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Special REPORT

CME ACCREDITED MARCH 2001

# Current Strategies In ICU Sedation

## OBJECTIVES

After completing this activity, the participant should be able to:

1. List the benefits of sedating patients in the intensive care unit (ICU)
2. Explain the theoretical characteristics of the ideal ICU sedative
3. List the various agents used for sedation in the ICU
4. Detail the various advantages and disadvantages of the agents used for sedation in the ICU
5. Detail current standards for monitoring of sedated patients in the ICU.

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## NEEDS STATEMENT

The intensive care unit (ICU) has been an omnipresent facet of modern hospital life. Generally, the ICU is a gloomy place. Sick patients are there, they are anxious, they are suffering. Researchers have focused on making sure patients are in the best condition possible upon their arrival to the ICU. Similarly, researchers have devised innovative techniques for controlling pain in the ICU. Still, today, patients' anxiety in the ICU is a serious barrier to improved care.

This monograph was developed to educate anesthesiologists and pharmacists about current options for ICU sedation and thereby to improve patients' convalescent experience.

## ACCREDITATION AND CREDIT DESIGNATION STATEMENTS

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of the Dannemiller Memorial Educational Foundation and McMahon Publishing Group. The Dannemiller Memorial Educational Foundation is accredited by the ACCME to provide continuing medical education for physicians.

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## PRESENTER

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## INTENDED AUDIENCE

This activity is intended for anesthesiologists and hospital pharmacists.

## METHOD OF PARTICIPATION

This activity should take approximately 1 hour to complete. The participant should, in order, read the objectives and monograph, answer the 10-question, multiple-choice post-test, and complete the evaluation on page 8. The evaluation form provides each participant with the opportunity to comment on the quality of the instructional process, the perception of commercial bias, and his or her views on future educational needs. To receive credit for this activity, follow the instructions provided on the post-test. This credit will be valid through March 31, 2002. No credit will be given after this date.

## Introduction

The intensive care unit (ICU) is an uncomfortable and often frightening environment for patients. Thus the use of sedation to reduce anxiety and lessen the chance of unwanted recall of ICU events is common. ICU sedation is complex and evolving; there are many disease processes that must be understood prior to selecting an agent for sedation, and there are a variety of agents available. The choice of sedative must be tailored to each patient's physiology and pathology. This requires a sound knowledge of the pharmacokinetic and pharmacodynamic effects of the many agents available to the ICU practitioner. The assessment of patients' mental status and a careful evaluation of their level of pain, followed by treatment of the pain, should be completed prior to instituting sedation. Such evaluations may have to be delayed in postsurgical patients having residual anesthesia or heavy sedation.

## Sedation Needs in the ICU

Patients in the ICU are in a foreign environment, one that they have not chosen. Moreover, their family members are not continuously available for comfort. Patients are usually confined to bed, are attached to equipment via tubes and wires, and often are intubated and ventilated. They experience pain, fear, and loss of control. The most important reasons for the administration of sedation in an ICU setting are to reduce anxiety and prevent both short- and long-term neurosis and psychosis. The provision of amnesia is an equally important consideration. Inadequately sedated patients may develop a syndrome not dissimilar to post-traumatic stress disorder, characterized by anxiety, irritability, nightmares, and a preoccupation with death. There are many causes of ICU anxiety; the most common ones are listed in Table 1. Foremost, if not first, on the list of causes of anxiety in patients who are conscious and aware of their presence in the ICU, is the fear of death or serious injury from illness. They usually also have feelings of helplessness, loss of control, disorientation, and panic. Moreover, the significant noise from personnel and medical equipment can increase patient anxiety and disrupt their normal sleep patterns. In fact, the average time patients in the ICU spend sleeping is less than 2 hours per day. The loss of normal circadian rhythms, the disruption of normal sleep patterns and the awareness of discomfort all contribute to patient anxiety and promote the development of psychological stress.

