PREVENTION OF SENITIAL EVENTS.

1/3 or inpatient sentinel events are related to respiratory depression (Chan P., et al., NEJM 2008).

During the 2-week capnography pilot – 3 RRTs were prevented.

REASONS FOR CAPNOGRAPHY MONITORING:

ISMP Medication Safety Alert!

DRAW CURTAINS, MUTED ALARMS, AND DIVERTED ATTENTION LEAD TO TRAGEDY IN THE POSTANESTHESIA CARE UNIT

From the March 21, 2013

Problem: Last April, a 17-year-old girl died following an uncomplicated tonsillectomy performed in an outpatient ambulatory surgery center after receiving a dose of IV fentanLYL in the postanesthesia care unit (PACU). The case made headline news again recently when a civil lawsuit filed by the teen’s parents was resolved. While it is too late to reverse the tragic outcome of this case, we call upon all hospitals and outpatient surgery centers to learn from the event and take action to prevent a similar tragedy in your facility.

Following surgery, the teen arrived in the PACU where a nurse anesthetist administered a dose of fentanLYL by slow IV push to the patient to help manage pain. The drug led to respiratory depression and eventual respiratory arrest. The patient was found pulseless and breathless 25 minutes after receiving the fentanLYL. Resuscitation efforts were initiated, and the patient was transferred from the ambulatory surgery center to a hospital emergency department. As a result of oxygen deprivation, the patient suffered profound, irreversible brain injury and died.
The Physiology of Breathing

The respiratory and cardiovascular systems work together to ensure a constant supply of oxygen to the cells and the removal of carbon dioxide from the cells.

- **Ventilation**= the movement of air into and out of the lungs
  - One Ventilation Cycle= one inspiration & one expiration
    - The purpose of inspiration is to bring oxygen into the body
    - The purpose of expiration is to release carbon dioxide from the body
  - The volume of air exchanged in one cycle= tidal volume
    - Shallow breathing causes a decrease in tidal volume
    - Shallow breathing causes ineffective ventilation
  - End tidal = the end of exhalation
    - End-tidal CO₂ (EtCO₂) is the measurement of carbon dioxide at the end of expiration

- **Respiration**=Gas Exchange of oxygen and carbon dioxide
  - Oxygen diffuses into the blood from inhaled air, then into the cells in the body
  - Carbon Dioxide diffuses out of the cells and into the blood; then out of the blood and into the exhaled air

Adequate **Ventilation** and **Respiration** must occur for **Oxygenation** of the tissues.
Oxygenation and Ventilation: What’s the Difference?

- **Oxygenation** = oxygen available in the body
  - Measured by Pulse Oximetry (Sp0₂)

- **Ventilation** = movement of Oxygen into the lungs and the release of Carbon Dioxide from the body
  - Measured via end-tidal CO₂ (EtCO₂) by Capnography
  - EtCO₂ is the BEST method of assessing ventilatory status
CO₂ Regulation

**Hyperventilation**

- As respiration rate and depth increase
- More CO₂ is exhaled
- Blood CO₂ decreases

**Hypoventilation**

- As respiration rate and depth decrease
- Less CO₂ is exhaled
- Blood CO₂ increases


Causes of Hyperventilation:

- anxiety
- pulmonary embolus
- bronchospasm
- decreased cardiac output
- hypothermia
- pulmonary edema
- cardiac arrest
- Metabolic rate
- Tidal volume

Hyperventilation - CO2 (hypocarbic)
Hypoventilation Causes

- Sedation
- Overdose
- Intoxication
- Head trauma
- Postictal

- Pain
- Fever
- Sepsis
- Chronic hypercapnia

- Metabolic rate:
  - ↑

- Tidal volume:
  - ↓

- Respirations:
  - ↓

- Hypoventilation = ↑ CO2
- Hypercarbia/hypercapnia
Respiratory Side Effects of Narcotics

- Even in therapeutic doses, narcotics can cause respiratory depression
  - The brain stem’s respiratory center is depressed by narcotics
  - The respiratory center fails to adequately stimulate the lungs
  - The Patient’s respiratory rate drops
  - The Patient’s breaths become shallow
  - Because of this hypoventilation, CO₂ elimination falls behind CO₂ production
  - The build up of CO₂ is called HYPERCAPNIA
  - The depressed brain stem fails to sense the change in pH caused by the retained CO₂

- Carbon Dioxide Narcosis leads to RESPIRATORY ARREST
Carbon Dioxide (CO₂) Narcosis

- Up to 14% of patients using narcotics suffer from respiratory depression. ¹
- 50% of CODE BLUE events are related to narcosis. ²
- Respiratory failure caused by acute hypercapnia can occur in a matter of minutes. ³


What is Capnography?

Noninvasive, continuous measurement of exhaled carbon dioxide (EtCO2) concentration over time. A breath-by-breath indication of ventilatory status.

