About This Document

The purpose of this tool kit is to provide evidenced-based recommendations and best practices on safe and effective assessment, monitoring, and intervention of patients at risk for unrecognized respiratory depression outside the ICU.

Intended Audience

This document is intended for health care practitioners and leaders involved in caring for adult and pediatric patients in hospital procedural and non-procedural areas.

Organization of This Document

This document is organized into the following sections: Introduction, improvement project method, respiratory monitoring care process, recommendations (by care process step), and approach and tools for implementing these respiratory monitoring guidelines.

Acknowledgement

The San Diego Patient Safety Council wishes to acknowledge each of the institutions listed on the cover that contributed the valuable time of its expert clinicians in the creation of this tool kit:

(Facilitator) Patty Atkins, RN, MS, Vice President, Quality & Patient Safety

Coletta Boone, BS, RCP, Clinical Lead
Cheryl Dailey, RN, MSN, Director, Patient Safety
Ray Daniels, BS, RCP, RRT-NPS, Manager, Respiratory Care, Non-Invasive Cardiology, Vascular Ultrasonography & EEG Svs
Rossanne Decastro, RN, MSN, CNS, CMSRN
Susan Dempsey, RN, BC, MN, PCCN, CNS, Medical-Surgical Services
Jill Donaldson, RN, MSN, CNS, CMSRN, Surgical Clinical Nurse Specialist
John Engelbert, PharmD, Coordinator, Clinical Pharmacy
Kristy Fillmore, MScn, RN, Clinical Specialist
Melissa Flaherty, PharmD, Coordinator, Corporate Pharmacy Clinical
Carolyn Gooding, Sr. Product Manager
Katy Green, RN, Manager, ED
Jim Harrell, RCP, Manager, Pulmonary Services
Cheryl Holsworth, MSN, RN, Sr. Specialist
Jaleisha Smith Jacobs, RN, MPH, Sr. Specialist
Lourdes Januszewicz, MSN, RN, CNS, CCRN
Marquet Johnson, DNP, RN, ACNS-BC, CCRN, CNS
Zaram Lopez, RCP, Respiratory Care Critical Care Educator
Chrizil Mangaliag, RN
Cara Mears, Sr. Sales Consultant
Kevin McQueen, BA, HCM, RCP, RRT, CM, Patient Safety Officer
Mark Munsey, BSN, RN, CCRN, Clinical Lead, RRT/CTU
Ron Owen, RRT, Manager, Pulmonary
Allison Perkins, MS, RN, CNS
Ann Patterson, Director, Respiratory Therapy

Albert Rizos, PharmD, System Sr., Clinical Pharmacy Specialist
Adriana Robles, PharmD, Safe Medication Practice
Angela Rosenblatt, MS, PharmD, BCPS, BCNSP, Coordinator, Corporate Pharmacy Clinical
Sarah Schleifer, MSN, RN, ACNS-BC, CCRN, CNS
Diana Schultz, PharmD, Medication Safety Pharmacist
LeAnn Shipp, RN, MSN, ACNS-BC
Karen Simpson, RN, MSN, Senior Performance Improvement Specialist
Tim Vanderveen, PharmD, MS, VP, Center for Safety and Clinical Excellence
Laura Wellnitz, RCP, Clinical Lead
Melissa Yager, MS, RN, CNS, ONC
Julie Zimmerman, RN, CNS

Disclosure

This document is a collection of experience and learning from San Diego Patient Safety Council members incorporating referenced evidence-based literature and is not intended to be a comprehensive source for all relevant information. The San Diego Patient Safety Council and its collaborating organizations are not responsible for any claims or losses arising from the use of, or from any errors or omissions in this tool kit. It is important for hospitals to incorporate current state of monitoring technology as the organization transitions to these recommended future state EtCO₂ monitoring practices.

A financial grant provided by Cardinal Health Foundation was administered by the Hospital Association of San Diego and Imperial Counties for facilitation and tool kit writing activities. No payment was made to any council member. Sharp HealthCare Foundation Patient Safety Fund received compensation for the facilitator’s time. CareFusion did not supervise, oversee, or influence any of the proceedings and does not accept any responsibility for the information contained in this document. SDPSC collaborating organizations are not responsible for any claims or losses arising from the use of or from any errors or omissions in this tool kit.

This document is in the public domain and may be used and reprinted without permission provided appropriate reference is made to the San Diego Patient Safety Council and the authors of the included tools and documents. The information and tools in this document are available in electronic format at www.hqinstitute.org.

© 2014 San Diego Patient Safety Council
Appendix A: Assessment Tools Information ...................................................................................................................................................... A-1
Appendix B: Respiratory Monitoring Prioritization Process .................................................................................................................... B-1
Appendix C: OSA Treatment Information .................................................................................................................................................... C-1

Introduction

Contents

Introduction ........................................................................................................................................................................................................... 4
Method ................................................................................................................................................................................................................. 5
Care Process .................................................................................................................................................................................................. 5
1. Assess for Risk Factors ................................................................................................................................................................. 6
2. Identify Risk Level .......................................................................................................................................................................... 8
3. Monitor? ........................................................................................................................................................................................................ 9
4. Determine Monitoring ............................................................................................................................................................... 9
5. Educate/Engage/Coach .............................................................................................................................................................. 12
6. Monitor Patient ........................................................................................................................................................................... 13
7. Intervene ................................................................................................................................................................................................ 15
8. Document, Communicate, and Evaluate ............................................................................................................................................... 17
Implementing Guidelines ............................................................................................................................................................................................................. 18
References ........................................................................................................................................................................................................... 22

Glossary

- ADE – Adverse Drug Event – Any injury, harm, or adverse reaction associated with drug use including errors and proper dosage and administration.
- BIPAP – Bilevel Positive Airway Pressure
- BMI – Body Mass Index
- Capnograph – A real-time waveform that displays the change in concentration of carbon dioxide in exhaled air and displays a numerical value and waveform tracing.
- Capnography – A monitoring device that measures the concentration of carbon dioxide in exhaled air and displays a numerical value and waveform tracing.
- CPAP – Continuous Positive Airway Pressure
- End Tidal Carbon Dioxide Monitoring – The continuous, non-invasive measurement of exhaled carbon dioxide released at the end of respiratory expiration.
  NOTE: When EtCO₂ monitoring is referenced in this tool kit, the reference includes the continuous monitoring of EtCO₂.
- EtCO₂ – End-Tidal Carbon Dioxide – The level of carbon dioxide released at the end of respiratory expiration.
- Moderate Sedation – An induced state of sedation characterized by a minimally depressed consciousness such that the patient is able to continuously and independently maintain a patent airway, retain protective reflexes, and remain responsive to verbal commands and physical stimulation.¹
- Monitoring – The practice of using observations including, but not limited to, the use of sedation assessment scales and technologies to collect serial measurements to anticipate and recognize advancing sedation or respiratory depression.²
- Non-Invasive Ventilation (NIV) – The administration of mechanical ventilatory support without using an invasive artificial airway. Types of NIV are Bilevel Positive Airway Pressure (BIPAP) and Continuous Positive Airway Pressure (CPAP).
- Opioid Tolerant – Those patients who take a regular, daily, around-the-clock narcotic pain medicine. [Food and Drug Administration]
- Opioid Naïve – Those patients who are not taking a regular, daily, around-the-clock narcotic pain medicine. [Food and Drug Administration]
- OSA – Obstructive Sleep Apnea – A chronic disorder characterized by brief periods of recurrent sleep disordered breathing caused by airway obstruction from large airway collapse on inspiration during sleep.
- PCA – Patient Controlled Analgesia
- Provider – Medical doctor, physician, physician assistant, nurse practitioner
- Pulse Oximetry – A non-invasive method for monitoring a patient’s blood-oxygen saturation level and pulse rate.
  NOTE: When pulse oximetry is referenced in this tool kit, the reference refers to the continuous monitoring of SpO₂.
- Rapid Response Team (RRT) – A team of health care providers who responds to hospitalized patients with early signs of clinical deterioration on non-intensive care units to prevent respiratory or cardiac arrest.
- Respiratory Rate – The number of breaths per minute.
- Respiratory Depression – Abnormally slow and/or shallow respiration, resulting in an increased level of carbon dioxide in the blood. The rate is defined as < 8 or < 10 breaths per minute and/or paradoxic rhythm with little chest excursion.³
- SDPSC – San Diego Patient Safety Council
- Sentinel Event – Any unanticipated event in a health care setting resulting in death or serious physical or psychological injury (or the risk thereof) to a patient or patients, not related to the natural course of the patient’s illness. [The Joint Commission]
- SpO₂ – Oxygen saturation – The concentration of oxygen in the blood.
### Need for Change

There is growing evidence supporting what clinicians, providers, anesthesiologists, and pharmacists know is a serious patient safety risk: Postoperative patients are subjected to significant harm or death while receiving sedating medications without appropriate monitoring and intervention. In fact, the Anesthesia Patient Safety Foundation (APSF) stated in 2011 that preventable deaths and anoxic brain injury from unrecognized opioid-related sedation and respiratory depression remain a serious and growing patient safety concern. In 2012, The Joint Commission’s Sentinel Event Alert Issue #49, identified these sentinel events, described their common underlying causes, and encouraged hospitals to prevent occurrences in the future.

A number of contributing factors makes the risk of respiratory depression more commonplace in hospital procedural and non-procedural areas. These include:

- An increase in patients with obesity, sleep-disordered breathing, and Obstructive Sleep Apnea (OSA);
- The increased use of general anesthesia to manage patient pain and improve satisfaction;
- A growing reliance on Patient Controlled Analgesia (PCA) delivery systems on medical-surgical units;
- Unrealistic expectations for frequency of assessments by nurses on medical-surgical units;
- Inconsistent screening of and non-standard orders for at-risk, sedated patients outside the Intensive Care Unit (ICU); and
- Variability of respiratory monitoring practices between units and caregivers.

Incidents of permanent damage and death from opioid-induced respiratory depression are avoidable. An increase in End-Tidal Carbon Dioxide (EtCO₂) might be the only early clue to hypoventilation and potential respiratory compromise. Continuous evaluation of EtCO₂ allows clinicians to actively monitor patients for inadequate ventilation before oxygen desaturation and harm occur. This technique enhances patient safety by providing continuous data on airway patency, ventilatory rate and quality, and circulatory sufficiency.

### Performance Improvement Project

SDPSC consists of countywide acute care facilities with representatives from across multiple disciplines, including nurses, pharmacists, providers, and respiratory care practitioners. Members reviewed literature, consulted institutional thought leaders, applied process improvement and facilitation tools, and shared experience and best practices to obtain consensus in building a comprehensive set of recommendations for safe and effective respiratory monitoring of patients in procedural and non-procedural hospital units. This tool kit contains these recommendations along with the tools to assist hospitals in implementing the guidelines.

### Goal

The goal of this SDPSC improvement project is to provide evidenced-based recommendations and best practices for safe and effective assessment and monitoring of patients at risk for respiratory depression outside the ICU, resulting in:

- Reduced sentinel events for patients
- Decreased adverse drug events
- Reduced liability and monetary fines
- Increased compliance with policies/procedures
- Increased patient satisfaction scores
- Reduced length of stays and transfers to higher levels of care, and
- Reduced pharmacy (e.g., less Narcan) and laboratory (e.g., less arterial blood gas) costs.

### Scope

The scope of this SDPSC improvement project includes adult and pediatric (older than 14 years or hospital-defined) patients receiving any kind of sedating medication in procedural and non-procedural areas (e.g., emergency department, endoscopy, post anesthesia care units, interventional radiology, catheterization laboratory).

