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Monitoring and delivery of sedation

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Editor's key points

- Depth of sedation monitoring relies on clinical criteria, although neurophysiological approaches are emerging.
- Pulse oximetry is effective for detecting hypoxaemia, but independent monitoring to detect hypoventilation is required given the low margin of safety for sedative drugs.
- Patient- and procedure-dependent factors are critical in selecting optimal monitoring approaches and sedative drugs.

Sedation for medical procedures is provided in a variety of clinical settings by medical personnel with differing levels of education and training. Although generally a safe practice, there is a degree of morbidity and mortality associated with sedation practice. Monitoring standards continue to be refined by professional societies with the goal of improving care. The depth of sedation should be monitored with clinical criteria. Processed electroencephalographic monitors currently do not contribute significantly to sedation care. Monitoring ventilation using pulse oximetry should be abandoned for more direct methods, such as capnography-transcutaneous carbon dioxide, respiratory acoustical and thoracic impedance monitoring could also play a role. Propofol has become widely utilized for sedation, although there are concerns about its margin of safety and synergistic interactions with other agents. Dexmedetomidine and propofol/ketamine also have utility. Patient-controlled sedation pumps and target-controlled infusion devices have been developed to improve patient care and satisfaction. A computer-assisted propofol sedation device to be used by non-anaesthesiologists has been approved in the USA by the Food and Drug Administration. More computer-assisted sedation delivery devices are likely to be developed, but their clinical utility is unclear.

Keywords: computer-assisted infusion; drug interactions; monitoring, depth of anaesthesia; sedation; monitoring, ventilation

While seemingly a straightforward aspect of the anaesthetic practice, the provision of sedation can be challenging. There are many factors to be considered when caring for an individual patient. Patients present with a variety of medical co-morbidities, some procedures require deeper levels of sedation than others, and the degree of noxious stimulation often changes during the course of a procedure. Often the procedure involves the patient's mouth or airway impeding access by the anaesthesia provider. The sedating agents in common use can blunt airway reflexes, cause respiratory depression, and can interact synergistically to potentiate these effects. Procedures requiring sedation are often performed in offices, clinics, or sections of a hospital that are far away from assistance. Ultimately care must be individualized to account for all of these variables.

This review considers our current understanding of monitoring for sedation with examination of emerging technologies. It will discuss some pharmaceutical choices for providing sedation, but it is not meant to be a comprehensive review of anaesthetic pharmacology. Devices and technologies that have been developed to improve delivery of sedation will be discussed. The contentious topic of what degree of education and training should be required to deliver sedation, particularly propofol sedation, will not be addressed.

Monitoring of sedation

Standards and guidelines

Sedation practice is widespread across healthcare systems and is practiced in a wide variety of settings and administered by healthcare providers with a diverse range of education, training, and experience. Administering agents that blunt a patient's sensorium and can compromise their respiratory and cardiovascular function is inherently risky. These risks have been recognized for some time, particularly when sedating medications are combined with opioids.[1] The incidence of significant morbidity or mortality is difficult to ascertain, but it is certainly greater than zero, and appears to have contributed to the recent death of comedienne Joan Rivers after care at an outpatient endoscopy clinic in New York City.[2] Review of monitored anaesthesia care (MAC) cases in the ASA closed-claims database confirms that significant morbidity and mortality can occur: respiratory depression because of an absolute or relative overdose of sedating agents was responsible for 21% of MAC-related claims.[3] Over half of these adverse events were felt to be preventable with better monitoring. In an attempt to minimize patient risk and to standardize practice, organizations of anaesthesiologists have issued guidelines for monitoring during sedation (Table 1).[4–8] The guidelines universally require assessment of the depth of

sedation and the use of pulse oximetry and non-invasive arterial pressure monitoring. Recommendations concerning the monitoring of ventilation are evolving.

In order to be able to better quantify and analyse sedation-related adverse events, the World Society of Intravenous Anesthesia (WSIVA) international task force has proposed a reporting tool[9] that is unique in that it combines physiologic descriptors, interventions, and outcome measures. One report has already demonstrated that this tool can be utilized and events can be appropriately categorized as being sentinel, moderate, minor, or minimal risk events.[10] Widespread adoption of this tool would certainly improve our ability to identify and better understand the safety issues involved with sedation.

Assessment of depth of sedation

Clinical scales/scores

Administration of sedation medication results in a continuum of effect ranging from anxiolysis to general anaesthesia. The depth of sedation often varies during a procedure, which requires vigilance and ongoing assessment and documentation. Several depth of sedation assessment methods are used in clinical practice and in research protocols; these include the ASA Continuum of Sedation, the Modified Observer's Assessment of Alertness/Sedation Scale (MOASS), and the Ramsay Sedation Scale (RSS) (Table 2).[11–14] Practitioners should assess the depth of sedation periodically throughout a procedure by utilizing one of these scales or by assessing responsiveness to verbal and tactile stimulation. The authors know of no data to demonstrate that one scale or approach is superior to another.

Processed EEG

The above assessment methods require that the patient be periodically stimulated, which can interfere with the procedure and may be difficult during prolonged procedures or where the patient is physically distant. Processed EEG monitors, such as the bispectral index monitor (BIS™, Covidien, Inc., Boulder, CO, USA), have been evaluated to determine their efficacy in monitoring the depth of sedation. Multiple observational studies have correlated processed EEG indices with the MOASS, RSS, or the ASA Continuum of Sedation during sedation in volunteers[15 16] and in patients undergoing sedation in a variety of clinical settings, such as endoscopy suites,[17 18] dental offices,[19] the emergency department,[13 20] and the operating theatre.[21 22] Uniformly, these studies find a significant correlation between the processed EEG index and the sedation scale. However, there is a lack of discrimination of index value associated with each sedation state (Fig. 1): so, a particular index value can herald several different sedation states. In addition, the provision of analgesics can further confound the relationship between processed EEG index and sedation depth. Some authors find that this lack of precision negates the utility

Table 1 Standards and guidelines concerning sedation from national organization

	American Society of Anesthesiologists[4]	The Association of Anaesthetists of Great Britain and Ireland[5]	European Society of Anesthesiologists[6]	Australian and New Zealand College of Anaesthetists[8]
Level of statement	Standards	Standards and guidance	Guidelines	Guidelines
Year written/ updated	2011	2013	2007	2014
Assessment of depth of sedation	Required	Required	Required	Required
Arterial pressure measurement	Required, at least Q 5 min	Required*	Required	Required
Pulse oximetry	Required	Required*	Required	Required
Electrocardiogram	Required	'Conscious sedation' with continuous verbal contact: not required. Deep sedation: required	Required	May be required according to the clinical status of the patient
Capnometry	Moderate and deep sedation: required unless precluded or invalidated by the nature of the patient, procedure, or equipment	'Recommended' for moderate and deep sedation and when (a) ventilation cannot be directly observed, for example MRI/CT, (b) multiple drugs/anaesthetic drug techniques are used, or (c) pre-assessment highlights increased clinical risk	Not required	May be required according to the clinical status of the patient
Notes		* Document states that monitoring for minimal sedation/anxiolysis is 'dictated by co-morbidity'	Guidelines are for non-anaesthesiologists. Taskforce currently updating[7]	