been practiced here. This guideline will provide additional criteria for risk assessment and parameters for monitoring.

*Should we do it here?* Yes, the staff at this hospital are committed to evidence-based practice in a culture of patient safety.

*Can we do it here?* A rapid needs assessment should be completed to determine how many patients at UAMC would require monitoring on a typical day. The current inventory of EtCO2 monitors should be checked. Based on the results of the needs assessment and an accurate count of the hospital’s current supply of monitors, this group can make a recommendation about purchasing additional EtCO2 monitors if needed.

*How can we do it here?* The working group assessed the barriers and supports to adopting the ASPMN’s guideline at UAMC and came up with a plan to address the barriers
and maintain the supports.

Assessment of Barriers and Supports

Grimshaw et al. report that there are no standardized approaches for assessing barriers and supports to knowledge translation (2012). Diverse methods are utilized and described in the literature, such as interviews, focus groups, and surveys. Implementers of knowledge translation projects are left to use their judgment about how to best assess the barriers and supports in their own contexts (Grimshaw et al., 2012).

For this project, the interprofessional working group used direct observation and experience to assess barriers and supports of implementing the CPG on EtCO2 monitoring. Members conveyed their observations about barriers and supports to the rest of the group informally during the discussions of how to implement the CPG. The author reconstructed those barriers and supports from meeting notes (author’s meeting notes January to March 2012).

**Barrier 1:** Nurses lacked the ability to order end-tidal CO2 monitoring. Monitoring required a physician’s order. There were delays in care as RNs contacted physicians to request orders.

**Barrier 2:** There seemed to be shortage of end-tidal CO2 monitors. It was not clear whether this was a supply problem or a distribution problem, so the working group decided to conduct a point prevalence study to find out how many patients on a typical day are at high-risk for OIRD in this hospital, and compare that against the number of monitors owned by the hospital.

**Barrier 3:** Large numbers of new graduate nurses had recently been hired as part of
a hospital expansion, and they were unfamiliar with the use of capnography.

Support 1: There was a pre-established infrastructure for nursing staff education through unit-based educators that could be utilized for continuing education on EtCO2 monitoring.

Support 2: There was a good foundation of knowledge and competence among experienced RNs about capnography and risk factors for OIRD.

Support 3: A comprehensive nursing protocol about end-tidal CO2 monitoring already existed and just needed to be updated with the new ASPMN guidelines and more description of risk factors for OIRD.

Support 4: Nurses were highly motivated to keep their patients safe, and the organization promotes quality and safety.

Support 5: There was an existing inventory of sixty-three portable EtCO2 monitors that were integrated with the PCAs but capable of being used for patients not on a PCA.

Support 6: There was a computerized order entry system for patient care orders.

Intervention

Based on their assessment of barriers and supports to EtCO2 monitoring, the working group developed a multifaceted intervention with four components, aiming to quickly and effectively address the barriers and build on the existing supports. The components are described in this section and categorized according to the theory-based taxonomy proposed by Leeman, Baerholdt, and Sandelowski (2007). Their taxonomy is based on a content analysis of forty three empirical studies on the implementation of research-based practice changes between 1995 and 2005, and it links the methods used in
each study to the applicable theory that underpins them (Leeman, Baerholdt & Sandelowski, 2007). This section also provides an indication of the success rates of these types of interventions based on previous systematic reviews of the implementation science literature (Grimshaw et al., 2012).

**Component 1—Developed a Computer Order Entry Prompt for End-Tidal CO2 Monitoring:** To address the barrier of delayed care due to the nurses being unable to order EtCO2 monitoring directly, a conditional order was developed for UAMC’s electronic health record (Sunrise Clinical Manager®). The conditional order is a type of standing order that is inactive until the conditions are met. This order describes the risk factors for OIRD and states that if the patient has one or more of the risk factors, the order maybe activated.

The Informational Systems Support (ISS) and Pharmacy teams developed this order with guidance from the working group (author’s meeting notes April 8, 2012; J. Kane, personal communication, May 4, 2012). The conditional order was added to all order sets involving opioid medications. The order is pre-selected, meaning that it automatically becomes part of the patient’s medical record unless the provider opts out of it by de-selecting a checkbox.

Conditional orders are meant to be activated, so the order for EtCO2 monitoring is not an active order unless: (a) the ordering provider activates the order during the order entry session based on an assessment of the patient’s risk factors; or (b) the RN believes the patient to be at risk, activates the order, and notifies the provider that monitoring has been initiated. Figure 3 shows how the order appears on the computer screen.

This component of the intervention targeted both physicians and nurses for practice
change. Physicians and nurses can each activate the order, and both will see the order and be reminded to assess the risk factors and consider whether to activate it.

This intervention functions as a reminder system aimed at changing both physician and nursing practice. It also serves a clinical decision-making support function, since it provides the risk factors for OIRD in the order where they can be quickly accessed and used for risk screening. Reminder systems have been shown to be effective methods for changing the behavior of providers, improving performance by as much as 10-20% (Grimshaw et al., 2004). Reminder systems are most effective when integrated with existing workflow (Shojania & Grimshaw, 2005). Reminder systems and clinical decision-making support systems serve as a way of increasing the practitioner's perception of behavioral control and as such fit under the Theory of Planned Behavior (Ajzen, 1991 as cited in Leeman, Baerholdt & Sandelowski, 2007).

Figure 3: Conditional Order for EtCO2 Monitoring

Component 2—Increased the Supply of End-Tidal CO2 Monitors and Proposed a New Distribution System: The working group worked with the purchasing department to
purchase additional portable EtCO2 monitors (based on the results of the needs assessment). The group advocated to the Chief Nursing Officer (CNO) and Chief Executive Officer (CEO) for the purchase of thirty new monitors. The purchase was approved in May 2012, bringing the total inventory up to ninety-three. When the new monitors arrived in late June, each of the ten medical-surgical units stored one on the unit. When the monitor was deployed for use with a patient, the nurse was instructed to immediately notify the materials management department to back-fill the shelf space with a replacement monitor.

This component of the intervention targeted nurses. It was intended to affect nursing practice by making EtCO2 monitors more readily available on each unit. It is considered an environmental change intervention that increases the practitioner’s perception of behavioral control. In this case the intention is to make it easier for the nurse to perform the desired behavior (initiate monitoring on the patient). This type of intervention is founded on the Theory of Planned Behavior (Ajzen, 1991 as cited in Leeman, Baerholdt & Sandelowski, 2007).

Component 3—Updated the Nursing Protocol: The working group updated the nursing protocol on monitoring for OIRD to provide guidance for nurses on how to assess risk and when to initiate continuous monitoring. The protocol provides detailed descriptions of risk factors for OIRD. UAMC’s Nursing Clinical Practice Committee reviewed and approved the revised protocol in March 2012. The revised protocol includes an appendix with information from the manufacturer about how to operate the monitoring equipment. The working group introduced the new protocol to all designated units and discussed it during unit-based shift huddles. RNs were notified about the new conditional
order process at the same time.

This component of the intervention targeted nurses. It was a nursing practice intervention with an educational component. The Nursing Protocol serves as an internal evidence-based guideline for patient care, outlining the process for decision-making and setting an expectation about the standard of nursing care. It also serves as a reference document about how to operate the monitoring equipment (UAMC Patient Care Services, 2012). By revising the protocol and notifying nurses about the rationale for the changes, the intention was to raise awareness of OIRD and how to prevent it. Awareness-raising interventions stem from Rogers’ Diffusion of Innovations Theory (Rogers, 2003 as cited in Leeman, Baerholdt & Sandelowski, 2007).

Component 4—Enhanced Staff Education: The Clinical Nurse Specialist on the working group developed a new education module for nurses about OIRD, including how to assess sedation and respiratory status, and how to use capnography. The author rolled out the module to all RNs on the designated units and reinforced the information during unit-based shift huddles. The author began to incorporate more information about OIRD into the bi-weekly nursing orientation presentations for newly hired RNs.

This component of the intervention targeted nurses with the aim of improving nursing practice through education. Educational interventions stem from Rogers’ Diffusion of Innovations Theory (Rogers, 2003 as cited in Leeman, Baerholdt & Sandelowski, 2007). Educational interventions are generally not effective at improving patient outcomes, but are effective at increasing provider knowledge (Shojania & Grimshaw, 2005).
**Timeline**

All of the interventions with the exception of purchasing new equipment were introduced by April 2012. The point prevalence survey was conducted in April 2012. As a result of that survey, in May the Chief Nursing Officer and Chief Executive Officer approved the purchase of an additional thirty portable end-tidal CO2 monitors. The monitors did not arrive until late June, when they were immediately put into circulation.

**Continuous Project Monitoring**

The author monitored the implementation of the intervention throughout the year. During daily rounds, the author conducted semi-structured interviews using a convenience sample of nurses, in real-time at the point of care, to determine whether any barriers to implementation needed to be addressed. For example, if a high-risk patient had an order for EtCO2 monitoring but there was no monitor in the patient’s room, the author would ask the nurse a series of questions to determine why the monitor was not there. Or, if there was a monitor in the patient’s room, but the patient was not wearing it, that would trigger a discussion about what attempts had been made to communicate with the patient about the purpose and benefits of the monitor. The author participated in resolving barriers and procuring monitors when needed, as part of her professional responsibilities.