Respiratory monitoring defined in this tool kit includes surveillance of a patient’s ventilation and oxygenation via these methods:

- Pulse Oximetry
- Capnography – Capnometry and Transcutaneous monitoring
- Acoustic respiratory monitoring
- Multi-parameter monitoring
- Physical assessment.

This improvement project excludes:

- Monitoring during cardiopulmonary resuscitation
- Neonatal and pediatric patients
- Patients in the ICU
- Actively laboring women not at high risk
- Medication and sedation protocols (see previous SDPSC tool kits).

"Leah was a healthy 11-year-old girl," says her mother, Lenore Alexander. "In the surgery, the doctors used an epidural anesthetic, which was left in place for postoperative pain management. I stayed with Leah that night and finally fell asleep after being up for more than 36 hours. When I woke up two hours later, I found Leah dead. My screams were what alerted hospital staff that something had happened to Leah."

"Leah was not monitored, neither by a pulse oximeter nor capnograph," says Ms. Alexander. "Had she been monitored, perhaps she would still be alive today."

Leah’s mother visited SDPSC members and shared her poignant account of the events leading up to her daughter’s death. Lenore works to make continuous postoperative monitoring (The Law) and help prevent other children suffering the same fate as Leah. **San Diego Patient Safety Council dedicates this tool kit to Leah Coufal and her mother, Lenore Alexander.**
Method

SDPSC met as a group and in workgroups over one year using meeting facilitation techniques to reach consensus, devise assessment and monitoring standards, and document best practices.

Step 1: Created a Shared Vision

SDPSC members determined the improvement project charter: current state, need for change, problem statement, project scope, key stakeholders, elevator speech, goal, potential benefits, and tool kit deliverables.

Step 2: Established Workgroups

SDPSC’s facilitator identified four workgroups: Obstructive Sleep Apnea; Non-Procedural/Central Nervous System Depressed; Procedural/Postop; and Technology/Cost Benefit Analysis. Members volunteered to participate in at least one of the workgroups and met outside the regular council meeting times to investigate current practices and identify recommendations.

Step 3: Discussed Findings

Each workgroup reviewed literature; gathered current in-house practices, protocols, order sets, and tools; and assembled and reported issues/barriers, recommendations, and next steps. Collaboratively, SDPSC members vetted workgroup recommendations against the following criteria: target-audience-focused, actionable, meaningful, practical, evidenced-based (if possible), and at appropriate level of detail.

Step 4: Documented Recommendations

Members’ collective experience, literature review, and shared practices contributed to SDPSC discussions and decision-making. The facilitator polled each member using the “Fist to Five” technique to achieve consensus on processes, algorithms, recommendations, protocols, and other tool kit deliverables.

Care Process

SDPSC members developed a high-level flow diagram of a bedside caregiver’s respiratory monitoring care process (Figure 1.0). This figure illustrates the problem-solving and decision-making process of assessing, planning, implementing, and evaluating respiratory status and care for the non-ICU patient:

1. Assess for Risk Factors – The bedside caregiver assesses the patient for the presence of identified risk factors using standardized and validated tools (see Step 1, Assess for Risk Factors section).

2. Identify Risk Level – The bedside caregiver categorizes and identifies the patient’s risk level for respiratory depression as Very Low, Low to Moderate, Moderate to High, or Very High (see Step 2, Identify Risk Level section).

3. Monitor? – Knowing the patient’s risk level, the bedside caregiver references the Respiratory Monitoring Risk Level table and determines if the patient should be monitored (see Step 3, Monitor? section).

4. Determine Monitoring Method – If the patient should be monitored and based on the patient’s risk level, the bedside caregiver identifies how the patient should be monitored, including the monitoring type, frequency, location, etc. (see Step 4, Determine Monitoring Method section).

5. Educate/Engage/Coach – The bedside caregiver engages the patient and family/care partner by educating and coaching them on the monitoring device (e.g., proper use, alarms, warning signs), procedures, and expectations (see Step 5, Education/Engage/Coach section).

6. Monitor Patient – The bedside caregiver monitors the patient’s oxygenation and ventilation for airway obstruction or respiratory depression (see Step 6, Monitor Patient section).

7. Intervene – During the care process, in the event of an alarm or early indication of respiratory deterioration, the bedside caregiver evaluates monitored data and responds to the data as appropriate, (see Step 7, Intervene section).

8. Document, Communicate, and Evaluate – The bedside caregiver determines whether to continue monitoring of patient by periodically evaluating the patient’s risk level with measurable criteria (by starting over at Step #1 of the Care Process (see Step 1, Assess for Risk Factors section).

Figure 1.0: Respiratory Monitoring Care Process Flow

San Diego Patient Safety Council
2013 Respiratory Monitoring of Patients Outside the ICU Tool Kit | June 2014
Assess for Risk Factors

Risk Assessment Guidelines

A critical barrier to identifying patients at risk for respiratory depression is accurately screening for suspected and known risk factors. SDPSC members recommend using a standardized approach, including who is responsible for the screening, when to screen, using which validated tools, and the frequency of screening. SDPSC offers the following assessment guidelines and tool recommendations from members’ collective experience and literature reviews.

- Recommend use of validated sedation assessment tools to screen patients for respiratory depression risk factors. This is part of the care teams (i.e., provider, nurse, respiratory care practitioner, pharmacist) initial assessment process.
- Ensure shared responsibility for ongoing assessment of patient ventilation and oxygenation status during wakefulness and sleep, including physical airway and risk of OSA.
- Ensure a pre-sedation assessment is completed prior to sedation administration.
- Obtain patient’s history for:
  - Family or any history of OSA
  - Anesthesia history, specifically if the patient or immediate family member has history with over sedation or respiratory depression (e.g., history of receiving a reversal agent)
  - History of analgesic use or abuse, duration, and side effects to identify potential opioid tolerance or intolerance.
- Screen the patient for:
  - Recent unplanned administration of reversal agents.
  - Opioid-naive patients receiving high-dose opioid in a short period of time (i.e., stacked medications); continuous infusion (e.g., IV PCA with basal rate); or concomitant administration of sedating agents (e.g., benzodiazepines, antihistamines).
  - Risk factors for respiratory depression identified in this tool kit.
  - Conduct a full body skin assessment of the patient prior to administering a new opioid to rule out the possibility that the patient or family/care partner has an applied fentanyl patch or implanted drug delivery system or infusion pump.  

Use Validated Risk Assessment Tools

Sedation Assessment Tools

SDPSC evaluated sedation scales as part of its 2010 ICU sedation improvement project and continue to recommend a common scale be adopted for consistent and effective use throughout the hospital. Selected sedation scales should have acceptable measures of reliability and validity for pain management outside of purposeful sedation and anesthesia and critical care. Both the Richmond Agitation Sedation Scale and the Riker Sedation-Agitation Scale are used at SDPSC member organizations and are validated, evidenced-based tools.

OSA Assessment Tools

SDPSC reviewed several assessment tools available for identifying patients at risk for OSA:

- **STOP BANG Questionnaire** – consists of eight Yes/No questions. One study showed patients who screened positive on the questionnaire were more likely to have postoperative complications than those that screened negative.
- **The Berlin Questionnaire** – consists of 11 questions organized into three categories and has been validated in patients in primary care settings.
- **American Society of Anesthesiologists (ASA) Checklist** – consists of 14 questions organized into three categories for anesthesiologists to screen patients for OSA.
- **Epworth Sleepiness Scale** – consists of a scale for patients to rate themselves on the likelihood of dozing off in eight situations.

When deciding which screening tool to use, consider the patient population used to validate the tool. The STOP BANG, Berlin, and ASA Checklist screening tools have been well validated in the adult surgical population with similar moderately high predictive values. (For information on screening tool evaluations and obtaining these tools, see Appendix A.) SDPSC recommends using the STOP BANG questionnaire for routine screening of the adult surgical population 18 years and older because of its ease of use.

SDPSC members were not able to identify a validated OSA assessment tool for pediatric or obstetric populations.

Respiratory Depression Risk Factors

To aid bedside caregivers in identifying which patients are at risk for respiratory depression, SDPSC members reviewed literature, including The Joint Commission’s Sentinel Event Alert: Issue #49 Risk Factors, examined existing practices, and then identified and categorized the predictive factors into risk areas: medication-related, known or suspected OSA/sleep disorder, other medical conditions/diseases, medical condition/disease, medical history/physical state, and other environmental conditions. The rationale for each risk factor category is described in this section.

Medication-Related Risk Factors

All medically sedated patients are at risk for over-sedation and respiratory depression:

- **Opioid-Infusion Therapy** – PCA (with and without basal dose), PCEA, or Epidural
- **Unplanned Administration of Reversal Agents**
- **Opioids, Sedatives, and Moderate Sedation** (or a.k.a. conscious sedation) including receiving concomitant sedatives/other sedating medications (e.g., benzodiazepines, antihistamines, diphenhydramine, sedatives, or other central nervous system depressants).
- **General Anesthetic Agents**. The following should be considered: length of surgery, duration of anesthesia, physical condition of patient, and use of spinal morphine.
Known or Suspected Obstructive Sleep Apnea (OSA) and Sleep Disorders

Patients with known or suspected OSA are susceptible to the respiratory-depressant effects of sedatives, opioids, and inhaled anesthetics, which increases the risk of developing complications postoperatively. The American Academy of Sleep Medicine estimates that 80 to 90% of people with OSA are undiagnosed. 19

- Recognize the factors that increase vulnerability for the disorder (i.e., age, male gender, obesity, family history of OSA, menopause, craniofacial abnormalities, and certain health behaviors, such as smoking and alcohol use). 20
- Include the patient’s family/care partner during the OSA assessment to assist in describing sleep behavior.
- Recognize respiratory depression may occur on the third or fourth postoperative day in patients with OSA as sleep patterns are reestablished and “REM rebound” occurs. 21
- Recognize hospitalized patients often suffer from sleep deprivation due to intensive care and monitoring.

Other Medical Conditions/Diseases

Any patient who also has a medical condition that may negatively affect the ventilatory status is at risk for respiratory depression. These conditions include:

- **Pulmonary/Cardiac/Renal Conditions**, such as:
  - Hypertension
  - Congestive heart failure
  - Acute respiratory distress
  - Central nervous system disorder (e.g., contributes to ineffuctual air exchange)
  - Pre-existing pulmonary or cardiac disease or dysfunction or major organ failure decreased profusion and/or metabolism
  - Pulmonary dysfunction (e.g., diagnosed or suspected OSA, Chronic obstructive pulmonary disease, pneumonia)
  - Cardiac dysfunction (e.g., congestive heart failure, coronary artery disease, cardiac dysrhythmia, hypertension)
  - Chronic renal disease (Creatinine >1.4 mg/dL, BUN >30 mg/dL) and hepatic disease affects metabolism and excretion of medications
- **Neurological Deficit**, for example:
  - Acute stroke
  - Patients who are seizing or post-ictal phase 22
- **Diabetic Ketoacidosis** 23
- **History of Substance Abuse**. If a history of recent drug abuse (i.e., last 7 days of continuous use), consider the patient’s tolerance, onboard medications, and drug interactions.
- **Opioid Tolerance**
- **Hypercoagulation Disorder**
- **Uncontrolled Pain**. Patients requiring higher dosage of medication are at more risk from stacked medication to control pain.
- **Pregnancy**. Sleep Disordered Breathing symptoms are common in pregnancy.