## Changing Sedation Standards

Keeping in mind that providing ICU sedation and analgesia are still important goals for the practitioner, several factors have driven fundamental changes in ICU sedation practices over the past decade. These include the introduction of new drugs into the ICU, improved methods for delivery of medications, increased use of regional techniques to control pain, and a better understanding of the adverse outcomes associated with untreated pain and anxiety in the ICU setting. Additional changes in the approach to ICU sedation have come about because of increased involvement of patients' family members, and their preference for an arousable patient. Other factors influencing care are stringent ICU nurse-staffing quotas and the high cost of some of the ICU sedatives. These changes have altered both the goals of providing "ideal" ICU sedation and analgesia, and the ability to achieve these goals. Recently, a better understanding of the indirect cost of ICU sedation (including length of stay in the ICU and in the hospital and adverse outcomes from ICU events) has refocused the provider away from the direct cost of the sedative agents.[1-3]

*Table 1. Common Causes of Anxiety in the ICU*

| | |
|---|---|
| Fear | Pain |
| Loss of control | Chemical imbalances |
| Confusion | Medications |
| Memory loss | Temperature |
| Sleep deprivation | Noise, lights and alarms |

## Choices of Agents For Pain Control and Sedation

The typical ICU patient is nearly impossible to define. Thus, the "ideal" sedative is equally difficult to define. Arguably, the trend is toward more arousable patients during sedation. With this in mind, the ideal sedative would be one that is easy to administer, has a rapid onset and a predictable effect, alleviates both pain and anxiety, promotes cardiac and respiratory stability, maintains arousability during sedation and allows rapid recovery after discontinuation. Other desirable attributes are little or no interaction with other drugs and minimal or no accumulation of metabolites. However, no single sedative possesses all of these qualities, and the caregiver commonly must combine agents based on an understanding of the patient's needs and the pharmacodynamic effects of each drug.

ICU practitioners choose from an average of 18 different sedative-analgesic agents.[4] To help focus the practitioner on achieving successful ICU sedation, practice parameters for intravenous analgesia and sedation in critically ill adults were developed in 1995 by a Task Force of the American College of Critical Care Medicine. The parameters were developed based on a careful review of the scientific literature and on the members' own experiences. They were published in executive summary form.[5] The primary recommendations for analgesia in the ICU were morphine sulfate for most patients and fentanyl for hemodynamically unstable patients. Meperidine and nonsteroidal anti-inflammatory drugs were not recommended because of their known side effects. For sedation in the ICU, midazolam and propofol were recommended for short-term (<24 hours) sedation. Lorazepam was recommended for long-term sedation and haloperidol was recommended for the treatment of delirium in the critically ill adult.

In 1998, a preliminary report summarized a national survey of the use of sedating agents used in the ICU.[6] The most commonly used agents match those recommended by the Task Force and are summarized in Table 2, page 3. Propofol, midazolam, and fentanyl are used for short-term sedation/analgesia and morphine sulfate, lorazepam, diazepam, and haloperidol for longer ICU sedation.

*Table 2. National Survey on ICU Sedation Practices*

| | Fentanyl | $MSO_4$ | Lorazapam | Midazolam | Haloperidol | Propofol |
|---|---|---|---|---|---|---|
| Frequent use (%) | 36 | 87 | 81 | 68 | 48 | 33 |
| Route (%) | | | | | | |
| Intermittent bolus | 37 | 56 | 61 | 55 | 82 | 11 |
| Continuous infusion | 59 | 39 | 30 | 41 | 2 | 86 |
| Length of sedation (%) | | | | | | |
| <24 h | 21 | 6 | 5 | 25 | 9 | 26 |
| >24 h | 79 | 95 | 95 | 75 | 92 | 74 |

Adapted from *Crit Care Med.* 1998;26:A24.

