

Reducing Harm from Respiratory Depression in Non-ICU Patients

Through Risk Mitigation
and Respiratory Monitoring

GUIDELINES OF CARE TOOL KIT

NOV 2017



The Hospital Quality Institute (HQI) collaborates with California hospitals and hospital systems to accelerate patient safety and quality improvement.

This tool kit reflects the experience and learning of HQI and its member hospitals and hospital systems. Its purpose is to provide evidence-based recommendations and best practices on safe and effective assessment, monitoring, and intervention of patients outside the ICU who are at risk for respiratory depression. This resource is for the use of health care professionals, not consumers. The medical information contained herein is provided as an information resource only; it is not intended to be used or relied upon for any diagnostic or treatment purposes. This tool kit is not intended for patient education, does not create any patient-physician relationship, and should not be used as a substitute for professional diagnosis or treatment.

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Executive Summary

The Hospital Quality Institute (HQI) Mission is: *to advance and accelerate patient safety and quality improvement for coordinated statewide impact, with aims to achieve zero defects, optimize clinical effectiveness, and enhance patient and family experience in health care.*

The purpose of this tool kit is to advance the mission by providing evidenced-based recommendations and best practices on safe and effective assessment, monitoring, and intervention for patients at risk for unrecognized respiratory depression in a non-ICU environment.

In 2014, the Respiratory Monitoring of Patients Outside the ICU Guidelines of Care Tool Kit was created. Since then, health care organizations continued to strive to implement effective frontline and systematic practices that recognize and prevent respiratory depression. HQI member organizations agreed that an update of the original tool kit was needed.

In 2017, a California statewide, multidisciplinary group from member hospitals and hospital systems met to review current literature, assess community practice, and provide evidence-based recommendations and best practices that reduce patient harm from respiratory depression through risk mitigation and respiratory monitoring. The result of this group's work is the 2017 update of the 2014 tool kit.

INTENDED AUDIENCE

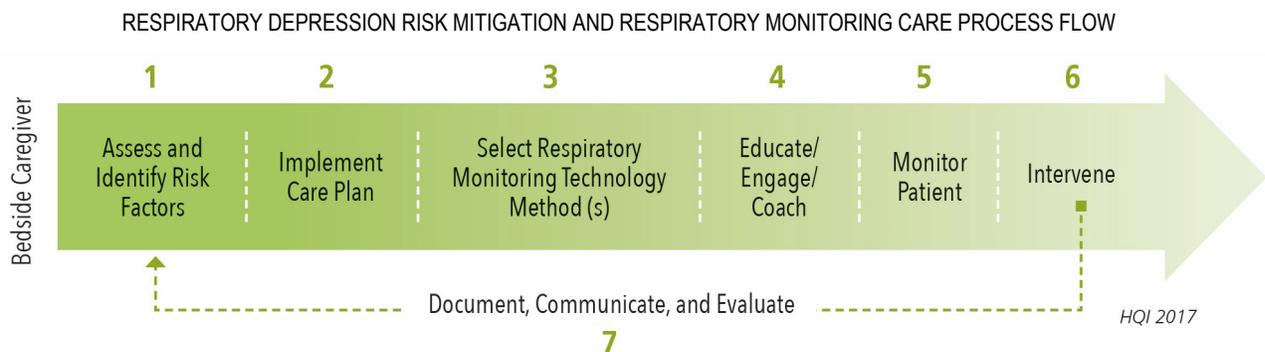
This tool kit is primarily designed for frontline providers, as a source for key guidelines and decision-support tools to help risk assessment and risk mitigation related to respiratory depression in patients older than 14 years.

Additionally, the tool kit should be seamlessly designed into the providers' workflow and integrated with organization-wide improvement efforts, rather than being treated as a simple "tack on" to existing care processes. To enable this, health care managers should consider using the recommendations in this tool kit as a foundation for ongoing, systemic improvement. Improvements that hardwire and drive the "quadruple aim" – improving health, improving patient care, reducing cost, and improving patient and workforce experience through specifically designed and reliably delivered care.¹

WHAT IS IN THIS TOOL KIT?

This tool kit offers improvements in the process of care, a new decision-support aid for frontline providers, and enhanced recommendations and lessons learned on implementing a hospital-wide respiratory depression improvement effort.

- **Respiratory Depression Risk Mitigation and Respiratory Monitoring Care Process.** This tool kit presents an updated high-level flow diagram for the respiratory monitoring process, with an emphasis on assessment and providing decision support. For each step of the process, the tool kit provides an overview of the evidence, along with specific tools and practice guidelines to assist health care providers in implementing best practice. See page 11 of this tool kit.



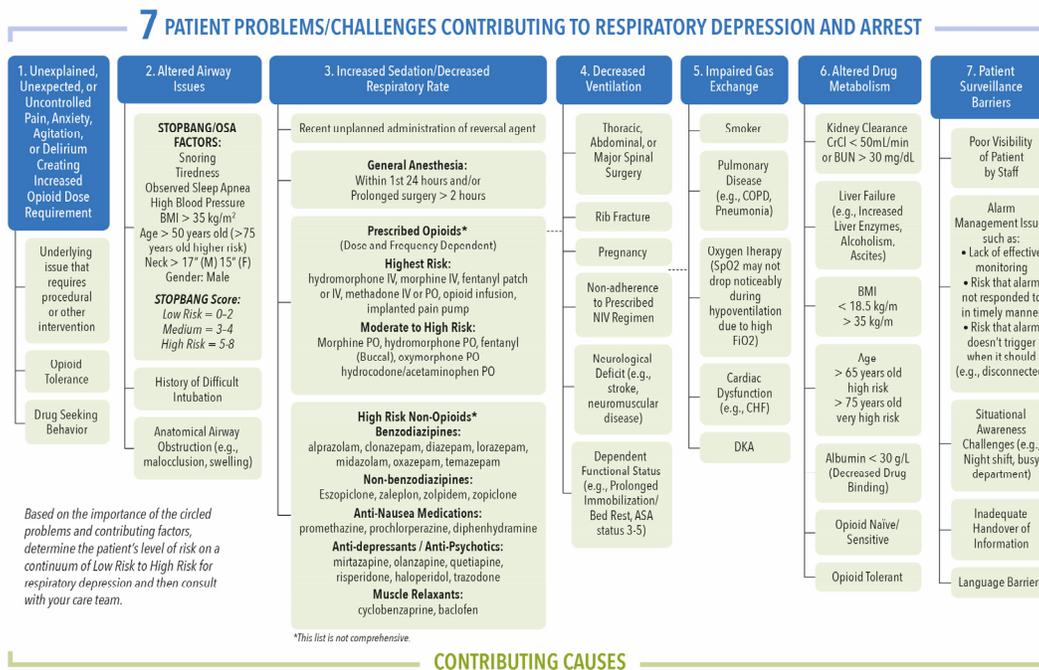
- **Highlighting Risk Assessment and Decision-Support Tools.** Key resources included in the tool kit are the California Opioid Assessment and Action Safety Tool (COAST) for Adults – that promotes proactive risk assessment – and targeted risk reduction strategies to improve safety for patients receiving opioid therapy outside the ICU. COAST for Adults does

not result in a scientifically-validated risk score. Instead, it serves as a practical guide to provide decision support and prompt frontline providers to consider key risk factors and best practice guidance for addressing those risk factors. Additionally, common patient profiles are provided to characterize the levels of risk. See page 13 of this tool kit.

California Opioid Assessment and Action Safety Tool (COAST) for Adults

1. Proactively assess the patient by **circling** all contributing causes that are present below. PAUSE and ASSESS the number of circled problems/challenges.
2. Implement Targeted Risk Reduction Tactic(s) to mitigate modifiable risk factors and reduce overall risk; use electronic respiratory monitoring as needed.
3. Re-assess risk according to patient's plan of care and hospital policy; look at all problems/challenges with every reassessment.

This tool is not intended to provide a scientific, validated score rather it is meant to serve as a decision-support job aid.



- **Lessons Learned.** This section helps improvement teams at the organizational level by providing a description of the methodology used to develop the guidelines in this tool kit. It is recommended that hospitals use this change management model, or a similar one, when developing and implementing safe and effective respiratory monitoring guidelines. To help change leaders improve the respiratory monitoring care process in their hospitals, this section offers lessons learned on managing change at the organizational level and provides guidance on how to: (See page 43 of this tool kit)
 - Make the case,
 - Standardize, simplify, and clarify,
 - Implement technology, and
 - Maintain and continue improvements.

LEVERAGING TECHNOLOGY: MORE THAN A LIVING DOCUMENT

In addition to being a resource, this suite of tools also provides frontline decision support through a dynamic web application that can be viewed on any browser-enable device. The digital version allows fast access to critical algorithms within a few screen taps, and provides frequent updates and commentary on current and emerging best practices. It is a dynamic tool that is included with the tool kit available for download at www.hqinstitute.org/tools-resources.

Additionally, the web application includes a blog that serves as a hub for organizations to share their emerging knowledge about how best to implement and sustain improvement using the recommendations and best practices in the tool kit.

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Glossary

ADE. (Adverse Drug Event). Any injury, harm, or adverse reaction associated with drug use including errors and event occurring with proper dosage and administration.

APSF. Anesthesia Patient Safety Foundation

ASA. American Society of Anesthesiologists

A T M O S P H E R E. An acronym for remembering the warning signs of respiratory depression: **A**bnormal slowness of respiration, **T**reatment of pain/agitation ineffective, **M**ental status change or reduced level of consciousness, **O**xygen saturation is low, **S**norring or other noisy respirations, **P**asero Opioid-Induced Sedation Scale, **H**ypoxia, **E**levated carbon dioxide level in the circulation blood, **R**ichmond Agitation Sedation Scale, **E**nvironmental barriers/alarming.

BIPAP. Bilevel Positive Airway Pressure

BMI. Body Mass Index

Capnogram. A real-time waveform that displays the change in concentration of carbon dioxide in the respiratory cycle.

Capnography. A monitoring device that measures the concentration of carbon dioxide in exhaled air and displays a numerical value and waveform tracing.

CKD. (Chronic Kidney Disease). Abnormalities of kidney structure or function, present for >3 months, with implications for health.

CNS. Central Nervous System

CO₂. Carbon Dioxide

COAST. California Opioid Assessment and Action Safety Tool

Continuous Ventilation Monitoring. The monitoring of patient ventilation that may be accomplished by using devices specifically designed to monitor the effectiveness of ventilation either by CO₂ levels or minute ventilation, such as continuous End-Tidal CO₂ (EtCO₂) monitoring or Respiratory Volume Monitoring (RVM).

CPAP. Continuous Positive Airway Pressure

DKA. Diabetic Ketoacidosis

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.

Fist to Five Technique. A voting technique (1 to 5 fingers up or down) used by teams to poll team members and help achieve consensus.

HQI. Hospital Quality Institute

pH. (Potential of hydrogen). A numeric scale used to specify the acidity or basicity of an aqueous solution.

Post-Procedural Sedation. An induced state of sedation characterized by a minimally depressed consciousness such that the patient can continuously and independently maintain a patent airway, retain protective reflexes, and remain responsive to verbal commands and physical stimulation.²

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.³

MOSS. Michigan Opioid Safety Scale

Motivational Interviewing. A method that works on facilitating and engaging intrinsic motivation within the client to change behavior.⁴

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. Patients who are considered opioid-tolerant are those who have been taking, for a week or longer, at least 60 mg of oral morphine daily, or at least 30 mg of oral oxyCODONE daily, or at least 8 mg of oral HYDRomorphone daily, or an equianalgesic dose of another opioid. [Food and Drug Administration]

Opioid Naïve. Those patients who are not taking a regular, daily, around-the-clock narcotic pain medicine for at least 7 days. [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.

Oxygenation. The act of adding oxygen to the human body.

PaCO₂. Partial pressure of carbon dioxide in arterial blood.

PCA. Patient Controlled Analgesia

PCO₂. Partial pressure of carbon dioxide

PCEA. Patient-Controlled Epidural Analgesia

POSS. Pasero Opioid-Induced Sedation Scale

Provider. Medical doctor, physician, physician assistant, nurse practitioner

PtcCO₂. Transcutaneous CO₂

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.

RASS. Richmond Agitation Sedation Scale

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 paradoxical rhythm with little chest excursion.⁵

Respiratory Volume Monitoring. (RVM). Monitors the adequacy of ventilation using minute ventilations value

RRT. (Rapid Response Team). A team of health care providers that responds to hospitalized patients with early signs of clinical deterioration on non-intensive care units to prevent respiratory or cardiac arrest.