Medical History/Physical State Risk Factors

The following medical history/physical state risk factors compound existing medications, OSA/sleep disorders, and medical conditions/diseases, which increase the patient’s risk for respiratory depression:

- **Surgical Considerations**, specifically:
  - Prolonged surgery (more than 2 hours)
  - Thoracic or other large surgical incisions that may impair breathing (e.g., upper abdominal) due to discomfort/pain on deep breath or guarding against incisional sites.
  - High risk for venous thromboembolism 24
- **Physical Conditions**:
  - BMI equal or greater than 35 kg/m 2. 25 Patients with obesity-induced changes in hemodynamic status and regional blood flow can affect how medications are absorbed. Many medications used in anesthesia and pain management are fat soluble and stored in fat, therefore, may have slower or delayed absorption. Additionally, obesity is the main risk for OSA.
  - BMI equal or less than 18.5 kg/m 2. 26, 27 Patients with low body weight often have difficulty with breath and metabolism of medications.
- **Anatomical Nasal Obstructions**. Patients with abnormalities of the bony and soft tissue structure of the head and neck are at risk for breathing obstruction.
- **Neck Circumference**. Men with a neck circumference of 17 in. and women with a neck circumference of 16 in. are at risk for OSA per the American Academy of Sleep Medicine. 28

- **Medical History Considerations**:
  - Smoking
  - Age (older than 65 years or younger than 14 years). Physiological changes associated with aging can alter pharmacokinetics of medications. Risk is 2.8 times higher for individuals aged 61-70, 5.4 times higher for ages 71-80, and 8.7 higher for those over age 80. 29 Younger individuals with overgrown tonsils, adenoids, or both are at risk due to their smaller airways.
  - **History with Difficult Intubation**
  - **Decreased Level of Consciousness/Condition**
  - **Spinal Cord Injury**
  - **Non-adherence to Prescribed Regimen** – Patients that are not following their prescribed non-invasive ventilation (NIV) therapy.
- **Need for Supplemental Oxygen**

Other Considerations/Environmental Conditions Risk Factors

In addition to all listed risk factors, it is important to assess environmental conditions affecting the safe surveillance of patients in the unit. Consider the following situations:

- **Poor Visibility of Patient by Staff** due to staffing or environmental barriers (e.g., darkened room or far distance from nursing station).

- **Situational Awareness Challenges**, such as:
  - Code situation (i.e., nursing focus on patients is distracted by the emergency)
  - Unit hand-offs and shift change
  - Alarm fatigue – see The Joint Commission Proposed 2014 National Patient Safety Goal on Alarm Management (www.jointcommission.org.)
The bedside caregiver identifies the patient’s risk level for respiratory depression using Figure 2.0, which helps in prioritizing the level of monitoring needed (see Figure 3.0).

NOTE: Appendix B presents the complete Respiratory Monitoring Prioritization Process (for patients outside the ICU).

Risk level is often determined by a single factor (e.g., PCA), and also impacted by a combination of factors that require full assessment and judgment by the bedside caregiver. Patients with any “escalating factor” move up in risk level. Considering a patient’s risk level status can change, it is recommended the bedside caregiver periodically evaluates risk.

**Identify Risk Level**

**Medication-Related and Known or Suspected OSA/Sleep Disorder Risk Factors**

**Very High Risk***
- Opioid Infusion Therapy – PCA (with and without Basal), PCEA, or Epidural
  - Start Monitoring: Upon initiation of PCA
  - Stop Monitoring: When PCA discontinued; After 6 hours from discontinuing epidural
- Recent Unplanned Administration of Reversal Agents
  - Start Monitoring: Upon administration of agent
  - Stop Monitoring: Up to 2 hours after the most recent administration
- Known or Suspected OSA/Sleep Disorder (NOT using NIV as prescribed)
- General Anesthesia within 1 to 4 hours
  - (consider patient-specific complications for adverse risk from anesthesia)
  - Stop Monitoring: If no observed apnea or desaturation, discontinue after 1st 24 hours postop

**Moderate to High Risk***
- Opioids & Concomitant Sedatives/Medication Stacking/Other Sedating Medications
  - Start Monitoring: Monitor 1st 24 hours
  - Stop Monitoring: 24 hours unless risk level changes
- Moderate (a.k.a. Conscious) Sedation
  - Start Monitoring: Upon administration of sedative; Q5 minutes during procedure
  - Stop Monitoring: Follow standardized scoring system for your facility
- General Anesthesia within 5 to 24 hours
  - Recommend monitoring postop (consider patient-specific complications for adverse risk from anesthesia)
  - Stop Monitoring: If no observed apnea or desaturation, discontinue after 1st 24 hours

**Low to Moderate Risk***
- Opioids, Sedatives
  - Start Monitoring: Monitor 1st 24 hours
  - Stop Monitoring: 24 hours unless risk level changes
- Known or Suspected OSA/Sleep Disorder (using NIV as prescribed in Facility)

**Very Low Risk**
- No known or suspected Medication-Related, OSA/Sleep Disorder, Medical Conditions/Diseases, Medical History/Physical State, or Other Considerations/Environmental Conditions Risk Factors
  - No continuous monitoring necessary

*When using supplemental oxygen, evaluate the patient need for EtCO<sub>2</sub> monitoring independent of SpO<sub>2</sub> values.

SDPSC acknowledges many hospitals are not fully equipped to offer EtCO<sub>2</sub> monitoring on patients that may benefit and that triaging the monitors for the most critical patients may be necessary (until the appropriate numbers of monitors are acquired).
Monitor?

Based on the risk level identified in Step #2, including the frequency, dose, and duration of opioid delivery, SDPSC suggests using the appropriate respiratory monitoring method (Table 3.0).

### Table 3.0: Respiratory Monitoring Prioritization Recommendations based on Risk Level

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Very Low Risk</th>
<th>Low to Moderate Risk</th>
<th>Moderate to High Risk</th>
<th>Very High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor</td>
<td>Recommend periodic monitoring with Pulse Oximetry</td>
<td>Recommend continuously monitoring with Pulse Oximetry</td>
<td>Strongly recommend continuous monitoring with Pulse Oximetry</td>
<td>Strongly recommend continuous monitoring EtCO2 and Pulse Oximetry</td>
</tr>
<tr>
<td>Location</td>
<td>Bedside</td>
<td>Bedside</td>
<td>Remote/centralized and/or close proximity/high visibility</td>
<td>Remote/centralized and/or close proximity/high visibility</td>
</tr>
</tbody>
</table>

- SDPSC acknowledges many hospitals are not fully equipped to offer EtCO2 monitoring on patients that may benefit and that triaging the monitors for the most critical patients may be necessary (until the appropriate numbers of monitors are acquired).
- All risk factors identified apply to sedated patients outside the ICU (e.g., post anesthesia care unit, interventional radiology, endoscopy, catheterization laboratory, emergency).
- SDPSC monitoring recommendations are inclusive of existing best practices and standardized protocol for pulse oximetry monitoring.
- An example of a patient with Very Low Risk is a marathon runner in the emergency department with a broken wrist and no health risks.
- When using supplemental oxygen, evaluate the patient for EtCO2 independent of SpO2 values.

### Determine Monitoring

#### Ventilation vs. Oxygenation Monitoring

The two separate physiologic processes of respiration: ventilation (eliminating carbon dioxide from the body) and oxygenation (getting oxygen into the body) are measured with separate technology. Table 4.0 compares monitoring methods for both of these physiologic processes.

### Table 4.0: Ventilation and Oxygenation Monitoring Comparison

<table>
<thead>
<tr>
<th>EtCO2 Monitoring (Measures Ventilation)</th>
<th>SpO2 Monitoring (Measures Oxygenation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures carbon dioxide</td>
<td>Measures oxygen saturation (oxygen attached to hemoglobin)</td>
</tr>
<tr>
<td>Reflects breath-to-breath ventilation</td>
<td>Reflects oxygenation</td>
</tr>
<tr>
<td>Detects hypoventilation immediately</td>
<td>Detects hypoxia</td>
</tr>
<tr>
<td><strong>EARLY INDICATOR OF HYPOVENTILATION</strong></td>
<td><strong>LATE INDICATOR OF HYPOVENTILATION</strong></td>
</tr>
<tr>
<td>Should be used with pulse oximetry</td>
<td>Should be used with EtCO2 monitor</td>
</tr>
<tr>
<td>Both assist in non-invasive monitoring of physiological status</td>
<td></td>
</tr>
</tbody>
</table>

#### Continuous Monitoring Options

Early recognition of respiratory compromise and timely intervention through improved monitoring, staffing levels, and resources are urgently needed to improve the tragic and preventable illnesses and deaths from opioid-induced respiratory depression and in-hospital cardiopulmonary arrests among medical-surgical patients. In 2010, the Federal Drug Administration recommended hospitals monitor for signs of over- or under-infusion of high-alert medications by using patient monitoring systems, such as cardiac, pulse oximetry, and EtCO2, when available. Intermittent monitoring through observation, even when performed every 15 minutes, may be inadequate since respiratory arrest can occur within minutes.

This section and table 5.0 presents a summary of available ventilation and oxygenation monitoring options: acoustic respiratory rate, transcutaneous monitoring pulse oximetry, and capnography.

#### Acoustic Respiratory Rate Monitoring

Acoustic respiratory rate monitoring is a proprietary monitoring system that uses a specialized acoustical sensor to monitor the patient’s respiratory rate via the sound of airflow in and out of the patient’s airway. This is displayed as RRa or respiratory rate acoustical. Respiratory rate if too high (Tachypnea) or too low (Hypopnea) can signify physiologic stress.

#### Transcutaneous CO2 Monitoring

Transcutaneous CO2 monitoring is a non-invasive method for monitoring PO2 and PCO2 by artificially inducing hyperperfusion in a small area of the surface of the skin. This is performed by local heating of the skin and measuring the partial pressure of oxygen or carbon dioxide.

Transcutaneous CO2 monitoring is usually more accurate than capnography, especially if validated with an arterial blood gas reading. However, disparate results can occur if the patient is in a hypoperfusion state (shock), is given vasoactive drugs, or has poor skin perfusion or integrity. Transcutaneous CO2 monitoring is only used for continuous monitoring and not for periodic checks.

#### Pulse Oximetry

Pulse oximetry is a non-invasive method for monitoring a patient’s blood-oxygen saturation level and pulse rate. SDPSC found that research indicates pulse oximetry is a LATE indicator of respiratory depression. Furthermore, The Joint Commission Sentinel Event Alert, Issue #49 on the Safe use of Opioids in hospitals, recommends that...
staff should be educated not to rely on pulse oximetry alone because pulse oximetry can suggest adequate oxygen saturation in patients who are actively experiencing respiratory depression, especially when supplemental oxygen is being used.

**Capnography**

Capnography is an indicator of too much carbon dioxide in the blood by continuous monitoring of EtCO₂. There is growing evidence in the literature that capnography is a valuable tool for early detection of respiratory depression and compromise in patients located outside the ICU:

- Capnography, or expired carbon dioxide monitoring, is valuable to diagnose the simple presence or absence of respirations, airway obstruction, or respiratory depression, particularly in patients sedated in less accessible locations (e.g., MRI, computerized axial tomography devices, darkened rooms).  
- Capnography more readily detects hypoventilation compared with pulse oximetry or visual observation.  
- Capnography is capable of significantly clarifying the respiratory picture with regard to over-sedation, and when used in conjunction with oxygen saturation can dramatically enhance the overall picture of the patient’s respiratory status.  
- Early studies indicate that capnography is more effective than pulse oximetry in providing initial warning of respiratory depression in patients receiving supplemental oxygen.

In 2007, the Institute for Safe Medication Practices stated, “Do not rely on pulse oximetry readings alone to detect opioid toxicity; use capnography to detect respiratory changes caused by opioids, especially for high risk patients (sleep apnea, obesity), and frequently assess the quality of respirations in addition to the respiratory rate along with specific signs of over-sedation.”

NOTE: Although pulse oximetry monitors provide valuable information and essential parameters, it is not sufficient for timely, accurate respiratory status. The focus of this tool kit is the inclusion of EtCO₂ parameters for clinical decision-making on procedural and non-procedural units.