The newest agent that has been approved for short-term ICU sedation is the selective alpha$_2$-agonist dexmedetomidine. This receptor-specific sedative also possesses analgesia-sparing properties. One of the more interesting properties of this class of drugs is their unique ability to preserve respiratory function and arousability despite dose-dependent sedation.[7,8]

One of the basic requirements of the practitioner is to thoroughly understand the pharmacodynamic effects of the commonly employed ICU sedatives and analgesics. Benzodiazepines usually cause anxiolysis and amnesia. However, this class of compounds also can have the paradoxical effect of increasing patient agitation, particularly in the elderly. Midazolam has a rapid onset and a short duration of action, and its elimination from the body is only minimally dependent on renal function. When given rapidly and in higher concentrations, midazolam causes both respiratory depression and hypotension. Both these effects are potentiated by the coadministration of opioids. The longer-acting drug lorazepam produces minimal cardiovascular and respiratory depression but has inactive metabolites that remain in the body. It also is associated with prolonged weaning during extubation.[5,9]

The sedative-hypnotic propofol has a rapid onset and a very short duration of action. It also leads to dose-dependent respiratory depression, hypotension, and hyperlipidemia.[10] Most studies indicate that, upon discontinuing infusions, propofol is associated with a faster time to weaning from mechanical ventilation than midazolam.[9] The elimination of propofol from the body is only minimally dependent on hepatic function.

In sharp contrast to the benzodiazepines and propofol, the opioid compounds provide analgesia and are more consistent and potent at impairing respiratory drive. However, opioids are not good sedatives and provide no amnesia when used as sole agents in the ICU. Their most common use is for pain control and to potentiate the sedative effects of midazolam or propofol. Morphine sulfate causes hypotension through a histamine mechanism while fentanyl is not associated with significant cardiovascular changes when used as a sole agent.[5] However, when combined with sedatives, both fentanyl and morphine cause significant hypotension. Haloperidol is recommended for treatment of delirium in critically ill adults.[11] The Task Force defined delirium as rambling and incoherent speech, together with altered sensory perception and disorientation. The clinical effects of haloperidol begin 0.5 to 1 hour after administration, and last 4 to 8 hours. This agent is not approved for I.V. use by the Food and Drug Administration. The newest ICU sedative, dexmedetomidine, has important cardiovascular and respiratory effects that are considered further along in this monograph.

## Monitoring Pain, Sedation, and Agitation

New standards set forth by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) emphasize the need for monitoring sedation and pain in the ICU and following surgical procedures. These standards are an outgrowth of the monitoring required for provision of conscious sedation outside the operating room or ICU.

There are various methods to assess pain control. The most commonly used in the perioperative period and in the ICU is the Visual Analogue Scale (VAS) for pain, which ranges from "no pain" (usually scaled as zero) to "the worst pain imaginable" (typically scaled as 100). A pain questionnaire can also be used to assess qualitative aspects of pain, but historically this has been constrained by the need for some level of patient consciousness. Interestingly, the newest sedative agent, dexmedetomidine, has an uncommon attribute of providing sedation while preserving arousability. This makes the likelihood of conscious performance of questionnaires a distinct possibility with dexmedetomidine. The attempt to interpret hemodynamic changes such as increases in blood pressure and heart rate as indicators of pain is inadequate. This is because many factors other than pain can cause hemodynamic events, including hypoxia, hypercarbia, anxiety, and the response to pharmacologic agents.

The Ramsay Sedation Scale is likely the measure of sedation most commonly applied in the ICU setting.[1] This scale ranges from 1 (awake, anxious, agitated, and restless) to 6 (asleep and not responsive). Most sedation protocols strive for maintaining patients at a Ramsay 3 (patient sleeps but responds to commands). Riker's Sedation-Agitation Scale also can be used for monitoring.[12] It ranges from 7 (dangerous agitation) to 1 (unarousable). Most sedation protocols strive for maintaining patients at a Riker 4 (calm and cooperative). Many ICUs employ their own sedation scale. These are usually a combination of the Riker and Ramsay scoring systems. None of the scales currently in use has been validated.[1] This has led to the use of "home recipes" for assessing sedation. These generally function well, especially when used for longitudinal monitoring in a given patient. The importance

of these assessment scales extends beyond JCAHO requirements: Scales allow targeted goals for sedation and permit consistency between nursing shifts.