SAS. Riker Sedation-Agitation Scale

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.

STOP BANG Screening Tool. An acrostic questionnaire for assessing a patient's risk for obstructive sleep apnea: Snoring, Tiredness, Observed apnea, high blood Pressure, Body mass index (BMI), Age, Neck circumference, and male Gender.

TRRT. Targeted Risk Reduction Tactics

Ventilation. The process of exchange of air between the lungs and the ambient air.

Introduction

NEED FOR CHANGE

Avoidable patient harm in United States hospitals is a major public health concern⁶ that may lead to as many as 200,000-400,000 deaths per year and 2-4 million preventable cases of serious harm.⁷ Post-operative and opioid-induced respiratory depression (OIRD) are common and important sources of harm.^{8,9,10,11} Severe respiratory complications significantly increase mortality risk, length of stay, 30-day readmissions, and cost of care.¹² Fortunately, with the right application of practice guidelines and technology, major harm as a result of these complications is highly preventable. (One study estimated found that 97% of OIRD-associated adverse events were possibly or probably preventable with better monitoring.¹³)

However, there is a “knowing-doing gap” between what is known in the literature and what happens in everyday practice,¹⁴ and respiratory depression continues to be an important patient safety concern. This tool kit aims to help bridge that gap, by providing a structured approach to determining and delivering the safest respiratory care for every patient.

“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 post-operative 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.”¹⁵

HQI endorses the Anesthesia Patient Safety Foundation statement¹⁶ that urges health care professionals to consider the potential safety value of using available technology to continuously monitor both oxygenation and ventilation in patients at risk for respiratory depression. A shared need exists for hospitals to set respiratory monitoring guidelines of care for patients located outside the ICU.

HQI encourages review and usability testing of new technologies. For example, virtual reality is being tested in hospitals to reduce opioid use. This technology supports the engagement of patients in their health care and may help to reduce harm from respiratory depression. The reduction of opioids prescribed may decrease the risk of respiratory depression.

PERFORMANCE IMPROVEMENT PROJECT

In 2017, a California statewide, multidisciplinary group from member hospitals and hospital systems assembled to update the 2014 tool kit. Workgroup members included nurses, pharmacists, physicians, respiratory care practitioners and quality and patient safety professionals. The workgroup 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 HQI improvement project is to provide evidenced-based recommendations and best practices for safe and effective assessment, risk mitigation, and monitoring of patients at risk for respiratory depression outside the ICU, resulting in:

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

Scope

The scope of this HQI improvement project includes patients older than 14 years receiving any kind of sedating medication in non-ICU inpatient care units.

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
- Respiratory volume monitoring
- Multi-parameter monitoring
- Physical assessment

This improvement project excludes:

- Monitoring during cardiopulmonary resuscitation
- Neonatal patients
- Patients in the ICU
- Actively laboring women not at high risk
- Medication and sedation protocols (see related tool kits at www.hqinstitute.org/tools-resources)

Method

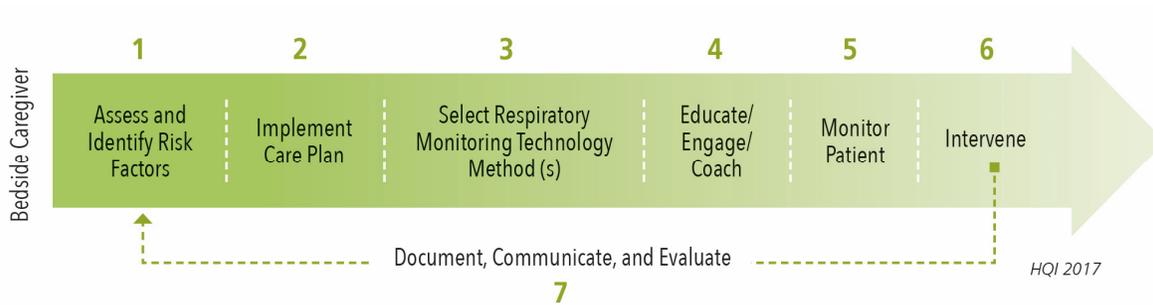
Workgroup members met using meeting facilitation techniques to reach consensus, devise assessment and monitoring standards, and document best practices, as follows:

- **Step 1: Created a Shared Vision:** Members reviewed and updated 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:** Facilitators identified four subgroups based on previous tool kit sections. Members volunteered to participate in at least one of the subgroups and met to investigate current practices and identify recommendations.
- **Step 3: Discussed Findings:** Each subgroup reviewed literature; gathered current in-house practices, lessons learned, protocols, order sets, and tools; and assembled and reported issues/barriers, recommendations, and next steps. Collaboratively, members vetted subgroup recommendations against the following criteria: target-audience-focused, actionable, meaningful, practical, evidenced-based (if possible), and at the appropriate level of detail.
- **Step 4: Documented Recommendations:** Members' collective experience, literature review, and shared practices contributed to discussions and decision-making. The facilitators polled each member using the "Fist to Five" technique to achieve consensus on processes, figures, algorithms, recommendations, protocols, examples, and other tool kit deliverables.

Respiratory Monitoring Care Process

Workgroup members developed a high-level flow diagram of a frontline provider's respiratory monitoring care process (Figure 1). 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:

FIGURE 1: RESPIRATORY MONITORING CARE PROCESS



- 1 **Assess and Identify Risk Factors.** The frontline provider assesses the patient for the presence of risk factors using standardized and validated tools and a tool that aids with decision support, and then identifies the patient's risk.
- 2 **Implement Care Plan.** Knowing the patient's risk, the frontline provider determines appropriate tactics and initiates those tactics to reduce known risks wherever possible.
- 3 **Select Respiratory Monitoring Technology Method(s).** If the frontline provider determines the patient should be monitored, and based on the patient's risk, the caregiver selects the appropriate respiratory monitoring technology method(s) based on the available technology.
- 4 **Educate/Engage/Coach.** The frontline provider 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.
- 5 **Monitor Patient.** The frontline provider monitors the patient's oxygenation and ventilation for airway obstruction or respiratory depression.
- 6 **Intervene.** During the care process, in the event of an alarm or early indication of respiratory deterioration, the frontline provider evaluates monitored data and responds to the data as appropriate.
- 7 **Document, Communicate, and Evaluate.** The frontline provider determines whether to continue monitoring the patient by periodically evaluating the patient's risk level with measurable criteria (by starting over at Step 1 of the Care Process).

1 Assess and Identify Risk Factors

The Respiratory Monitoring Care Process begins with the frontline provider assessing the patient for the presence of suspected or known risk factors using standardized and validated tools. Risk is not often determined by a single factor (e.g., Patient Controlled Analgesia [PCA]), but impacted by a combination of risk factors that require full assessment and judgment by the frontline provider. Patients with any “escalating” factor are considered higher risk. Considering a patient’s risk status can change, it is recommended the frontline provider periodically evaluates risk.

ASSESSMENT TOOLS

A critical barrier to identifying patients at risk for respiratory depression is accurately screening for suspected and known risk factors. Workgroup members recommend using a standardized risk assessment approach, including who is responsible for the screening, when to screen, which standardized and validated tools to use, and the frequency of screening. Table 1 lists the respiratory and sedation assessment tools evaluated by members.

TABLE 1: RESPIRATORY AND SEDATION ASSESSMENT TOOLS

ASSESSMENT TOOL	INFORMATION
American Society of Anesthesiologists (ASA) Checklist	Consists of 14 questions organized into three categories for anesthesiologists to screen patients for OSA. ¹⁷
Berlin Questionnaire	Includes questions about snoring, daytime somnolence, body mass index, and hypertension and is a brief and validated screening tool that identifies persons in the community who are at high risk for OSA. ^{18, 19}
Epworth Sleepiness Scale	Is used in the field of sleep medicine as a subjective measure of a patient's sleepiness. ²⁰
Michigan Opioid Safety Scale (MOSS)	Incorporates patient risk, respiratory rate, and sedation into one bedside score that could be used to improve patient safety during inpatient opioid therapy. Scoring is based on a summation of risk data with objective bedside measures of over-sedation trumping a patient's subjective reports of pain. ^{21, 22}
Pasero Opioid-Induced Sedation Scale (POSS)	Assesses sedation when administering opioid medications to manage pain. ^{23, 24}
Richmond Agitation Sedation Scale (RASS)	Measures the agitation or sedation level of a patient ^{25, 26, 27} (Sedation Guidelines of Care Tool Kit 2009 available for download at www.hqinstitute.org/tools-resources)
Riker Sedation-Agitation Scale (SAS)	Contains subjective scales to assess agitation and sedation in adult intensive care unit (ICU) patients who have rarely been tested for validity or reliability. ²⁸
STOP BANG Screening Tool	Consists of eight Yes/No questions. One study showed patients who screened positive on the questionnaire were more likely to have post-operative complications than those that screened negative. ^{29, 30}

CALIFORNIA OPIOID ASSESSMENT AND ACTION SAFETY TOOL (COAST) FOR ADULTS

Workgroup members recognize, from lessons learned, the complexity of identifying a patient's risk for respiratory depression. To aid frontline providers in identifying which patients are at risk for respiratory depression, members reviewed literature, examined existing practices, and reviewed current assessment tools to identify causes. These contributive causes were categorized into seven patient-specific problems and challenges, and assembled in the form of a systematic tool to aid with decision support called the California Opioid Assessment and Action Safety Tool (COAST) for Adults (Figure 2).

NOTE: The COAST for Adults has not been validated through scientific research, and input is welcome in the creation of future refined versions of this tool.

By aligning contributive causes with their respective patient problems, clinical teams may be better able to target risk reduction tactics, thus reducing overall risk and avoiding the need for respiratory monitoring. When specific problems are identified, nurses and other clinical team members may systematically use the accompanied Targeted Risk Reduction Tactics (TRRT) (see Table 2: Targeted Risk Reduction Tactics in Step 2: Implement Plan of Care in this tool kit).

A case study using the COAST for Adults and the selected Targeted Risk Reduction Tactics are available for download at: www.hqinstitute.org/tools-resources.

For situations where the overall risk cannot be reduced to a safe level, respiratory monitoring should be used as a safety net.

ELECTRONIC EARLY WARNING SYSTEM

Workgroup members recommend using the risk factors documented in this tool kit to devise an early warning system with alerts in the electronic medical record. This tool kit can assist in the development of a point-based assessment system where the appropriate expertise, such as a nurse, pharmacist, respiratory care practitioner, physician, or Rapid Response Team (RRT), could proactively evaluate the patient based on the specific type of risk and severity of actual or potential risk.

RESPIRATORY DEPRESSION RISK FACTORS

This section compiles assessment guidelines and tool recommendations from workgroup members' collective experience and literature reviews. **Each numbered risk factor below, including the (bolded) rationale for each risk factor, corresponds to the patient problems and challenges identified in the COAST for Adults (see Figure 2).**

1. Unexplained, Unexpected, or Uncontrolled Pain, Anxiety, Agitation, or Delirium Creating Increased Opioid and Other Central Nervous System (CNS) Depressant Dose Requirement

Underlying Issue That Requires Procedural or Other Intervention. Patients requiring higher doses of medication for uncontrolled pain are at risk because medication dose-stacking is common in attempting to control pain. If the underlying cause of the pain is not understood and the patient is given analgesia, the symptoms may be masked and the patient may be at risk for complications related to a pathophysiologic process such as: bleeding, tissue trauma, compartment syndrome, neuropathic pain, or an infectious process.

Anxiety, agitation, and/or delirium may be indicative of underlying issue, such as hypoxemia and should be addressed using evidenced-based guidelines.³¹

Opioid Tolerant. See #6 in this list of Respiratory Depression Risk Factors.

Drug Seeking Behavior. Patients with unexplained pain, and where all underlying causes have been thoroughly ruled-out, may benefit from a behavioral health assessment. Caution should be taken to avoid assumptions about patients who have a substance abuse history and report pain. Thorough assessments of underlying causes should be performed and ruled out before suspecting drug-seeking behavior.