**Table 5.0: Monitoring Table**

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Acoustic RR Monitoring</th>
<th>Capnography Monitoring</th>
<th>CO₂ Monitoring</th>
<th>Pulse Oximetry</th>
<th>Transcutaneous CO₂ Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical respiratory rate</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological respiratory rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breathing pattern waveform</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate indication of a No Breath condition</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequacy of ventilation (Measure of CO₂ and waveform)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Confirm intubation and maintenance of endotracheal tube</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Return of spontaneous circulation</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pulmonary embolism indication</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Monitoring Recommendations by Risk Factor Category**

This section organizes SDPSC’s recommended monitoring protocols by the risk factors category.

**Medication-Related**

NOTE: SDPSC considers opioid tolerance a medical condition.

**Opioid Infusion Therapy**

When considering patients on PCA (with or without a basal dose), PCEA, or epidural, SDPSC recommends patients receiving opioids should be monitored with both pulse oximetry and capnography.

- If supplemental oxygen is not being administered, monitoring with pulse oximetry is acceptable.
- If supplemental oxygen is being administered, monitoring with capnography or without pulse oximetry is desirable.

SDPSC classifies any patient on a PCA pump as being at Very High Risk for respiratory depression. It is recommended:

- At a minimum, monitor the patient with pulse oximetry and continuous EtCO₂.
- Start respiratory monitoring upon initiation of PCA.
- Discontinue respiratory monitoring when intravenous PCA is discontinued or 6 hours after continuous epidural infusion.
- Assess the patient’s previous history of analgesic use or abuse, duration, and possible side effects to identify potential opioid tolerance or intolerance.
- If the patient has a fentanyl patch or implanted drug delivery system in combination with PCA therapy, the risk for respiratory depression is greater than with no PCA.
- More vigilant monitoring of sedation and respiratory status should be performed when patients may be at greater risk of adverse events, such as at peak medication effect, during the first 24 hours after surgery; after an increase in the dose of an opioid, coinciding with aggressive titration of opioids; recent or rapid change in end-organ function (especially hepatic, renal, and/or pulmonary); or when moving from one opioid to another. Respirations should be counted for a full minute and qualified according to rhythm and depth of chest excursion while the patient is in a restful/sleep in a quiet non-stimulating environment.

**Sedation**

When considering patients on opioids, sedatives, and moderate (conscious) sedation, SDPSC recommends the following:

- Classify any patient on opioids or sedatives as Low to Moderate Risk for respiratory depression.
- Start respiratory monitoring upon initiating the first 24 hours.
- Discontinue respiratory monitoring at 24 hours, unless risk level changes.
- Classify any patient on opioids and concomitant sedatives/medication stacking/other sedating medications (e.g., benzodiazepines, antihistamines) as Moderate to High Risk for respiratory depression. It is strongly recommended to place patient on an EtCO₂ monitor and it is recommended to monitor the patient with pulse oximetry.
**Determine Monitoring**

- Start respiratory monitoring upon initiating the first 24 hours.
- Discontinue respiratory monitoring at 24 hours, unless risk level changes.
- Classify any patient on moderate (or conscious) sedation as **Moderate to High Risk** for respiratory depression. It is strongly recommended to place patient on an EtCO₂ monitor and it is recommended to monitor the patient with pulse oximetry.
- Start respiratory monitoring upon administration of sedative and check every 5 minutes during procedure.
- Discontinue respiratory monitoring following outcome of the sedation assessment.

**Unplanned Administration of Reversal Agents**

When considering any patient having had recent unplanned administration of reversal agents, SDPSC recommends the following:

- Classify any patient receiving **unplanned administration of reversal agents** (e.g., Narcan) as **Very High Risk** for respiratory depression. It is strongly recommended to monitor patient with continuous EtCO₂ and pulse oximetry.
- Start respiratory monitoring upon reversal agent administration.
- Discontinue respiratory monitoring up to 2 hours after the most recent administration.
- Provide vigilant monitoring when reversal agent’s impact subsides.

**General Anesthesia**

When considering patients on general anesthesia, SDPSC recommends the following:

- Classify any patient following **general anesthesia within hour 1 to 4** as **Very High Risk** for respiratory depression. It is strongly recommended to monitor patient with continuous EtCO₂ and pulse oximetry.
- Consider patient-specific complications for adverse risk from anesthesia.
- If no observed apnea or desaturation, discontinue continuous monitoring after the first 24 hours postop.
- Classify any patient following **general anesthesia within hour 5 to 24** as **Moderate to High Risk** for respiratory depression. It is strongly recommended to place patient on an EtCO₂ monitor and it is recommended to monitor the patient with pulse oximetry.
- Recommend monitoring during postop.
- Consider patient-specific complications for adverse risk from anesthesia.
- If no observed apnea or desaturation, discontinue monitoring after the first 24 hours.

**Known or Suspected OSA/Sleep Disorder**

When considering patients with known or suspected OSA/Sleep Disorder, SDPSC recommends the following:

- Classify any patient **diagnosed with OSA and using NIV as prescribed (in the facility)** as **Low to Moderate Risk** for respiratory depression. It is recommended to monitor the patient with pulse oximetry. (If the patient requires supplemental oxygen, evaluate the patient for EtCO₂ monitoring needs based on adherence to prescribed NIV therapy.)
- Classify any patient **diagnosed with OSA and NOT using the NIV as prescribed (in the facility)** as **Very High Risk** for respiratory depression. It is strongly recommended to monitor patient with continuous EtCO₂ and pulse oximetry.
- Provide respiratory monitoring for the first 24 hours postop.
- Discontinue respiratory monitoring at the end of the 24 hours, unless risk level changes.
- Do not discontinue monitoring until patient is stable on NIV therapy and using as prescribed.
- Classify any patient with **suspected OSA or sleep disorder** (but not officially diagnosed) as **Very High Risk** for respiratory depression. It is strongly recommended to monitor patient with continuous EtCO₂ and pulse oximetry.
- Provide respiratory monitoring for the first 24 hours postop.
- Discontinue respiratory monitoring at the end of the 24 hours, unless risk level changes.
- Do not discontinue monitoring until patient is stable on NIV therapy.

---

**Medical History/Physical State**

**Consider any of the following condition affecting airway maintenance:**

**Surgical Considerations:**
- Prolonged surgery (greater than 2 hours)
- Thoracic/other large incisions (if interfere with adequate ventilation)
- High risk for venous thrombembolism

**Physical Conditions:**
- BMI equal or greater than 35 kg/m², equal or less than 18.5 kg/m²
- Anatomical nasal obstructions
  (Abnormalities of the bony and soft tissues of the head and neck)
- Neck circumference (17 in. males, 16 in. females)

**Medical History Considerations:**
- Smoking
- Age (older than 65 years or younger than 14 years)
- History with difficult intubation
- Decreased level of consciousness/condition
- Non-adherence to prescribed non-invasive ventilation therapy
- Need for supplemental oxygen

**Other Medical Conditions/Diseases:** Any condition that may negatively affect patient ventilatory status, such as:

- Pulmonary/cardiac/renal co-morbidity
  (e.g., hypertension, congestive heart failure, acute respiratory distress, chronic renal disease)
- Neurological deficit (i.e., current stroke, active seizures postictal)
- Diabetic Ketoacidosis
- History of substance abuse
- Opioid tolerant
- Hypercoagulation disorder
- Uncontrolled pain
- Pregnancy

**Other Considerations/Environmental**

**Poor Visibility of Patient by Staff?**

*Yes*  
If poor visibility, evaluate patient’s need for Pulse Oximetry and EtCO₂ monitoring.

**Situational Awareness Challenges?**

*Yes*  
If no observed apnea or desaturation, discontinue monitoring.
Escalating Factors

SDPSC identifies any condition affecting airway maintenance as an escalating factor for evaluating the patient’s need for pulse oximetry and EtCO₂ monitoring (see Figure 6.0).

Medical History/Physical State

- Surgical Considerations
  - Prolonged surgery (greater than 2 hours)
  - Thoracic/other large surgical incisions that may impair breathing
  - High risk for venous thromboembolism

- Physical Conditions
  - BMI equal or greater than 35 kg/m² or equal or less than 18.5 kg/m²
  - Anatomical nasal obstructions
  - Neck circumference (17 in. males, 16 in. females)

- Medical History/Considerations
  - Smoking
  - Age (older than 65 years, younger than 14 years)
  - History with difficult intubation
  - Decreased level of consciousness/condition
  - Spinal cord injury
  - Non-adherence to prescribed NIV therapy:
    - Educate the patient and family/care partner on the risks.
    - Evaluate patient need for EtCO₂ monitoring, RRT rounding, or higher level of care.
  - Need for supplemental oxygen

Other Medical Conditions/Diseases:

- Pulmonary/cardiac/renal co-morbidity
- Neurological deficit (NOTE: For patients who are actively seizing, capnography can improve decision-making regarding ventilation effectiveness.)
- Diabetic Ketoacidosis
- History of substance abuse
- Opioid tolerance (see Glossary)
- Uncontrolled pain
- Evaluate for prolonged length of stay until pain managed
- Pregnancy

Other Considerations/Environmental

SDPSC recommends the bedside caregiver evaluate for environmental and other considerations that can elevate the risk of respiratory depression:

- Poor visibility of patient by staff – If staff cannot see the patient due to staffing or environmental barriers (e.g., darkened room, far distance from nursing station), evaluate patient need for EtCO₂ monitoring, RRT rounding, or higher level of care. Centralized monitoring is recommended; however, if not available, SDPSC recommends using local monitors with automatic pause of infusion, if applicable.

- Situational awareness challenges – In the following situations where monitoring the patient may be compromised, evaluate the patient need for EtCO₂ monitoring, RRT rounding, or higher level of care:
  - Code situation (i.e., nursing focus distractions by emergency)
  - Unit hand-offs and shift change.

Educate/Engage/Coach

Patient and family/care partner engagement is an important care strategy for achieving better health outcomes. This section offers recommendations for successful patient and family/care partner engagement before and during respiratory monitoring and when discontinuing monitoring.

Engage Before Monitoring

- Obtain patient’s baseline understanding, experience, motivation level, and concerns regarding having a monitor attached.
- Explain to the patient and family/care partner the following:
  - The patient’s risk level and what it means for his/her care and the necessity of monitoring.
  - The purpose of EtCO₂ monitoring and its importance. For example, “You are connected to a special nasal cannula that monitors breathing more accurately than just watching you with our eyes.”
  - What the monitor is measuring. For example, “The EtCO₂ monitor measures carbon dioxide (CO₂) with each exhalation and monitors the respiratory rate, which ensures breathing is deep enough and fast enough.”
  - The rationale for frequent monitoring and that the patient may be awakened to assess the effect of pain medication.
  - How long the patient will be wearing the monitoring device.
  - The monitor’s various alarms, who else can hear the alarms, who will be responding to the alarm, what to do when the alarm sounds (i.e., call for help if needed), and why they should never silence an alarm or turn off the machine.
- Provide printed educational materials to the patient and family/care partner at the appropriate time:
  - Ensure materials are at the appropriate reading level and address any learning challenges (e.g., language, hearing impaired).
- Address specific concerns as they arise.
- Explain the importance of alerting staff of any breathing problems or other reactions.

