Monitoring Children During Analgesic Delivery

Terri Voepel-Lewis, PhD, RN
Associate Research Scientist
Department of Anesthesiology, Section of Pediatrics
University of Michigan Health Systems, Ann Arbor
terriv@umich.eu

Objectives

- Discuss the relevant evidence related to postoperative monitoring of children receiving analgesic medications
- Identify several potential pitfalls (e.g., sensitivity, costs) of various clinical monitoring techniques during analgesic use
- Define the current best practices and recommendations for monitoring children receiving opioid analgesics

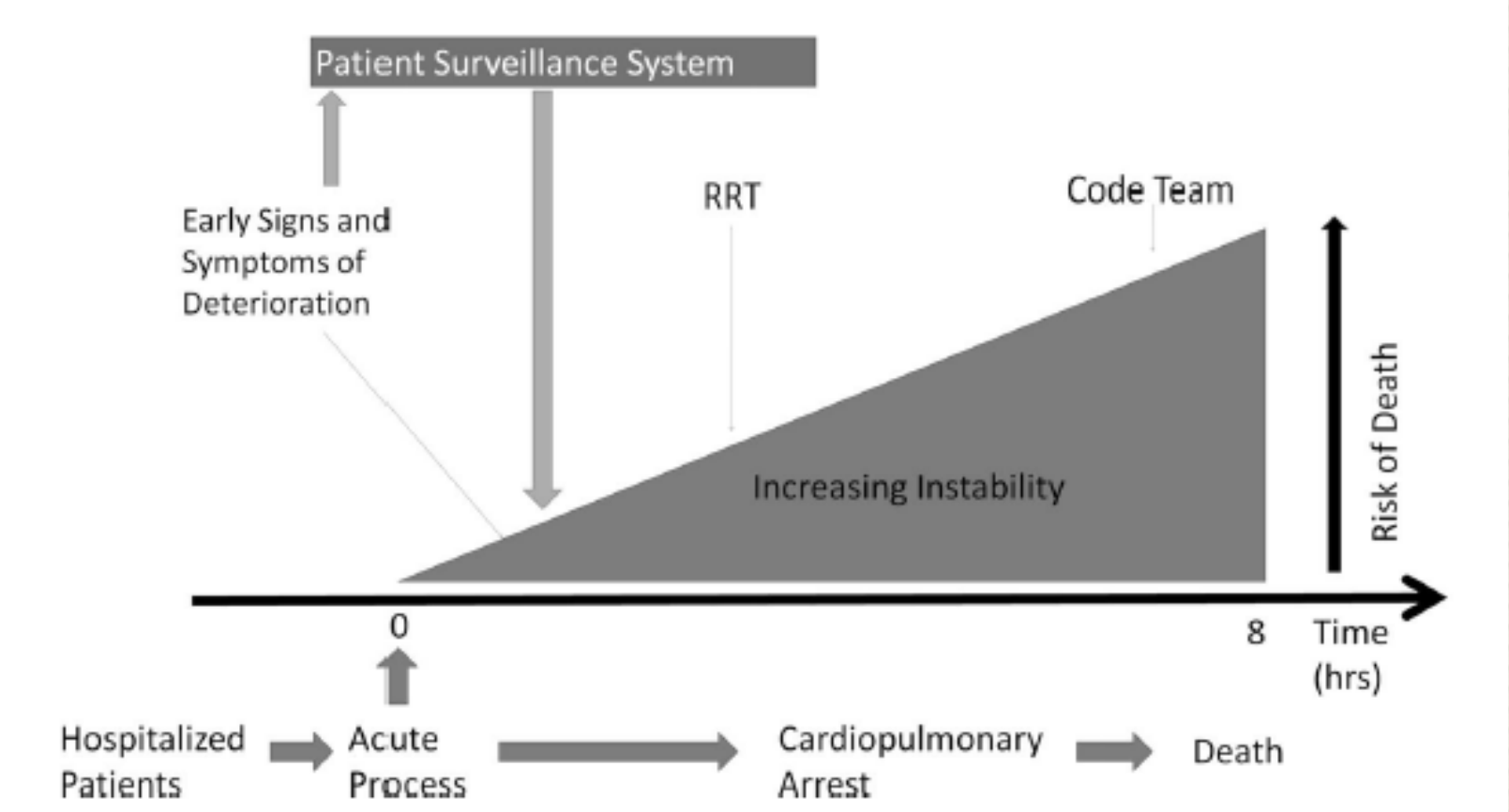
Why monitor?