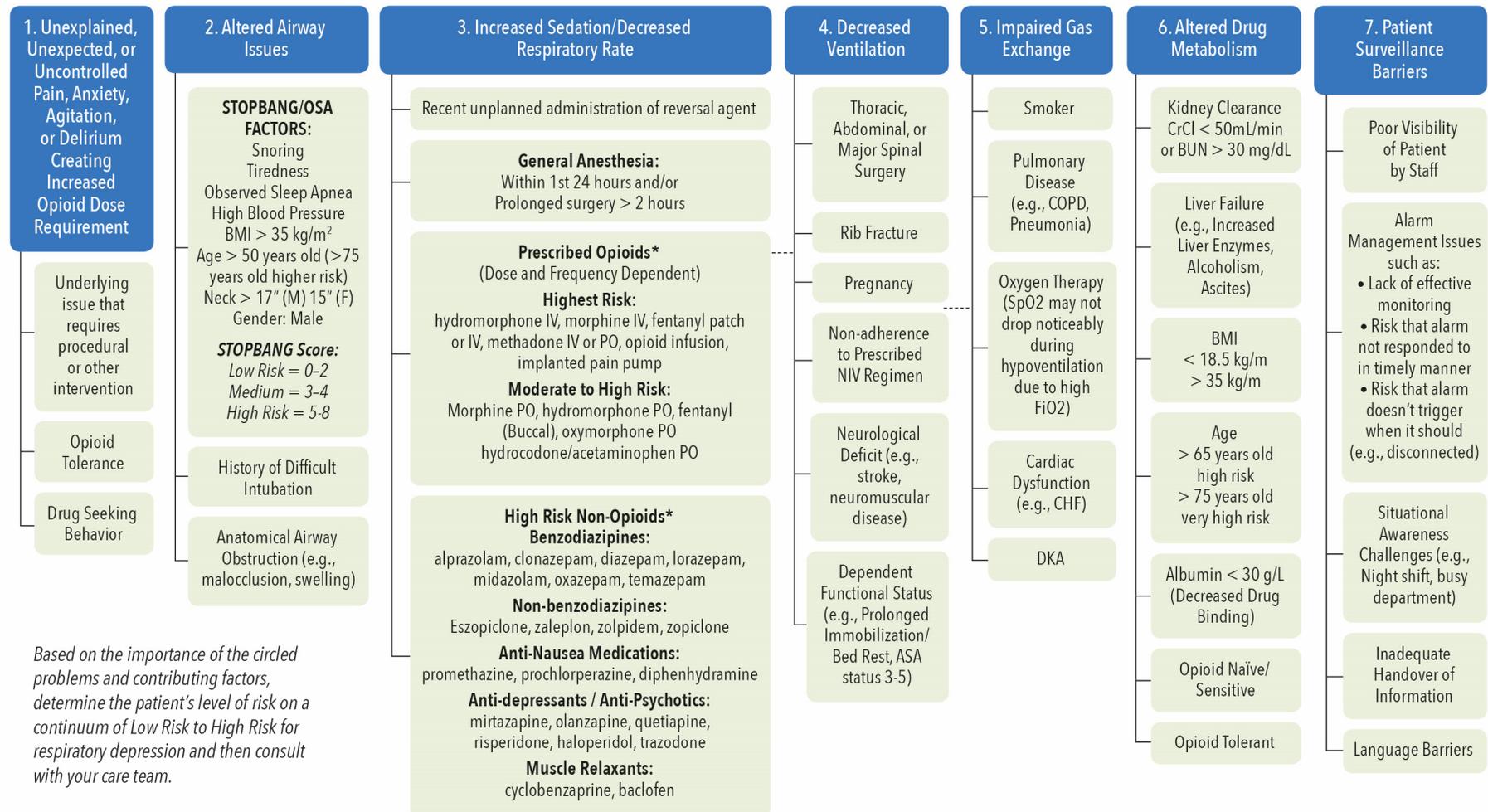
FIGURE 2: CALIFORNIA OPIOID ASSESSMENT AND ACTION SAFETY TOOL (COAST) FOR ADULTS

California Opioid Assessment and Action Safety Tool (COAST) for Adults

1. Proactively assess the patient by **circling** all contributing causes that are present below. PAUSE and ASSESS the number of circled problems/challenges.
2. Implement Targeted Risk Reduction Tactic(s) to mitigate modifiable risk factors and reduce overall risk; use electronic respiratory monitoring as needed.
3. Re-assess risk according to patient's plan of care and hospital policy; look at all problems/challenges with every reassessment.

This tool is not intended to provide a scientific, validated score rather it is meant to serve as a decision-support job aid.

7 PATIENT PROBLEMS/CHALLENGES CONTRIBUTING TO RESPIRATORY DEPRESSION AND ARREST



Based on the importance of the circled problems and contributing factors, determine the patient's level of risk on a continuum of Low Risk to High Risk for respiratory depression and then consult with your care team.

*This list is not comprehensive.

2. Altered Airway Issues

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 post-operatively.^{32,33} The American Academy of Sleep Medicine estimates that 80 to 90% of people with OSA are undiagnosed.³⁴ Workgroup members recommend hospitals track patients diagnosed with OSA and difficult intubation history by indicating this ongoing risk factor in their electronic medical record.

Workgroup members reviewed several assessment tools available for identifying patients at risk for Obstructive Sleep Apnea (OSA). The STOP BANG Screening Tool and American Society of Anesthesiologists (ASA) Checklist screening aids have been well-validated in the adult surgical population with similar moderately high predictive values. Members recommend using the STOP BANG questionnaire for routine screening of the adult surgical population 18 years and older because of its ease of use.

NOTE: Workgroup members were not able to identify a validated OSA assessment tool for patients younger than 14 years or the obstetric population.

When deciding which OSA screening tool to use, consider the patient population used to validate the tool:

- *Recognize the factors that increase vulnerability for the disorder (i.e., snoring, tiredness, observed sleep apnea, high blood pressure, obesity (Body Mass Index > 35 kg/m), age >50, neck circumference (men > 17 inches and women > 16 inches) male gender, family history of OSA, menopause, craniofacial abnormalities, and certain health behaviors, such as smoking and alcohol use).³⁵*
- *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 post-operative day in patients with OSA as sleep patterns are reestablished and "REM rebound" occurs.³⁶*
- *Recognize hospitalized patients often suffer from sleep deprivation due to intensive care and monitoring.*

History of Difficult Intubation. The hospital should have a plan and specialized equipment readily available to address the needs of patients with difficult airway intubations.

Anatomical Nasal Obstructions (e.g., malocclusion, swelling). Patients with abnormalities of the bony and soft tissue structure of the head and neck are at risk for breathing obstruction.

3. Increased Sedation/Decreased Respiratory Rate

Ensure a pre-sedation assessment is completed prior to sedation administration. Workgroup members evaluated sedation scales as part of its 2010 ICU sedation improvement project (see www.hqinstitute.org/tools-resources) 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, Pasero Opioid-Induced Sedation Scale, and the Riker Sedation-Agitation Scale are used at workgroup members' organizations and are validated, evidenced-based tools^{37,38} (see Table 1: Respiratory and Sedation Assessment Tools).

Assessing sedation levels during sleep is a set of challenging competing priorities. Promoting sleep is important to the healing process yet when the patient's sleep is not interrupted to assess sedation level, the patient may be over-sedated and at risk for respiratory depression. Workgroup members recommend monitoring respiratory status by counting respirations for a full minute and assessing respiratory effort quality according to rhythm and depth of chest excursion while the patient is in a restful/sleep in a quiet non-stimulating environment.³⁹ If respirations are inadequate in rate or depth, the patient should be awakened to assess sedation level. In addition, the patient should be awakened to assess sedation level when sedating medications are peaking, with new or increased doses of sedating medications or if there is any concern about over-sedation. Patients and families must be educated that the patient will be awakened periodically to assess sedation level so that safety processes are well understood and expected.⁴⁰

Recent Unplanned Administration of Reversal Agents (e.g., naloxone). Naloxone is generally considered safe for opioid reversal. The serum half-life of naloxone is usually between 60-90 minutes. Recent administration of naloxone is a contributing factor because when it wears off, the opioid over-sedation is re-manifested.

General Anesthesia. The following should be considered: duration of anesthesia, physical condition of patient, use of spinal morphine, and prolonged surgery (more than 2 hours).

Prescribed Opioids. All opioids have sedative effects to some degree dependent upon medication, dose, and frequency (see COAST for Adults for opioids workgroup members identified as most sedating):

- **Conduct a full body skin assessment** of the patient prior to administering a new opioid to rule out the possibility that the patient has an implanted drug delivery system, infusion pump, or applied a fentanyl patch.⁴¹
- **Opioid-Infusion Therapy.** For example, PCA (with and without basal dose), Patient-Controlled Epidural Analgesia (PCEA), or Epidural.
- **Implanted Pain Pump.** Patients who have implanted pain pumps may be at risk for over-sedation if the pump is not interrogated to assess the medication, dose, and frequency of pain administration. Patients who have implanted pain pumps typically have a long history of chronic pain and complex pain management needs; therefore, a referral to a pain service or pain specialist may be required. The hospital's policy should:
 - Establish a systematic assessment of the patient and the implanted pain pump on admission;
 - Establish documentation of the patient's pain pump information;
 - Identify someone competent in pain pump interrogation within the organization, and
 - Describe the necessary protocol for managing patient's pain.

High Risk Non-Opioids.

- **Sedation.** Receiving concomitant sedatives or other sedating medications (e.g., benzodiazepines, antihistamines, muscle relaxants, antidepressants, antipsychotics, pain adjuvants, antiemetic, sedatives).⁴² This is consistent with the black box warning on benzodiazepines.
- **Major Mental Illness.** Patients on psychotropics that are highly sedating and patients receiving multiple psychotropics are at increased risk of over sedation when opioids are administered. Opioid use may mask or mimic mental illness and a psychiatric consultation may help to differentiate behavioral symptoms. Any changes to psychotropic medications should be reviewed carefully by a psychopharmacology specialist.

4. Decreased Ventilation

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

The following conditions may impair breathing due to discomfort/pain on deep breath or guarding against incisional sites.

Thoracic, Abdominal, or Major Spinal Surgery.

Rib Fracture. Pain from fractures restrict ventilation.

Pregnancy. Sleep-disordered breathing symptoms are common in pregnancy.

Non-adherence to Prescribed Non-Invasive Ventilation (NIV) Regimen. Patients may not adhere to their prescribed NIV therapy for many reasons (e.g., discomfort, nausea, delirium, agitation).

Neurological Deficit. The following neurological conditions may result in decreased ventilatory capacity:

- Acute stroke
- Neuromuscular disease
- Brain injury
- Spinal cord injury
- Patients who are seizing or post-ictal phase⁴³
- Any condition that decreases level of consciousness

Dependent Functional Status. For example, prolonged immobilization/bed rest, or ASA status of 3-5.

5. Impaired Gas Exchange

The following medical conditions affect gas exchange and subsequent challenges in managing oxygenation and ventilation.

Smoker. Smoking affects gas exchange in numerous mechanisms, but the primary effect involves the collapse of alveoli and decreased oxygen transfer into the blood and decreased CO₂ excretion. These baseline alterations in blood gases should be considered in interpreting oxygenation and ventilation values.

Pulmonary Disease. For example: chronic obstructive pulmonary disease, pneumonia, or pulmonary fibrosis.

Oxygen Therapy. Patients with increased SpO₂ may create a false confidence in level of risk. For example, normally SpO₂ is sensitive to hypoventilation. As PaCO₂ rises, arterial O₂ decreases as a result. Normal PaCO₂ is 40, and normal max for arterial O₂ (PaO₂) is 100, which corresponds with approximately 100% SpO₂. If the patient is receiving supplemental oxygen with an FiO₂ that is higher than room air, the arterial O₂ is much higher than 100. When the arterial O₂ drops due to an increase in PaCO₂, the PaO₂ stays above 100 mmHg, and saturation levels remain in the higher percentages longer; often misleading the clinicians to believe the patient is doing well, when the patient may in fact be in significant respiratory depression.

Cardiac Dysfunction. For example: hypertension, congestive heart failure, coronary artery disease, and cardiac dysrhythmia.

Diabetic Ketoacidosis (DKA)⁴⁴. Electrolyte and fluid shifts in the treatment of DKA may cause pulmonary infiltrations and alterations in gas exchange.

6. Altered Drug Metabolism/Sensitivity

The following medical conditions affect metabolism and excretion of medications:

Kidney Clearance. Patients with chronic renal disease (i.e., Creatinine clearance < 50 mL/min or BUN > 30 mg/dL).

Liver failure. For example: patients with increased liver enzymes, alcoholism, ascites, and other evidence of hepatic failure.

Body Mass Index (BMI):

- **BMI equal to or less than 18.5 kg/m.**^{45, 46} Patients with low body weight can have difficulty in breathing and in metabolizing medications.
- **BMI equal to or greater than 35 kg/m.**⁴⁷ 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, which may have slower or delayed absorption. Additionally, obesity is the main risk for OSA.

Age (patients older 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 times higher for those over age 80.⁴⁸ Younger individuals with overgrown tonsils, adenoids, or both may be at risk due to their smaller airways.