**Star Point 5: Methods for Evaluation of Process and Patient Outcomes**

There were three parts to the evaluation of this Practice Inquiry Project:

(a) Pre- and post-intervention measures of the number of medical-surgical patients who were monitored with capnography for opioid-induced respiratory depression; (b) a survey of medical-surgical RNs on their perceptions of the use and effectiveness of EtCO2
monitoring; and (c) measures of the number of cases of OIRD in 2011 as compared with data about the number of cases of OIRD in 2012.

1) Number of Patients Monitored with EtCO2

Pre-Intervention Data Collection. At the start of this Practice Inquiry Project in April 2012, a point prevalence survey was conducted over a twelve-hour period on ten Adult Health medical-surgical units. The purpose of the survey was three-fold: (a) to provide a snapshot of the number of patients at risk for OIRD on a typical day in Adult Health; (b) to establish a baseline of how many patients were actually being monitored with capnography versus those for whom it was ordered but unavailable; and (c) to assess the hospital’s need to purchase additional portable end tidal CO2 monitors (as described above).

The survey was conducted by a team of Pain Resource Nurses (PRNs) who enlisted the help of the Charge Nurse on each of the ten units. The Pain Resource Nurse team is a group of nurses with additional training in pain management who serve as pain champions on their respective units. UAMC has supported a Pain Resource Nurse program since 2009 (J. Hall, personal communication, August 14, 2012).

A one-page data collection tool listing the risk factors for OIRD was provided on each unit. A copy of the data collection tool can be found in Appendix B. The Charge Nurses on each unit were asked to put checkmarks in the boxes for risk factors pertaining to each of their patients. They were also asked to physically enter the patients’ rooms to observe whether the patients: (a) had a monitor in the room; and (b) were wearing it. A team of four PRNs rounded on each unit periodically during the twelve-hour period to answer questions and provide support.
The data collection tool included nine patient risk factors and nine iatrogenic risk factors. Each of the risk factors was based on evidence gathered by the American Society of Pain Management Nursing in support of their Guidelines for Monitoring or Opioid-Induced Respiratory Depression.

Post-Intervention Data Collection. In early April 2013, a point prevalence survey was conducted over a twelve-hour period on the same ten Adult Health medical-surgical units. The purpose of the survey was to provide a count of the number of patients who were actively monitored with capnography versus those for whom it was ordered but unavailable. Data were also collected about whether there was a conditional order for EtCO2 monitoring that had not been activated. In addition to the data collected in the chart audit, each patient was visually assessed to determine whether a monitor was actually being worn. The survey was conducted on all ten adult health medical-surgical units. The survey was an abbreviated version of the survey from the previous year, since the needs assessment did not need to be repeated.

Acute Pain Service Consult Log. A secondary source of data about the number of patients monitored with capnography took the form of a daily consultation log of the Acute Pain Service, which is maintained by this author. The Acute Pain Service is regularly consulted to see patients with complex pain management issues at the request of the patient's primary in-patient physician team. These patients are usually on high doses of opioid medications and are at high risk for OIRD. This author made a note in the log about whether the consult patients had EtCO2 monitors ordered and were wearing them. This
information provided an indication of whether high-risk patients were being monitored differently from the general patient population.

2) *Survey of RNs’ Perceptions of the Use and Effectiveness of Capnography*

   The purpose of the survey was to assess nurses’ perceptions on the use and effectiveness of capnography in monitoring for OIRD on medical-surgical units. The survey provided an opportunity for nurses to provide feedback about additional supports or barriers to practice that may not have been evident from the baseline assessment or the continuous process monitoring. After one year’s implementation of the intervention, it was expected that all nurses would have accumulated sufficient experience with capnography to gain some insights into what worked well or did not work well with regard to capnography in the medical-surgical setting. The survey approach was a cross-sectional descriptive design using a five-point Likert-type scale developed by the investigator.

   *Survey Instrument.* The survey was web-based and began with five basic demographic questions to allow for correlation of education level and nursing experience with the responses about monitoring. The ten Likert scale questions addressed awareness, attitudes, concerns, and current practice with end-tidal CO2 monitors. The last question was an open-ended qualitative question. The RN was invited to make any comment he or she wanted to make about EtCO2 monitoring. The open-ended responses were grouped according to themes that emerged. Responses to the open-ended questions may also indicate avenues for further investigation in a follow-up study.

   The survey instrument was reviewed by a convenience sample of six nurses with expertise in pain management and end tidal CO2 monitoring, to establish content validity
and estimate time for completing the survey. The reviewers expressed concern that more than twenty questions might be a deterrent to completing the survey during work hours. The survey was designed to take from five to ten minutes of the respondent’s time. Based on feedback from the nurses, minor wording changes were made on two questions. The survey instrument may be found in Appendix C.

The survey was pilot tested with a convenience sample of twelve medical surgical nurses (not advanced practice, and not pain resource nurses) that the investigator contacted through professional networks. Each was sent a link to the survey via email. All twelve completed the survey. The Cronbach’s alpha score for internal consistency was calculated to be alpha 0.81 which is an acceptable score (Gliem & Gliem, 2003).

The survey was conducted using an online survey tool. An explanation of the purpose of the survey was sent by e-mail to all registered nurses working on each of the ten medical-surgical units. The e-mail contained a link to the online survey. A modified Dillman’s approach was used to increase response rate, whereby a second e-mail was sent after two days, a third after two more days, and a final reminder on the last day (Thorpe et al., 2008). The survey remained open for ten days. An incentive was offered for participation in the survey. The incentive consisted of being entered into a random drawing to win one of five gift cards valued at fifty dollars. The recruitment letter can be found in Appendix E.

3) Patient Outcomes: Incidence of OIRD

Baseline data about the number of OIRD cases (indicated by the number of cases requiring naloxone rescue) existed for 2011, though those data were from two different
sources using two different methodologies. This fact illustrates the challenges of obtaining consistent data that allow for a valid comparison over time and/or between institutions.

The first set of data were collected as part of a retrospective chart review conducted by a group of second-year pharmacy doctoral students from The University of Arizona College of Pharmacy in early 2012 (Abbott et al., 2012). Their process will be described in detail in Chapter Four.

The second set of data were compiled by UAMC staff as part of day-to-day quality analysis. The process began with a hospital pharmacist sending reports to the Pain Service every time naloxone was pulled from a medication dispensing machine at any location in the hospital. A Clinical Nurse Specialist certified in Pain Management then investigated each case to determine whether the medication was actually administered for opioid-induced respiratory depression. This method was also used for collecting the post-intervention patient outcome data for this project throughout 2012.

Methods for Data Analysis

The pre- and post-intervention data on the total number and proportion of patients being monitored with capnography were compared. The percent change over time in the number of patients monitored was calculated. Because the data were categorical rather than interval, a nonparametric method was used to analyze the data. The Fisher’s Exact test was used to test for statistical significance of the results.

Data from the nurses’ survey were described by reporting the frequency of responses to each question. The response rate was calculated for each of the ten medical surgical units surveyed. The data were compiled in a Microsoft Excel spreadsheet where
they were examined for incomplete responses. The data were cross-tabulated to identify any associations between demographic factors and the answers to substantive questions about EtCO2 monitoring. Responses to the Likert scale question were grouped according to three categories: (a) patient-specific concerns, and (b) ease of use, and (c) supply and distribution. Responses to the open-ended question were examined for themes. Responses that matched the Likert categories were grouped accordingly. Other responses were grouped into a new category.

Summary

This chapter described the design and implementation of the Practice Inquiry project, which was based on the ACE Star conceptual model. The decision-making process leading to the development of the multifaceted intervention was described, including the barriers and supports identified by the interprofessional working group. The evaluation methods were also presented.
CHAPTER FOUR: RESULTS

This chapter presents the results of the intervention to increase nurses’ use of capnography for the early detection of opioid-induced respiratory depression. Data were collected to measure the number of patients who were monitored with EtCO2 monitors. Nurses were surveyed about their perceptions of the use and effectiveness of EtCO2 monitoring. Lastly, data were collected on the number of cases in which naloxone had to be administered to rescue a patient from the effects of opioid-induced respiratory depression.

Number of Patients Monitored with EtCO2

Pre-Intervention Data

On the day of the baseline point prevalence survey conducted in April 2012, there were 245 patients on the ten adult health units included in this study. The purpose of the survey at that time was not only to establish baseline data for this study, but also to ascertain how many patients on a typical day were at high risk for opioid-induced respiratory depression. This information was necessary in order to determine whether the hospital owned a sufficient number of EtCO2 monitors to meet the daily needs.

Data were collected on patient risk factors based on the ASPMN guidelines (nine medical-surgical and nine iatrogenic), as well as the number of patients who were being monitored with capnography. The medical-surgical risk factors were: Age greater than seventy-one, body mass index greater than thirty, obstructive sleep apnea (diagnosed by physician, reported by patient/family, or observed by RN), chronic obstructive pulmonary disease, heart failure, renal insufficiency (as evidenced by a creatinine of 1.5 or higher, or a rapid increase from baseline), neurological disorder resulting in muscle weakness, airway
disorder (tracheomalacia or laryngomalacia), and status of less than twenty-four hours after surgery. The iatrogenic risk factors were: continuous opioid infusion (drips or patient-controlled analgesia (PCA) with basal rate), PCA with incremental opioid dosing only, RN-administered intravenous bolus doses of opioids, oral (PO) opioids, Fentanyl patches, benzodiazapines, antihistamines, or sedating antiemetics such as promethazine.

