Monitoring for Sedation

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Non-operating room anesthesia (NORA): sedation and NORA difficult because patients often quite ill, preprocedure evaluation may be spotty, cases require continuous vigilance as patients move across spectrum of sedation, proceduralists may have unrealistic expectations (eg, that patient will not move during procedure and recover quickly), evidence-based medicine in field of sedation lacking in anesthesiology literature, sedating agents are respiratory depressants (ie, suppress ventilatory drive or ability to maintain patent airway), combining agents (particularly opioids) synergistically causes trouble with ventilation, patients commonly found to have obstructed airway based on response to sedative drugs, airway often shared with proceduralist (eg, bronchoscopy or gastroenterology procedures), and sedation often performed by oneself in “dark, distant places far away in the hospital”

Adverse events: American Society of Anesthesiologists (ASA) closed-claim database — respiratory depression due to absolute or relative overdose of sedating agents responsible for 21% of claims related to monitored anesthesia care (>50% of those claims believed to be preventable with improved monitoring); Society for Intravenous Anesthesia — introduced uniform reporting tool for sedation-related adverse events; included description of problem, intervention strategy, and outcome; group of physicians applied this tool to sedation cases in emergency department and demonstrated that adverse events could be appropriately categorized as sentinel, moderate, minor, or minimal; found that rate of sentinel events 1% (≈1000 patients cared for); Anesthesia Quality Institute — put forward set of metrics to be used for procedural sedation; departments of anesthesia now responsible for overseeing provision of sedation throughout medical center (must ensure that policies and procedures for appropriate care and monitoring of sedation practices are in place)

Assessing depth of sedation

ASA continuum of depth of sedation: minimal sedation (eg, midazolam) produces amnesia (patient responds normally to verbal commands); moderate sedation/analgesia (conscious sedation) defined as drug-induced depression of consciousness (patient responds purposefully to voice alone or to light tactile stimulation; reflex withdrawal from painful stimulation not considered purposeful response); deep sedation/analgesia characterized by purposeful response to painful stimulation or when repeatedly stimulated; general anesthesia defined as drug-induced state of unconsciousness (patients not rousable by either verbal or painful stimulation); providers should be able to recover or resuscitate patients from at least 1 state deeper than state they wish to achieve Modified Observer’s Assessment of Alertness and Sedation (MOAAS) scale — gradations stronger than those of ASA continuum; consists of 6 categories: category 1 — patient responds readily to name spoken in normal tone (correlates with state of anxiolysis); category 4 — patient responds lethargically to name spoken in normal tone; category 3 — patient responds to name called loudly or repeatedly; category 2 — patient responds only after mild prodding or shaking; category 1 — patient responds only to painful stimulation (correlates with deep sedation); category 0 — patient not responsive to painful stimuli; categories 2, 3, and 4 — indicate moderate sedation

Monitoring sedation: problematic because assessment itself can be stimulating; processed electroencephalography (EEG) monitoring may be useful for sedation because it provides continuous index value in real time; many studies have been performed using bispectral index (BIS) monitoring; basic concept of studies — mean values of sedation states significantly different from each other; however, error bars wide, with significant overlap of index values across spectrum of sedation; eg, BIS value of 80 falls within 25% to 75% population range of MOAAS sedation scores 2 to 4, but also falls within error bars of scores 1 and 5; therefore, ability of any particular value to line up with a particular sedation state is quite poor; influence on outcomes — studies have shown that processed EEG has no advantages over conventional monitoring for short procedures; however, for extended procedures (eg, endoscopic retrograde cholangiopancreatography) using deep sedation, processed EEG may offer advantages (eg, less amount of propofol administered, quicker recovery) over conventional monitoring, but no difference in safety was demonstrated

Monitoring ventilation: challenges — direct observation inadequate to assess significant respiratory embarrassment or hypoventilation; respiratory depression important contributor to morbidity during sedation; even during moderate

Educational Objectives

The goal of this program is to improve the anesthetic management of conscious sedation and the incorporation of anesthesia information management systems (AIMS) into clinical practice. After hearing and assimilating this program, the clinician will be better able to:

1. Identify the challenges of conscious sedation in the non-operating room setting.
2. Evaluate the methods for monitoring sedation.
3. List the options for monitoring ventilation in sedated patients.
4. Explain the utility of AIMS.
5. Cite potential cost savings that can be achieved through the use of AIMS.