Engage While Monitoring

- Continuously reinforce the importance of monitoring to the patient and family/care partner:
  - Explain they should expect to hear an alarm and the patient should wake up. It may be annoying, but remind them why the noise is important (e.g., “It reminds you to wake up and breathe deeply.”).
  - Stress the importance of wearing the monitoring cannula or NIV appropriately and self-correct.
  - Discuss that some alarms are false but to never silence an alarm without consulting the bedside caregiver.
- Continuously validate the patient is able to:
  - Verbalize understanding of the above points,
  - Ask questions, and
  - Demonstrate proper use of the monitoring cannula or NIV.
- Continue to emphasize the importance of alerting staff of any breathing problems or other reactions.
Addressing Patient Engagement Issues

Patients commonly resist additional monitoring, and it is important for bedside caregivers to address the underlying issues:
- Seek to understand the root cause of the patient’s lack of engagement (e.g., lack of knowledge, discomfort in wearing apparatus, fear of stigma of having a chronic condition, denial)
- Address the root cause(s).
- Reinforce the importance of monitoring through relevant stories and examples.
- Involve the patient’s provider, if helpful.
- Explain that monitoring in certain circumstances is hospital policy or the patient may have to move to a higher level of care.
- Be sure to document patient and family/care partner refusal to engage, as well as any direct interference during monitoring (see 8. Document, Communicate, and Evaluate section).

Engage When Discontinuing Monitoring

- Explain to the patient and family/care partner that the monitoring will be provided until no longer deemed necessary by the provider or no longer clinically indicated.
- Recognize and address possible patient and family/care partner anxiety with discontinuing the monitoring (e.g., they may perceive it as premature).

Sample Policies, Guidelines, and Educational Materials

Sample policies, guidelines, and educational materials shared by SDPSC members are available for download on the www.hqinstitute.org website. Please note that these samples are the property of the sharing organization and may be updated periodically.

Monitor Patient

Whenever possible, the patient’s own NIV equipment should be used during the hospital stay if in good condition. The bedside caregiver should engage patient in its proper use and address any concerns. This section recommends guidelines in the use of peripheral oxygenation and ventilation equipment for continuous monitoring the patient’s respiratory status.

Prepare Equipment

Before connecting the patient to a respiratory monitor, it is recommended to:
- Select the most appropriate respiratory monitor based on the patient’s risk and application.
- Consider impact to patient’s comfort and adherence to prescribed NIV therapy when selecting type and size of monitor.
- Consider sensor accuracy in high humidity and air flow (i.e., sensor may be limited in presence of humidified or high flow air).
- Before attaching the EtCO₂ nasal cannula to the patient, check proper preparation and attachment of the sensor tubing. Check and replace tubing, if needed.
- Ensure adequate surveillance of the patient.
- Ensure alarms are audible, consider alarm hearing distance, and set strategies to ensure adequate volume levels.

Establish Baseline Parameters

Normal and abnormal ventilation values are:
- Normal values – 35-45 mmHg
- Abnormal values:
  - <35 mmHg Hyperventilation/Hypocapnia
  - >45 mmHg Hypoventilation/Hypercapnia.

Based on these values, determine the patient’s baseline and consider any adverse condition affecting oxygen exchange, such as metabolic acidosis/alkalosis and chronic elevated CO₂ levels (e.g., chronic obstructive pulmonary disease).

Clinical respiratory parameter goals should be individualized to the patient to maintain ventilation.

Respiratory monitor manufacturers provide safe, default alarm settings for the general patient population. Table 7.0 presents SDPSC recommended default alarm settings for respiratory monitor critical alarms, which are consistent with literature and practice. **Bedside caregivers should tailor these default alarm settings to the patient’s needs and prevent alarm fatigue.**

<table>
<thead>
<tr>
<th>Table 7.0: Recommended Respiratory Monitor Default Alarm Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alarm Setting</strong></td>
</tr>
<tr>
<td>EtCO₂</td>
</tr>
<tr>
<td>Respiratory Rate</td>
</tr>
<tr>
<td>No breath delay</td>
</tr>
<tr>
<td>Pulse Oximetry</td>
</tr>
</tbody>
</table>

While monitoring, ensure baseline values are maintained, be ready to respond to changes, and document adjusted alarm limits.
Conduct Ongoing Patient Assessment and Monitoring

Respiratory monitors that are functioning reliably cannot substitute the practice of frequent, direct observation to obtain an accurate respiratory profile of the patient. This section provides respiratory assessment and monitoring recommendations for all caregivers.

**Full Respiratory Status Assessment**

- Assess patient’s respiratory status: rate, depth, rhythm, quality, and consciousness.
- Analyze the four stages of the CO₂ waveform (Figure 8.0):
  - Phase I – Beginning of exhalation
  - Phase II – Ascending phase
  - Phase III – Alveolar plateau
  - Phase IV – Represents the inspiratory cycle.
- Observe trends over the past several hours/days and shifts for abnormal waveforms (Figure 8.0).
- Be attentive when distinguishing between sleep and respiratory depression.
- Following a dose of sedation/analgesia, wait until medication peak time then assess patient’s SpO₂ and EtCO₂.
- If monitoring devices are integrated with the electronic medical record, ensure monitoring data is transferring correctly.
- Treat for OSA (For OSA treatment information, see Appendix C).

Patient Transport Monitoring

- Initiate monitoring before the patient leaves the “source” area and ensure patient receives the same level of basic physiologic monitoring during transport as received in the source area.
- Evaluate ventilation status after every patient transfer by the receiving bedside caregiver.
- Consider recovery state and peak effect of medication when transitioning the patient.

Moderate Sedation and Monitoring

- During moderate (a.k.a. conscious) sedation, monitor oxygenation, ventilation, circulation, and level of consciousness.
- Consider modifying respiratory monitor alarm parameters for patients undergoing moderate sedation to provide an early warning indicator in this high-risk situation.

Medication Management and Monitoring

- Evaluate the patient’s medication need based on trended respiratory monitoring parameters and pain scale rating.
- Considering that most serious and life-threatening potential adverse drug events are infusion drug-related, monitor oxygenation and ventilation in any patient being administered high-alert IV medications that are known to cause respiratory depression.
  
  For additional SDPSC recommendations addressing high-alert IV medications, refer to SDPSC’s High-Alert IV Medication Tool Kit and SDPSC’s High-Alert IV Medication Dosing Limits Tool Kit available for download from the [www.hqinstitute.org](http://www.hqinstitute.org) website.
- Use dose limits for order entry of medications.

### Four stages of CO₂ waveform

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Beginning of exhalation</td>
</tr>
<tr>
<td>II</td>
<td>Ascending phase</td>
</tr>
<tr>
<td>III</td>
<td>Alveolar plateau</td>
</tr>
<tr>
<td>IV</td>
<td>Inspiratory cycle</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Waveform Shape</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tall</td>
<td>Higher CO₂, may have a prolonged flat area</td>
</tr>
<tr>
<td>Short and Rounded</td>
<td>Shorter, rounded, and choppy</td>
</tr>
<tr>
<td>Flat</td>
<td>Abnormal shape, elongated upstroke or downstroke</td>
</tr>
<tr>
<td>E.</td>
<td>No air exchange due to cessation of breathing or total airway obstruction</td>
</tr>
<tr>
<td>N.</td>
<td>Elevated baseline, waveform shape may be normal or abnormal but key is not returning to 0 baseline</td>
</tr>
</tbody>
</table>

**Normal**

Waveform shape will represent a normal waveform (higher CO₂) with a flat area.

**Hypoventilation**

Waveform shape will represent a taller waveform (higher CO₂) with a prolonged flat area (alveolar plateau).

**Shallow Breathing Hypoventilation**

Respiratory rate may or may not change with a decrease in EtCO₂. Waveform shape will be abnormal in shape, shorter and smaller. It may be rounded and choppy in shape.

**Airway Obstruction**

Respiratory rate may or may not change with a decrease in EtCO₂. Waveform shape will be abnormal with elongated upstroke or downstroke. Waveform will be shorter, rounded, and choppy.

**Apnea**

Waveform, EtCO₂ value, and Respiratory rate will be absent. No air exchange is taking place due to cessation of breathing or total airway obstruction.

**Rebreathing**

Elevated baseline. Waveform shape may be normal or abnormal but key is not returning to 0 baseline.

Courtesy of Mission Hospital St. Joseph Health System’s Hospital
Consider automatic triggers to contact respiratory therapy if patient is needed for respiratory monitoring per medication(s) ordered.

- Use standardized medication order sets.
- Recognize medication factors influencing the patient’s oxygenation and ventilation:
  - Opioid class, dose, and route
  - Duration of therapy
  - Opioid tolerant or opioid naive
- Avoid concurrent, multiple administration routes of medications
- When multiple routes are required, ensure respiratory monitoring when:
  - Stacking (i.e., multiple modalities used with overlapping half-life and potencies) repeat IV/IM opioids, addition of PRN benzodiazepine/sedative
  - Long-acting medications
  - Unknown chronic/long-acting opioid use.

- Observe patient for up to 2 hours after administration of reversal agents, such as Naloxone (half-life is 1 to 1.5 hours) and Flumazenil (initial half-life 4 to 11 minutes; terminal half-life is 40 to 80 minutes), to ensure patients do not become re-sedated after agents wear off.

**Alarm Management Strategies**

This section provides considerations for organization-wide strategies to ensure effective and efficient use of respiratory monitors.

- Educate bedside caregivers on alarm data provided by respiratory monitoring devices and applying the data to the care of the patient. If needed, consult experts to interpret the data.
- Perform regular machine calibration per manufacturer’s instructions to ensure alarm sensitivity.
- Standardize alarm limits (as approved by appropriate medical committees) and adjust as appropriate to patient condition.
- Systematically create strategies to reduce alarm fatigue. For additional strategies, see The Joint Commission Sentinel Event Alert Issue #50 and The Joint Commission Proposed 2014 National Patient Safety Goal on Alarm Management (www.jointcommission.org).
- Conduct a hospital gap analysis of medical device alarm safety against The Joint Commission recommendations presented in Sentinel Event Alert Issue #50.

**Sample PCA EtCO₂ Order:** Perform continuous EtCO₂ monitoring. Document value with each instance of vital signs and with each pain assessment for the duration PCA use. Contact provider for a CO₂ value less than 35 or greater than 45 or if patient is excessively drowsy. Any of these findings may be an indication to consider adjusting the PCA dose.

---

**Respiratory Status Zones**

SDPSC characterizes a patient’s respiratory deterioration into three high-level status zones: Safe, Risk, and Harm (Figure 9.0). This section describes each zone and typical, zone-specific interventions.

**Safe Zone: Effective Breathing**

With adequate patient screening, assessment, and monitoring, patients will be more likely to stay in the Safe Zone preventing respiratory decline into the Risk and Harm Zones. Safe Zone interventions include screening patient for monitoring appropriateness (e.g., STOP BANG assessment and sedation assessment) and effectiveness including EtCO₂ monitoring based on risk level.

**Risk Zone: Respiratory Depression**

Bedside caregiver knowledge of respiratory depression warning signs (see Figure 10.0) plus effective monitoring can result in prompt intervention of a patient in the Risk Zone. Risk Zone interventions include using a reversal agent, transferring patient to higher level of care, notifying RRT, and/or adjusting medications.

**Harm Zone: Respiratory Arrest**

The Harm Zone is characterized by a patient experiencing acute respiratory compromise or an adverse event/reaction to opioid and sedatives. Harm Zone intervention requires calling a Code and assisting with ventilation and oxygenation.
Alarm Response Algorithm

Figure 11.0 provides an algorithm for responding to a respiratory monitor alarm.

1. Assess Patient

The bedside caregivers must be trained in reading respiratory monitored data and attentive to the respiratory warning signs.

- When the alarm sounds, first assess if the patient is breathing.

1a. Is Patient Arousable?

Try to arouse the patient using the following methods:

- Call patient’s name while stimulating him/her, such as shake shoulders, move arm, etc.
- Apply nail bed pressure.
- Perform a sternal rub.

Is patient breathing?