- To ensure efficacy and safety of treatments
- To address the variability in treatment response
- To guide appropriate changes in care
- To prevent serious and, sometimes, tragic analgesic-related adverse drug events (ADE)

Death Preventable with Better Monitoring

- SPA respondents recalled multiple opioid-related respiratory depression (ORRD) deaths and life-threatening events
  - Nelson KL. Anesth Analg 2010;110:754 –60
- Apnea-related death and neurologic injury deemed preventable in 16 of 86 children after T&A
  - Coté CJ. Anesth Analg 2014;118:1276
- 97% of 357 ORRD events in ASA closed claims deemed preventable with better monitoring
  - Lee AL. Anesthesiology 2015;pub ahead of print

Death Preventable with Better Monitoring (Surveillance)



Taenzer AH. Anesthesiology 2011;115:421

Opioid Monitoring Protocol Described by Morton in 1993

- Importance of monitoring patient and equipment had been emphasized but no prior guidance
- “Regular” assessment of sedation and use of pulse oximetry during PCA recommended

Record hourly

Time	SpO_2	Resp Rate	Sedation Score Eyes open: 0 = Spontaneously 1 = To speech 2 = To shake 3 = ***Unrousable*** **(Call Doctor)**	Pain Score Eyes open: 0 = No pain A = Asleep 1 = Not really sore 2 = Quite sore 3 = **Very sore** **(Crying)** **(Call Doctor)**	Nausea Score 0 = None 1 = Nausea only 2 = Vomiting x1 in last hour 3 = **Vomiting >×1 in last hour** **(Call Doctor)**	T c s r

Morton NS. Pediatr Anesth 1993;3:179

Assessment and Monitoring Practices

- Survey responses from ASPM Nurses in 2009 and 2014
- Increase in sedation assessment

- Increase in monitoring during PCA and epidural use
  - Pulse oximetry (continuous and intermittent)
  - Capnography use low but increased

Jungquist CR. Pain Manag Nurs 2014;15:682

Assessing Efficacy

- Pain intensity
  - Multiple valid and recommended assessment techniques
    - Stinson JN. Pain 2006;125:143
    - Von Baeyer. Pain 2007;127:140
  - Pain scores over-simplify assessment and have different meanings for different children
    - Voepel-Lewis T. Pediatr Pain News 2013;13:1
    - Voepel-Lewis T. Anesth Analg 2011;112:415

MORPHIT: an observational study on morphine titration in the postanesthetic care unit in children

- Titration every 5 minutes to achieve pain < 30/100 (VAS or FLACC scores) over 90 minutes
- Up to ***13 doses*** (total dose up to ***0.35 mg/kg***) given
- 20% were excessively sedated at the end of titration
  - Bernard R. Pediatr Anesth 2014;24:303
- "Pain score guided titration is risky and inappropriate"
  - Voepel-Lewis T. Pediatr Anesth 2014;24:453
- *"Avoid using opioids to reach arbitrary pain ratings"*
  - JC Sentinel Event Alert, 2012

Better Efficacy Assessment

- Pain Relief (change in pain after treatment)
  - Relief that facilitates function (e.g., rest, play, recovery)
  - "*Not all pain can be eliminated*" –Joint Commission 2012
- Pain impact, interference or "bother"
  - Does pain interfere with recovery and the ability to perform recovery-related activities (e.g., deep breathe, ambulate, take part in physical therapy, drink/eat)