OPIOID TOLERANT OR OPIOID NAÏVE?

Critical to the pain management process is determining if the patient is opioid naïve or opioid tolerant. The following definitions should be used as guidelines when determining a patient's opioid status:

Definition of Opioid Tolerant

"Patients who are considered opioid-tolerant are those who have been taking, for a week or longer, at least 60 mg of oral morphine daily, or at least 30 mg of oral oxyCODONE daily, or at least 8 mg of oral HYDROMORPHONE daily, or an equianalgesic dose of another opioid." (Food and Drug Administration)

This history must immediately precede the intended course of PCA therapy. If a wash-out period of a week or longer has occurred since the above dosages were taken, reconsider whether the patient truly meets this definition of tolerance.

Definition of Opioid Naïve

Patients who do not meet the definition of opioid tolerant—who have not had narcotics doses at least as much as those listed above for a week or more—are opioid naïve.

If the patient is opioid tolerant and in need of chronic pain management, it is recommended that experts on pain management are consulted.

Albumin <30 g/L. Patient with an albumin level less than 30 g/L have a decreased drug-binding effect, which may cause a higher level of circulating opioid in the blood stream.

Opioid Naïve/Sensitive. See callout box for definition for Opioid Naïve. Patients who are opiate-naïve are at high risk if they are receiving high-dose opioids in a short period of time (i.e., stacked medications); continuous infusion (e.g., intravenous PCA with basal rate); or concomitant administration of sedating agents (e.g., benzodiazepines, antihistamines). Abnormalities in pharmacogenetics may contribute to opioid sensitivity and testing may be helpful.⁴⁹

Opioid Tolerant. See callout box for definition for Opioid Tolerant.

- Abnormalities in pharmacogenetics may contribute to opioid tolerance and testing may be helpful.⁵⁰
- History of substance abuse may create opioid tolerance.
- History of recent drug abuse (i.e., last seven days of continuous use) may create opioid tolerance.

7. Patient Surveillance Barriers/Environment

Barriers to patient surveillance from environmental situations can increase the risk of not detecting respiratory depression. Consider the following situations when determining the patient's risk for respiratory depression:

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

Alarm Management Issues. See the Joint Commission National Patient Safety Goal on Clinical Alarm Management and follow the facility's Alarm Management Strategies in this tool kit regarding:

- Lack of effective monitoring
- Alarm is not responded to in a timely manner, because:
 - Staff is too busy
 - Alarm does not reach staff (not audible, staff preoccupied, communication failure)
 - Staff ignores because of history of false alarms
 - Staff confused about which alarm and which patient needs attention
- Alarm did not trigger when it should have, because:
 - Disconnection
 - Technology failure
 - User error (e.g., alarm parameter or sound level inappropriate)

Situational Awareness Challenges, such as: code situation (i.e., nursing distracted by the emergency), short staffing, night shift (because of the competing priority of promoting sleep, which often deters a full sedation level assessment).

Inadequate Handover of Information. For example, at interdepartmental or intradepartmental handovers and shift change.

Language Barriers. Limitations or comfort with language can dissuades patient understanding and cooperation.

2 Implement Care Plan

This step is a decision point in the care of the patient. Using critical thinking, determine and implement the best care plan to reduce known risks wherever possible by addressing the problem using targeted risk reduction tactics and then monitoring the problem.

A) MITIGATE USING MODIFIABLE RISK FACTORS

Table 2 presents recommendations to reduce risks identified from using the COAST for Adults (see [Step #1](#) of this tool kit).

NOTE: For convenience, the Targeted Risk Reduction Tactics table can be copied on the back side of the COAST for Adults.

TABLE 2: TARGETED RISK REDUCTION TACTICS

PROBLEM / CHALLENGE	TARGETED RISK REDUCTION TACTICS TO CONSIDER
Global Risk Mitigation Tactics	<ul style="list-style-type: none"> • Use patient and family engagement strategies such as motivational interviewing • Set realistic pain level expectations and teach patient to rate pain according to level of functional impact (e.g., Defense and Veterans Pain Rating Scale) • Conduct stepwise approach to analgesia including around-the-clock non-opioids (e.g., acetaminophen, nonsteroidal anti-inflammatory drugs, gabapentinoids) • Use multimodal medication management with integrative therapies (e.g., ice, positioning, distraction, nerve blocks) • Use dose limits for order entry of medications • Consider avoiding the use of basal infusions with PCA in opioid naïve patients • Consider avoiding the use of any other opiates, especially oral, when patient is on PCA • Use standardized medication order sets to lessen variance; however, one size does not fit all patients • Follow the hospital's guidelines for assessment and reassessment. • Differentiate between pain, anxiety, and agitation • Develop individualized pain management plan of care including frequency of monitoring • Be aware of the complexity with patients with chronic pain and the transitions from IV to PO delivery of medications, and include in the patient's care plan obtaining a pain service consult or other specialist • Be familiar with and use Figure 5: Patient Deterioration Response Algorithm (see Step #6 of this tool kit) • Stay focused on the risk of over-sedation and not only issues of managing pain/functional pain assessment • For those patients who have uncontrolled pain, know the opioid amount used for the past 24 hours and consider peak effect and concomitant use of all Central Nervous System (CNS) depressant; this will help facilitate a safe and effective transition to other routes of administration • Consult pain service or specialist for complex pain management needs
<p>In addition to the Global Risk Mitigation Tactics, implement the following tactics in the presence of specific patient problems or challenges.</p>	
1. Unexplained, Unexpected, or Uncontrolled Pain causing increasing opioid dose	<ul style="list-style-type: none"> • Suspect underlying issue: Consult with physician regarding an underlying issue (e.g., bleeding, infection, nerve compression, infectious process, or other issue that requires a procedural intervention or medical management) • Implement evidenced-based guidelines for management of anxiety, agitation, and/or delirium, instead of medicating simply to alleviate symptoms • Implement standard process for screening patient with substance abuse that involves use of the state Prescription Drug Monitoring Program database where available (e.g., California's CURES Database)

PROBLEM / CHALLENGE	TARGETED RISK REDUCTION TACTICS TO CONSIDER
2. Altered Airway Issues	<ul style="list-style-type: none"> • Assess airway history (e.g., difficult intubation, anatomical airway obstructions) and implement individualized plan to address specific risks; ensure communication of these risks across the care continuum • Adjust patient positioning to optimize ventilation • Perform continuous electronic monitoring of ventilation • Pre-operative patients: Implement individualized plan for difficult airway intubation • Use non-invasive ventilation • Suspected OSA patients: Consider sleep study • Consider automatic electronic medical record triggers for respiratory therapy evaluation if the patient has known or suspected OSA or other respiratory depression risks
3. Increased Sedation/ Decreased Respiratory Rate	<ul style="list-style-type: none"> • For unavoidable high-risk opioids, recommend a second-level review by a pain management specialist, if available • Engage pain service consult for individual pain plan • Use physician order management to ensure a single, clear approach is being used to manage pain • Implement screening process for patients with opioid tolerance
4. Decreased Ventilation	<ul style="list-style-type: none"> • Adjust patient positioning to optimize respiration • Implement routine incentive spirometry • Use non-invasive ventilation therapies • Use positive pressure therapy devices • Engage in early mobilization • Perform continuous electronic monitoring of ventilation
5. Impaired Gas Exchange	<ul style="list-style-type: none"> • Adjust patient positioning to optimize respiration • Perform lung recruitment maneuvers such as incentive spirometry • Use non-invasive ventilation therapies • Use supplemental oxygen (caution: must monitor for hypercapnia) • Perform continuous monitoring of oxygenation and ventilation
6. Altered Drug Metabolism	<ul style="list-style-type: none"> • Avoid morphine in patients with decreased renal clearance • Consider risk of increased circulating medications in patient with hepatic disease, decreased renal clearance, or low serum albumin • Individualize patient's pain management plan based on other identified problems/challenges (e.g., opioid naïve, opioid tolerant) not addressed with global risk mitigation tactics
7. Patient Surveillance/ Barriers / Environment	<ul style="list-style-type: none"> • Perform ventilation and/or oxygenation monitoring with patient-individualized alarm default settings • Standardize handover communications and measure effectiveness • Instruct on the dangers of turning off alarms • Consider relocating patient for increased visibility and/or assign a sitter to observe the patient • Use centralized, remote monitoring if available

B) USE DECISION SUPPORT TO GUIDE RESPIRATORY MONITORING

Because of the complexity of numerous patient problems and multiple contributing risks, there is no algorithmic method to determine the level of risk for respiratory depression. Much research is needed to develop statistical models that can predict a specific risk level for any individual or set of confounding risk factors present. Until these predictive analytics models are created, each patient should be assessed for risk factors with critical-thinking applied to determine whether the patient is very low, low-to-moderate, or moderate-to-high risk.

Based upon the specific problems outlined in the COAST for Adults plus the degree and number of contributing causes, use critical thinking to determine the patient’s individual risk level by categorizing them into the risk levels below, and then using the appropriate respiratory monitoring method also noted in Table 3.

Common patient risk profiles, included but not limited to those listed in Table 4, may assist with identifying or validating a patient’s risk level.

TABLE 3: RESPIRATORY MONITORING PRIORITIZATION RECOMMENDATIONS BASED ON COAST FOR ADULTS RISK^a

Risk Level	Very Low Risk	Low to Moderate Risk	Moderate to High Risk
Monitor ^b	Recommend periodic oxygenation monitoring ^c	Recommend continuous oxygenation monitoring ^c	Strongly recommend continuous ventilation monitoring and oxygenation monitoring ^c
Location	Portable monitoring at bedside	Portable monitoring at bedside	Remote/centralized and/or close proximity/high visibility

^a Considering not all hospitals are fully equipped to offer ventilation monitoring on patients that may benefit, triaging monitors for the most critical patients may be necessary (until the appropriate numbers of monitors are acquired).

^b Monitoring recommendations are inclusive of existing best practices and standardized protocol for pulse oximetry monitoring.

^c When using supplemental oxygen, evaluate the patient for adequate ventilation independent of SpO₂ values.

TABLE 4: COMMON PATIENT RISK PROFILES AND RATIONALE

EXAMPLES OF COMMON PATIENT RISK PROFILES*	PROBABLE RESPIRATORY DEPRESSION RISK LEVEL	RATIONALE
30-year-old healthy, athletic person who is post-operative knee surgery and has a history of using post-operative opioids successfully; one opioid prescriber and engaged family members present	Very Low Risk	No history of opioid sensitivity. No reason to suspect opioid metabolism derangement causing increased circulating opioid in blood. Engaged family at bedside helps stimulate wakefulness and monitor sedation and respirations.
A patient with severe uncontrolled pain requiring increased opioid dose requirements; exact history of substance abuse difficult to ascertain	Moderate to High Risk	Discerning the cause of uncontrolled pain is challenging and any potential underlying cause should be addressed while also considering: opioid withdrawal, low pain threshold, and high opioid tolerance. Without knowing the degree of substance abuse the appropriate escalation of opioid dose is difficult. Patients with a history of opioid abuse may have high tolerance and the safe zone between pain relief and respiratory depression can be very narrow. ⁵¹

EXAMPLES OF COMMON PATIENT RISK PROFILES*	PROBABLE RESPIRATORY DEPRESSION RISK LEVEL	RATIONALE
A patient who has multiple prescribers of opioids and other CNS sedating medications (e.g., surgeon, anesthesiologist, and hospitalists)	Moderate to High Risk	Multiple prescribers of opioids and other CNS depressants is an indicator that there may not be a single prescriber that is overseeing total doses, drug interactions, and timing of peak medication effects.
Post-operative patient with a history of known or suspected OSA and who refuses non-invasive ventilation	Moderate to High Risk	Patients with known or suspected OSA are at high risk for apnea when anesthetic agents and opioids are also present.
Hypoventilation situations with oxygen therapy	Moderate to High Risk	Any patient who has a risk of hypoventilation due to sedation or other risk factors AND has oxygen therapy is at moderate to high risk because oxygen therapy may create a normal pulse oximeter value even though the patient may have hypercapnia.
Patient with opioid tolerance using multi-modal analgesic tactics and who has one opioid prescriber with oversight of all CNS depressant medications dosing and timing of peak effects	Low to Moderate Risk	For patients who have a tolerance to opioids, having careful prescribing practices helps avoid the concomitant effects of CNS depressant medications.
A 76-year-old patient with prolonged anesthesia who has an abdominal incision and pain with deep breathing also has renal insufficiency and low albumin	Moderate to High Risk	<p>Patient is older than 75 years.</p> <p>Effects of prolonged anesthesia may continue for up to 24 hours.</p> <p>Painful abdominal incision may restrict ventilation.</p> <p>Renal insufficiency will decrease excretion of the opioids and cause increased circulating opioid in the blood.</p> <p>Low albumin will decrease opioid binding and create increased circulating opioid in the blood.</p>

*All patient risk profiles are at increased risk for the night shift.