- No: If the patient cannot be aroused, check if the patient is breathing. If the patient is not breathing, call Code immediately.
- Yes: If the patient is arousable and breathing, assess the patient’s breathing:
  - Evaluate the patient’s breathing data (respiratory rate, quality, rhythm, and depth) over time to identify any gradual increase or decrease in respiratory rate, EtCO₂ waveforms, and/or SpO₂ results.
  - Assess the patient’s EtCO₂ data with other patient data, such as medications, vital signs, etc.
  - Think critically of what the numbers reflect the patient’s overall respiratory status.
  - Evaluate any continuous IV infusion to rule out medication error.
  - Check pump programming.
  - Perform a sternal rub.

1b. Is Patient Breathing Effectively?

Yes: If patient is breathing effectively, re-assess patient per protocol.

No: Call RRT immediately and then:

- Contact provider (and keep informed).
- Consult respiratory care practitioner.
- Check medications.
- Consider obtaining arterial blood gas.
- Consider administering reversal agent.
- Consider referral to a higher level of care.
- Consider initiating supplemental oxygen (and jointly provide an intervention to support ventilation).

2. Is Alarm Valid?

Yes: Go to Step 3

No: If the alarm appears to be invalid, troubleshoot equipment:

- Fix/confirm correct placement of cannula and sensors on the patient.
- Analyze waveforms for irregularities.
- Check alarm parameters are appropriate for the patient.
- Check for improper tube placement or equipment malfunction.

3. Re-Assess Patient and Intervene (per Protocol)

Regularly, re-assess patient (see Step #1 in Figure 1.0: Care Process) and:

- Assess the patient’s respiratory rate, quality, rhythm, and depth for any early signs of hypoventilation.
- Assess the patient’s vital signs trends for any indication of decompensation.
- Assess the patient’s pain and level of sedation, and consider adjusting opioid dose and/or frequency.
- Evaluate for OSA/sleep disorder.
- Consider obtaining authorization to initiate NIV procedures, if needed, including:
  - Bilevel Positive Airway Pressure (Inspiratory Positive Airway Pressure 15, Expiratory Positive Airway Pressure 5, Rate 12)
  - Continue EtCO₂ monitoring with NIV.
Clinical Scenarios

Scenario #1

A 50-year-old female patient was transferred to the Telemetry unit at 1800 following a complicated hemicolectomy. Dilaudid PCA was infusing to control pain. At 0330, EtCO₂ trended up from 45 to 62 mmHg over the next 4 hours. The nurse repeatedly silenced the alarm since the SpO₂ remained at 100%. When the day shift nurse arrived at 0730, the patient’s pulse oximetry reading had dropped to 92% with a respiratory rate of 6 and the patient was difficult to arouse. Narcan was given, and the RRT was called.

Scenario #1 Key Take-away: A patient may have near normal SpO₂ and still have hypoventilation. For this patient, ventilation was impaired, but oxygenation was not.

Scenario #2

A 58-year-old male patient with morbid obesity (BMI 40 kg/m²) and a history of intractable low back pain was admitted to the hospital. X-rays demonstrated severe bone-on-bone changes in both knee and hip areas. The patient was placed on a PCA continuous basal infusion with a PCA demand dose and on continuous SpO₂ and EtCO₂ monitoring at 1800. Soon after starting PCA, the patient desaturated to a SpO₂ of 84%. The patient was placed on a 40% oxygen aerosol mask and EtCO₂ monitoring, and PCA continuous basal infusion was discontinued at 1930. A PCA demand dose was continued for patient pain control. The following morning, the patient appeared to be very lethargic and difficult to arouse with a SpO₂ in the high 90% range. The EtCO₂ monitor was reapplied with readings of 76 mmHg (Normal EtCO₂ = 35-45 mmHg) indicating an elevated carbon dioxide level. At 0745 on first rounds, the patient was transferred to ICU for treatment and continuous EtCO₂ and SpO₂ monitoring of OSA complicated by obesity and PCA.

Scenario #2 Key Take-away: This opioid naïve patient had multiple risk factors (morbid obesity, OSA, and a basal infusion), which should have alerted the nurse that the patient is at high risk for respiratory depression. The ICU transfer could have been prevented and BIPAP initiated, if screening had been done.

Scenario #3

A 45-year-old female patient was admitted to the Oncology floor from Recovery following a radical hysterectomy. The patient’s oxygen saturation was 100% with a noted respiratory rate of 7 on arrival to the floor from PACU. The nurse was considering administering Narcan, which would normally result in a call to the RRT (and possibly a transfer to ICU). However, the patient was placed on a capnography monitor that showed a normal EtCO₂ of 40 mmHg. The nurse was able to continue monitoring the patient’s ventilation and oxygenation, and Narcan was not required or administered.

Scenario #3 Key Take-away: Capnography validated the patient’s ventilation status. This prevented the unnecessary use of reversal agents, which would have resulted in significant pain for the patient.

Scenario #4

A 42-year-old male patient in the hospital for 8 days was transferred out of the ICU after Coronary artery bypass graft surgery to Progressive Care unit at 1830. The patient had a history of alcohol abuse and appeared to be agitated due to withdrawal. The patient’s vital signs were normal. Incisional pain was rated at 7 out of 10, so the nurse gave Norco at 2030. The patient was given multiple doses of Ativan (at 2100, 2200, and 0100) for agitation and morphine for pain. The EtCO₂ alarm alerted the nurse that the patient’s EtCO₂ was 47 and respiratory rate was 6. The nurse tried to arouse the patient, but he was barely responsive. The RRT was called and additional labs were taken. The patient was intubated and administered a reversal agent.

Scenario #4 Key Take-away: Assuming the cause of agitation was due to alcohol withdrawal without ruling out respiratory depression and hypoxemia was an error. Incorrectly treating the patient for withdrawal contributed to the patient’s respiratory depression.

8 Document, Communicate, and Evaluate

This section presents SDPSC recommendations for hospitals when establishing standardized and systematic practices for documenting, communicating, and evaluating a patient’s risk for respiratory depression.

Document

- Give front line clinicians and respiratory care practitioners input to the design of documentation practices.
- Document risk screening results, risk level, sedation score, and monitoring checks for provider (and next care providers) in:
  - Care plans,
  - Problem lists, and
  - Shift-to-shift reports.
- Document when initiating the monitoring protocol then check and document as follows:
  - every 15 minutes for 1 hour;
  - every 30 minutes for 1 hour;
  - every hour for 4 hours; and
  - every 4 hours.
- Follow standard of care guidelines for charting SpO₂ monitoring.
- Document as patient condition changes.
- Document any respiratory consultation.
- Document patient’s tolerance of prescribed NIV therapy.
- If patient’s risk level is Moderate to High or Very High Risk (see Figure 2.0), document notification to provider if intervention is not aligned with risk.
- Consider where and how respiratory risk levels, monitoring assessments, interventions, responses, etc. data are documented for leaders, managers, and front line staff to track and report for improvement efforts and through the quality system.
Implementing Guidelines

Communicate

**During Inpatient Stay**
- Incorporate patient respiratory risk level into preoperative checklist and review at shift-to-shift reporting.
- Notify patient and family/care partner of patient’s respiratory risk level including precautions and warning signs.
- Apprise all care team members (i.e., nursing, respiratory care practitioner, provider, pharmacist) of the patient’s respiratory risk level and what monitoring protocols have been implemented.
- Visually indicate for all care team members when a patient is at high risk for respiratory compromise. For example, post a precautionary sign, such as ARC-At-risk for Respiratory Compromise, in patient’s room and/or visually flag respiratory risk level in the medical record.

**For Transferring Patients**
- Educate transportation staff on the importance of maintaining at-risk patients at the same level of basic physiologic monitoring during transport as they received in the source area.
- Incorporate into the transfer process the communication to the receiving facility/care provider of ventilation status, respiratory risk level, and OSA screening results.

**For Discharging Patients**
- Provide patient and family/care partner after-care instructions based on respiratory risk and ensure understanding of risks. Patients with multiple risks factors undergoing surgery may need targeted education regarding risk and monitoring needs at home.
- Notify provider of respiratory risk level before discharging, as well as the next care provider.
- For patients with OSA/sleep disorder:
  - Incorporate into discharge process the communication of respiratory risk level and screening results.
  - Transition patient back to prescribed NIV home regimen (if it is effective).

Evaluate

The decision to discontinue respiratory monitoring must be determined after conducting a re-assessment of the patient and a thorough evaluation of the patient’s respiratory risk factor.
- At a minimum, assess patient’s sedation, respiratory rate, quality, depth, and rhythm.
- Consider re-assessing the patient immediately (within 5 minutes) prior to sedation administration. 40
- If patient remains at respiratory risk, consider implementing recommended monitoring protocol.
- If patient is no longer at respiratory risk based on monitoring recommendations, discontinue monitoring (see Monitoring Recommendations by Risk Factor Category section).
- Consider remote/centralized monitoring, if possible and recommended.

Implementing Guidelines

This section provides a description of the methodology used by SDPSC to develop the guidelines in this tool kit. It is recommended that hospitals use this same or similar change management model when developing and implementing safe and effective respiratory monitoring guidelines.

Enlist Champions and Mobilize Commitment

To start, form a hospital task force, clarify roles and responsibilities, and manage resistance by identifying stakeholders:
- Patient/Family/Care Partner
- Nursing
- Providers
- Respiratory Therapy
- Anesthesiologists
- Biomedical
- Clinical Pharmacists
- Supply Chain
- Discharge Planning
- Process Improvement Department
- IS/IT Pharmacy-IT Department
- Service Line Experts: Pain, Oncology, Diabetes
- Those responsible for standard order sets.

Define and Evaluate Current State

The task force must identify the current state to target change effectively. To do so, the task force should compile organizational data for sharing and discussing:
- Consider holding focus group sessions with bedside nurses and respiratory care practitioners from various non-ICU settings to better characterize current front line practices and challenges.
- Engage key stakeholders in identifying at-risk patients to scope in the most important target populations.
- Assess organizational use of reversal agents outside of anesthesia and examples of near misses or adverse events.

Create a Shared Need

It is important that the task force recognizes the case for standardization is based on scientific evidence, best practice, participants’ experience, etc. Facilitation should be encouraged to allow for discussion and clarification and ensure that the task force aligns fully on project scope. The outcome should be a concise, case description for respiratory monitoring standards.

Elevator Speech

An “Elevator Speech” can be used to quickly convey key elements of the improvement project to staff, such as:
- **What:** The goal of this project is to provide evidenced-based community standards and best practices for safe and effective
Implementing Guidelines

respiratory monitoring of at-risk patients for early detection and intervention in non-ICU hospital units.

- **Why**: This is important because hospitalized patients are subjected to significant harm or death after receiving sedating medications without appropriate monitoring and intervention.

- **Success**: We will have achieved success with this project when we have implemented safe, effective respiratory monitoring protocols across our hospital, as evidenced when no patient sustains an adverse event while receiving sedation medication.

- **Need**: We need your support and commitment in developing and adopting these standards and facilitating this change to all applicable areas and individuals. Your support and expertise are vital in keeping our patients safe.

**Value Analysis**

The task force should outline the costs and benefits to perform a meaningful value analysis of the improvement project for key decision-makers and ensure the optimal number and type of EtCO₂ monitors and resources are available.

**Costs**

Table 12.0 presents major direct and variable costs that a hospital can expect when implementing a respiratory monitoring program using EtCO₂ monitors.