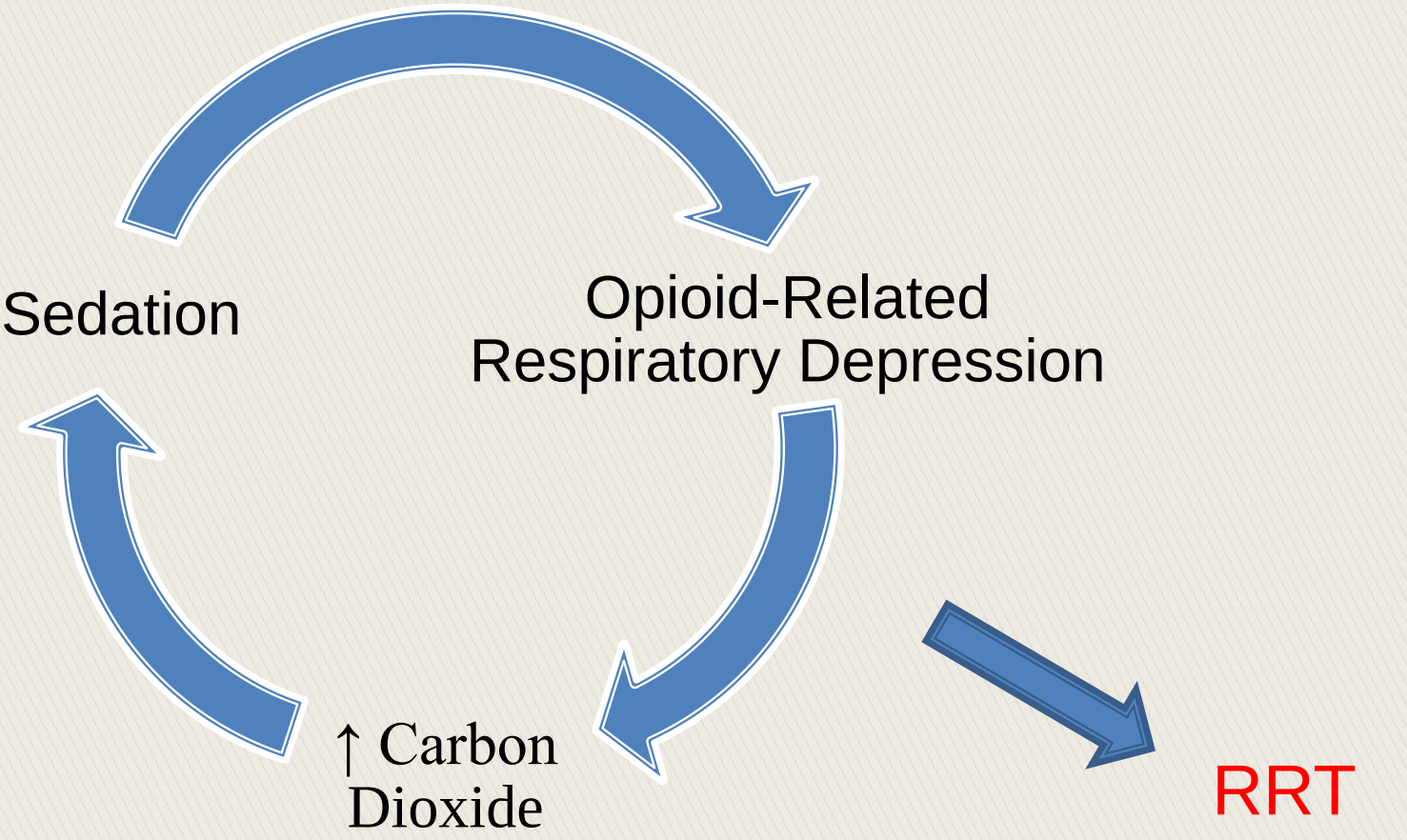
Loss of postoperative pain stimuli can increase risk

Physiologic Assessment

- VS relevance?
  - Non-specific for pain
  - Late sign of problem

- Respiratory Status
  - Rate = *poorly correlated with hypoxemia*
  - Pattern (inter-breath interval – shorter then longer intervals)
  - Depth (normal, shallow, deep)
  - Quality of effort (labored)
  - Breath sounds (snoring)

Sedation Predicts ORRD



Assessing Sedation

- Only 22% of practitioners recognized importance of excessive sedation
  - Grissinger M. *Patient Saf Advis* 2013;10:19

- *Children have died in arms of parents who assumed they were asleep*
  - Coté CJ. Anesth Analg 2014;118:1276