Of the 245 patients surveyed, the majority (n=174, 71%) had at least one medical-surgical risk factor for OIRD. Twenty-two patients (9%) were less than twenty-four hours postoperative. Thirteen were noted to have obstructive sleep apnea (5%), though this may be an underestimate, as obstructive sleep apnea is under-diagnosed (Hutchison & Rodriguez, 2008). A comparison of the number of patients with medical-surgical risk factors is shown in Figure 4.

Figure 4: Patients with Medical-Surgical Risk Factors for OIRD
With regard to iatrogenic risk factors, most patients had at least one medication risk factor \((n=193, 79\%)\). Four patients \((2\%)\) were at high risk due to being on continuous opioid infusions; in this case patient-controlled analgesic pumps with a basal rate. A comparison of the number of patients with iatrogenic risk factors is shown in Figure 5.

![Figure 5: Patients with Iatrogenic Risk Factors for OIRD](image)

The three risk factors highlighted above (obstructive sleep apnea, status of less than twenty-four hours postoperative, and receiving opioids via continuous infusion) affected thirty-nine patients \((16\%)\) on the day of the survey. Yet very few patients that day had orders for EtCO2 monitoring \((n=26, 11\%)\). Of the twenty-six patients with orders for EtCO2, only eleven of those patients were actually wearing monitors. Twelve nurses reported being unable to obtain a monitor. For the three remaining patients there was no
explanation given. The hospital owned sixty-three EtCO2 monitors at that time. Appendix D shows the complete table of data from the pre-intervention survey.

Post-Intervention Data

On the day of the survey in April 2013, there were 238 patients on the ten units included in the study. The majority of the patients had conditional orders for EtCO2 monitoring \( (n=185, 78\%) \). Of the 185 patients with conditional orders, only 15 \( (8\%) \) had been formally activated. Twenty-seven patients, however, were actually being monitored \( (11\%) \), leaving twelve patients monitored without active orders. Table 1 compares the pre- and post-intervention data.

Table 1: Patients Monitored with EtCO2

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention</th>
<th></th>
<th>Post-intervention</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( N=245 )</td>
<td></td>
<td>( N=238 )</td>
<td></td>
</tr>
<tr>
<td>EtCO2 Ordered</td>
<td>26</td>
<td>10.6%</td>
<td>185</td>
<td>77.7%</td>
</tr>
<tr>
<td>Wearing EtCO2</td>
<td>11</td>
<td>4.4%</td>
<td>27</td>
<td>11.3%</td>
</tr>
</tbody>
</table>

After the intervention, 77.7\% of patients had conditional orders for EtCO2, compared to 10.6\% who had active orders before the conditional order was introduced as part of this project. This was an increase of 633\%. These patients had conditional orders that could be activated immediately. The percentage of patients actually wearing a monitor post-intervention was 11.3\% as compared to only 4.4\% at baseline, an increase of 156\%.

The Fisher's exact test was used to compare the proportions of patients with EtCO2 orders and those actually wearing monitors before and after the intervention. There was a
statistically significant increase in the number of patients with orders for EtCO2 monitoring ($p<0.0001$), and in the number of patients actually wearing monitors ($p=0.0063$).

The Acute Pain Service consult log listed 157 high-risk patients. Of those, 125 had orders for EtCO2 monitoring (79.6%). The number of patients actually wearing the monitors was 74 (47.1%). Table 2 shows the number of high-risk patients from the Acute Pain Service consult log.

Table 2: High-Risk Patients Monitored with EtCO2

<table>
<thead>
<tr>
<th></th>
<th>N=157</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EtCO2 Ordered</td>
<td>125</td>
<td>79.6%</td>
</tr>
<tr>
<td>Wearing EtCO2</td>
<td>74</td>
<td>47.1%</td>
</tr>
</tbody>
</table>

Figure 6 provides a graphical representation of the change over time, using a proportional scale to correct for the different population sizes of each category.
Nurses’ Perceptions on the Use and Effectiveness of EtCO2 Monitoring

A total of 383 RNs were invited to participate in the survey. The survey was open for ten days in late March, 2013. A total of 171 nurses took the survey, and 167 completed it (98%). The four incomplete surveys were deleted from the data set by the investigator to maintain consistency. The response rate was forty-four percent, which is an acceptable rate for unit-specific scales pertaining to nurses’ work environments (Kramer, Schmalenberg, Brewer, Verran, & Keller-Unger, 2009). Table 3 provides the detail about how many RNs from each unit participated. The largest response rate was from the Trauma unit, Diamond 2 North (D2N, 67%). The smallest response rate was from the Cardiac unit (4W, 24%).
Table 3: RN Survey Response Rates

<table>
<thead>
<tr>
<th>UNIT</th>
<th>RNs invited to take survey</th>
<th># RNs completing survey</th>
<th>Response rate per unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>3E</td>
<td>31</td>
<td>12</td>
<td>39%</td>
</tr>
<tr>
<td>3NE</td>
<td>43</td>
<td>18</td>
<td>42%</td>
</tr>
<tr>
<td>3NW</td>
<td>46</td>
<td>18</td>
<td>39%</td>
</tr>
<tr>
<td>4NE</td>
<td>58</td>
<td>28</td>
<td>48%</td>
</tr>
<tr>
<td>4W</td>
<td>41</td>
<td>10</td>
<td>24%</td>
</tr>
<tr>
<td>5E</td>
<td>28</td>
<td>12</td>
<td>43%</td>
</tr>
<tr>
<td>6E</td>
<td>32</td>
<td>14</td>
<td>44%</td>
</tr>
<tr>
<td>7W</td>
<td>46</td>
<td>20</td>
<td>43%</td>
</tr>
<tr>
<td>D2N</td>
<td>30</td>
<td>20</td>
<td>67%</td>
</tr>
<tr>
<td>D3N</td>
<td>28</td>
<td>15</td>
<td>54%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>383</td>
<td>167</td>
<td>44%</td>
</tr>
</tbody>
</table>

Demographics

Demographic data were collected to assess whether any associations existed between demographic categories and responses to questions about EtCO2 monitoring. Frequencies were measured for nurses’ age range, years of practice, and level of education in nursing. Information about the unit where the nurse worked was collected to assess whether any particular unit reported different barriers to practice that needed to be addressed on that unit. Nurses were also asked estimate how many patients they had monitored with EtCO2 in the previous six months in order to determine whether certain units had a higher proportion of patients being monitored. Areas where differences were noted in the responses of nurses from specific demographic categories will be described in subsequent sections of this chapter.

Of the 167 nurses who completed the survey, the majority were baccalaureate-
prepared nurses \((n=132, 79\%)\), thirty-one were associate-degree nurses \((19\%)\) while four were masters-prepared nurses \((2\%)\). With regard to number of years of experience as a nurse, forty respondents had been nurses for more than ten years \((24\%)\), with two of those nurses writing a comment that they had been nurses for more than forty years. Thirty-two nurses \((19\%)\) had between six to ten years of experience, fifty-three \((32\%)\) had between three and five years experience, and forty-two \((25\%)\) were nurses with less than three years of experience.

*Units with High Volume of EtCO2 Monitoring*

Nurses were asked to estimate how many patients they had monitored with capnography in the previous six months. The purpose of this question was to identify a group of nurses who had a high volume of recent experience using capnography with patients. By correlating those data with the unit those nurses worked on, it was possible to determine which units had a higher volume of patients monitored over a six-month period. This information provided a different level of detail than the before and after point-prevalence surveys, which provided only a snapshot of where patients were being monitored at those two points in time.

Of the 167 nurses surveyed, forty-nine \((29\%)\) reported monitoring more than twenty patients in the previous six months. This was the largest category. Twenty-three \((14\%)\) monitored between eleven and fifteen patients, thirty-three \((20\%)\) monitored between six and ten patients, thirty-one \((19\%)\) monitored between one and five patients, and one nurse monitored only one patient in the previous six months. The units where these nurses worked were ranked in order from high to low according to the volume of
patients monitored with EtCO2 over the previous six months per self-report of nurses. This ranking can be seen in Table 4.

**Table 4: Nurses Self-Report of High Volume of Patients Monitored with EtCO2**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Number of Nurses who Report Monitoring &gt; 20 Patients with EtCO2 in the Previous Six Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2N</td>
<td>10</td>
</tr>
<tr>
<td>7W</td>
<td>8</td>
</tr>
<tr>
<td>5E, 4NE</td>
<td>7</td>
</tr>
<tr>
<td>D3N</td>
<td>6</td>
</tr>
<tr>
<td>3E, 3NE, 6E</td>
<td>3</td>
</tr>
<tr>
<td>3NW</td>
<td>2</td>
</tr>
<tr>
<td>4W</td>
<td>0</td>
</tr>
</tbody>
</table>

It should be noted that the low survey response rate from the nurses on 4W (24%) might not allow for an accurate representation of the volume of patients monitored with EtCO2 on that unit.

**Grouping of the Responses by Category**

The ten Likert-scale questions were grouped according to the three themes that were identified during the survey design: (a) nurse perceptions about the use of the monitors; (b) nurse-reported behaviors of patients regarding EtCO2 monitoring; and (c) the supply and distribution of EtCO2 monitors and tubing. A complete table of results of the Likert scale questions may be found in Appendix F. Responses to the open-ended question at the end of the survey were also grouped according to these categories, where applicable.
There were forty-nine narrative responses, the majority of which \( (n=47, \ 96\%) \) applied to one of these three categories. The two other comments were on the topic of the conditional EtCO2 ordering process that will be discussed later in this chapter.