Faculty Disclosure

In adherence to ACCME Standards for Commercial Support, Audio Digest requires all faculty and members of the planning committee to disclose relevant financial relationships within the past 12 months that might create any personal conflicts of interest. Any identified conflicts were resolved to ensure that this educational activity promotes quality in health care and not a proprietary business or commercial interest. For this program, the following has been disclosed: Dr. Mathews is on an advisory panel for Masimo Corporation and receives grant/research support from Covidien, Masimo Corporation, and Respiratory Motion, Inc. Dr. Paganelli reported nothing to disclose. The planning committee reported nothing to disclose.
Capnography: many studies show capnography allows for O₂ saturation for monitoring adequacy of ventilation: administered with significantly more episodes of O₂ saturation <90%; in this has led to recommendation that O₂ be withheld during procedures; these technologies either have not reached widespread adoption due to competition with proceduralist, improper application, and data sometimes being unreliable; limitation of findings — high reading indicates prolonged hypoventilation; however, normal reading may be produced by hypoventilation with inadequate sampling and low reading may be produced by hyperventilation; normal ventilation with inadequate sampling, or ongoing hypoventilation with inadequate sampling or acute low tidal volume; reading of no CO₂ may be produced by powered-down machine or improper application for detecting presence or absence of ventilation less useful for determining adequacy of ventilation

Other approaches: these technologies either have not reached widespread adoption or cannot yet be recommended for widespread adoption

Transcutaneous CO₂: assessment of whole-body CO₂; De Oliveira et al (2010) compared transcutaneous CO₂ monitoring with nasal capnography during gynecologic procedures; patients progressively sedated with propofol; when deep sedation achieved, arterial blood gas (ABG) drawn; correlation with ABG significantly higher with transcutaneous CO₂ than with end-tidal CO₂; transcutaneous CO₂ slow to detect apnea; study recommended combining transcutaneous CO₂ and end-tidal CO₂

Acoustic monitoring of breathing: acoustic sensor (RRA) — applied to patient’s neck and connected to monitor; no data on procedural sedation; one study using monitor during sedation for colonoscopies showed that monitor more useful for detecting presence of ventilation and less useful for determining adequacy of ventilation; shown to be more effective than capnography at detecting short periods of apnea; monitor that processes signals from larynx using principles of entropy — 2013 study found this monitor detected apnea with sensitivity of 95% and specificity of 92%

Chest wall impedance: traditional impedance monitors (used in all recovery rooms to determine respiratory rate from the xiphoid, and lateral) connected to monitor, which shows tidal volume and minute ventilation; readings from this unit change only minimally during chest wall movement while glottis closed

Suggested Reading


Anesthesia Information Systems: Improving Patient Care and Operating Room Function

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Adoption of anesthesia information management systems (AIMS): 73% of anesthesia training programs have adopted AIMS; in United States, AIMS estimated to have been adopted in 12% to 50% of practices; in European university system, estimates range from 15% to 50%; Stol et al (2014) observed that diffusion of AIMS mimicked diffusion of other technologies (eg, cell phones and home computers); phases of development consist of innovators (early adopters), early majority, late majority, and laggards

Benefits of AIMS: include improved containment of cost, management of operating room on daily basis, improved reimbursement, opportunities to improve quality of care, increased safety, and improved documentation; translation of data from AIMS enhances research

Use of AIMS: AIMS specifically designed to appear similar to handwritten anesthesia chart; system documents vital signs, gas flow, concentration of gases, status of muscular blockade, administration of fluids, measurement of electrolytes, recording of blood transfusions, urine output, and administration of medications; records values typically in 5-min intervals; each value consists of whole table of data that can be retrieved (eg, quantity of 7.0 French endotracheal tubes used, use of Macintosh 3 blade, difficulty of intubation, coverage of eyes, use of bite block); records time-stamped events (eg, duration of tourniquet, length of cardiopulmonary bypass)

Vanderbilt University: developed in-house system based on its specific needs; pop-ups serve as reminders (eg, administration of antibiotics); system monitors itself; paging function built into system (eg, may select which person to page with specific message and where to go); allows remote view of record by video feed (eg, may view vital signs and ECG); excellent method for surveillance; includes app that can run on smartphone

Choosing an AIMS: many vendors available; some systems allow scanning of pharmacy drugs (name of drug, time of administration, and dose automatically inserted into record); some AIMS may not be able to retrieve data from electronic medical records