Failures to Recognize

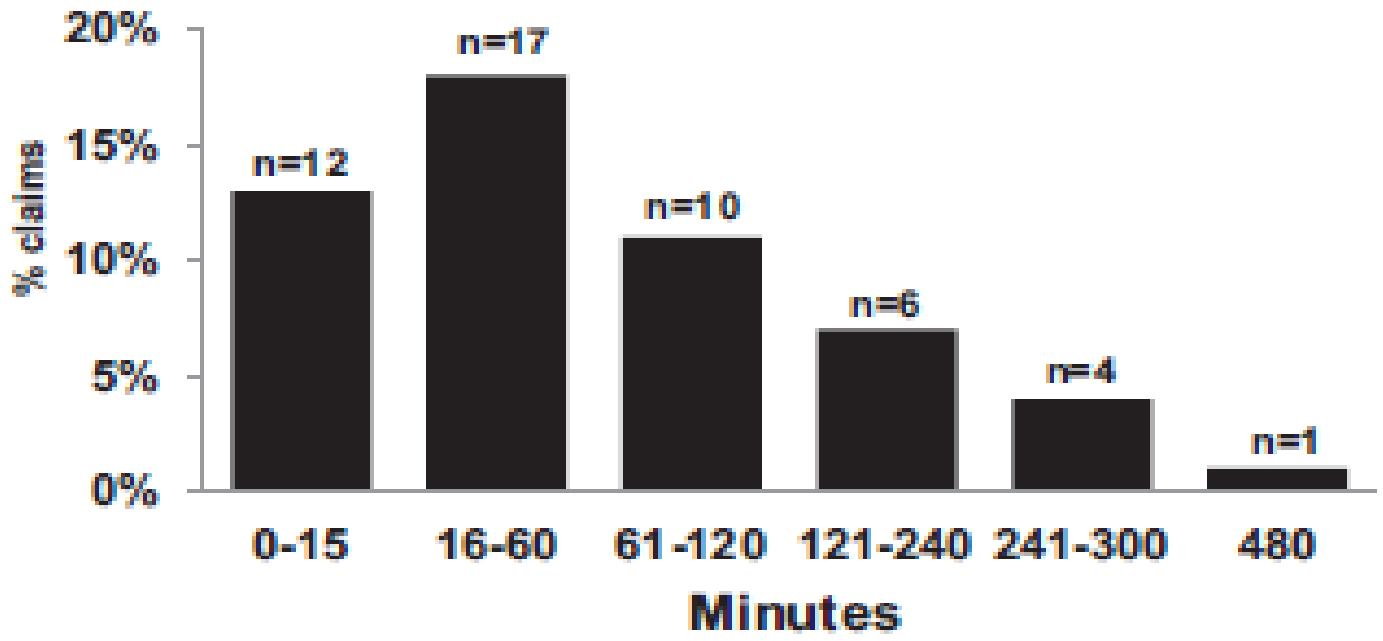


Fig. 1. Time between last nursing check and discovery of opioid-induced respiratory depression (RD). Claims with unknown timing (n = 39) and not applicable (at home, n = 3) not shown.

Lee LA. Anesthesiology 2015;pub ahead of print

Assessing Wakefulness may Improve Recognition

- Ability to stay awake was better determinant of return to baseline during sedation
  - Malviya S. Anesthesiology 2004;100:218
- Pasero Opioid Sedation Score
  - **Level 3 - Frequently drowsy, arousable, *drifts off to sleep during conversation***
    - ***Unacceptable; decrease opioid dose 25% to 50%***
  - **Level 4 - Somnolent, minimal or no response to verbal or physical stimulation**
    - ***Unacceptable; stop opioid; monitor closely until sedation < 3***
      - Pasero C. J Perianesth Nurs 2009;24:186

Frequency of Assessments

- Allow sufficient time to assess response to analgesic
  - Joint Commision Alert 2012
- More frequent and vigilant assessments
  - High risk patients (OSA) and at night
    - Brown KA. Anesth Analg 2014;118:1157
  - First day postoperatively
    - Taylor S. Am J Surg 2003;186:472
  - Neuraxial, PCA delivery, and continuous infusions
  - Need for supplemental oxygen
    - Voepel-Lewis T. Pediatr Anesth 2013;23:162