**Table 12.0: Major Direct and Variable EtCO₂ Monitoring Costs**

<table>
<thead>
<tr>
<th>Direct Costs</th>
<th>Variable Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment lease/purchase payment</td>
<td>Labor</td>
</tr>
<tr>
<td>Warranty and service cost per year</td>
<td>Ongoing competency</td>
</tr>
<tr>
<td>Supplies/consumables</td>
<td>Implementation (e.g., training)</td>
</tr>
</tbody>
</table>

**Benefits from Enhanced Clinical Care**

Key benefits the task force can share with stakeholders once EtCO₂ monitors are incorporated into patient care outside the ICU:

- **Provides early and reliable detection of hypoventilation** – As procedures extend beyond the traditional areas, EtCO₂ monitoring is an important and reliable indicator of hypoventilation for early intervention and prevention of adverse events.

- **Offers a non-invasive solution** – EtCO₂ monitoring is a non-invasive diagnostic tool offering caregivers a continuous assessment of a patient’s ventilation status.

- **Reduces unnecessary and costly of ABG testing** – One study suggests the use of capnography could decrease the need for repeated arterial blood gases testing.⁴¹

- **Indicates early abnormal EtCO₂ findings** – Another study found a majority of patients with acute respiratory events had EtCO₂ abnormalities that occurred before oxygen desaturation or observed hypoventilation.⁴²

- **Integrates well with current and future practices** – Breathing pattern, respiratory rate, and oxygen saturation levels are important safety measurement standards common in today’s clinical practice in the ICU, ED, and step-down units. SDPSC members see a trend with integrating EtCO₂ readings into tomorrow’s practice for both procedural and non-procedural areas.

- **Optimizes patient safety** – Continuous EtCO₂ monitoring embeds proven technology and offers supplemental clinical data as a safety net for bedside caregivers and at-risk patients outside the ICU.

**Benefits from Cost Avoidance**

EtCO₂ monitoring is becoming a standard practice and often is included in a typical patient room charge. Therefore, the focus of a value analysis is on avoiding Risk Zone and Harm Zone costs. SDPSC identified costs that can be avoided when clinical practice includes continuous EtCO₂ monitoring of at-risk patients outside the ICU:

- CMS penalties for value-based programs (e.g., mortality complications, patient satisfaction scores, hospital and provider reputation) from federal and state program

- RRT costs (i.e., number of RRT calls for patients with a respiratory depression component)

- Transfer to higher level of care costs

- Number of interventions in response to EtCO₂ alarm costs

- Additional medication costs (e.g., Narcan, Solu-Medrol)

- Respiratory treatment and laboratory (e.g., ABG) costs

- Intubation costs

- Adverse event and investigation costs

- Adverse drug event and investigation costs (estimated cost used by SDPSC for discussion purpose of ADE was $7,725)⁴³

- Medical liability costs

- Caregiver “second victim” of adverse event costs (i.e., personal grief, turmoil).

**Quality Metrics**

Sometimes the most compelling strategy to create a shared need is to use quantitative and qualitative data to highlight the benefits of the technology. The more effective the care while the patient is in the Safe Zone the less cost is incurred and the better the outcomes. Figure 13.0 identifies possible quantitative quality metrics to monitor respiratory monitoring safety guidelines.

**Figure 13.0: Possible Respiratory Monitoring Quality Metrics by Zone**

- **HARM**
  - Adverse Event, Respiratory Arrest
  - Code blue data
  - Percent of postop opioid-related adverse events
  - Mortality data

- **RISK**
  - Respiratory Depression
  - Rapid Response Team data
  - Unplanned reversal agent use (e.g., number of patients given Narcan)
  - Occurrence report data
  - Respiratory depression event data
  - Transfer to higher level of care data

- **SAFE**
  - Effective Oxygenation and Ventilation
  - Appropriate use of technology or application (e.g., number of patients in which EtCO₂ or pulse oximetry used)
  - Appropriate documentation (e.g., number of patients documented EtCO₂ according to hospital policy)
  - Appropriate alarm management (e.g., number of instances finding alarm off, audits on appropriate alarm settings)
  - OSA screening effectiveness (e.g., patients with OSA suspected)
Additional patient, employee, and provider satisfaction may be indirectly impacted and these qualitative measures can offer valuable practice feedback.

**Purchasing Considerations**

SDPSC identified the following questions to answer when purchasing and implementing EtCO₂ equipment outside the ICU:
- What are the organizational needs?
- What are the current respiratory monitoring capabilities (e.g., equipment, brand, resources)?
- What quantity is optimal?
- What model configuration type (e.g., standalone, built into centralized structure, attached to PCA) is optimal?
- Who are all the purchasing stakeholders? For example:
  - Finance
  - Executives
  - Physician partners
  - Risk department/legal
  - Products committee
  - Clinical practice/quality committee
  - Sedation committee
  - Materials/supply chain departments
  - Respiratory departments
  - Information systems
  - Anesthesia departments.

**Standardize, Simplify, and Clarify**

A standard approach to respiratory monitoring across a hospital should extend beyond the assessments, processes, and monitoring protocols. It is recommended that policies and procedures, standard orders, documentation, education, and communication be standardized as well to simplify and clarify respiratory monitoring of at-risk patients for improved patient safety. Establishing an advisory group for governance of procedural monitoring (including representatives from emergency department and RRT) is recommended.

**Policies, Protocols, and Process**

Standard policies, protocols, and work processes are effective methods that provide a margin of safety in minimizing variance in assessing, detecting, and intervening patients at risk for hypoventilation. When developing and implementing these practices, be sure to engage in active listening and learning with all stakeholders. Ensure policies, protocols, and processes include standardization related to:
- Respiratory assessment initiation and frequency
- Frequency, mode, and duration of IV opioid delivery in determining monitoring method and frequency
- EtCO₂ monitoring initiation, frequency, and duration (inpatient and outpatient)
- Default alarm settings
- Centralized monitoring usage for higher acuity patients
- Integration of the Alarm Response Algorithm (see Figure 11.0) into bedside documentation for monitored patients
- Response to patient refusal to participate in care
- Non-invasive ventilation treatments
- Patient risk level on discharge/transfer paperwork
- Change of care documentation and communication
- Pharmacy communication based on medication ordered and reversal agent administration
- Monitoring patients during transport
- Quality improvement metrics
- Standards for long-term care, home health, and acute care rehabilitation environments.

**Standard Order Sets**

SDPSC recommends that each hospital establish standard order sets. Standardized order sets should:
- Include frequency, mode, and duration of IV opioid delivery to determine monitoring method and frequency.
- Address monitoring respiratory parameters as part of a clinical routine,
- Specify when alarm sounds what interventions are available to the nurse (unless part of protocol), and
- Identify when to remove, suspend (e.g., eating), and remove monitoring.

It is important that providers participate in all discussions related to order set standardization. Also, pharmacy and therapeutics committees should be kept apprised of any planned changes with medications.

**Documentation Guidelines**

SDPSC recommends the task force conduct a comprehensive and careful analysis of documentation to identify changes to any documentation forms, both paper and computerized, based on the recommended standards. For example, hand-off documentation should be updated to include patient’s risk level for hypoventilation. Consider which quality metrics are most meaningful when designing documentation fields and guidelines.

**Care Team Education**

SDPSC recommends the following when designing a respiratory monitoring education program:
- Recognize the initial, substantial effort needed to train providers, respiratory care practitioners, and nursing personnel in reading capnography waveforms.
- Address any barriers to nurse-provider communications related to monitoring.
- Consider engaging RRT members, anesthesia department, and respiratory staff as educators.
- Educate all disciplines providing care for at-risk patients (e.g., providers, nurses, anesthesiologists, pharmacists).
- Educate at bedside and during unit meetings, staff orientations.
- Enable opportunities for staff to routinely use capnography and gain experience with the use and interpretation of capnograms.
Implementing Technology

SDPSC acknowledges many hospitals are not fully equipped to offer EtCO₂ monitoring on patients that may benefit and that triaging the monitors for the most critical patients may be necessary (until the appropriate numbers of monitors are acquired).

SDPSC recommends the following considerations when implementing respiratory monitoring technology:

- Provide consistent technology throughout the hospital.
- Inconsistency among units increases patient safety risk due to complexity and staff knowledge of variations.
- Recommend central monitoring along with nurse notifications.
- Institute regular servicing of EtCO₂ monitors and educate staff to periodically inspect tubing, cannula, etc.
- If network capable, recommend integrating monitoring with hospital’s electronic medical record.
- During patient set-up, use two patient identifiers (not room number) and a standard process to prevent incorrect patient identification for remote monitoring.
- Involve a multidisciplinary team in planning and implementing the technology for improved acceptance and compliance.

Remote/Centralized Monitoring

SDPSC suggests using remote/centralized ventilation status monitoring whenever possible for patients classified as Very High Risk for respiratory depression. However, if remote/centralized monitoring is not feasible, SDPSC recommends hospitals:

- Start with what monitoring equipment exists, place the patient in close proximity to nursing stations, and work to integrate new technologies, such as:
  - Remote/centralized monitoring technologies and practices
  - Pulse oximetry technology integrated into the hospital’s call-light system.
  - Hand-held devices that provide viewing of alarm data.

Benefits of Remote/Centralized Monitoring

The benefits of a model in which experts in alarm and waveform analysis and response protocols continuously monitor patients’ trended data from a remote/centralized location include:

- Continuous monitoring of multiple patients at one time.
- Allows for easy identification and resetting of false alarms.
- Enables prompt notification to the bedside caregiver of any alarm or irregularity for timely intervention.
- Based on the technology:
  - Reacts to certain alarm parameters and restricts patient’s from over self-medicating (e.g., PCA)
  - Provides measurement of multiple parameters with one technology
  - Enables setting or adjusting alarms remotely.
  - Enhances existing bedside monitoring with added surveillance for the bedside caregiver.
- (Centralized) Reduces the demand for high cost areas as patients can remain at the current level of care.
- (Centralized) Reduces the costs associated with transferring patients between levels of care.

Remote/Centralized Monitoring Considerations

The following should be considered when establishing a remote/centralized monitoring model:

- Recommend a dedicated RRT nurse/charge nurse to proactively assist technicians in viewing monitored parameter trends. This nurse would initiate contact with the primary bedside caregiver or charge nurse, as well as notify RRT to go to the unit and check the patient.
- Allow for the initial cost of expert education of technicians and dedicated nurses.
- Review and update nursing notification, documentation, and communication processes and procedures, as appropriate.
- Set realistic staffing ratios and policies for the dedicated remote monitoring staff/technicians.

Maintain and Continue Improvements

The task force should establish a systematic method for maintaining and continuing respiratory monitoring improvements. These methods may include:

- Monitor and report trends in quality metrics (see Figure 13.0).
- Integrate action plans into audit processes.
- Set thresholds where action plans need to be developed.
- Assess results to characterize gaps in practice.
- Periodically review order set, policies, protocols, education, etc.
- Continuously evaluate scientific literature and adopt and share best practices.
References

Appendix A: Assessment Tools Information

<table>
<thead>
<tr>
<th>Assessment Tool</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richmond Agitation Sedation Scale</td>
<td>Included with the SDPSC Sedation Guidelines of Care Tool Kit 2009 available for download from the <a href="http://www.hqinstitute.org/highriskmed">www.hqinstitute.org/highriskmed</a> website</td>
</tr>
<tr>
<td>Berlin Questionnaire</td>
<td>Refer to <a href="http://www.asahq.org">www.asahq.org</a></td>
</tr>
<tr>
<td>Epworth Sleepiness Scale</td>
<td>Copyrights managed by Mapi Research Trust organization at <a href="http://www.mapi-trust.org">www.mapi-trust.org</a></td>
</tr>
<tr>
<td>American Society of Anesthesiologists (ASA) Checklist</td>
<td>Refer to <a href="http://www.mapi-trust.org">www.mapi-trust.org</a></td>
</tr>
</tbody>
</table>

### Abstracts of OSA Screening Tool Evaluation


**BACKGROUND:** Obstructive sleep apnea (OSA) is a major risk factor for perioperative adverse events. This study was conducted to develop and validate a concise and easy-to-use questionnaire for OSA screening in surgical patients.