*Ease of Use and Effectiveness of EtCO2 Monitors*

Four questions addressed the topic of the ease of use and effectiveness of the EtCO2 monitors: (a) I find the EtCO2 monitor easy to set up; (b) I find the EtCO2 values easy to interpret; (c) EtCO2 monitoring interferes with patient care; and (d) If the patient won’t wear the EtCO2 tubing, a continuous pulse oximeter is equally effective for detecting respiratory depression.

Nurses viewed EtCO2 monitors as being easy to set up, with 99% strongly agreeing or agreeing to that statement. Ninety percent agreed or strongly agreed that the values displayed on the monitor were easy to interpret. Figure 7 illustrates these results. Seventy-five percent of nurses did not perceive EtCO2 monitors as interfering with their ability to care for patients. Thirty percent of nurses neither agreed nor disagreed that it interfered. The question about whether pulse oximetry is equally effective as a monitoring tool for OIRD was intended to provide some indication about the nurse’s view of the relative effectiveness of the two types of monitoring. Seventy-eight percent of the nurses disagreed or strongly disagreed that pulse oximetry was equally effective.

Seven nurses’ narrative comments (14%) were about the use and effectiveness of the monitors. Two nurses stated that EtCO2 monitoring was beneficial for patient safety, “I love the monitors – It saved my patient’s life a few weeks ago!!!!” and “I think it is a useful tool that assists us as nurses in caring for our patients and catching problem early on. If we
wait until the sat drops we have already lost the game.” The remaining comments noted limitations in the use of the monitors, “I feel as though this tool is very limited in its use. You cannot review trends accurately, and when a patient has their door closed, you cannot hear it alarm,” and “The alarm should be for the RNs to be heard outside the rooms, alongside with tele alarms.”

Figure 7: RN Perceptions on the Ease of Use and Interpretation of EtCO2 Monitors

Patient Adherence to the Use of EtCO2 Monitors

Four questions addressed the topic of patient adherence with the use of EtCO2 monitors: (a) Patients complain that the EtCO2 tubing is a nuisance; (b) Patients complain that the EtCO2 alarm wakes them up when they are sleeping; (c) Patients often refuse to wear the EtCO2 tubing; and (d) I find that patients do not understand what the monitor is for even after I explain it to them. The first three questions specifically address observed
patient behavior, while the fourth addresses the issue of whether the patient understands the purpose of the monitor.

Ninety-two percent of the nurses ($n=154$) strongly agreed or agreed that patients complain about the alarm waking them. Eighty-three percent of nurses ($n=139$) strongly agreed or agreed that patients complain about the EtCO2 tubing. Sixty-five percent of nurses ($n=108$) strongly agreed or agreed that patients often refuse to wear the EtCO2 tubing. Figure 8 illustrates the responses to the questions about patient tolerance of, and adherence to, EtCO2 monitoring.

![Figure 8: Patient Tolerance and Adherence to EtCO2 Monitoring](image)

On the question of whether the patients do not understand what the monitor is for, half of the nurses ($n=84$) strongly disagreed or disagreed that patients do not understand. Twenty-five percent of nurses ($n=41$) strongly agreed or agreed that patients do not understand, while twenty-five percent ($n=42$) neither agreed nor disagreed on whether the
patients understood. Figure 9 illustrates nurses’ perception of patients’ understanding of the purpose of EtCO2 monitoring.

![Bar Chart](chart.png)

**Figure 9: RN Perceptions of Patients’ Understanding of EtCO2 Monitoring**

Of the forty-nine narrative comments submitted about EtCO2 monitoring, twelve were about patient adherence and the importance of patient education (24%). Two nurses reflected on the importance of communicating to patients and educating them “Once patients know it is for their safety, they usually are agreeable to it” and “It is an essential safety device, and 90% of patients are willing to wear it when you explain its importance!” Another nurse pointed out that the alarms and tubing may go beyond being uncomfortable or annoying for patients, to negatively affecting the patient’s ability to rest and recover, “I find the EtCO2 alarms exacerbate confusion and restlessness in patients who are already confused and restless.”
Supply and Distribution of EtCO2 Monitors and Tubing

Two questions asked about the ability of nurses to obtain the monitoring equipment and tubing when needed: (a) I am able to obtain an EtCO2 monitor when I need one; and (b) I am able to obtain tubing for the EtCO2 monitor when I need it. Seventy-one percent of survey respondents (n=119) strongly disagreed or disagreed that they were able to obtain the monitoring equipment when needed. Thirty-five percent strongly disagreed or disagreed that they were able to obtain the tubing when needed. Figure 10 illustrates these results.

Figure 10: RN Perceptions of EtCO2 Equipment and Supply Availability

Of the forty-nine narrative comments submitted in the survey, twenty-eight (57%) were on the theme of EtCO2 equipment and supply. Many nurses linked this supply problem with patient safety. As one nurse expressed it, “Every time we need EtCO2 monitors there are none available and we are placed on a waiting list by Materials. Very
unsafe when you need one!” Another said, “I have many patients who should be wearing an EtCO2 monitor but am practically never able to obtain one from Materials. I feel this is a significant safety issue.”

Several nurses questioned whether this was a quantity issue (not enough monitors for the number of patients in the facility who regularly need them) or a distribution issue (inefficient systems for cleaning the monitors after use and getting them back into circulation). One nurse wrote, “We either need more or a much better system to obtain them.” Other comments included, “We need MORE please!” and “Thank you for buying more monitors... they are needed!”

Comments about the tubing were less about the availability than about the quality and durability. As one nurse expressed, “I can get tubing but it does not last long enough. It doesn’t interfere with patient care but it is a hassle for me to get the monitor and constantly replace the tubing.” Another wrote, “I can get the tubing but it does not last very long. Sometimes we have different kinds of tubing.”

The Likert scale data were analyzed by unit to ascertain whether any one unit was disproportionately affected by supply and distribution challenges. The results showed no appreciable difference among the ten units. Nurses from every unit reported difficulties with obtaining the necessary equipment and tubing.

**RN Comments About Conditional Orders for EtCO2 Monitoring**

There were two comments by nurses that did not apply to any of the three aforementioned categories. Each comment addressed physicians’ practice. One nurse stated, “I feel the physicians are entering an order for EtCO2 monitoring for every single
patient, even when it is not indicated.” Another nurse stated, “Some MDs are not aware as to why we have to monitor patients using the EtCO2. We have been asked as to why the patient is on O2, nursing staff have informed MDs that the patient is not on O2 but he/she is being monitored since they have a PCA and meet the criteria for monitoring.” These comments will be discussed in Chapter Five.

Incidence of Opioid-Induced Respiratory Depression

Baseline Data for Incidence of OIRD in 2011

As described in Chapter Three, the baseline data on the incidence of OIRD for this project came from two different sources. The first set came from a study conducted at UAMC by a team of doctoral students from The University of Arizona College of Pharmacy in early 2012 (Abbott et al., 2011). The team conducted a review of all electronic medical records from 2011 that were identified as being potential cases of OIRD based on hospital records (N=127). The identification of charts for the retrospective review was based on pharmacy reports that were generated whenever naloxone was pulled from the medication dispensing machine (n=108). Starting with those patient charts, the pharmacy team members combed through the medical record to screen out cases where: (a) naloxone was not actually administered to the patient (n=16); (b) naloxone was administered after a conscious sedation procedure (n=21); (c) naloxone was administered in the emergency department to reverse opioid use occurring prior to arrival at UAMC (n=2); (d) location of naloxone administration could not be determined from the medical record (n=4); or (e) naloxone was administered to rule out opioid-induced respiratory depression and the
patient did not respond (n=16). The remaining cases (n=49) were determined to be true cases of OIRD (Abbott et al., 2011).

Of those forty-nine patients, the team documented that seventeen of them (35%) were monitored with capnography. However, according to G. Leonetti, a co-author of the study, the chart review process looked only at the orders in the medical record. It did not provide a mechanism to determine how many of the patients with orders for EtCO2 monitoring were actually being monitored (G. Leonetti, personal communication, May 10, 2012).

In parallel with this pharmacy study, the Clinical Nurse Specialist (CNS) on the Acute Pain Service also tracked and analyzed cases of OIRD from all sources: (a) naloxone withdrawals from the medication dispensing machine as reported by the Pharmacy Department; (b) cases from the Patient SafetyNet™ system as forwarded by the Quality and Safety Department; (c) other cases not captured by the above, but forwarded to the CNS by other hospital staff. Each case was analyzed to confirm whether it was a case of OIRD. Only those cases to be true cases of OIRD were logged. The total number of cases calculated by this method was seventy. When adjusted for the number of patient-days in 2011, the incidence was 4.9 per 10,000 patient-days, or a rate of .05%. That rate is at the lower end of published figures of the incidence or OIRD from the scientific literature cited throughout Chapter One. The data collection tool that was initiated during the pharmacy students’ project, and which has been modified for continued use by the hospital can be found in Appendix G.
Preliminary Data for the Incidence of OIRD in 2012

For 2012, the potential cases of OIRD (as determined by naloxone being withdrawn from the medication dispensing machine) were tracked on an ongoing basis using a similar method as the CNS used in 2011. If the Acute Pain Service staff was consulted, the cases were followed-up immediately. If the Acute Pain Service was not consulted, there was a delay of up to two months before cases would be sent to the Pain Service for analysis. There are several mechanisms by which potential cases of OIRD are identified for review: (a) hospital incident reports entered by staff into the University Hospital Consortium’s Patient SafetyNet™ system (Masimo Corporation, Irvine, CA); (b) Rapid Response Team (RRT) incident reports; (c) Physician Peer Review cases; and (d) Pharmacy naloxone reports.