Pulse Oximetry – *Continuous or Intermittent?*

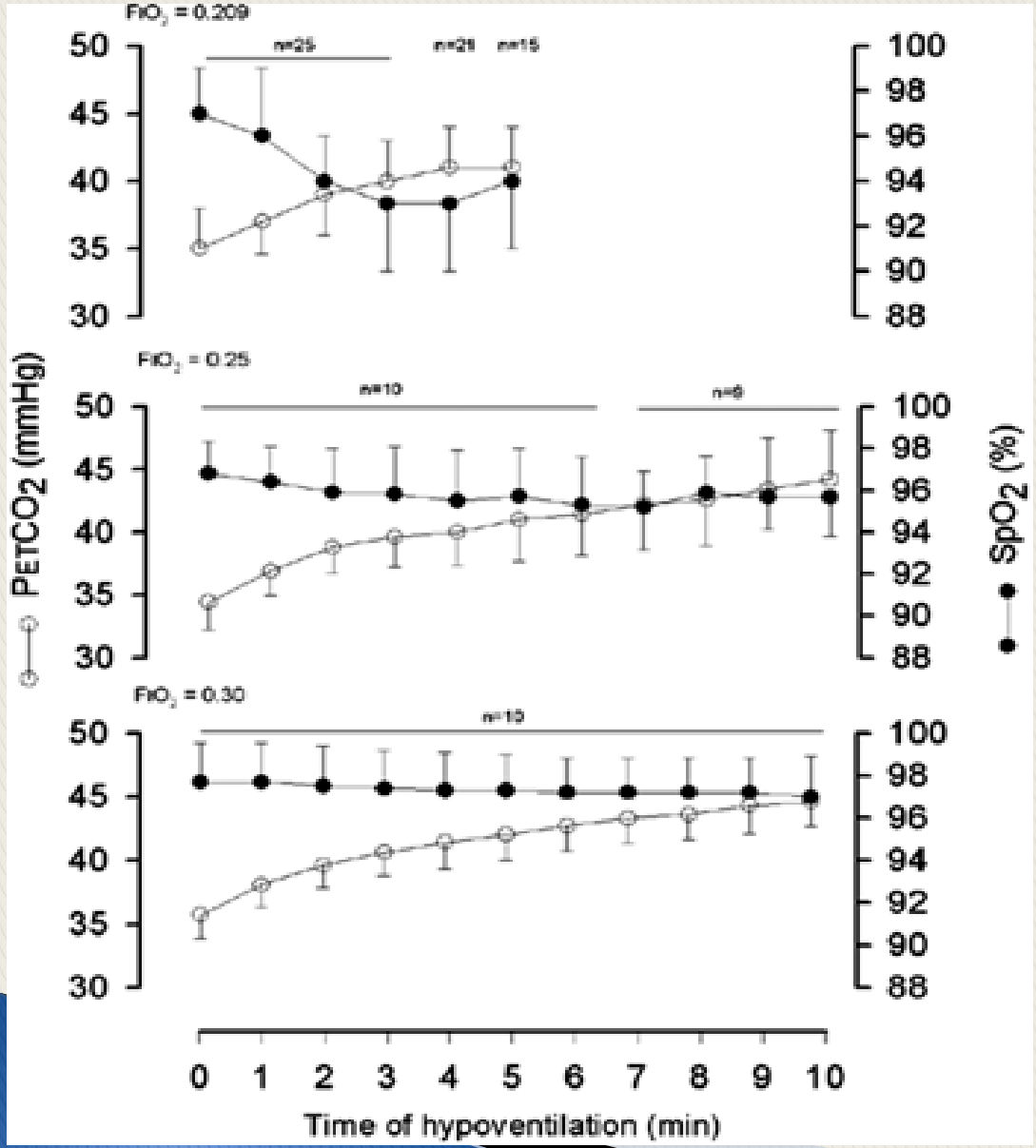
Pulse Oximetry

- Use on general care floors provides early warning, triggers rapid response and may prevent postoperative deterioration
  - Overdyk FJ. Anesth Analg 2007;105:412
  - Taenzer AH. Anesthesiology 2010;112:282
- Average nursing response time < 1 minute; longer response for patients with the most alarms
  - Voepel-Lewis T. Int J Nurs Studies 2013;50:1351

Failure to Recognize

- Case Discussion
  - Patient DCd from PACU at 19:00 after multiple doses morphine; several more doses through 21:00
  - Continuous monitoring with pulse oximetry
  - Patient receiving 2 L/min O_2
- Multiple episodes of desaturation with alarm notification
- Lack of problem recognition and intervention
- Ultimately respiratory and cardiac arrest