C) CONSIDER MONITORING RECOMMENDATIONS BY PROBLEM/CHALLENGE

Targeted risk reduction tactics should be used whenever possible to reduce the risk of respiratory depression. If monitoring is necessary, consider the following recommendations based on common patient problems/challenges (Table 5).

TABLE 5: MONITORING RECOMMENDATIONS

PROBLEM / CHALLENGE	WHEN TO START	WHEN TO DISCONTINUE
Patient diagnosed OSA and using NIV as prescribed (in the facility)	Monitor the patient with pulse oximetry. If the patient requires supplemental oxygen, evaluate the patient for continuous ventilation monitoring needs based on adherence to prescribed NIV therapy. <i>NOTE: Whenever possible, the patient's own NIV equipment should be used during the hospital stay if in good condition. The frontline provider should engage patient in its proper use and address any concerns.</i>	Consider discontinuing ventilation monitoring at 24 hours, if the risk level has decreased (using lower doses of sedating medications, no recent hypoventilation/ apneic events noted on the monitoring device history).
Patient diagnosed with OSA and not using the NIV as prescribed (in the facility)	Monitor patient with continuous ventilation monitoring and pulse oximetry. Provide respiratory physiological monitoring for the first 24 hours post-op.	Consider discontinuing respiratory monitoring at 24 hours, if the risk level has decreased (using lower doses of sedating medications, no recent hypoventilation/ apneic events noted on the monitoring device history). Do not discontinue monitoring until patient is stable on NIV therapy and using as prescribed.
Patient suspected OSA or sleep disorder	Monitor patient with continuous pulse oximetry and a ventilation monitor. Provide respiratory physiological monitoring for the first 24 hours post-op.	
Moderate-to-High and High-Risk patients following general anesthesia	Monitor patient with continuous pulse oximetry and a ventilation monitor. Recommend monitoring at least first 4 hours post-op. Consider patient-specific complications for adverse risk from anesthesia.	If no observed apnea, significant hypoventilation, or desaturation, consider discontinuing continuous monitoring after the first 24 hours post-op.
Patient on PCA (with or without a basal dose), PCEA, or epidural	Monitor patient with both pulse oximetry (monitoring oxygenation) and capnography or respiratory volume monitoring (monitoring ventilation). If supplemental oxygen is not being administered, monitoring with pulse oximetry may be acceptable. If supplemental oxygen is being administered, monitoring with capnography or respiratory volume monitoring with or without pulse oximetry is desirable. ⁵² At a minimum, for any patient on a PCA pump, monitor the patient with pulse oximetry and continuous ventilation monitoring. Start respiratory monitoring upon initiation of PCA. ⁵³	Consider discontinuing respiratory monitoring 2 hours after intravenous PCA is discontinued or 6 hours after continuous epidural infusion.
Patient on opioids and concomitant sedatives/medication stacking/other sedating medications	Monitor patient with ventilation monitoring. Start ventilation monitoring upon initiating the first 24 hours.	Consider discontinuing ventilation monitoring at 24 hours, if the risk level has decreased (using lower doses of sedating medications, no recent hypoventilation/ apneic events noted on the monitoring device history).
Patient on procedural sedation	Monitor patient with continuous ventilation monitoring. It is recommended to monitor the patient with pulse oximetry. Start ventilation monitoring upon administration of sedative and check every 5 minutes during procedure.	Consider discontinuing ventilation monitoring following outcome of the sedation assessment.

PROBLEM / CHALLENGE	WHEN TO START	WHEN TO DISCONTINUE
Patient given unplanned administration of reversal agents (e.g., naloxone)	Monitor patient with continuous pulse oximetry and a ventilation monitor. Start ventilation monitoring upon reversal agent administration. Provide vigilant monitoring when reversal agent's impact subsides as the patient may be at risk of a relapse into respiratory depression.	Consider discontinuing ventilation monitoring 2 hours after the most recent administration. Observe patient for at least 4 hours after unplanned 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.
Patient with fentanyl transdermal patch	If patient is moderate to high or high risk for respiratory depression, monitor patient with ventilation monitoring. Start ventilation monitoring upon initiating fentanyl patch.	Consider discontinuing capnography monitoring 24 hours after discontinuance of patches or until discharge (if patient will remain on patches post discharge)
Patients who are neurologically impaired	If patient is moderate to high or high risk for respiratory depression, monitor patient with ventilation monitoring.	Consider discontinuing ventilation monitoring, if no recent hypoventilation/ apneic events noted on the monitoring device history), no abnormal vital signs, and neurological assessments are stable for 24 hours or more.

When to Change Monitor Settings

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, and/or non-opioid CNS depressant 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.

For additional recommendations addressing high-alert IV medications, refer to the High-Alert IV Medication Tool Kit and the High-Alert IV Medication Dosing Limits Tool Kit available for download at www.hqinstitute.org/tools-resources.

3

Select Respiratory Monitoring Technology Method(s)

Early recognition of respiratory compromise and timely intervention through improved monitoring, staffing levels, and resources are urgently needed to improve the tragic and preventable events from opioid-induced respiratory depression and in-hospital cardiopulmonary arrests among medical-surgical patients.⁵⁴ In 2010, the Food and 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. However, intermittent monitoring through observation, even when performed every 15 minutes, may be inadequate since respiratory arrest can occur within minutes.

Hospitals have made significant investments in electronic respiratory monitoring (e.g., Capnography, Transcutaneous CO₂ Monitoring, Respiratory Volume Monitoring). Workgroup members recognize that continued technological investment advances the ability to meet the demands of the increasing risks to patient respiration.

NOTE: Electronic respiratory monitoring does not replace physical assessment. Physical assessment is needed to identify patients at greatest risk that may most benefit from an electronic monitoring device to add redundancy to the vigilance of respiratory safety.

ELECTRONIC RESPIRATORY MONITORING TECHNOLOGY

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.

Oxygenation Monitoring

Pulse Oximetry

Pulse oximetry is a non-invasive method for monitoring a patient's blood-oxygen saturation level and pulse rate. 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**.

Indications: Indications for pulse oximetry include the following: endotracheal intubation, cardiac arrest, sedation, asthma/chronic obstructive pulmonary disease, respiratory complaints, acute respiratory distress syndrome, sleep disorders/sleep apnea, and shunts in cyanotic heart diseases.

Contraindications: Presence of an ongoing need for measurement of pH, carbon dioxide, total hemoglobin, and abnormal hemoglobin may be a relative contraindication to pulse oximetry.

Ventilation Monitoring

Capnography

Capnography is an indicator of the level of 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., Magnetic resonance imaging (MRI), computerized axial tomography (CT) devices, darkened rooms).⁵⁵
- Capnography more readily detects hypoventilation compared with pulse oximetry or visual observation.⁵⁶
- Capnography is capable of significantly clarifying the respiratory picture regarding over-sedation, and when used in conjunction with oxygen saturation can dramatically enhance the overall picture of the patient's respiratory status.⁵⁷
- Early studies indicate that capnography is more effective than pulse oximetry in providing initial warning of respiratory depression in patients receiving supplemental oxygen.⁵⁸

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, and frequently assess the effectiveness of ventilation 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 monitoring of the effectiveness of ventilation.

Indications: Capnography monitors ventilation. It tracks respiratory rate as well as a breath-by-breath trend of CO₂ as it is eliminated from the lungs.

Contraindications: There are no contraindications for the use of capnography provided that the data obtained are evaluated in the context of the patient's clinical circumstances. It is generally safe to use capnography for the monitoring of all patients.⁵⁹

Respiratory Volume Monitoring

Respiratory Volume Monitoring (RVM), also referred to as Minute Ventilation, is a proprietary monitoring system that uses a specialized set of three bio-impedance electrode leads attached to the patient's chest. Respiratory volume impedance monitoring is a Food and Drug Administration-approved technology that is used for quantitative monitoring of ventilation quality.⁶⁰ Unlike capnography, RVM may be used regardless of non-invasive ventilation devices (CPAP/BiPAP).

RVM is a direct non-invasive measure of respiratory status. The RVM device provides real-time measurements of minute ventilation in both intubated and non-intubated adult patients.

Challenges: RVM does not work well in unilateral pneumonia, multiple unilateral chest fractures, and upper airway obstructions.

Indications: RVM is indicated for monitoring ventilation. The device monitors respiratory rate and minute ventilation and provides a percentage of the expected minute ventilation for a patient's age, height, and weight. Currently, Food and Drug Administration approved for use with adult patients only.

Contraindications: There are no documented absolute contraindications for use of RVM. In patients with adhesive allergy, alternative monitoring devices to RVM should be considered.

Transcutaneous CO₂ Monitoring

Transcutaneous CO₂ (PtcCO₂) 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. Some limitations of Transcutaneous CO₂ monitoring results have been noted in patients with severe hypercapnia.⁶¹

Indications: Transcutaneous CO₂ monitoring is indicated for use as a monitor of oxygen and/or carbon dioxide in patients who either lack arterial access or have the need for continuous monitoring.

Contraindications: There are no documented absolute contraindications for use of Transcutaneous CO₂ monitoring. In patients with poor skin integrity and/or adhesive allergy, alternative monitoring devices to Transcutaneous CO₂ should be considered.

TECHNOLOGY COMPARISON AND CAPABILITIES

Electronic Monitoring Capabilities

Workgroup members acknowledge that the demand for ventilation monitoring is outdistancing the current capability in some hospital environments. A thoughtful examination of monitoring capabilities and needs of patients is necessary as inventories are being increased. Additionally, treatment and drug choices that can compromise respiration is essential to continue reducing risk. Table 6 summarizes the capabilities of available electronic oxygenation and ventilation monitors.

TABLE 6: SUMMARY OF ELECTRONIC RESPIRATORY MONITORING CAPABILITIES

CAPABILITIES	PULSE OXIMETRY	CAPNOGRAPHY EtCO ₂ MONITORING	RESPIRATORY VOLUME MONITORING	TRANSCUTANEOUS CO ₂ MONITORING
Mechanical respiratory rate		X	X	
Physiological respiratory rate		X	X	
Breathing pattern waveform		X	X	
Immediate indication of a No Breath condition		X	X	
Adequacy of ventilation		X	X	
Confirm intubation and maintenance of endotracheal tube		X		
Return of spontaneous circulation		X		X
Pulmonary embolism indication	X	X	X	

Table 7 compares the monitoring methods for both physiological processes of respiration.

TABLE 7: ELECTRONIC OXYGENATION AND VENTILATION MONITORING COMPARISON

SpO ₂ MONITORING (MEASURES OXYGENATION)	EtCO ₂ MONITORING (MEASURES VENTILATION)	RVM MONITORING (MEASURES VENTILATION)	TRANSCUTANEOUS CO ₂ MONITORING (MEASURES VENTILATION)
Measures oxygen saturation (Oxygen bound to hemoglobin)	Measures ventilation (Expired CO ₂)	Measures ventilation (Minute Ventilation)	Measures ventilation (transcutaneous carbon dioxide and oxygen levels)
Reflects oxygenation	Reflects breath-to-breath ventilation	Reflects breath-to-breath ventilation	Reflects ventilation
Detects hypoxia LATE INDICATOR OF HYPOVENTILATION	Detects hypoventilation immediately EARLY INDICATOR OF HYPOVENTILATION	Detects hypoventilation immediately EARLY INDICATOR OF HYPOVENTILATION	Detects hypoventilation EARLY INDICATOR OF HYPOVENTILATION
Should be used with ventilation monitoring	Should be used with oxygenation monitoring	Should be used with oxygenation monitoring	Should be used with oxygenation monitoring if Transcutaneous CO ₂ monitoring device does not include SpO ₂

All devices assist in non-invasive monitoring of physiological status.

Multi-Parameter System

It is recommended that hospitals using multi-parameter systems (e.g., heart rate, pulse oximetry, EtCO₂) adequately monitor both oxygenation and ventilation.

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4 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.