Preliminary, unverified data for 2012 show seventy cases of OIRD (D. Jarzyna, personal communication, April 10, 2013). Twenty-four percent of those patients (n=17) were monitored with EtCO2 monitors, as evidenced by documentation of EtCO2 values in the medical record, or nurses’ notes in the record attesting to the fact that the patient was wearing a monitor. These data are still being reviewed for accuracy and should not be used for citation purposes. However, the incidence per 10,000 patient-days for comparison to 2011 was 4.8, and the rate was .05%, just as it was for 2011. After testing for the significance of difference between two independent proportions, the p-value was .876. The decrease from 2011 to 2012 was not statistically significant.
Summary

This chapter presented the results of a Practice Inquiry project to improve nursing practices in monitoring for opioid-induced respiratory depression. Results of three evaluation components were outlined: (a) Pre- and Post-intervention measures of the number of medical-surgical patients who were monitored with capnography for opioid-induced respiratory depression; (b) a survey of medical-surgical RNs on their perceptions of the use and effectiveness of EtCO2 monitoring; and (c) baseline data of the number of cases of OIRD in 2011 as compared with current data about the number of cases of OIRD in 2012. The significance of these findings will be discussed in Chapter Five.
CHAPTER FIVE: DISCUSSION

The purpose of this Practice Inquiry Project was to design, implement, and evaluate the effectiveness of a multifaceted intervention to improve patient monitoring for opioid-induced respiratory depression. The intervention was designed to promote the adoption of an American Society of Pain Management Nursing Guideline on the use of capnography to detect early signs of OIRD on high-risk patients on medical-surgical units. This chapter discusses the results of the project, examines limitations of the interventions and the evaluation, and suggests future activities.

Process Outcome: Increased EtCO2 Monitoring

The results showed that the number of patients monitored with EtCO2 more than doubled over the one-year period, and that this was a statistically significant increase. The results also showed that the number of patients with conditional orders increased seven-fold. Almost 80% of adult medical-surgical patients have a conditional order for EtCO2 monitoring, yet only 11% were actually monitored. In order to understand the implications of these results, the conditional order process needs to be examined more closely.

*Conditional Orders and Individualized Patient Care*

The ASPMN recommendations state that patients receiving opioid medications should be assessed for individual combinations of risk factors for OIRD (Jarzyna et al., 2011). There is unfortunately no scorecard or algorithm to calculate an individual’s precise risk. If a patient is deemed to be high-risk as a result of having multiple risk factors, providers should ensure that monitoring is implemented (Jarzyna et al., 2011).
The lack of a specific formula to screen and identify who is at risk and who is not, who should be monitored and who should not, posed challenges for designing an order system. There are examples of other hospitals that have avoided this issue by simply creating protocols to monitor all patients on a PCA (Overdyk et al., 2007). Research conducted at UAMC (Abbott et al., 2012) indicates that patients receiving RN-administered intravenous bolus doses or oral opioids are also at risk for OIRD. In fact, PCAs with incremental dosing only (no basal rate) have, by design, a built-in safety mechanism. When a patient begins to become sedated, they may fall asleep and stop pushing the button. At that point they are no longer administering medication to themselves. However, as discussed in Chapter One, there is no consensus in the literature regarding whether PCAs pose a higher or lower risk than other modes of medication delivery.

The ASPMN guidelines do not advocate monitoring all patients on opioid therapy with EtCO2. Indeed, such a comprehensive approach would pose a logistical and financial hardship for most institutions and would result in the needless monitoring of patients at very low risk. A national survey of OIRD monitoring practices suggested that financial considerations may limit the degree to which technological monitoring is used (Willens et al., 2013). However, the Anesthesia Patient Safety Foundation suggests we can not afford not to monitor (Weinger & Lee, 2011). The ASPMN guidelines recommend that the decision to monitor or not to monitor should be individualized for each patient. Who decides whom to monitor?

*Shared Responsibility Among Physicians and Nurses*

The working group discussed at length the question of who should be responsible
for assessing patient risk and deciding whom should be monitored. Monitoring is a key role of nursing outlined in the Nurse Practice Act (Arizona State Board of Nursing, n.d.) and is critical to preventing failure to rescue. The Joint Commission advocates for enhanced monitoring by nurses to prevent OIRD (TJC, 2012). A nurse may independently monitor a patient’s vital signs without a physician order, and end-tidal CO2 did not seem to the interprofessional working group to be different. The working group felt it was crucial that the nurse be able to practice to the full extent of his or her scope, and be able to monitor a patient independently if the patient’s status warranted it. The Institute of Medicine, in its report on “The Future of Nursing” advocates for nurses to practice to the full extent of their scope (IOM, 2010). The Nurse Practice Act also outlines the nurse’s scope with regard to assessment, which would include an assessment of risk for OIRD (Arizona State Board of Nursing, n.d.)

On the other hand, there was concern among the working group that nurses do not always have access to as much information about their patients as the physicians have. The consensus of the group was that the physicians should take responsibility for assessing patient risk factors and making a decision to activate the order for monitoring if needed. This consensus was reflected in the educational materials that were sent to all staff about the conditional orders.

The conditional orders are designed so that the order is pre-selected. The physician can either: (a) activate the order (instructing the nurse to initiate monitoring); (b) ignore the order (leaving it as a conditional order that can be activated later by either the nurse or physician); or (c) de-select the order (removing it entirely from the patient’s order list).
The intent was that this system would result in the physician being primarily responsible for assessing the patient’s risk and making an informed decision about whether the patient should be monitored or not. The secondary intent was to create a flexible system enabling the nurse to initiate monitoring if the patient’s condition warranted it.

The results of this study show that physicians are not assessing risk or activating EtCO2 orders. Neither are they de-selecting them. They are leaving them as conditional orders and trusting the nurses to decide whether to monitor patients or not based on the patient’s response to treatment. The result is that the burden of responsibility for assessing risk factors and monitoring has fallen squarely on Nursing’s shoulders.

What did the nurses say in the EtCO2 monitoring survey? Two nurses raised the issue of the ways in which the conditional orders for EtCO2 monitoring are entered by the physicians. One nurse stated, “I feel the physicians are entering an order for EtCO2 monitoring for every single patient, even when it is not indicated.” This statement likely reflects the fact that the conditional order is pre-selected in the in opioid medication order sets and has become ubiquitous throughout the hospital’s computer order entry system. The risk with this situation is that when EtCO2 monitoring is ordered on every patient, the significance of the order becomes lost. Nurses may become complacent to the order.

Another nurse noted that physicians are unaware that an order for EtCO2 monitoring has been placed, and when they observe a nasal cannula, they think it is for the administration of oxygen. “Some MDs are not aware as to why we have to monitor patients using the EtCO2. We have been asked as to why the patient is on O2, nursing staff have informed MDs that the patient is not on O2 but he/she is being monitored since they have a
PCA and meet the criteria for monitoring." This statement indicates that physicians may also be becoming blind to the ubiquitous conditional orders.

From the author's experiences over the past year, it appears as though the physicians believe that by having a conditional EtCO2 order pre-selected in the order sets, they have fulfilled their responsibility towards patient safety with regard to opioid therapy. They assume that the nurses will activate the order if the need arises. On the other hand, many nurses see the conditional order and believe that if the physician wanted the patient to be monitored he or she would have activated the order. The result is that each thinks the other is responsible, when in fact, in many cases, no one is acknowledging that responsibility and acting on it.

*Unintended Consequences of Conditional Orders*

One of the clear messages communicated by nurses in the survey was that EtCO2 monitors are very difficult to obtain. Yet the inventory of monitors in the hospital (93) far exceeds the number of monitors being worn by patients on the day of the post-intervention point prevalence survey (27). Where are the 66 remaining monitors?

The portable EtCO2 monitors used on the medical-surgical units are also circulated to the Post Anesthesia Care Unit (PACU). During the pre-intervention point prevalence survey (which also included a needs assessment of monitors for the hospital), the PACU Manager estimated they used a maximum of 15 monitors at any one time (S. Singer, personal communication, April 26, 2012). As patients were transferred out of the PACU to the medical-surgical units, they took their monitors with them. The Materials Management Department did regular “sweeps” to round-up unused monitors and bring them to the
PACU.

One possibility for the remaining 51 monitors is that they are sitting unused in patient’s rooms or being stored on the medical-surgical units. Now that conditional orders are being ordered for the majority of the patients, nurses may be reluctant to put them back into circulation for fear that they might be needed on a patient with a conditional order. The conditional orders may be prompting hoarding behavior among the nurses.

Further quality improvement efforts will involve tagging the monitors with wireless electronic sensors so their location can be tracked by computer. This will allow hospital staff to conduct a flow analysis of the distribution of monitors throughout the day, and will allow nurses to find a monitor when needed. UAMC instituted a similar system for wheelchairs in 2009 with some success.

**Reminder Function of Conditional Orders**

Even though the conditional orders have not worked exactly as intended, the evaluation showed that significantly more patients were wearing EtCO2 monitors at the end of the project than at the beginning. It may be that the conditional orders are reminding nurses about the value of EtCO2 monitoring, and triggering them to monitor their patients.