Supplemental O_2 Impairs Detection of ORRD



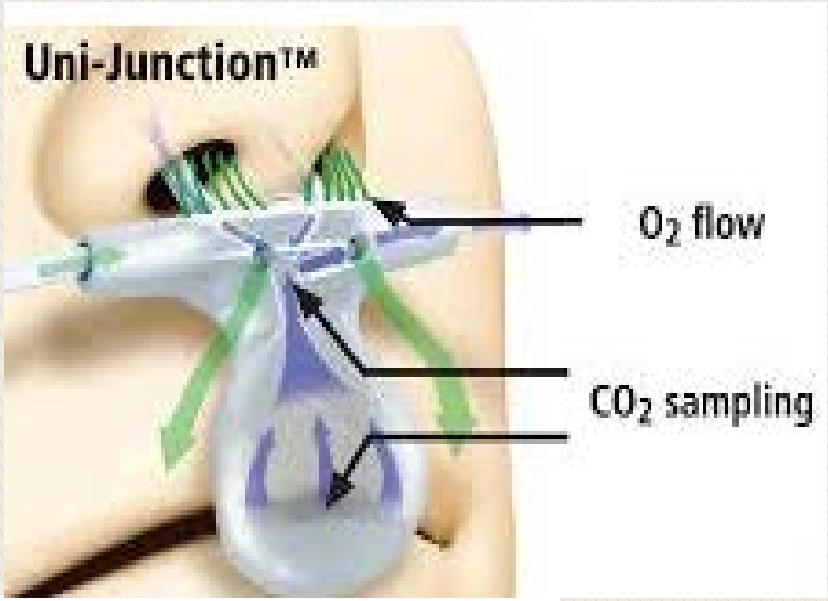
← Room air

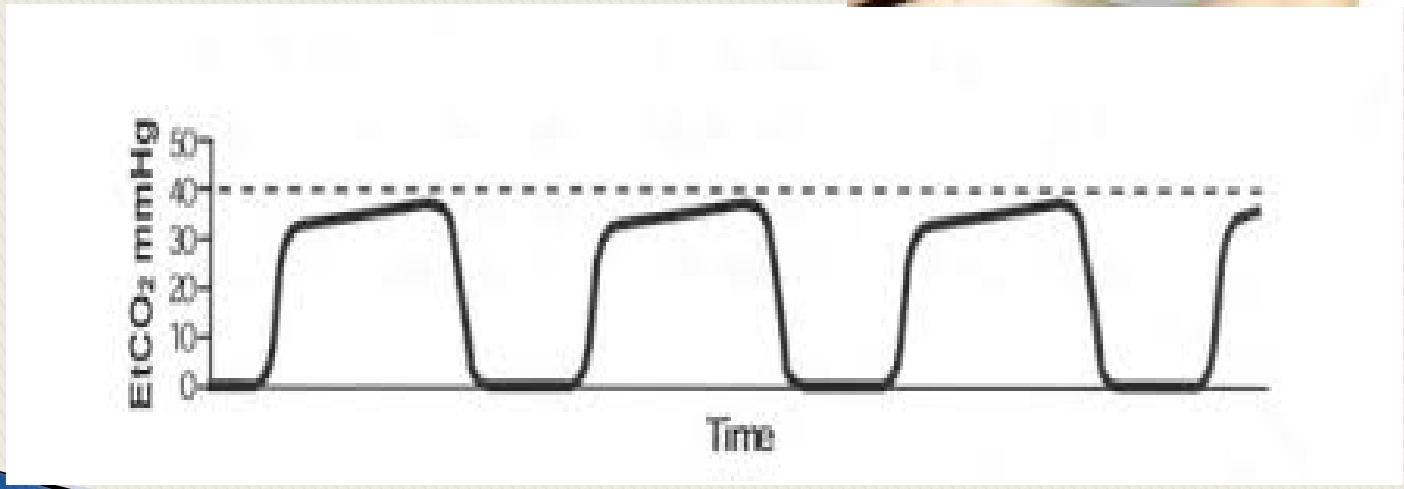
← FiO_2 .25

← FiO_2 .30

• Fu ES. Chest 2004;126:1552

Capnography



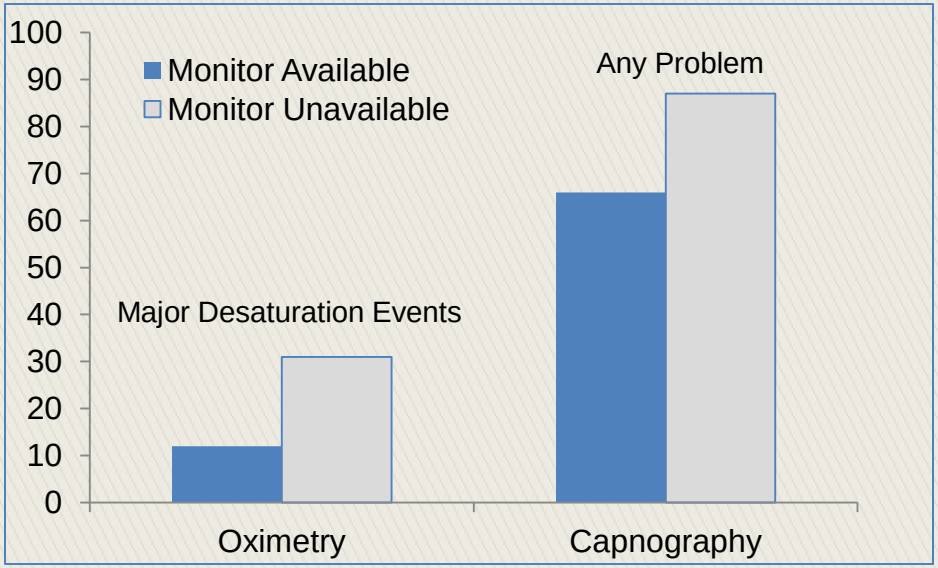


Capnography use During Sedation

- Nurses blinded to capnography
  - Desaturation 70% less likely for intervention group (notified of apnea at 15s) than control (notified at 60s)
    - Lightdale JR. Pediatrics 2006;117:e1170
- Hypoventilation occurred prior to hypoxemia and without Δ RR
- Persistent $\downarrow EtCO_2$ preceded persistent $SpO_2 < 95\%$
- 3.7 minute lag from $\downarrow EtCO_2$ to hypoxemia (r 1-10 min)
    - Anderson JL. Ann Emerg Med 2007;49:9
    - Langhan ML. Pediatr Emerg Care 2011;27:394

Pulse Oximetry vs. Capnography

- Blinded, randomized trial in 402 children (OR)
  - Pulse oximetry + capnography
  - Pulse ox only
  - Capnography only
  - Neither



- When pulse ox unavailable, provider unaware of major desaturation in 77% of cases

Coté CJ. Anesthesiology 1991;74:980-87

Capnography during Sedation-Young Adults

- Standard care (incl. pulse ox) vs. standard + capnography
- *No differences* in hypoxemia (SpO_2<91; 25 vs. 26%) or profound hypoxemia (SpO_2<81%; 3 vs. 3%)
- Capnographic changes preceded hypoxemia in 63% of episodes *(mean time 32 seconds)*
  - Absent alveolar plateau – 25.6%
  - Apneic period – 18.6%
  - No case where ↑$EtCO_2$ values suggested hypoventilation
    - Van Loon K. Anesth Analg 2014;119:49