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

ENGAGE PATIENT/FAMILY BEFORE RESPIRATORY MONITORING

- Review risk assessment information with patient and family/care partner.
- 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 monitoring ventilation and its importance. For example, "You are connected to a special nasal cannula or have electrodes on your chest 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 with each exhalation and monitors the respiratory rate, which ensures breathing is deep enough and fast enough" or "The RVM monitor measures how much air is going in and out of your chest with each breath and lets the nurses know if your breathing is compromised."
 - 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 the alarm should never be silenced or the machine turned off.
- Provide printed educational materials to the patient and family/care partner at the appropriate time:
 - Ensure education materials are at the appropriate reading level and address any learning challenges (e.g., language, hearing impaired).
 - During pre-operative education, showcase the monitors and cannulas or electrodes to increase the patient's understanding and compliance post-operatively.
- Address specific concerns as they arise.
- Explain 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 frontline providers 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, language barriers).*
- *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.*
- *Stay attuned to communication barriers and assist as needed (e.g., enlist the help of a qualified interpreter for those with limited English proficiency).*
- *Document patient and family/care partner refusal to engage, as well as any direct interference during monitoring (see Step 7. Document, Communicate, and Evaluate section).*

ENGAGE PATIENT/FAMILY WHILE RESPIRATORY 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.").
 - When using EtCo₂ monitors, stress the importance of wearing the monitoring cannula appropriately and how to self-correct (e.g., "Take 2 to 3 slow deep breaths if you hear the alarm.").
 - Discuss that some alarms are false but to never silence an alarm without consulting the frontline provider.
- Continuously validate that the patient can:
 - Verbalize understanding of the above points,
 - Ask questions, and
 - Demonstrate proper use of the monitoring cannula or electrodes.
- Continue to emphasize the importance of alerting staff of any breathing problems or other reactions.

ENGAGE PATIENT/FAMILY WHEN DISCONTINUING RESPIRATORY MONITORING

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

5 Monitor Patient

This section recommends guidelines on using assorted respiratory monitoring devices (i.e., oxygenation and ventilation equipment) for continuous monitoring of patient respiratory status.

A) 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 the patient's adherence when selecting type of monitor (e.g., patient refuses to wear EtCO₂ cannula).
- If using EtCO₂ to monitor ventilation, 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 for 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.
- If the patient room has a door, test alarm audibility with the door open and with the door closed; ensure education/training on device's audible controls; and check audibility at the beginning of the shift.

NOTE: Electronic respiratory monitors that are functioning reliably cannot substitute the practice of frequent, direct observation to obtain an accurate respiratory profile of the patient.

B) ESTABLISH BASELINE PARAMETERS

Frontline providers should tailor default alarm settings to the patient's needs and prevent alarm fatigue.

NOTE: The following baseline parameters are for facilities at sea level.

Pulse Oximetry

Normal and abnormal pulse oximetry values are:

- Normal values: 95-100% is considered normal
- Acceptable values: 90-94%
- Abnormal levels: Less than 90% is considered low or hypoxemia

Respiratory Minute Ventilation

The frontline provider enters specific patient demographics (e.g., height, weight, gender) and the RVM device calculates a predicted minute ventilation. The device then displays the data in a percentage for the clinician to monitor the effectiveness of ventilation. Normal and abnormal respiratory minute ventilation values are:

- Greater than 80% of predicted minute volume is considered normal
- 80% down to 40% of predicted minute volume is considered the cautionary zone
- 40% or less of predicted minute ventilation is considered the danger zone

Capnography

Normal and abnormal capnography ventilation values (at sea level) are:

- Normal values: 35-45 mmHg
- Abnormal values:
 - Less than 35 mmHg is considered hyperventilation/hypocapnia
 - Greater than 45 mmHg is considered hypoventilation/hypercapnia

CAPNOGRAPHY ALARM SETTING MANAGEMENT

Respiratory monitor manufacturers provide safe, default alarm settings for the general patient population. Table 8 presents workgroup-recommended default alarm settings for respiratory monitor critical alarms, which are consistent with literature and practice.

Based on these values, determine the patient's baseline, consider any adverse condition affecting oxygen exchange, such as metabolic acidosis/alkalosis and chronic elevated CO₂ levels (e.g., chronic obstructive pulmonary disease), and individualize clinical respiratory parameter goals to the patient for maintained, adequate ventilation.

TABLE 8: SUGGESTED RESPIRATORY MONITOR DEFAULT ALARM SETTINGS

ALARM SETTING	DEFAULT VALUE
EtCO ₂	High – 60 mmHg Low – 10 mmHg
Respiratory Rate	High – 48 breaths per minute Low – 6 breaths per minute
No breath delay	30 seconds
Pulse Oximetry	> 90% (or determined by the organization)

While monitoring waveforms, ensure baseline values are maintained, be ready to respond to changes, and document adjusted alarm limits.

For educational samples on Capnography waveforms, see www.hqinstitute.org/tools-resources.

C) FOLLOW FACILITY'S ALARM MANAGEMENT STRATEGIES

It is recommended organization-wide strategies exist to ensure effective and efficient use of respiratory monitors.⁶² Recommendations include:

- Educate frontline providers 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.
- Educate patient and families on the alarm purpose, when they should alert a caregiver and that the patient may be awakened to assess sedation level (see Educate/Engage/Coach section in this tool kit).
- 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.
- Conduct a hospital gap analysis of medical device alarm safety.
- Systematically create strategies to reduce alarm fatigue.

For additional strategies, see *The Joint Commission Sentinel Event Alert Issue #50 and The Joint Commission National Patient Safety Goal on Clinical Alarm Management* (www.jointcommission.org).

D) CONDUCT ONGOING PATIENT ASSESSMENT AND MONITORING

NOTE: Electronic respiratory monitors that are functioning reliably cannot substitute the practice of frequent, direct observation to obtain an accurate respiratory profile of the patient.

Monitoring During Patient Transport /and while away from the patient's room

Vigilant monitoring of patient's during transport and while away from the room is critical to ensuring the level of respiratory monitoring remain the same as the monitoring performed in the patient's room. The following practices are recommended to ensure this level of observation:

- Incorporate patient respiratory depression risk assessment, including the COAST for Adults, in pre- and post-transport handover workflow, communication, and documentation.
- Engage a multidisciplinary team involving all related parties, including nursing and transport services, to develop policies and procedures for respiratory monitoring during transport that address:⁶³
 - Transport planning by care team for patients identified as moderate to high risk and high risk for respiratory depression, patients on ventilators, and patients using continuous opioids;
 - Monitoring and addressing patient pain;

- Ensuring patient readiness for transport; and
- Monitoring vitals before, during, and after transport.
- Initiate monitoring before the patient leaves the originating patient care area and ensure patient receives the same level of basic physiologic monitoring during transport, and while at transported location (e.g. radiology, nuclear medicine, etc.) as received in the originating patient care area.
- Evaluate oxygenation and ventilation status after every patient transfer by the receiving frontline provider.
- Consider recovery state and peak effect of medication when transporting the patient.
- Consider using a visual indicator (e.g., wristband) to alert the nurse and transport team if the patient is at high risk for respiratory depression.
- Educate all care team members on transport policies and procedures.
- Consider respiratory monitoring proficiency of transport personnel.
- Refer to the *Reducing Adverse Drug Events Related to Opioids Implementation Guide* recommendations for ensuring safe transportation of patients:⁶⁴
 - Determine the absolute necessity of transportation versus bedside evaluation and procedures.
 - Minimize the transportation distance and time away from routine care.
 - Determine the appropriate staff to transport the patient.

Post-Procedural Monitoring After Sedation Procedure

For additional information on sedation procedures and monitoring, refer to the *Sedation Tool Kit* available at www.hqinstitute.org/tools-resources.

- Re-assess risk (see [Step 1 Assess and Identify Risk](#) in this tool kit).
- Consider modifying respiratory monitor alarm parameters for patients during the post-procedural sedation period to provide an early warning indicator in this high-risk situation.
- During post-procedural sedation, monitor oxygenation, ventilation, circulation, and level of consciousness and sedation.

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6 Intervene

RESPIRATORY STATUS ZONES

This section describes each zone and typical zone-specific interventions.

Workgroup members portray patient respiratory status as three high-level status zones: Harm, Risk, and Safe (Figure 3).

Harm Zone: Respiratory Arrest

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

Risk Zone: Respiratory Depression

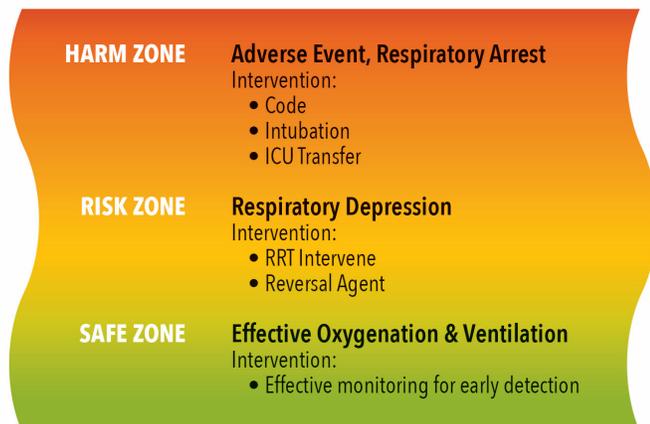
Frontline provider knowledge of respiratory depression warning signs (Figure 4) when effectively monitoring a patient can result in prompt intervention of a patient in the Risk Zone. Risk Zone interventions include using a reversal agent, transferring the patient to higher level of care, notifying the RRT, and/or adjusting medications.

Safe Zone: Effective Oxygenation and Ventilation

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 patients for monitoring appropriateness (e.g., STOP BANG assessment and sedation assessment) and effectiveness including continuous ventilation monitoring based on risk.

NOTE: For more information on sedation assessment tools (i.e., POSS, RASS), see Table 1: Respiratory and Sedation Assessment Tools in Step 1.

FIGURE 3: RESPIRATORY STATUS ZONES



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FIGURE 4: RESPIRATORY DEPRESSION WARNING SIGNS (WHEN MONITORING THE PATIENT)

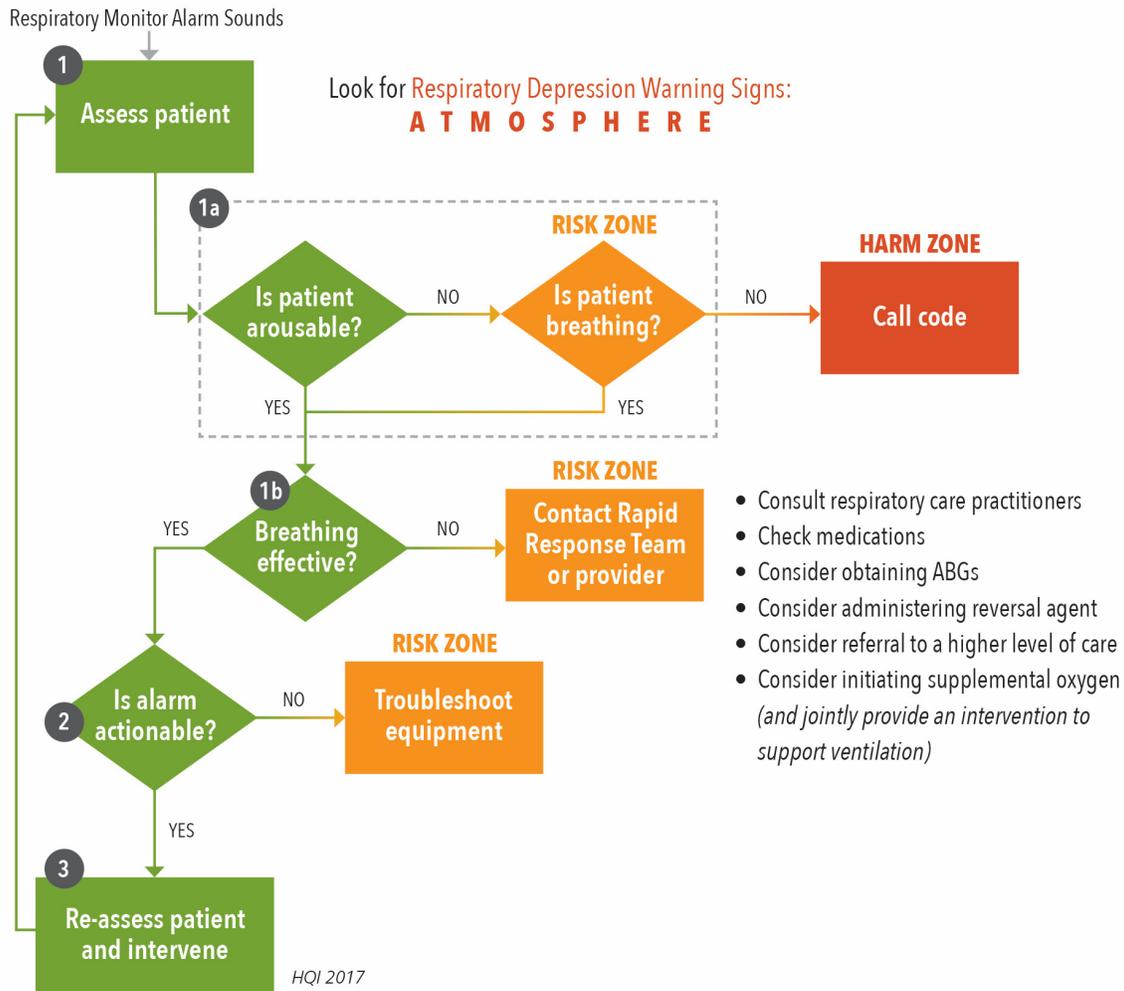
- A** - Abnormal slowness of respiration (<8 or <10 breaths/minute)
- T** - Treatment of pain/agitation ineffective (requiring increased medication doses)
- M** - Mental status change or reduced level of consciousness
- O** - Oxygen saturation is low
- S** - Snoring or other noisy respirations
- P** - Pasero Opioid-Induced Sedation Scale (POSS)
- H** - Hypoxia
- E** - Elevated carbon dioxide level in the circulating blood
- R** - Richmond Agitation Sedation Scale (RASS)
- E** - Environmental barriers/alarming

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PATIENT DETERIORATION RESPONSE ALGORITHM

Figure 5 provides an algorithm for responding to a patient's status that has deteriorated.