## Improving Patient Outcomes

Physicians have recently started placing more emphasis on patient outcomes during and after ICU stays. Inadequately treated pain and anxiety lead to a stress response that can worsen cardiac morbidity and mortality in the ICU setting. Pain, particularly that which follows major thoracic or abdominal surgery, can lead to abnormalities in pulmonary function and respiratory gas exchange. The most common of these abnormalities is a restrictive pattern of ventilatory impairment. This involves a decreased functional residual capacity and tidal volume leading to atelectasis, hypoxemia, and respiratory infection. These changes are more severe in the obese patient, in the elderly, and in those with preexisting cardiopulmonary disease.

Exacerbating this adverse respiratory outcome is the well-described pattern of biochemical change—known as the stress response—that follows injury to tissues from surgery, trauma, or sepsis. This response includes hormonal changes (eg, increases in levels of cortisol, glucagon, and blood glucose, and in the rate of gluconeogenesis), hypercoagulability, protein catabolism and increased sympathetic nervous system activity. Cardiac morbidity can be affected by the increased sympathetic nervous system activity. Activation of sympathetic outflow leads to increases in heart rate, blood pressure, and myocardial contractility. Myocardial oxygen demand is augmented simultaneously with a possible reduction in myocardial oxygen supply from hypovolemia. These supply and demand changes in the cardiac-compromised patient can lead to myocardial ischemia and even infarction. Alpha$_2$-agonists may reduce sympathetic outflow from pain and anxiety, and thereby diminish adverse cardiac effects.[8,13] Thus, the combination of pain control and analgesia provides important protection from these adverse events.

## New Techniques for ICU Sedation

Although there are clear advantages associated with using continuous sedation in the ICU to reduce anxiety levels, there are also several disadvantages. Continuous infusion of sedatives has been identified as an independent predictor of a longer duration of mechanical ventilation, as well as of a longer stay in the ICU and hospital.[2,14] Continuous infusion of sedatives also limits the clinician's ability to evaluate the mental status of the patient and may be troubling to family members who seek cognitive interactions with critically ill patients. Moreover, heavily sedated patients may undergo more diagnostic evaluations, since practitioners are unable to rouse patients for examinations.[2]

Physicians are also scrutinizing costs and determining how these can be reduced. A recent survey of ICU practices has shown that there is a lack of published data on the impact of early extubation on patient outcomes and on overall cost savings.[1] The authors of this survey noted a wide range of purchasing costs of the different agents used in the ICU for sedation and analgesia. They also commented on the lack of data on the variable effects or indirect costs of using different sedative analgesics. These variable effects include the duration of mechanical ventilation and the duration of ICU stay. Other inadequately studied variables include the long-term effects of inadequate sedation, and the adverse effects of excessive sedation, drug side effects, drug interactions, hemodynamic alterations, and drug wastage. The dearth of data underscores the fact that many clinicians make decisions based on their own experience with sedative drugs.

In the ICU setting, outcomes are sometimes simply defined as early extubation and shortened stays in the ICU and hospital. Several