Capnography on General Care

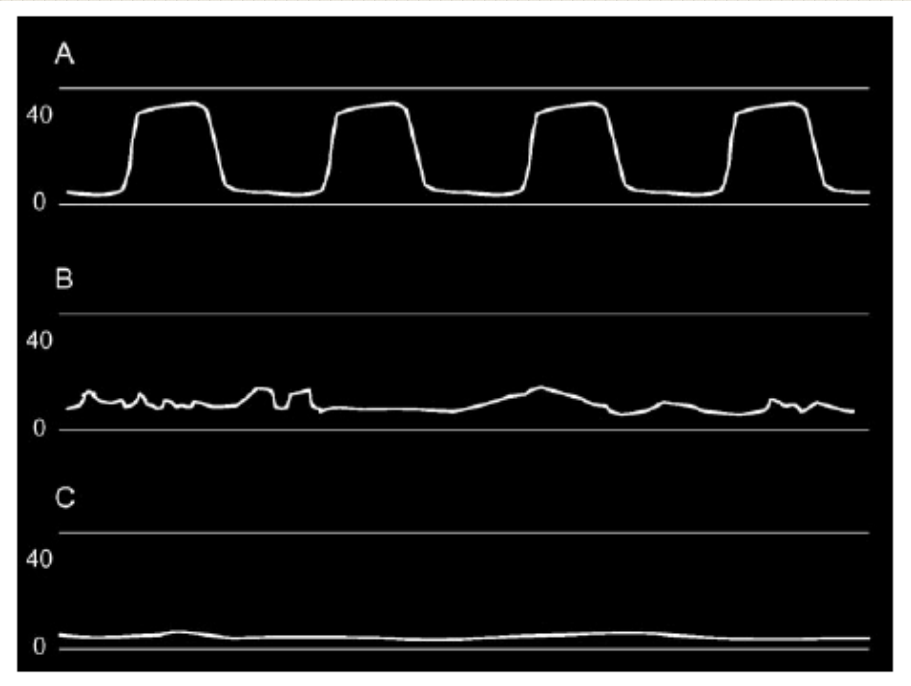
- Anecdotal and CQI Data– Adults only
  - Case series of 9 (of 634) capnography-monitored adults who required intervention for ORRD
    - 78% had identified risk factors
    - All receiving supplemental O_2
    - 78% had SpO_2> 92% at the time of alert
      - McCarter T. Am Health Drug Ben 2008;1
- Continuous monitoring (pulse ox + capnography) identified 19 deteriorating patients over 4 years
  - $EtCO_2$ alarm 2 hrs prior to SpO_2 alarm (in pts on O_2)
    - Danello SH. Hospital Pharmacy 2009;44:680*
    - Maddox R. APSF Newsletter Winter 2012*

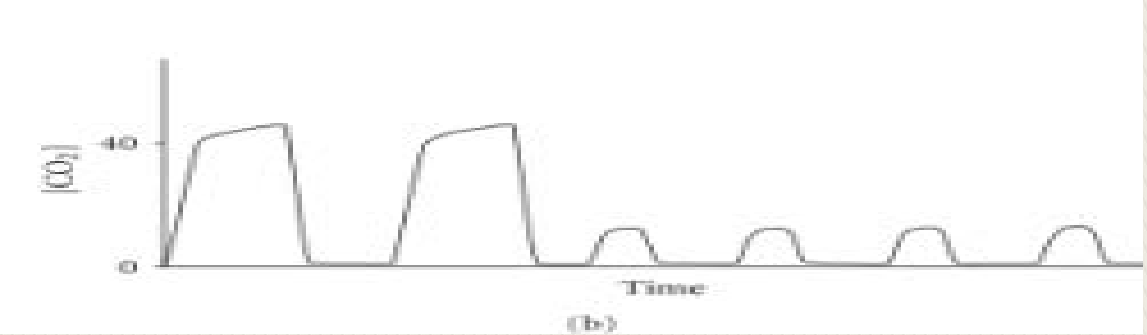
*Ray R. Maddox has received honoraria for speaking engagements sponsored by Cardinal Health, Alaris Products.