Further quality improvement efforts are planned regarding clinical decision aids for physicians and nurses to assess risk factors, stratify risk, and make an informed decision about whether to monitor an individual patient or not based on both risk factors and current patient condition. Clinicians will do an initial assessment of risk upon admission and then reassess as the plan of care changes or as the patient’s condition changes. The
intent, as with the conditional orders, is that both physicians and nurses will share responsibility for patient monitoring. The physicians will do the initial risk assessment at the initiation of opioid therapy, and the nurses will reassess at least once per shift, or more often if the patient’s treatment plan or physical condition changes.

_Nurses’ Perspectives_

It has been suggested in the literature that nurses need to embrace their role in monitoring (Pasero, 2013). Indeed, as was discussed in Chapter One, nurses are ideally situated, by virtue of their 24-hour presence at the bedside, to take responsibility for monitoring patients and maintaining their safety. Monitoring should be based both on patient risk factors (that can be assessed by physicians and/or nurses), and on patient response to medications (that is best assessed by nurses at the appropriate timer interval after medication administration). Physicians may facilitate the work of nurses and their patients’ safety by actively engaging in the process, assessing patient risk factors, and activating the conditional orders for EtCO2 monitoring when appropriate.

Nurses need to focus not only on monitoring, but on understanding the pharmacology of the medications they administer, such as the onset of action, peak effect, and duration of action (Jungquist et al., 2011). Such an understanding enables nurses to think critically about when their patient is likely to feel the full effects of the medication, and when the risk of over-sedation and respiratory depression is likely to be higher.

With an emphasis on the benefits of technological monitoring, there is a risk that clinicians will become over-reliant on the alarms to alert them to a deteriorating patient (Lynn & Curry, 2011). It is important to remember that technological monitoring is
intended to supplement, not replace, visual assessment and clinical reasoning on the part of clinicians.

Patient Outcomes

With more than a 600% increase in the number of patients monitored with capnography from the start of the project in 2012, to the one-year mark in 2013, the expectation was that the number of cases of OIRD would have decreased by a statistically significant degree. Although the incidence of OIRD did decrease slightly, the difference was not statistically significant. What are some of the possible explanations for this phenomenon?

One possibility is that the high number of patients being monitored with capnography on the day of the post-intervention point prevalence survey represented the culmination of a one-year effort to increase the number of patients monitored. It would be unrealistic to assume that 600% more patients were monitored from the first day of the project and every day thereafter. Unfortunately, the OIRD data are not available month-by-month to see whether the bulk of the cases occurred early in the year and then tapered off as the clinicians began to change their practice in favor of monitoring more patients.

Another possibility is that the wrong patients are being monitored. It could be that the nurses who are choosing to monitor their patients with capnography are doing so out of a desire to be conscientious rather than basing their decision on the patient's condition and risk factors. Different nurses practice nursing differently. Some will always monitor the patient if the physician’s order exists and the equipment can be procured.
The data do show, however, that at least some of the right patients are being monitored. The patients who are being treated by the Acute Pain Service are being monitored with capnography at higher rates than the general patient population. These patients generally have multiple iatrogenic risk factors. They tend to be on higher doses of opioids than the general patient population. Many of them receive opioids via continuous infusion. However, there is also an amelioration of risk because of the expertise in multimodal analgesia and opioid-sparing techniques provided by the pain service. In 2012, there were zero cases of OIRD among patients who were under the care of the acute pain service.

Another possibility is that we are not adequately assessing our patients for sleep apnea. As noted in Chapter One, obstructive sleep apnea is severely under-diagnosed in the United States. There is growing evidence of improved patient outcomes when patients receive enhanced monitoring as a result of a high score on the STOP-BANG assessment tool for obstructive sleep apnea (Dolezal, Cullen, Harp, Mueller, 2011; Lakdawala, 2011). As a future quality improvement initiative UAMC will consider introducing an assessment process for obstructive sleep apnea, particularly in the perioperative setting.

Recommendations for Practice

The following recommendations for practice were derived from the discussion of the outcomes of the quality improvement project above, as well as multiple other sources: (a) published evidence about OIRD as described in Chapter One, (b) ASPMN Clinical Practice Guidelines, (c) analysis of actual cases of OIRD and risk factors prevalent in UAMC’s patient population, and (d) professional clinical experience and expertise of the
author. As of the time of writing of this practice inquiry paper, these recommendations comprise a proposal from the author, to be discussed and assessed by relevant stakeholders at UAMC.

The first recommendation is to revive and expand the interprofessional working group to include more physicians, as well as allied health staff such as physical therapists and occupational therapists. Ideally, representatives from housekeeping, patient transport, and radiology would also be included. The goal is to include all services that interact with patients directly, particularly in patient rooms. Everyone who comes into contact with patients should be aware of signs and symptoms of over-sedation and respiratory depression, so they can alert the nurse or physician immediately if needed.

The interprofessional working group already includes analysts from the Quality and Safety Department. The group would be well-served to develop a more streamlined and comprehensive approach to identifying, tracking, and analyzing cases of OIRD. It would be helpful to track cases by unit, so that any deficiencies in that unit could be identified and addressed. Nurses on each unit should do the root cause analysis of each case on their unit, which would increase a sense of ownership for the incidents and raise awareness among unit staff. It would also be helpful to track the cases by the type of medication the patient was taking. For example, there may be cases of renally-impaired patients receiving morphine at the time of the OIRD incident. If such a trend is identified, then an alert could go out to physicians reminding them to select an alternative medication for those patients.

The next recommendation is to design a decision-making aid for clinicians to assess risk factors for OIRD and facilitate decision-making about the appropriate type of
monitoring to use, particularly on medical-surgical units. Patients who are less than 24-hours postop, who have obstructive sleep apnea (or risk factors for obstructive sleep apnea), or who are receiving opioids via continuous infusions would have mandatory EtCO2 monitoring. Patients with other risk factors would be assessed individually. High-risk patients receiving supplemental O2 must have continuous EtCO2 monitoring, whereas patients on room air could have continuous pulse oximetry if an EtCO2 monitor is not available.

Lastly, education must be expanded and improved for physicians, nurses, allied health staff, and non-clinical staff who have direct patient contact in patient rooms. Education would be tailored to the role of the staff person. Topics would include, but not be limited to: (a) signs and symptoms of over-sedation and OIRD, (b) what the monitors are for and what to do if they are alarming, (c) the fact that snoring is a non-reassuring sign that indicates an airway obstruction that must be addressed, and (d) how to do a thorough respiratory assessment.

Limitations of the Project

Analyzing and Tracking OIRD

Measuring patient outcomes for this project identified some shortcomings in the way UAMC tracks cases of OIRD. The data collection system is somewhat fragmented. Investigating each case of OIRD requires accessing multiple computer programs, because UAMC currently employs multiple systems at various points of care. A new integrated system will be introduced later in 2013 that will streamline the flow of information (The University of Arizona Health Network, 2012).
Interprofessional Working Group

There was a heavy nursing bias on the interprofessional working group. The two physicians experienced frequent constraints to participating. They were often needed in the Operating Room unexpectedly. It would have been helpful to have more involvement from physicians to gain a broader perspective on the problem of opioid-induced respiratory depression and pain management generally. There may have been some physician-targeted interventions that could have been developed to engage them more in the problem of opioid-induced respiratory depression. Future generations of this working group will endeavor to find strategies to facilitate more physician participation.

Physician Education

When information arises at UAMC that needs to be shared among all nurses, multiple strategies are employed. E-mail, printed flyers on walls, information packets that everyone must read and sign, unit-based in-services, monthly staff meetings, unit council meetings, and Microsoft SharePoint sites are some of the strategies. The use of multiple strategies ensures that the nurses will see the information at some point during their shift or while reviewing email from home. In many cases, nurses must sign a log sheet after they have read a designated piece of information to document that they have done so. Nurses are held accountable for the information that has been distributed.

This unit-based nursing structure for information dissemination does not apply to physicians, and communication between physicians often seems fragmented. Physicians were informed about the new conditional orders with appropriately detailed instructions including screen shots. Yet it does not appear that many of them acknowledged this
information as evidenced by the lack of physician activation of the conditional EtCO2 orders. Implementation science literature points out the ineffectiveness of passive interventions such as email distribution lists. Future quality improvement initiatives that aim to change clinician behavior will have to find a more active way to engage members of all the health professions.

RN Survey

The survey of medical-surgical nurses was quite limited in terms of the level of detail of the questions and the Likert-scale format. Future evaluation efforts should include qualitative methods such as focus groups and more narrative from the nurses about their experiences. This survey did, however, glean valuable information about the nurses’ experiences at the bedside. The survey also had the advantage of being very efficient to administer, which resulted in more nurses being able to participate and express their comments than would have been possible with qualitative methods such as focus groups.

Conclusion

Although the incidence of OIRD at UAMC is comparable to the lowest figures cited in the published literature from other facilities, the consequences of each case of OIRD can potentially be life-changing for the patient, for family members, and for the hospital staff who took care of the patient when the incident occurred. The goal for hospitals must be for OIRD to be a “never” event as was proposed by the Anesthesia Patient Safety Foundation (Weinger & Lee, 2011). It is also important that clinicians not become so involved in the analysis of data about OIRD risk factors and OIRD incidence rates, that they miss seeing each case of OIRD as an individual person who was harmed or potentially harmed by
treatment they received under the clinician’s care. Lastly, clinicians must not view technological monitoring as the sole solution to the problem of OIRD. To accept this view is to discount the astute clinical reasoning skills of bedside nurses. Indeed, if nurses themselves adopt this view, they risk losing the very bedside skills that set nursing apart from other healthcare professions.