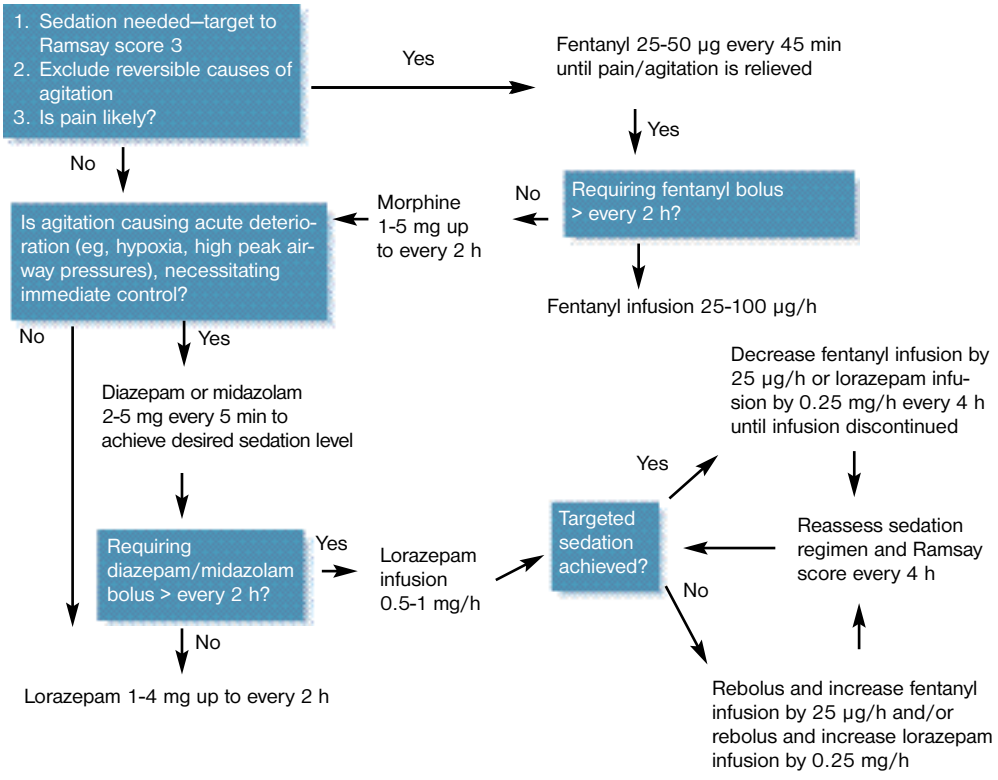



**Figure 1. Protocol for nursing management of sedation during mechanical ventilation.[3]**

recent studies have focused on determining whether specific new approaches to ICU sedation can improve the outcome of critically ill patients.[2,3] The new approaches include daily interruption of sedative infusions and protocol-directed sedation.

In a randomized, controlled trial of 128 adult patients on mechanical ventilation and receiving sedation via continuous infusions in an ICU setting, infusions were briefly discontinued each day until patients were awake.[2] The control group had infusions interrupted only at the discretion of the clinicians. The study found that daily interruption of sedation was associated with 2.4 fewer days of mechanical intervention and 3.5 fewer days in the ICU. The authors also noted a significant reduction in the daily dose of midazolam and morphine sulfate.

In a second study, a nurse-implemented sedation protocol for mechanically ventilated ICU patients with respiratory failure was tested against the traditional non–protocol-directed sedation at Barnes–Jewish Hospital in St. Louis.[3] The protocol is shown in Figure 1. Protocol-directed sedation significantly decreased the duration of mechanical ventilation by 25 hours, the length of ICU sedation by 1.8 days, and the length of hospital stay by 5.9 days. It also decreased the need for tracheostomy from 21% to 10%. Both approaches to improving patient outcomes, by interruption of sedation and by protocol-dictated sedation, also would be expected to reduce substantially both the direct (drug acquisition cost) and indirect costs of patient care.

## Dexmedetomidine for ICU Sedation

Dexmedetomidine is a new alpha$_2$-receptor agonist.[15] A less potent alpha$_2$-agonist, clonidine, has been used for over 3 decades for the treatment of hypertension and for the treatment of withdrawal symptoms from long-term abuse of drugs and alcohol. During that time, the alpha$_2$-agonists have been studied extensively in several other clinical settings because of their relatively diverse response. They are able to produce analgesia, anxiolysis, sedation, and sympatholysis, and thus are used primarily during the perioperative period. Dexmedetomidine is now being used as a novel approach to ICU sedation.[16]

*Sites of Action of Dexmedetomidine.* The target of the sedative action of dexmedetomidine appears to be in the locus coeruleus of the brain stem. This is a small bilateral nucleus in the upper brain stem that contains a large number of adrenergic receptors. The locus coeruleus is an important site mediating wakefulness. The alpha$_{2a}$-receptor subtype is involved in the sedative-hypnotic as well as the anxiolytic and analgesic actions of dexmedetomidine.[15] Other regions identified to have a high density of alpha$_2$-receptors include the substantia gelatinosa, and the intermediolateral cell column.[17] The principal site for the analgesic action of dexmedetomidine is believed to be the dorsal horn of the spinal cord. However, there is clear evidence for both spinal and supraspinal sites mediating analgesia.[15]

The dominant cardiovascular action of dexmedetomidine is a central sympatholysis (ie, the reduction of the sympathetic outflow of the autonomic nervous system). Secondarily, there is a peripheral presynaptic activation of alpha$_2$-receptors, which reduces norepinephrine release from the sympathetic terminals. The sympatholytic effects of dexmedetomidine are mediated in the central nervous system, but a transient hypertension can occasionally be observed upon the initial administration of dexmedetomidine. This is due to the alpha$_2$-receptors (specifically alpha$_{2b}$-adrenoreceptors) located on smooth muscle cells of the resistance vessels. The initial binding of dexmedetomidine to these receptors can cause a brief period of vasoconstriction. This can be minimized by avoiding rapid administration or bolus dosing of dexmedetomidine.