FIGURE 5: PATIENT DETERIORATION RESPONSE ALGORITHM



1 Assess Patient

The frontline provider 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.
- Look for Respiratory Depression Warning Signs (see Figure 4).

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 a 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 or change in oxygenation or ventilation status (e.g., EtCO₂ waveforms, SpO₂ results).
- Assess the patient's continuous ventilation data with other patient data, such as medications, vital signs, etc.
- Think critically of what the numbers reflect about the patient's overall respiratory status.
- Evaluate any continuous IV infusion to rule out medication error.
- Check pump programming.
- Perform IV-line reconciliation.

1b**Is Patient Breathing Effectively?**

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

No: Call Rapid Response Team 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 Actionable?**

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.
- Confirm alarm parameters are appropriate for the patient.
- Check alarm passcodes.
- Check for improper tube placement or equipment malfunction.
- Check/readjust nasal interface (may need to replace).

3**Re-Assess Patient and Intervene**

Regularly re-assess patient (see Step 1 Assess and Identify Risk in this tool kit) 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 (BiPAP) (Inspiratory Positive Airway Pressure 15, Expiratory Positive Airway Pressure 5, Rate 12).
 - Continue ventilation monitoring with NIV.

NOTE: For any event, it is important to conduct a prompt root cause analysis of the event.

CLINICAL SCENARIOS

Scenario #1

A 50-year-old female patient was transferred to the Telemetry unit at 1800 following a complicated hemicolectomy. Hydromorphone PCA was infusing to control pain. At 0330, EtCO₂ was 45. Over the next 4 hours, it trended to 62. 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. Naloxone 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 and alarm was silenced.

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 opioid infusion with a PCA demand dose and on continuous SpO₂ and EtCO₂ monitoring at 1800. Soon after starting the PCA, the patient desaturated to a SpO₂ of 84%. The patient was placed on a 40% oxygen aerosol mask, EtCO₂ monitoring, and PCA continuous basal infusion was discontinued at 1930. A PCA demand dose was continued for 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. The following morning at approximately 0745, 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 was at high risk for respiratory depression. The ICU transfer could have been prevented and BIPAP initiated, if screening had been done and continual EtCO₂ monitoring had been in place.

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 naloxone, 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 44 mmHg. The nurse was able to continue monitoring the patient's ventilation and oxygenation, and naloxone 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 3 days was transferred out of the ICU after Coronary Artery Bypass Graft surgery to the Progressive Care unit at 1830. The patient had a history of alcohol abuse and appeared to be agitated due to Alcohol withdrawal. The patient's vital signs were normal. Incisional pain was rated at 7 out of 10 and the nurse administered hydrocodone/acetaminophen at 2030. The patient was given multiple doses of lorazepam (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 drawn. 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.

Scenario #5

A 50-year-old obese female with a known history of sleep apnea and history of prior difficult intubation had 11 hours of anesthesia during a complex orthopedic surgery and required strict bedrest and flat positioning for 24 hours. The patient was extubated in the PACU and came to a stepdown unit post-operatively on a PCA-administered hydromorphone infusion with a basal rate. Throughout the first night, there were problems with sleep apnea, so a CPAP mask was applied and the basal PCA was discontinued. The SpO₂ was consistently monitored, the EtCO₂ was not consistently monitored as it was alarming repeatedly; when the nurse assessed the patient, she was wide awake. In addition, staff felt the SpO₂ readings were inconsistent ranging intermittently from the 20s to 100s. The patient roused very easily, causing the nurse, respiratory therapist, and physician to distrust the low readings. The patient had a history of anxiety and was on alprazolam at home and requested something for her nerves at 1600. Lorazepam 0.25mg was administered IV because the patient had an NG tube to low intermittent suction. The patient was on 8 Liter CPAP when sleeping (nasal cannula when awake), but roused easily for assessments and vital signs. By 1730, the patient went into respiratory arrest that progressed to an asystolic rhythm.

Scenario #5 Key Take-away: Patient was found to have an edematous pharynx upon intubation. Patient's CO₂ was not markedly elevated so it was determined to be more of an issue related to airway swelling.

Scenario #6

A 47-year-old male with known history of severe gastroesophageal reflux disease, previously treated surgically with the laparoscopic fundoplication procedure, was waking up post operatively following multi-level spinal fusion surgery. Approximately 6 hours following the surgery, the patient was recovering in a private room on an orthopedic floor with his spouse at the bedside. The patient was complaining of pain, anxiety, and nausea. As the patient became more anxious, he started to heave and make loud noises as if he was going to vomit. The patient and his spouse explained to the nurse that the prior laparoscopic fundoplication procedure prevented him from vomiting. The nurse in response to the patient's concerns followed the surgeon's standing post-operative orders and provided the patient with hydromorphone, alprazolam, and ondansetron. Following the administration of the medications, the patient was on room air and not being monitored by either a pulse oximeter or ventilation monitoring device. As the combined medications started to take effect, the nurse told the wife that her husband appeared to be resting. Approximately 20 minutes later the wife came out to the nurse's station yelling that her husband had stopped breathing. A fast response by an RRT nurse and administration of naloxone reversed the over-sedation and no long-term sequela occurred.

Scenario #6 Key Take-away: The administration of the multiple CNS depressant medications with questioning the stacking effect in addition to a prolonged surgery within the past 24 hours creates a high risk for respiratory depression. Close monitoring using ventilation technology (and/or family members if technology not available) should be used to monitor the patient's ventilatory status. The concern in this type of incident is what would have been the outcome if the spouse was not at the bedside. The lack of adequate electronic monitoring of the patient's ventilation status could have led to a catastrophic event.

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7 Document, Communicate, and Evaluate (It Takes a Team)

This section presents recommendations for hospitals when establishing standardized and systematic practices for documenting, communicating, and evaluating a patient's risk for respiratory depression. It is critical to assess and document the patient's risk for respiratory depression early in the care process and evaluate that risk often – as a team.

For examples of documentation, communication, and evaluation tools, see www.hqinstitute.org/tools-resources.

DOCUMENT

The following documentation practices are recommended:

- Give frontline providers and respiratory care practitioners the opportunity to provide input on 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,
 - Shift-to-shift reports, and
 - Pre-anesthesia/pre-operative checklist information.
- Follow hospital standard of care guidelines for charting vitals, oxygenation, and ventilation monitoring.
- Document as patient condition changes.
- Document any respiratory consultation.
- Document patient's tolerance or refusal of prescribed NIV therapy and/or continuous monitoring. For refusals, document the explanation of the risks and follow-up actions with patient and other caregivers.
- If patient's risk level is moderate to high or high risk (see [Step 1: Assess and Identify Risk Factors](#)), document notification to provider if intervention is not aligned with risk and escalate as needed.
- Consider where and how respiratory risk levels, monitoring assessments, interventions, responses, etc. data are documented for leaders, managers, and frontline staff to track and report improvement efforts using the organization's quality system.

COMMUNICATE

Frequent communication via all forums (huddles, communication boards, problem lists, electronic medical record alerts, handover documents, armbands, etc.) is critical to respiratory depression awareness.

During Inpatient Stay

- Incorporate patient respiratory risk level into pre-anesthesia/pre-operative checklist and review at shift-to-shift reporting.
- During any handover, communicate:
 - If patient has drug sensitivities,
 - If patient is at risk for OSA,
 - If patient received previous unplanned reversals, desaturation events, apneic events, and
 - If patient has history of difficult intubation.
- If patient has other co-morbidities (e.g., Chronic Obstructive Pulmonary Disease), notify patient and family/care partner of patient's respiratory risk level including precautions and warning signs.
- Apprise all care team members (e.g., 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, including the transport team, when a patient is at high risk for respiratory compromise and/or OSA. Some suggested examples:
 - Post a precautionary sign, such as ARC - At risk for Respiratory Compromise - on the patient's door.
 - Place a checkered bracelet on the patient's wrist.
 - Provide a laminated sheet of patient's risk (e.g., OSA) to go with the patient during transport.

For Transferring Patients

- Educate transport staff on the importance of maintaining at-risk patients at the same level of basic physiologic monitoring during transport as they received in the originating patient care area.
- Incorporate into the transfer process the communication to the receiving facility/unit/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 risk 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.
- For patients suspected of OSA/sleep disorder, provide discharge education, and consider following up with the provider.

EVALUATE AND RE-EVALUATE

NOTE: For any event, bring the frontline providers together, assess, identify lessons learned, and disseminate changes.

The decision to discontinue respiratory monitoring must be determined after conducting ongoing, routine assessment of the patient and a thorough evaluation of the patient's respiratory risk factor(s):

- Routinely assess patient's sedation, respiratory rate, quality, depth, and rhythm of respirations.
- Evaluate the patient's pain management plan and medication needs based pain scale rating and response based on trended respiratory monitoring parameters.
- Consider the effects of all sedating medications (e.g., benzodiazepines in combination with other sedatives may exacerbate the sedation level).
- Re-assessing the sedation level just prior to administering any sedating medication.⁶⁵
- If patient remains at risk for respiratory depression, consider continuing or implementing recommended monitoring protocol.
- If patient is no longer at risk for respiratory depression based on monitoring recommendations, discontinue monitoring (see [Table 5 Monitoring Recommendations](#) in this tool kit).
- 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 recommendations addressing high-alert IV medications, refer to the High-Alert IV Medication Tool Kit and the High-Alert IV Medication Dosing Limits Tool Kit available for download at www.hqinstitute.org/tools-resources.

Lessons Learned

This section provides a description of the methodology used by workgroup members 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.

For examples of generic project management tools and additional implementation information, see www.hqinstitute.org/tools-resources.

To develop guidelines, begin by forming a hospital team, clarifying roles and responsibilities, and manage resistance by identifying stakeholders.

DEFINE AND EVALUATE CURRENT STATE

The team must identify the current state to target change effectively. To do so, the team should compile organizational data for sharing and discussing:

- Consider holding focus group sessions with frontline providers and respiratory care practitioners from various non-ICU settings to better characterize current frontline practices and challenges.
- Engage key stakeholders in identifying at-risk patients.
- 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 team recognizes the case for standardization is based on scientific evidence, best practice, participants' experience, etc. At the same time, patient care must allow for customization based on specific patient characteristics and needs. Team facilitation should be encouraged to allow for discussion and clarification and ensure that the team 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 ZERO preventable episodes of respiratory depression secondary to the use of medications with sedation affect. To accomplish this, we need to provide evidenced-based community standards and best practices for safe and effective 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 evaluation, 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.

Enlist Champions and Mobilize Commitment

It is important to engage stakeholders and champions for mobilizing organizational commitment to the respiratory monitoring improvement project. Champions could include:

- Patient/Family/Care Partner
- Nursing, Nursing Leadership, Nurse Educators
- Providers
- Respiratory Therapy
- Anesthesiologists
- 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
- Biomedical
- Intensivists
- Hospitalists
- Procedural Area Representatives
- Patient Safety/Risk Professionals
- Quality and Regulatory resources
- Others, as needed

Value Analysis

The team should use internal data to customize a meaningful value analysis of the improvement project for key decision-makers that will ensure the optimal number and type of electronic respiratory monitors and resources are available.