Cost containment: AIMS may promote efficient use of drugs, account for supplies by tracking use, and assist in managing resources, especially personnel; Nair et al (2013) — University of Washington used Smart Anesthesia Messenger software to monitor gas flows; if flow excessive (eg, >2 L/min for sevoflurane), system sent message and continued to post reminder until compliance achieved; estimated cost savings of $100,000/yr on volatile gases alone; Duke University study — used AIMS as
cost-containment tool; analyzed use of drugs by case, service, and provider; looked at pharmacy records to assess wastage of drugs; information used to create expert panel recommendations that established guidelines for dispensing volumes of medications with increased efficiency; achieved savings of $1 million/yr using AIMS

Enhancement of billing and charge capture: improved documentation allows for changes in coding; interconnectivity of systems (eg, health information management, financial system, laboratory) allows capture for billing; Kheterpal et al (2007)—AIMS captured arterial wave and searched for documentation of insertion of arterial catheter; when documentation absent, text reminder sent to provider; compliance in documentation improved from baseline of 80% to 98%, which led to additional cost capture of $40,000

Improving management of operations: electronic record can document inefficiencies in operating room; examples include overbooking of operations, operation lasting longer than scheduled, anesthesiologist starting later than scheduled, and excessive turnover time; able to delineate surplus or deficits in staffing; data can be used to model efficient function of operating room and improve staffing; creation of surgical whiteboard—system creates chart of day’s surgical cases and populates each case with length of case, demographic data (eg, weight of patient), and information from preoperative and intraoperative record; this helps with planning of daily schedule; changes or additions to schedule allow for modifications of personnel; provides tracking of location of patient, which can be updated every minute; system detects gaps in which cases can be inserted; Dexter et al (2013)—considered past history of specific operation by surgeon and calculated predicted time of similar case; data updated with each new case; if case not yet finished but approaching expected finishing time for surgeon with wide standard deviation, system able to predict that surgeon would not finish on time; whiteboard then updated, which sent pop-up to operating room

Analytic server: sites available that can send alerts for various parameters (eg, failure to administer medications, abnormal blood pressure, low urine output); these servers can be superimposed on existing AIMS that presently do not provide analytic functions

Suggested Reading


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MONITORING FOR SEDATION/ANESTHESIA INFORMATION SYSTEMS

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To submit a test form by mail or fax, complete Pretest section before listening and Posttest section after listening.

1. Data from the American Society of Anesthesiologists (ASA) show that respiratory depression due to absolute or relative overdose of sedating agents is responsible for _______ of claims related to monitored anesthesia care.
   (A) 1% (B) 11% (C) 21% ** (D) 31%

2. Based on the ASA continuum of depth of sedation, purposeful response to painful stimulation is characteristic of:
   (A) Minimal sedation (C) Deep sedation **
   (B) Moderate sedation (D) General anesthesia

3. Studies of sedation outcomes have shown that compared with conventional monitoring, processed electroencephalography (EEG) monitoring is associated with:
   (A) Less amount of propofol administered during long procedures
   (B) Fewer adverse events during short procedures
   (C) Quicker recovery from short procedures
   (D) Fewer adverse events during long procedures

4. For monitoring adequacy of ventilation, _______ is preferred over _______.
   (A) End-tidal CO₂; O₂ saturation ** (B) O₂ saturation; End-tidal CO₂

5. Capnography is most useful for determining the _______ but less useful for determining the _______.
   (A) Adequacy of ventilation; presence or absence of ventilation
   (B) Presence or absence of ventilation; adequacy of ventilation **

6. Anesthesia information management systems (AIMS) have been adopted in _______ of anesthesia training programs.
   (A) 13% (B) 33% (C) 53% (D) 73% **

7. All AIMS are able to retrieve data from electronic medical records.
   (A) True ** (B) False

8. The University of Washington applied the Smart Anesthesia Manager to monitor which of the following?
   (A) Time in operating room (B) Starting time of surgery (C) Volume of gas used ** (D) Duration of anesthesia

9. A study from Duke University used AIMS to analyze the use of which of the following?
   (A) Drugs ** (B) Endotracheal tubes (C) Laryngeal masks (D) Nasal cannulae

10. Kheterpal et al (2007) used AIMS to search for documentation of which of the following?
    (A) Drug use (B) Insertion of arterial catheters ** (C) Schedule of operations (D) Use of personnel

Answers to Audio Digest Anesthesiology Volume 58, Issue 05: 1-B, 2-C, 3-D, 4-C, 5-B, 6-A, 7-D, 8-B, 9-B, 10-C