*Dexmedetomidine and Sedation in the ICU.* Both oral clonidine and intravenous dexmedetomidine have been used to provide preoperative sedation and anxiolysis in the surgical patient. Quantitatively, the sedation from the alpha$_2$-agonists is unique: Patients can be aroused readily but then return to a sleep-like state when left alone.[7] The maintenance of attentiveness during dexmedetomidine infusions has been documented by the use of the Critical Flicker Fusion test. For example, recent studies under the direction of Mervyn Maze, MD, Magill Professor of Anesthetics at England's Imperial College School of Medicine, Kensington and Chelsea and Westminster Hospital, London, indicated that the time at which a flickering light was perceived to become a fused line was equal in dexmedetomidine- and placebo-treated individuals (personal communication). Moreover, Hall et al have observed that performance on psychomotor tests is reasonably well preserved during dexmedetomidine sedation.[7] Therefore, patients sedated with alpha$_2$-agonists may be more cooperative and communicative than patients sedated with other drugs in the intensive care setting.

Two recent multicenter studies of dexmedetomidine vs conventional therapy (propofol or midazolam) for sedation in postsurgical patients have validated the effectiveness of dexmedetomidine for sedation. In a European study, patients receiving dexmedetomidine required 80% less midazolam for sedation. The dexmedetomidine-treated patients needed midazolam in an average dose of 4.9 µg/kg/h vs 23.7 µg/kg/h in the non-dexmedetomidine group.[16] In American trials, the use of midazolam decreased 60% to 70% and the use of propofol decreased 20% to 50% when dexmedetomidine was used for sedation.[18-20] Because dexmedetomidine has a specific target that causes sedation—the alpha$_2$-receptor in the locus coeruleus—strategies to block this action could result in immediate reversal of sedation. A drug that has not yet been approved by the FDA, atipamezole, is a selective alpha$_2$-adrenoceptor antagonist that immediately reverses the sedative properties of dexmedetomidine.[21]

*Dexmedetomidine and Analgesia in the ICU.* The analgesic effects of alpha$_2$-agonists were first described in 1974, when clonidine was administered to rats and nociceptive thresholds were increased.[22] In clinical trials, I.V. administration of dexmedetomidine has significantly reduced the pain and use of morphine sulfate associated with laparoscopic tubal ligation.[23] In 2 multicenter trials of dexmedetomidine compared to conventional therapy following cardiac surgical procedures, the use of dexmedetomidine for sedation was associated with a 50% to 80% reduction in the use of morphine sulfate.[16,18-20]

These findings are potentially very significant to care in the ICU, since any opioid-sparing effect will likely translate to improved respiratory drive and hence easier and/or faster weaning from mechanical ventilation. In fact, one study identified a significantly shorter time to extubation in the ICU of post-coronary artery bypass graft (CABG) patients receiving dexmedetomidine.[18]

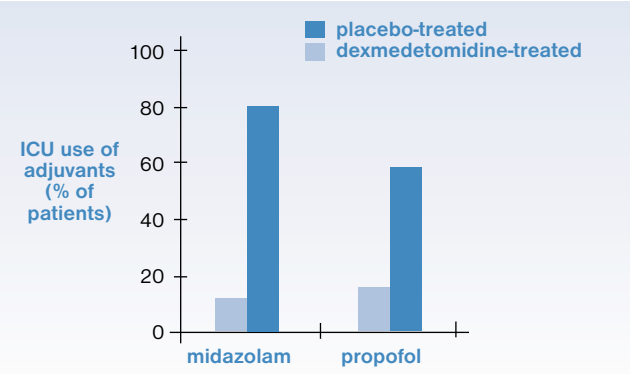
*Dexmedetomidine and Myocardial Ischemia in the ICU.* The alpha$_2$-receptor agonists have autonomic effects that reduce sympathetic outflow and augment vagal outflow. The guidelines for the use of dexmedetomidine in ICU sedation note the possibility of bradycardia and hypotension. Thus, according to the package insert, dexmedetomidine is not recommended in patients with heart block.