This project specifically addressed ways to promote change in nursing practice on medical-surgical units to increase the number of patients monitored with capnography with the goal of improving patient outcomes. This project demonstrated that a multifaceted intervention with educational components as well as active systems approaches was effective in changing nursing practice and improving EtCO2 monitoring processes. Furthermore, this project identified weaknesses in current practice and proposed recommendations for future quality improvement activities. Future studies will examine the effect on patient outcomes in greater detail.
APPENDIX A: INSTITUTIONAL REVIEW BOARD
APPENDIX A: INSTITUTIONAL REVIEW BOARD

FORM: Human Research Determination

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<tr>
<th>NUMBER</th>
<th>FORM DATE</th>
<th>PAGE</th>
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<tbody>
<tr>
<td>F309</td>
<td>08/01/2011</td>
<td>6 of 6</td>
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</tbody>
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Please note: if you determine that this activity is not considered human research and, therefore, does not require IRB review, such determination cannot for any reason be reversed or revoked at a later date for any part of the project. Further, data derived from this project may not in any way be presented as Human Research. **Note that any changes made to this protocol after receiving HSPP confirmation will need to be re-submitted and reviewed.**

1. PRINCIPAL INVESTIGATOR
   By signing below, I, the Principal Investigator, certify that I have accurately answered the items listed and believe that the proposed activity does not constitute engagement in Human Research according to DHHS or FDA regulations.

   Signature

   Date

2. SCIENTIFIC/SCHOLARLY REVIEW
   Based on the information provided by the Principal Investigator, I have determined that this project does not constitute Human Research.

   Signature

   Date

3. HSPP REVIEW
   Based on the information provided by the Principal Investigator, I have determined that this project does not constitute Human Research.

   Digitally signed by Mariette Marsh
   DN: cn=Mariette Marsh, o=HSPP, ou=Chair Designee, email=mashmp@email.arizona.edu, c=US
   Date: 2012.10.11 14:32:38 -07'00'
APPENDIX B: POINT PREVALENCE SURVEY DATA COLLECTION TOOL
**APPENDIX B: POINT PREVALENCE SURVEY DATA COLLECTION TOOL**

<table>
<thead>
<tr>
<th>Patient Room/Bed Number</th>
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</thead>
<tbody>
<tr>
<td><strong>CO-MORBID RISK FACTORS</strong></td>
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<tr>
<td>Age &gt;71 years</td>
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<tr>
<td>Obesity (BMI &gt; 30)</td>
</tr>
<tr>
<td>Obstructive Sleep Apnea (OSA)*</td>
</tr>
<tr>
<td>Outpatient use of CPAP (or prescribed use of CPAP, even if patient non-compliant)</td>
</tr>
<tr>
<td>Documented history of OSA per report of patient or significant other</td>
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<tr>
<td>Witnessed apneas and/or excessive snoring</td>
</tr>
<tr>
<td>COPD</td>
</tr>
<tr>
<td>CHF</td>
</tr>
<tr>
<td>Renal Insufficiency (creatinine &gt; 1.5)</td>
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<tr>
<td>Neurological disorder resulting in muscle weakness</td>
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<tr>
<td>Airway disease/condition such as tracheomalacia or laryngomalacia</td>
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<tr>
<td><strong>IATROGENIC RISK FACTORS (+meds actually given)</strong></td>
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<tr>
<td>Status &lt;24 hours post-op</td>
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<tr>
<td>Continuous opioid drip</td>
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<tr>
<td>PCA with bolus rate (with or w/o incremental doses)</td>
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<tr>
<td>PCA with incremental doses only</td>
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<td>IV fentanyl, dilaudid, or morphine (scheduled or PRN)</td>
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<tr>
<td>PO dilaudid, oxycontin, oxycodone, MS contin, morphine IR, Percocet, Vicodin, codeine</td>
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<td>fentanyl patch</td>
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<td>Benzidoazapines (lorazepam, aprazolam, clonazepam, temazepam, diazepam)</td>
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<td>Antihistamines (diphenhydramine, hydroxazine)</td>
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<td>Antiemetics (promethazine)</td>
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<td><strong>MONITORING (please write Y or N in the box)</strong></td>
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<td>EtCO2 monitor ordered in SCM?</td>
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<td>EtCO2 monitor in use?</td>
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<td>EtCO2 monitor unavailable?</td>
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APPENDIX C: NURSE ETCO2 SURVEY INSTRUMENT
APPENDIX C: NURSE ETCO2 SURVEY INSTRUMENT

**Study title:** Implementing a clinical practice guideline on the use of capnography in monitoring for opioid-induced respiratory depression on medical-surgical units

1. Age
   - 18-29
   - 30-39
   - 40-49
   - >50

2. How long have you been a Registered Nurse?
   - <2 years
   - 3-5 years
   - 6-10 years
   - >10 years

3. What is your highest education level in Nursing?
   - ADN
   - BSN
   - MSN
   - PhD/DNP

4. What unit do you currently work on?
   - 3E
   - 3NE
   - 3NW
   - 4NE
   - 4W
   - 5E
   - 6E
   - 7W
   - D2N
   - D3N

5. Approximately how many patients in the last 6 months have you monitored with an ETCO2 monitor, for any reason, and for any length of time? [Note: if you had the same patient for multiple shifts, count that as one patient.]
   - 0
   - 1-5
   - 6-10
   - 11-15
   - 16-20
   - >20
Please rate how strongly you agree or disagree with the following statements

<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>I am able to obtain an EtCO2 monitor when I need one</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>7</td>
<td>I am able to obtain tubing for the EtCO2 monitor when I need it</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>8</td>
<td>I find the EtCO2 monitor easy to set up</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>9</td>
<td>I find that patients do not understand what the EtCO2 monitor is for even after I explain it to them</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>10</td>
<td>Patients complain that the EtCO2 tubing is a nuisance</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>11</td>
<td>Patients refuse to wear the EtCO2 tubing</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>12</td>
<td>Patients complain that the EtCO2 alarm wakes them up when they want to sleep</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>13</td>
<td>If the patient won’t wear the EtCO2 tubing, a continuous pulse ox monitor will allow me to assess for respiratory depression</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>14</td>
<td>I find the EtCO2 values easy to interpret</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
<tr>
<td>15</td>
<td>EtCO2 monitoring interferes with patient care</td>
<td>Strongly Agree</td>
<td>Agree</td>
<td>Neither agree nor disagree</td>
<td>Disagree</td>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>

16. Is there any other comment you would like to make about EtCO2 monitoring? If so, please type it into the field below:
APPENDIX D: PRE-INTERVENTION POINT PREVALENCE SURVEY
## APPENDIX D: PRE-INTERVENTION POINT PREVALENCE SURVEY

<table>
<thead>
<tr>
<th>Unit</th>
<th>3E</th>
<th>3NE</th>
<th>3NW</th>
<th>4W</th>
<th>4NE</th>
<th>5E</th>
<th>6E</th>
<th>7W</th>
<th>D2N</th>
<th>D3N</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total # patients</td>
<td>16</td>
<td>30</td>
<td>29</td>
<td>28</td>
<td>30</td>
<td>14</td>
<td>23</td>
<td>27</td>
<td>24</td>
<td>24</td>
<td>245</td>
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<tr>
<td><strong>PATIENT RISK FACTORS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age &gt;71 years</td>
<td>4</td>
<td>7</td>
<td>7</td>
<td>12</td>
<td>9</td>
<td>2</td>
<td>4</td>
<td>10</td>
<td>10</td>
<td>4</td>
<td>69</td>
<td>28.2</td>
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<tr>
<td>Obesity (BMI&gt;30)</td>
<td>2</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>65</td>
<td>26.5</td>
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<tr>
<td>Obstructive Sleep Apnea (OSA)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>5</td>
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<td>COPD</td>
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<td>9.0</td>
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<td>CHF</td>
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<td>1</td>
<td>9</td>
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<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>28</td>
<td>11.4</td>
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<tr>
<td>Renal Insufficiency (creatinine &gt;1.5)</td>
<td>1</td>
<td>9</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>48</td>
<td>19.6</td>
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<tr>
<td>Neurological disorder resulting in muscle weakness</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>11</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>25</td>
<td>10.2</td>
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<tr>
<td>Airway disease/condition such as tracheomalacia or laryngomalacia</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>9</td>
<td>3.7</td>
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<tr>
<td>Status &lt;24 hours post-op</td>
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<td>0</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>22</td>
<td>9.0</td>
</tr>
<tr>
<td>No patient risk factors</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>8</td>
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<td><strong>MEDICATION RISK FACTORS</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous opioid drip</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
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<tr>
<td>PCA with basal rate (with or w/o incremental doses)</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<td>3</td>
<td>1</td>
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<tr>
<td>PCA with incremental doses only</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>11</td>
<td>4.5</td>
</tr>
<tr>
<td>IV fentanyl, dilaudid, or morphine (scheduled or PRN)</td>
<td>9</td>
<td>14</td>
<td>20</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>11</td>
<td>10</td>
<td>94</td>
<td>38.4</td>
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<tr>
<td>PO dilaudid, oxycontin, oxycodone, MS contin, morphine IR, Percocet, Vicodin, codeine</td>
<td>9</td>
<td>13</td>
<td>18</td>
<td>8</td>
<td>21</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>12</td>
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<tr>
<td>Fentanyl patch</td>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>2.4</td>
</tr>
<tr>
<td>Benzodiazepines (lorazepam, alprazolam, clonazepam, temazepam, diazepam)</td>
<td>4</td>
<td>7</td>
<td>18</td>
<td>6</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>58</td>
<td>23.7</td>
</tr>
<tr>
<td>Antihistamines (diphenhydramine, hydroxyzine)</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>24</td>
<td>9.8</td>
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<td>Antiemetics (promethazine)</td>
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<td>10</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<td>1</td>
<td>0</td>
<td>1</td>
<td>19</td>
<td>7.8</td>
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<tr>
<td>No medication risk factors</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>10</td>
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<td>3</td>
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<td>8</td>
<td>3</td>
<td>3</td>
<td>52</td>
<td>21.2</td>
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<tr>
<td><strong>MONITORING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EtCO2 monitor ordered in SCM?</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>26</td>
<td>10.6</td>
</tr>
<tr>
<td>EtCO2 monitor in use?</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>11</td>
<td>42.3</td>
</tr>
<tr>
<td>EtCO2 monitor unavailable?</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>12</td>
<td>46.2</td>
</tr>
</tbody>
</table>
APPENDIX E: SURVEY RECRUITMENT LETTER
APPENDIX E: SURVEY RECRUITMENT LETTER

Feedback needed on EtCO2 monitoring, win $50!