**METHODS:** Preoperative patients aged 18 year or older and without previously diagnosed OSA were recruited. After a factor analysis, reliability check, and pilot study; four yes/no questions were used to develop this screening tool. The four questions were respectively related to snoring, tiredness during daytime, observed apnea, and high blood pressure (STOP). For validation, the score from the STOP questionnaire was evaluated versus the apnea-hypopnea index from monitored polysomnography.

**RESULTS:** The STOP questionnaire was given to 2,467 patients, 27.5% classified as being at high risk of OSA. Two hundred eleven patients underwent polysomnography, 34 for the pilot test and 177 for validation. In the validation group, the apnea-hypopnea index was 20 +/- 6. The sensitivities of the STOP questionnaire with apnea-hypopnea index greater than 5, greater than 15, and greater than 30 as cutoffs were 65.6, 74.3, and 79.5%, respectively. When incorporating body mass index, age, neck circumference, and gender into the STOP questionnaire, sensitivities were increased to 83.6%, 92.9%, and 100% with the same apnea-hypopnea index cutoffs.

**CONCLUSIONS:** The STOP questionnaire is a concise and easy-to-use screening tool for OSA. It has been developed and validated in surgical patients at preoperative clinics. Combined with body mass index, age, neck size, and gender, it had a high sensitivity, especially for patients with moderate to severe OSA.


**BACKGROUND:** This study was conducted to validate the Berlin questionnaire and the American Society of Anesthesiologists (ASA) checklist in surgical patients and to compare them with the STOP questionnaire.

**METHODS:** Preoperative patients aged 18 year or older and without previously diagnosed OSA were recruited. The scores from the Berlin questionnaire, ASA checklist, and STOP questionnaire were evaluated versus the apnea-hypopnea index from in-laboratory polysomnography. The perioperative data were collected through chart review.

**RESULTS:** Of 2,467 screened patients, 33, 27, and 28% were respectively classified as being at high risk of OSA by the Berlin questionnaire, ASA checklist, and STOP questionnaire. The performance of the screening tools was evaluated in 177 patients who underwent polysomnography. The sensitivities of the Berlin questionnaire, ASA checklist, and STOP questionnaire were 68.9-87.2, 72.1-87.2, and 65.6-79.5% at different apnea-hypopnea index cutoffs. There was no significant difference between the three screening tools in the predictive parameters. The patients with an apnea-hypopnea index greater than 5 and the patients identified as being at high risk of OSA by the STOP questionnaire or ASA checklist had a significantly increased incidence of postoperative complications.

**CONCLUSIONS:** Similar to the STOP questionnaire, the Berlin questionnaire and ASA checklist demonstrated a moderately high level of sensitivity for OSA screening. The STOP questionnaire and the ASA checklist were able to identify the patients who were likely to develop postoperative complications.


**STUDY OBJECTIVES:** The authors initiated a protocol designed to screen patients preoperatively and monitor them postoperatively. The goal was to identify patients who were at risk for oxygen desaturation after discharge from the postanesthesia recovery room (PACU).

**METHODS:** Patients without previously diagnosed OSA presenting to the preoperative evaluation clinic were assessed over a 10.5-month period using a validated prediction rule to identify patients thought to be at high risk of OSA (sleep apnea clinical score, SACS > or = 15). Following surgery, patients were monitored in the PACU for significant respiratory events: apnea, increased FiO2 requirement, pain-sedation mismatch, or episodes of desaturation. Patients were placed in 3 groups based on their SACS and the presence or absence of recurrent PACU respiratory events (group 1: SACS < 15, no recurrent events; group 2: SACS > or =15, no recurrent events; and group 3: SACS > or = 15, recurrent events.) The number of oxygen desaturations > or = 4% per hour, the oxygen desaturation index (ODI), was calculated for each patient for 24 to 48 hours after PACU discharge. An ODI > 10 was the threshold chosen to indicate a high frequency of oxygen desaturation.

**RESULTS:** The percentage of patients with ODI > 10 differed significantly across the 3 study groups (12%, 37%, and 57%, for groups 1-3, p = 0.005). Mean ODI in group 1 was significantly different from groups 2 and 3 (5.8 compared to 10.0 group 2 and 11.4 group 3 with p = 0.001).

**CONCLUSIONS:** The authors have shown that combining preoperative screening is useful for identifying patients at risk for oxygen desaturation after PACU discharge.
Respiratory Monitoring Prioritization Process (for areas outside the ICU)

The ideal of EtCO2 monitoring in every patient may not be practical due to equipment limitations. This process is intended to help the bedside caregiver prioritize the use of EtCO2 equipment, including starting/stoping.

A. Assess sedation (using validated Sedation assessment tool) as part of the initial assessment process
B. Assess airway and OSA (using validated OSA Assessment tool)
C. Assess for risk factors of respiratory depression
D. Identify risk level and prioritize monitoring need (consider “escalating factors”):

Very High Risk*
- Opioid Infusion Therapy – PCA (with and without Basal), PCEA, or Epidural
  Start Monitoring: Upon initiation of PCA
  Stop Monitoring: When PCA discontinued; After 6 hours from discontinuing epidural
- Recent Unplanned Administration of Reversal Agents
  Start Monitoring: Upon administration of agent
  Stop Monitoring: Up to 2 hours after the most recent administration
- Known or Suspected OSA/Sleep Disorder (NOT using NIV as prescribed)
- General Anesthesia within 1 to 4 hours
  (consider patient-specific complications for adverse risk from anesthesia)
  Stop Monitoring: If no observed apnea or desaturation, discontinue after 1st 24 hours postop

Moderate to High Risk*
- Opioids & Concomitant Sedatives/Medication Stacking/Other Sedating Medications
  Start Monitoring: Monitor 1st 24 hours
  Stop Monitoring: 24 hours unless risk level changes
- Moderate (a.k.a. Conscious) Sedation
  Start Monitoring: Upon administration of sedative; QS minutes during procedure
  Stop Monitoring: Follow standardized scoring system for your facility
- General Anesthesia within 5 to 24 hours
  Recommend monitoring postop (consider patient-specific complications for adverse risk from anesthesia)
  Stop Monitoring: If no observed apnea or desaturation, discontinue after 1st 24 hours

Low to Moderate Risk*
- Opioids, Sedatives
  Start Monitoring: Monitor 1st 24 hours
  Stop Monitoring: 24 hours unless risk level changes
- Known or Suspected OSA/Sleep Disorder (using NIV as Prescribed in Facility)

Very Low Risk
- No known or suspected Medication-Related, OSA/Sleep Disorder, Medical Conditions/Diseases, Medical History/Physical State, or Other Considerations/Environmental Conditions Risk Factors
  No continuous monitoring necessary

* When using supplemental oxygen, evaluate the patient need for EtCO2 monitoring independent of SpO2 values.

E. Determine respiratory monitoring method based on risk level:

<table>
<thead>
<tr>
<th>Respiratory Monitoring Prioritization Recommendations Based on Risk*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk Level</strong></td>
</tr>
<tr>
<td>Monitor</td>
</tr>
<tr>
<td>Location</td>
</tr>
</tbody>
</table>

* SDPSC acknowledges many hospitals are not fully equipped to offer EtCO2 monitoring on patients that may benefit and that triaging the monitors for the most critical patients may be necessary (until the appropriate numbers of monitors are acquired).

b All risk factors identified apply to sedated patients outside the ICU (e.g., post anesthesia care unit, interventional radiology, endoscopy, catheterization laboratory, emergency).

c SDPSC monitoring recommendations are inclusive of existing best practices and standardized protocol for pulse oximetry monitoring.

d An example of a patient with Very Low Risk is a marathon runner in the emergency department with a broken wrist and no health risks.

e When using supplemental oxygen, evaluate the patient for EtCO2 independent of SpO2 values.
Appendix C: OSA Treatment Information

Obstructive Sleep Apnea Treatment Synopsis

Preoperative Care
The report updated in October 2013 by the American Society of Anesthesiologists (ASA) Task Force on Perioperative Management of Patients with Obstructive Sleep Apnea (OSA) recommends the preoperative evaluation of a patient for potential identification of OSA include a medical record review, patient/family interview and screening protocol, physical examination, and the preoperative initiation of CPAP should be considered, especially if OSA is severe.

Intraoperative Care
The ASA further lists anesthetic technique, airway management, and patient monitoring as significant intraoperative concerns for patients at increased perioperative risk from OSA who are particularly susceptible to the respiratory depressant and airway effects of opioids, sedatives, and inhaled anesthetics. To reduce the complications in the intraoperative and postoperative phases, avoid the use of opioid and sedative medications when possible. If opioids or sedatives are necessary, reduce the dose and titrate the medication slowly.

Patients at increased perioperative risk from OSA are especially susceptible to the respiratory depressant and airway effects of sedatives, opioids, and inhaled anesthetics due to the propensity for airway collapse. The possibility for postoperative respiratory compromise should be considered when selecting intraoperative medications for patient safety. Local anesthesia or peripheral nerve blocks, with or without moderate sedation, should be considered for superficial procedures when possible. For moderate sedation use, capnography should be used to continuously monitor ventilation because of the risk of airway compromise of undiagnosed OSA. For patients at an increased risk of OSA who require general anesthesia, a secured airway is considered safer than deep sedation without an airway. Intraoperative care should concentrate on airway management and patient monitoring to include the following: respiratory rate, oxygen saturation, and capnography.

Postoperative Care
Postoperative respiratory depression risk factors may include the underlying severity of the obstructive sleep apnea, systemic administration of opioids, use of sedatives, surgical site, and invasiveness of surgical procedure. The ASA recommends postoperative interventions that include postoperative analgesia, oxygenation, patient positioning, and monitoring. It is well documented that the most important interventions to improve outcomes and reduce complications occur during the first 24 postoperatively, although deaths have occurred after 24 hours. Patients are considered to be at risk for 3 to 5 days postoperatively with pain management strategies. The potential for apnea during rapid eye movement (REM) sleep on the third or fourth postoperative day (i.e., “REM rebound”) may be expected as sleep patterns are reestablished. Postoperative risk reduction strategies include the following:

- Positioning the patient in a lateral or semi-upright position — not supine
- Extubating the patient when he or she is fully awake
- Continuous centralized pulse oximetry or capnography
- Applying Non-invasive Positive Pressure Ventilation (NIPPV: CPAP, APAP, BiPAP modes) after extubation, especially for a patient who has undergone major abdominal surgery
- If the patient is on NIPPV at home, continuing therapy until hospital discharge
- Administering supplemental oxygen to maintain pulse oximetry above 90%
- Frequent monitoring of vital signs, especially respiratory rate and pattern
- If periods of apnea or desaturation are observed, notifying the attending and obtaining arterial blood gas
- Providing regional anesthesia for pain control
- Avoiding benzodiazepines due to effects minor tranquilizers may have on respiratory drive
- Treating with nonsteriodals whenever possible
- Preferably, administering opioids via epidural or regional catheter instead of intravenous or intramuscular routes
- Monitoring patients who have been administered narcotics.

Discharge
Provide patient education to patients who are suspected of having OSA on symptoms, OSA syndrome, risks, diagnosis, treatment, and further information and follow up as soon as possible with the family practice physician regarding the need for a sleep study. When providing this information at discharge, also include phone numbers for a contact person to call with questions if possible.

Copyright © 2013, the American Society of Anesthesiologists, Inc. Lippincott Williams & Wilkins. Anesthesiology 2014; 120:00–00 [cited 1/24/14].