However, these effects, particularly the heart–rate-lowering response, might have a potential benefit in reducing myocardial ischemia. Published data document the lower heart rates associated with dexmedetomidine in the perioperative period.[16,18,24] When dexmedetomidine was used as an anesthetic adjunct to CABG surgery, significant decreases in norepinephrine and intraoperative and postoperative tachycardia were noted.[25] Similarly, when dexmedetomidine was used for postoperative sedation, lower heart rates have been noted.[16] Although no specific study has evaluated myocardial ischemia with dexmedetomidine, 2 other alpha$_2$-receptor agonists reduce the incidence and severity of perioperative ischemia.[13,26] Dexmedetomidine also has been associated with a reduction in muscle rigidity and postoperative shivering in CABG patients.[25]

*Dexmedetomidine and Respiratory Function in the ICU.* The alpha$_2$-receptor agonists have little if any effect on respiratory function. In a high-dose safety study in volunteers, Dr. Ebert and his colleagues demonstrated remarkably well-preserved respiratory parameters and oxygen saturations in volunteers who were essentially unarousable from extremely high doses of dexmedetomidine (8- to 10-fold higher levels than recommended for therapy).[8] The alpha$_2$-agonists also do not potentiate the respiratory depression seen with opioids.[27,28] The preservation of respiratory function in the ICU with dexmedetomidine as a sedative has simplified the process of weaning from mechanical ventilation: There is no need to wean sedatives and analgesics prior to extubation. In fact, Cheung et al have recently reported better respiratory end points during extubation in patients receiving dexmedetomidine compared with patients weaned from propofol sedation.[29]

## New Paradigms for ICU Sedation

The goals of ICU sedation remain consistent: to reduce anxiety and fears. The traditional model involves providing pain relief followed by sedation as needed. Unfortunately, this model is sometimes hard to follow, since the assessment of pain may be impaired in patients who are unresponsive or agitated. If pain is clearly evident, opioids should be titrated to alleviate it. This titration is done gradually in nonintubated patients in order not to interfere with respiratory function. If pain can be ruled out as a cause of anxiety, then sedative-hypnotics are given. Both the benzodiazepines and propofol are used alone or as adjuncts to opioids. An interesting new approach to ICU sedation and analgesia is the use of dexmedetomidine as the first-line drug (Figure 2). This approach takes advantage of the unique properties of dexmedetomidine in providing both sedation and analgesia. Dexmedetomidine is usually initiated with a 1-µg/kg load over 10 minutes. This is followed by a maintenance infusion of 0.2 to 0.7 µg/kg/hour. Since dexmedetomidine is associated with patient arousability, evaluation of residual pain or anxiety can be made during the dexmedetomidine infusions and traditional sedatives and opioids can then be added as second-line therapy. Interestingly, multicenter studies employing dexmedetomidine for ICU sedation have indicated that 50% to 66% of patients need no additional adjuvants to control pain and anxiety.[16,18-20] Moreover, sedation can be maintained during ventilatory weaning since dexmedetomidine does not alter respiratory function.[29]




Adapted from *Anesthesiology* 1999;91:A197.

**Figure 2. ICU sedation and analgesia needs in mechanically ventilated patients.**

## Overcoming Difficulties With Sedation and Anxiety During Extubation

This period in the course of ICU care presents particular challenges to the patient and the practitioner. Oversedation can lead to prolonged weaning or the need for reintubation of the trachea, while undersedation can cause "bucking" on the tube, difficulties with mechanical ventilation and hemodynamic events. In the traditional model, weaning from sedation and mechanical ventilation requires patient alertness to be restored. This permits the return of anxiety and agitation. Often the anxiety necessitates restraints, which lead to further agitation. There has been a significant amount of unpredictability in the patient response to weaning from opiates, benzodiazepines, and propofol.