For additional information on value analysis development, see www.hqinstitute.org/tools-resources.

Benefits from Enhanced Clinical Care

The team can share with stakeholders the expected benefits once electronic ventilation monitoring is incorporated into patient care outside the ICU:

- **Provides early and reliable detection of hypoventilation.** As procedures extend beyond the traditional areas, electronic respiratory monitoring is an important and reliable indicator of hypoventilation for early intervention and prevention of adverse events.
- **Offers a non-invasive solution.** Electronic respiratory monitoring is a non-invasive diagnostic tool offering frontline providers a continuous assessment of a patient’s ventilation status.
- **Reduces unnecessary and costly ABG testing.** One study suggests the use of capnography could decrease the need for repeated arterial blood gas testing.⁶⁶
- **Indicates early abnormal ventilation findings.** Another study found most patients with acute respiratory events had ventilation abnormalities that occurred before oxygen desaturation or observed hypoventilation.⁶⁷
- **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, emergency department, and step-down units.
- **Optimizes patient safety and satisfaction.** Continuous electronic respiratory monitoring embeds proven technology and offers supplemental clinical data as a safety net for frontline providers and at-risk patients outside the ICU.

Costs

Table 9 provides major direct and variable costs that a hospital can expect when implementing an electronic ventilation monitoring program (i.e., technology, resources).

TABLE 9: MAJOR DIRECT AND VARIABLE ELECTRONIC VENTILATION MONITORING COSTS

COSTS	
Direct Costs	<ul style="list-style-type: none"> • Equipment lease/purchase payment (e.g., cabling, wireless servers, remote monitoring technology) • Warranty and service cost per year • Supplies/consumables • Implementation (e.g., training)
Variable Costs	<ul style="list-style-type: none"> • Labor • Ongoing competency

Benefits from Cost Avoidance

Electronic ventilation 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. Costs that can be avoided when clinical practice includes continuous electronic respiratory monitoring of at-risk patients outside the ICU include:

- Centers for Medicare and Medicaid Services penalties for value-based programs (e.g., mortality complications, patient satisfaction scores, hospital and provider reputation) from federal and state program
- RRT costs (e.g., number of RRT calls for patients with a respiratory depression component, number of code blues)
- Code Blue avoidance
- Transfer to higher level of care costs
- Number of interventions in response to electronic respiratory monitoring alarm costs
- Additional medication costs (e.g., naloxone, methylprednisolone)
- Respiratory treatment and laboratory (e.g., arterial blood gas) costs

- Intubation costs
- Adverse event and investigation costs
- Adverse drug event and investigation costs (estimated cost used for discussion purpose of adverse drug event was \$7,725)⁶⁸
- 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. Table 10 identifies possible quantitative quality metrics to monitor respiratory monitoring safety guidelines.

Additionally, patient, employee, and provider satisfaction may be indirectly impacted, and these qualitative measures can offer valuable practice feedback. There should be a balance between satisfaction and appropriate opioid use.

Workgroup members recommend hospitals identify the unplanned administration of naloxone as a precursor safety event (with learning) and define serious safety event.

TABLE 10: POSSIBLE RESPIRATORY MONITORING QUALITY METRICS

PROCESS MEASURES	OUTCOME MEASURES
Percent of surgical patients screened for OSA.	<ul style="list-style-type: none"> • RRT events related to drug-induced respiratory depression. Per 1,000 patient days.
Percent of at-risk patients electronically monitored for respiratory depression	<ul style="list-style-type: none"> • Transfer to higher care related to opioid use. Per 1,000 patient days.
Percent of patients receiving opioids who are also receiving benzodiazepines. Exclusions: opioid and benzodiazepine use during monitored sedation or anesthesia, patients on ventilators.	<ul style="list-style-type: none"> • Pharmacy report on reversal agents. Exclusions: Emergency department use for patients who have not yet received opioids during their stay (i.e., Naloxone use for reversal of opioid sedation per 1,000 patient days).⁶⁹

Purchasing Considerations

The following questions are recommended to pursue when purchasing and implementing respiratory monitoring equipment outside the ICU:

- What are the organizational needs?
- What is the scale of the initial effort? Centralized, unit based, or portable?
- What patients are considered Moderate to High Risk and High Risk for respiratory depression? Where are these patients located?
- What are the current respiratory monitoring capabilities (e.g., equipment, brand, resources)? When will current bedside monitors be sunsetted?
- 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, yet patient-customized, approach to respiratory monitoring across a hospital should extend beyond the assessments, work flows, and monitoring practices. Workgroup members recommend 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. Also recommended, is the establishment of a multidisciplinary advisory group (including representatives from the emergency department and RRT) for governance of these clinical monitoring practices.

Policies, Protocols, and Process

Standard policies or guidelines, protocols, and work flows are effective methods that provide a margin of safety in minimizing variance in assessing, detecting, and intervening with patients at risk for respiratory depression. When developing and implementing these practices, engage in active listening and learning with all stakeholders.

For sample policies and protocols shared by members, see www.hqinstitute.org/tools-resources.

Workgroup members recommend standardizing policies, protocols, and processes related to:

- Respiratory assessment initiation and frequency.
- Frequency, mode, and duration of IV opioid delivery in determining monitoring method and frequency.
- Continuous ventilation monitoring initiation, frequency, and duration (inpatient and outpatient).
- Guidance for the reversal of opioids, including:⁷⁰
 - Reversal protocols are active on all patients' medication administration record if there is an active order for a narcotic.
 - Nurses are allowed to administer reversal agents without prior physician order if protocol criteria are met.
 - Strategies are in place to guard against dose stacking.
- RRT assistance with possible narcotic over sedation events.
- Default alarm settings.
- Centralized monitoring usage for higher acuity patients.
- Integration of the alarm response algorithm (see Figure 5: Patient Deterioration Response Algorithm) into bedside documentation for monitored patients.
- Response to patient refusal to participate in care (e.g., provider converses with patient and family regarding consequences of refusing treatment and documents conversation).
- Non-invasive ventilation treatments.
- Patient risk level on discharge/transfer paperwork.
- Documentation history of OSA and positive risk of OSA/suspected OSA in the patient's Problem List for future reference.
- Change of care documentation and communication.
- Pharmacy communication based on medication ordered and reversal agent administration.
- Patient respiratory monitoring during transport.
- Quality improvement metrics.
- Standards for long-term care, home health, and acute care rehabilitation environments.

Standard Order Sets

It is recommended each hospital establish standardized order sets that include:

- Allowance for specific patient characteristics, such as age, morbidity, opioid sensitivity, weight;
- Frequency, mode, and duration of IV opioid delivery to determine monitoring method and frequency;
- Orders from the operating room, post-anesthesia care units, and emergency department follow the patient from admission to the floor to avoid duplicate and/or interactive medication orders;
- Monitoring respiratory parameters as part of a clinical routine,
- Interventions available to the nurse for when the alarm sounds (unless part of protocol); and
- When to remove, suspend (e.g., eating), and discontinue monitoring.

SAMPLE PCA ETCO₂ ORDER

Perform continuous ventilation monitoring. Document value with each instance of vital signs and with each pain assessment for the duration of 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.

Providers need to be aware of the possibility of duplicate orders when other physicians/providers are seeing the patient.

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

It is recommended that the team 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, handover 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

For sample education materials, competencies, and tools shared by members, see www.hqinstitute.org/tools-resources.

*For additional education strategies, see *The Joint Commission Sentinel Event Alert, Issues #49 and #50* and *The Joint Commission National Patient Safety Goal on Clinical Alarm Management* (www.jointcommission.org).*

Workgroup members recommend the following when designing a respiratory monitoring education program:

- Recognize the initial and ongoing substantial effort needed to train providers, respiratory care practitioners, and specific nursing personnel in reading ventilation and oxygenation waveforms.
- Design interdisciplinary education on respiratory depression and the risks and incorporate into new provider/employee (temporary or permanent) orientation.
- Address any barriers to nurse-provider communications related to monitoring.
 - Obtain medical staff buy-in.
 - Consider provider attitudes about additional monitoring.
- Consider using the Train-the-Trainer approach for an expert in each clinical area.
 - Consider engaging RRT members, anesthesia department, and respiratory staff as educators.
 - Engage nursing educators.
- Educate providers and staff on the following topics:
 - Differences between monitoring oxygenation and ventilation
 - Interpretation of vital signs and monitoring equipment
 - Current standards, protocols, best practices, order set, etc.
 - Respiratory risk factors prioritization
 - Monitoring recommendations by respiratory risk level
 - Respiratory depression warning signs (see Figure 4 in this tool kit)
 - Opioid use and the need to avoid opioid misuse
 - Dose stacking and dose equivalency
 - Alarm parameters and management
 - Monitoring device troubleshooting
 - Assessment of Capnography or RVM graph waveforms
 - Patient and family engagement in appropriate use of monitoring equipment
- Enable opportunities for staff to be educated:
 - At the bedside and during unit meetings and staff orientations.
 - Using existing educational processes (e.g., leader training, professional organization).
- Ensure education of all disciplines providing care for at-risk patients (e.g., providers, nurses, anesthesiologists, pharmacists).
- Develop respiratory monitoring competencies to demonstrate proficiency (e.g., case studies, scenarios) and use annually.
- Establish opportunities for staff to routinely use capnography and gain experience with the use and interpretation of capnograms.
- Reinforce the importance of applying critical thinking when reviewing alarm trend data.
- Annually evaluate and update the education design, methods, content, and modality to address knowledge gaps.

IMPLEMENTING TECHNOLOGY

One challenge with implementing new technology is aligning the investment with the demand cycle. This is especially true with incremental adoption and roll-out of monitoring technology outside of the ICU. Workgroup members recommend considering the following when implementing respiratory monitoring technology:

- Comply with Clinical Alarm Management goals and standards through relevant professional associations and accrediting bodies, such as The Joint Commission National Patient Safety Goal.
- 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.
- If the resources for centralized monitoring are not available, consider unit based or portable monitoring.
- Institute regular servicing of continuous ventilation 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.
- Consider important areas for implementing ventilation monitoring such as: Interventional Radiology, Emergency Department, Cardiology Laboratory, Gastroenterology Laboratory, procedural labs, Magnetic Resonance Imaging, and patients receiving PCA.

Remote/Centralized Monitoring

Using remote/centralized ventilation status monitoring whenever possible for patients at **Very High Risk** for respiratory depression is recommended. However, if remote/centralized monitoring is not feasible, it is recommended that hospitals start with what monitoring equipment exists, place the patient near 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.
- Portable 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 of false alarms.
- Enables prompt notification to the frontline provider 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 frontline provider.
- (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, continuous remote monitoring staff/technicians.

MAINTAIN AND CONTINUE IMPROVEMENTS

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

- Monitor and report trends in quality metrics (see Table 10: Possible Respiratory Monitoring Quality Metrics).
- Integrate action plans into audit processes.
- Provide for regular review of alarm settings to avoid false positive/false negative alarm issues.
- 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.

HQI AND SAN DIEGO PATIENT SAFETY COUNCIL HISTORY

In 2005, a three-year AHRQ grant launched the convening of San Diego physicians, nurses, pharmacists, and respiratory therapists from local acute care facilities to develop standard practice recommendations and toolkits that promote patient safety and help reduce medication errors. Later, known as the San Diego Patient Safety Council, the council was supported by Cardinal Health's Center for Safety and Clinical Excellence.

Subsequently, Cardinal Health Foundation awarded a grant of \$100,000 to Hospital Association of San Diego and Imperial Counties and CareFusion's Center for Safety and Clinical Excellence to support this work through 2014.

Regional initiatives included:

- Creation and adoption standardization of high risk IV medications (2006)
- Best practices for patient controlled analgesia (2008)
- ICU sedation guidelines of care (2009)
- Standardizing smart IV pump dose limits (2012)
- Respiratory Monitoring of Patients Outside the ICU Guidelines of Care Took Kit (2014)

In 2010, the Institute for Safe Medication Practices awarded San Diego Patient Safety Council its Cheers Award. The Cheers Awards honor individuals, organizations, and companies that have set a superlative standard of excellence for others to follow in the prevention of medication errors and adverse drug events

In 2013, San Diego Patient Safety Council was awarded the AAMI & Becton Dickinson's Patient Safety Award. This award recognizes outstanding achievements by health care professionals who have made a significant advancement toward the improvement of patient safety.

Today, HQI convenes interdisciplinary stakeholders to align with the HQI mission to advance and accelerate patient safety and quality improvement for coordinated statewide impact, with aims to achieve zero defects, optimize clinical effectiveness, and enhance patient and family experience in health care.

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