Subject: End-tidal CO2 survey and Amazon.com $50 gift card raffle!

You are invited to participate in a 5-10 minute, 7-question quality improvement survey on end-tidal CO2 monitoring. The purpose of this survey is to identify the perceptions of nurses regarding the use and effectiveness of portable EtCO2 monitors for detecting early signs of respiratory depression.

Please follow this link to the survey:
https://www.surveymonkey.com/s/EndTidalCO2

You may also enter a raffle to win a $50 Amazon.com gift card. FIVE entries will be selected at random to win, so your chances are good!

You are being asked to participate in this survey because you are a Registered Nurse at UAMC who uses portable end-tidal CO2 modules. Participation in this survey is completely voluntary. Your responses will be anonymous. The demographic information requested will be used only for survey purposes and will not be traced to individual responses.

FIVE Amazon.com gift cards valued at $50 each will be raffled off by the survey organizer. Participation in the survey is not required for participation in the drawing, and you may participate in the survey without entering the drawing. If you are under 18, you are not eligible to participate in either the survey or the raffle. Entries are limited to one entry per person. Participation in the raffle is void where prohibited by law. Participation in the raffle will not affect the anonymity of the survey. The raffle will be held via a random number system, separate from the content of the survey responses.

The survey will be available until 08:00 on Friday, April 5th, 2013.

Thank you for your consideration,

Heather Carlisle, MSN, PhD, ANP-BC
Nurse Practitioner, Pain Management
The University of Arizona Medical Center-University Campus
APPENDIX F: RESULTS OF RN ETCO2 SURVEY
### APPENDIX F: RESULTS OF RN ETCO2 SURVEY

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able to obtain monitor</td>
<td>2.99% 5</td>
<td>15.57% 26</td>
<td>10.18% 17</td>
<td>32.93% 55</td>
<td>38.32% 64</td>
</tr>
<tr>
<td>Able to obtain tubing</td>
<td>7.78% 13</td>
<td>28.74% 48</td>
<td>28.74% 48</td>
<td>27.54% 46</td>
<td>7.19% 12</td>
</tr>
<tr>
<td>Easy to set up</td>
<td>53.29% 89</td>
<td>45.51% 76</td>
<td>1.20% 2</td>
<td>0% 0</td>
<td>0% 0</td>
</tr>
<tr>
<td>Patients do not understand</td>
<td>4.79% 8</td>
<td>20.36% 34</td>
<td>24.55% 41</td>
<td>44.91% 75</td>
<td>5.39% 9</td>
</tr>
<tr>
<td>Patients complain nuisance</td>
<td>33.53% 56</td>
<td>49.70% 83</td>
<td>12.57% 21</td>
<td>3.59% 6</td>
<td>0.60% 1</td>
</tr>
<tr>
<td>Patients refuse to wear</td>
<td>26.35% 44</td>
<td>38.32% 64</td>
<td>17.37% 29</td>
<td>17.96% 30</td>
<td>0% 0</td>
</tr>
<tr>
<td>Patients complain alarm wakes</td>
<td>44.91% 75</td>
<td>47.31% 79</td>
<td>3.59% 6</td>
<td>4.19% 7</td>
<td>0% 0</td>
</tr>
<tr>
<td>Pulse Ox instead</td>
<td>1.20% 2</td>
<td>5.39% 9</td>
<td>14.97% 25</td>
<td>51.50% 86</td>
<td>26.95% 45</td>
</tr>
<tr>
<td>Easy to interpret</td>
<td>39.52% 66</td>
<td>50.90% 85</td>
<td>5.99% 10</td>
<td>2.40% 4</td>
<td>1.20% 2</td>
</tr>
<tr>
<td>Interferes with patient care</td>
<td>1.20% 2</td>
<td>2.40% 4</td>
<td>30.54% 51</td>
<td>44.91% 75</td>
<td>20.96% 35</td>
</tr>
</tbody>
</table>
APPENDIX G: DATA COLLECTION TOOL FOR NALOXONE RESCUE
### APPENDIX G: DATA COLLECTION TOOL FOR NALOXONE RESCUE

<table>
<thead>
<tr>
<th>Team Contentos Data Collection Form</th>
<th>Chart Review</th>
<th>Complete</th>
<th>Incomplete – Need Help</th>
<th>Not Included in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient MRN #</td>
<td>Patient VIN #</td>
<td>DOB</td>
<td>Date of Event</td>
<td>IP or OBS</td>
</tr>
<tr>
<td>BMI or HT</td>
<td></td>
<td></td>
<td>Check age if DOB before 1994</td>
<td></td>
</tr>
</tbody>
</table>

**Naloxone Administration (Use Chartmaxx - Look at MAR on Event Date)**

1. Was naloxone administered?  
   - Yes  
   - No  
   - (stop)  
   - Unknown
2. Why was naloxone given?  
   - Respiratory Depression  
   - (procedural stop)  
   - Unknown
3. Response to Naloxone  
   - Positive  
   - Negative  
   - Not Documented
4. Administered in the ER?  
   - Yes (stop)  
   - No  
   - Unknown
5. Naloxone given < 24 hrs after start of opioid  
   - Yes  
   - No  
   - Unknown
6. Was the pt pregnant at the time of administration?  
   - Yes (stop)  
   - No  
   - Unknown

**Opioid Route and Administration (Use Chartmaxx - Look at MAR or Use SCM – look at Orders)**

7. Oral opioids  
   - Yes  
   - No  
   - Unknown  
   - a) Regular continuous  
   - b) PCA continuous with bolus added
8. Epidural containing opioid  
   - Yes  
   - No  
   - Unknown  
   - a) Antihistamines (list on the wiki)  
   - b) Benzodiazepines (list on the wiki)
9. Intrathecal bolus dose  
   - Yes  
   - No  
   - Unknown
10. Bolus dose  
    - a) Patient initiated  
    - b) Nurse initiated IV

**Patient Risk Factors - Diagnosis and Procedures (Use Chartmaxx – Look in Coding Summary under Procedure Information or Operative Report)**

15. Any Surgery Before Event  
    - Yes  
    - No  
    - Unknown  
    - a) Surgery below neck but above diaphragm  
    - b) Surgery below diaphragm but above groin

**Patient Outcome (Use Chartmaxx – Look in Rapid Response Report/ D/C Summary/ or Transfer Note)**

16. Transferred to higher level of care  
    - Yes  
    - No  
    - Unknown
17. Intubation following respiratory depression (after event but on same day as event)  
    - Yes  
    - No  
    - Unknown
18. Death  
    - Yes  
    - No  
    - Unknown
19. Death due to  
   - Respiratory depression  
   - Other factors  
   - Unknown

**Team Contentos Data Collection Form | Chart Review | Complete | Incomplete – Need Help | Not Included in this study**

**Patient Risk Factors - Other (Use SCM)**

20. Documented Apnea  
    - Yes  
    - No  
    - Unknown
21. Documented Daytime sleepiness  
    - Yes  
    - No  
    - Unknown
22. Fall risk/needs assistance walking  
    - Yes  
    - No  
    - Unknown

**Patient Risk Factors – Labs on or close to date of event (Use SCM - Look in Labs)**

23. Albumin < 0.03 g/dL  
    - Yes  
    - No  
    - Unknown
24. BUN > 30 mg/dL  
    - Yes  
    - No  
    - Unknown
25. ETCO2 monitored  
    - Yes  
    - No  
    - Unknown
26. Troponin Level Post Event

**Look to see if pt was on opioid prior to admission (Use SCM – Look for Medication Reconciliation form or H&P)**

27. Increased dose requirement (definitions on wiki)  
   a) opioid naive pt (high dose, short amt of time)  
   - Yes  
   - No  
   - Unknown
   b) opioid tolerant pt (dose given in addition to regular opioid dose)  
   - Yes  
   - No  
   - Unknown

**Notes:**

---

1 Created by: Abbott, Leonetti, Barrackhouse, Biegelman, 2012
REFERENCES


The University of Arizona Medical Center. (2012). Protocol 1380.0 on the use of EtCO2 monitoring for respiratory depression. Patient Care Services.