According to Dr. Ebert, the newly introduced sedative dexmedetomidine might be useful during the process of weaning from mechanical ventilation. The agent preserves respiratory drive and the ventilatory response to carbon dioxide. Thus sedation need not be discontinued and the caregiver can focus on ensuring that the patient meets his or her ventilatory end points during weaning rather than on treating unwanted side effects from cessation of sedatives and analgesics.

A recent preliminary report by Albert Cheung, MD, of the University of Pennsylvania, Philadelphia, and co-authors Dr. Ebert and Charles Hogue, MD, of Washington University, St. Louis, summarized an evaluation of 38 patients randomized to receive either dexmedetomidine or propofol for sedation after CABG surgery.[29] Propofol was weaned prior to extubation while dexmedetomidine sedation was not discontinued. In the dexmedetomidine-treated patients, arterial $pCO_2$ was significantly lower (and more physiologic) immediately prior to and after extubation than in the propofol-treated patients. The analgesic and sympatholytic effects of dexmedetomidine should help lessen the hemodynamic and metabolic responses to weaning and extubation, they concluded.

## Summary: New Trends for ICU Sedation

With the JCAHO recommendations for standardized monitoring of sedation and analgesia in the ICU and the recent evidence for improved economic and patient outcomes by incorporating new strategies and drugs in the ICU, the new millennium brings the possibility of improved patient care. The adoption of protocols for daily interruption of long-term sedation or the incorporation of rigid guidelines to assess and achieve sedation and analgesia can reduce time on ventilators and lengths of stay in the ICU setting. The introduction of the new sedative dexmedetomidine also has potential to reshape patient care in the ICU. The ability to sedate and provide analgesia while still maintaining patient arousability and respiratory function can lead to an entirely new approach to patient care and weaning from mechanical ventilation. A thorough understanding of the pharmacodynamic responses to sedative drugs is required for their use. Future studies should focus on the short- and long-term outcomes resulting from institution of these novel approaches to ICU care.

## Questions

Choose the single letter response that best answers the question or completes the sentence.

1. **The most important reasons for administration of sedation in the ICU are:**
   a. to reduce anxiety
   b. to prevent short- and long-term neurosis and psychosis
   c. both of the above
   d. none of the above
2. **A 1995 Task Force of the American College of Critical Care Medicine recommended for short-term sedation in the ICU**
   a. lorazepam
   b. midazolam and propofol
   c. dexmedetomidine
   d. diazepam
3. **Lorazepam produces minimal cardiovascular and respiratory depression but is associated with prolonged weaning during extubation.**
   b. False
   a. True
4. **The opioid compounds provide analgesia, and are more consistent and potent than benzodiazepines and propofol at impairing respiratory drive.**
   a. True
   c. False
5. **One of the unique characteristics of dexmedetomidine is that it:**
   a. provides sedation and analgesia
   b. provides sedation while preserving arousability
   c. causes respiratory depression
   d. is not analgesic
6. **Continuous infusion is associated with prolonged mechanical ventilation and longer ICU, hospital stays.**
   a. True
   d. False
7. **New approaches to ICU sedation include daily interruption of sedative infusions, protocol-directed sedation**
   a. True
   b. False
8. **In a study at the Barnes-Jewish Hospital in St. Louis:**
   a. protocol-directed sedation increased length of ICU stay
   b. protocol-directed sedation increased length of hospital stay
   c. protocol-directed sedation had no effect on care
   d. protocol-directed sedation significantly decreased duration of mechanical ventilation and length of ICU, hospital stays
9. **The site of action of dexmedetomidine is:**
   a. the hippocampus
   b. the cerebellum
   c. the locus coeruleus of the brain stem
   d. the medulla oblongata
10. **Cardiovascular effects of dexmedetomidine include reduced sympathetic outflow, increased vagal outflow**
    a. True
    b. False

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## Current Strategies in ICU Sedation
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