Monitoring Limitations

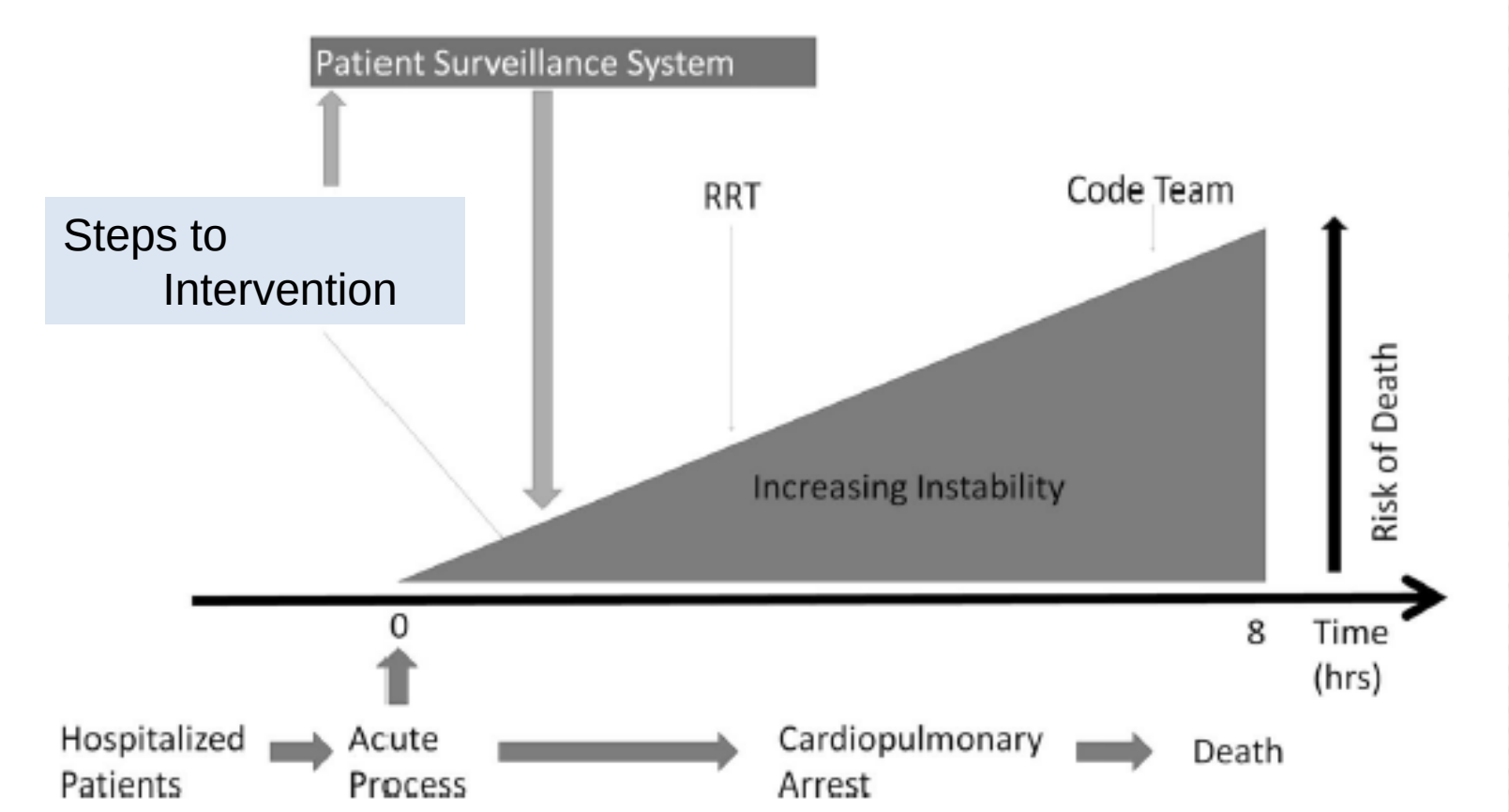
- Audible alarms with staff notification
- False alarms, alarm fatigue, desensitization
  - 70% false alarm rate reported for $EtCO_2$ in adults
    - Applegate R. Proceeding of the Society for Technology in Anesthesia Annual Meeting, 2013: A5027
  - Parameter changes and appropriate delays can decrease false alarm rate
- Continuous monitoring $\rightarrow$ false sense of security
- Capnography in non-intubated children
  - Room air contamination and mouth breathing
  - Restricted mobility and tolerance issues

Failure to Recognize





Comprehensive Surveillance



Taenzer AH. Anesthesiology 2011;115:421

Recommendations

- APSF advocates continuous monitoring
  - PCA, neuraxial, serial IV dosing
  - High risk patients (OSA)
    - Weinger NB. APSF Newsletter Winter 2006-7;21:61
- Careful monitoring of sedation
    - ASMP (Jaryzna) Pain Manag Nurs 2013
- VS, pain Level, respiratory status, sedation level for all postop patients receiving IV opioids
  - “Hospitals may choose to use monitoring technology”
    - CMS IV Medication Requirements

http://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertificationGenInfo/Downloads/Survey-and-Cert-Letter-14-15.pdf

Summary