- A numerical value of the EtCO2
- A graphic waveform of the concentration of CO2 over time
- A true respiratory rate detected from actual exhaled airflow
The Capnography Monitor

Capnogram: Wave form

Capnometer: Numeric measurement of End-tidal CO₂

awRR: Airway Respiratory Rate

Oxygen Saturation

Heart Rate

IPI-Integrated Pulmonary Index: a single number that describes the patient’s respiratory status

Sampling Line
Where is Capnography Used?

**Capnography Applications**

**Medical surgical units**
- Monitoring patients who are receiving PCA or epidural opioid medications; detecting respiratory depression
- Aids in decision making for clinical staff

**Procedural sedation**
- Effectively monitors the patient’s airway providing the earliest indication of airway compromise

**Critical care unit**
- Detects apnea immediately, regardless of supplemental oxygen administration, and provides an earlier warning than pulse oximetry
- Provides a continuum of care of ventilation monitoring from intubated patients during mechanical ventilation to monitoring the weaning of the patient from the ventilator

**Pre-hospital and emergency department**
- Detects airway obstruction, ventilation problems, endotracheal tube placement and verification
- Provides continuous feedback on airway, breathing and ventilatory status for non-intubated patients

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Go live – Capnography project

- Expected in April 2014.
- System wide education for physicians and nursing staff
- Procedural vs. nonprocedural capnography
Risk Criteria for Capnography: Monitoring of patients on PCA pump and Parental Opioid Administration of less than or equal to 2 hours: Capnography should be mandatory for patients with at least 2 Moderate risk criteria or one High Risk Criteria

**Moderate risk Criteria:**

1) Age 70 and older.
2) Morbid obesity defined as BMI>40.
3) Patients with severe Cardio- Pulmonary disease (COPD, CHF, Cardiomyopathy, Emphysema, oxygen Dependent) (ASAIII and higher)
4) Concomitant use of CNS depressant medications i.e. Benzodiazepines.

**High Risk Criteria:**

1) Persistent Hypoxemia, defined as SpO2 of ≤92%
2) Patients with history of respiratory arrest due to narcotics.
3) Patients identified during PACU stay as requiring Capnography monitoring.
4) Patients with known OSA or suspected OSA (Using the STOP-BANG criteria)

**STOP-BANG CRITERIA**

High risk of OSA: answering yes to three or more items
Low risk of OSA: answering yes to less than three items
Where do I find capnography screening tool and orders:

On the back of the PCA order set (will be incorporated into EMR)
Assessing Ventilation Using Capnography

- Normal EtCO₂ is 35 – 45 mm Hg
- Normal IPI is 8-10
- If EtCO₂ is > 60 or IPI 4 or below:
  - Stop opioid
  - Stimulate patient and encourage deep breathing
  - Notify physician
  - Monitor respiratory status and sedation level closely
- If the IPI is 2 or less:
  - Follow above guidelines and
  - Notify physician stat and RRT
Capnography order set

- Continuous Capnography Monitoring Notify Physician for Sedation Score of 3.
- Continuous Capnography Monitoring Respiratory Until 2/17/2014 3:57:38 PM
- Consult Pulmonary Medicine Capnography
Where can I find documentation about events/alarm triggering for my patients?

- INTEGRATED CLINICAL SUMMARY

<table>
<thead>
<tr>
<th>Vital Signs - Adult (Long Form)</th>
<th>Asmt Date</th>
<th>Asmt Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capnography</td>
<td></td>
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<tr>
<td>EtCO2</td>
<td></td>
<td></td>
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<tr>
<td>IPI</td>
<td></td>
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<tr>
<td>Side Effects</td>
<td></td>
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<tr>
<td>Sedation Score = 5</td>
<td>Sleep, Easy to Arouse</td>
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<tr>
<td>Sedation Score = 4</td>
<td>Alert and Awake</td>
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<tr>
<td>Sedation Score = 3</td>
<td>Slightly Drowsy, Easily Aroussable</td>
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<tr>
<td>Sedation Score = 2</td>
<td>Frequently drowsy- arousable</td>
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<tr>
<td></td>
<td>Drifts to sleep during conversation</td>
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</tr>
<tr>
<td></td>
<td>SPO2 &lt; 92%</td>
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<td>IPI &lt; 4</td>
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<tr>
<td>Required Interventions</td>
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<tr>
<td>Sedation Score = 5</td>
<td>Somnolent, Decreased/No Response to Verbal/Physical Stimulation</td>
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<td>SPO2 &lt; 90</td>
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<td>RR &lt; 10 (adults)</td>
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<td>RR &lt; 16 (infant/child)</td>
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<tr>
<td></td>
<td>EtCO2 &gt; 60mmHg</td>
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<td>IPI &lt; 2</td>
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<tr>
<td>Capnography Comment</td>
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</table>
Review ICS if Capnoalarms triggered

Alarm Triggered

Refer patient for Sleep Medicine consult upon D/C

* Physician should renew capnography order daily if patient’s condition warrants
Physician Education

- Update for Moderate/Deep Sedation Learning Module – Capnography section
- Newly appointed physicians will be required to take new module for pediatric/adult moderate sedation
- Meeting with surgeons
- Meetings with hospitalist groups and JRI personnel