Moderate Sedation/Analgesia

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Faculty

Susan Engman Lazear, RN, MN, received her undergraduate education at the Walter Reed Army Institute of Nursing in Washington, D.C. After completing her BSN, she served as an Army Nurse at Letterman Army Medical Center in San Francisco for four years. She then attended the University of Washington School of Nursing and received a Master's in Nursing, specializing in Burn, Trauma and Emergency Nursing. After receiving her MN, she started Airlift Northwest, the air ambulance service based in Seattle which serves the entire Northwest region, including Alaska. Mrs. Lazear left the air ambulance service to start her own nursing education and consulting business, Specialists in Medical Education. For the past 20 years she has been teaching emergency nursing courses throughout the country. She lives in the Seattle area. Mrs. Lazear continues to teach and publish. She is both an editor and contributing author of Critical Care Nursing, published by W.B. Saunders Company, in June of 1992. She served as an author and reviewer of the Emergency Nursing Core Curriculum 6th Edition, published by W.B. Saunders Company in 2007. She has been named to the Who's Who in American Healthcare list annually since 1992.

Faculty Disclosure

Contributing faculty, Susan Engman Lazear, RN, MN, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

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Division Planner Disclosure

The division planner has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for all nurses, especially those in procedural and diagnostic areas, such as radiology, endoscopy, cardiac cath, outpatient surgery, intensive care, and emergency departments.

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Course Objective

The purpose of this course is to provide nurses with the knowledge required for safe drug delivery based on standardized operational guidelines. Preprocedural, intraprocedural, and postprocedural patient care are presented, as well as a thorough review of the drugs used, their advantages and disadvantages, and the safe administration of these agents.

Learning Objectives

Upon completion of this course, you should be able to:

1. Define moderate sedation, including the goals and objectives.
2. Detail the necessary components of the preprocedural patient care period, including patient assessment, selection, and preparation.
3. List the duties and responsibilities of those who provide care for the patient receiving moderate sedation medications.
4. Detail patient care provided during the postsedation period, including the minimal parameters that should be met by the patient prior to discharge after sedation.
5. Present the advantages and disadvantages of the various methods and routes of medication administration.
6. Review the most commonly used pharmacologic agents for moderate sedation.
7. List the advantages, disadvantages, and limitations of pulse oximetry and end-tidal carbon dioxide monitoring in the sedation setting.
8. Describe the various techniques for cardiac monitoring. Explain the advantages of each of these methods.
9. Outline the role of bispectral indexing in moderate sedation patients.
10. Develop a sedation documentation form that includes the appropriate information.
11. Discuss the most common complications occurring during or after moderate sedation.
12. Outline the anatomic and physiologic differences between children and adults and how these differences impact pediatric moderate sedation patients.
13. Describe the anatomic and physiologic differences in the elderly and the impact of these differences on the administration of sedation.
14. Explain how sedation practices should be altered in sedating the obstetric patient.
15. Review issues that impact moderate sedation administration for patients in the intensive care unit or those undergoing procedural interventions.
16. Identify practice issues for nurses administering moderate sedation.

Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

Moderate sedation/analgesia (formerly referred to as conscious sedation) was once a task performed exclusively by anesthesiologists but is now a common nursing practice in a number of settings. The interest in and use of moderate sedation has dramatically increased as more nurses and care providers become trained in the safe delivery of patient care while administering sedative agents.

In 2001, the Joint Commission developed a new definition of moderate sedation that is now widely accepted and used. The Joint Commission identifies moderate sedation/analgesia as the second level in a continuum between minimal sedation (i.e., anxiolysis) and deep sedation (i.e., anesthesia). Thus, the Joint Commission defines moderate sedation/analgesia as "a drug-induced depression of consciousness during which individuals served respond purposefully to verbal commands either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained" [1]. The Joint Commission has mandated that an institution's sedation practices be monitored and evaluated by the department of anesthesia. In response to this mandate, the American Society of Anesthesiologists (ASA) developed practice guidelines for nonanesthesiologists who provide sedation and analgesia [2; 3; 4]. The practitioner should recognize that sedation is part of the continuum that progresses from minimal to moderate to deep sedation and eventually reaches the state of general anesthesia. Each individual patient should be closely and continuously monitored to prevent this progression to the deeper sedated states [5]. Practitioners of sedation should have the necessary skills to rescue a patient from a deeper level of sedation than that intended [5].

Much like the Joint Commission, the ASA has defined moderate sedation in the following manner [2]:

- Depression of consciousness is drug-induced.
- Patient responds purposefully to verbal commands, either alone or accompanied by light tactile stimulation.
- Airway is patent without interventions, and spontaneous ventilation is adequate.
- Cardiovascular function is usually maintained.

Moderate sedation/analgesia can be used to achieve a number of objectives. Moderate sedation allows a patient to tolerate an unpleasant procedure while maintaining consciousness and cooperation. Many of the pharmacologic agents used will provide mood alteration and partial amnesia. The patient does not remember the majority of the procedure and awakens in a comfortable, composed state. The choice of medications used depends on the objectives desired; some medications will provide for an elevation in the patient's pain threshold, while others have no analgesic properties. However, it is important to note that the term moderate sedation cannot be used synonymously with pain management, as not all sedating medications will achieve the parameters of pain control. An additional goal of sedation is a rapid return of the patient to his/her presedation state with a decreased risk of resedation. It is imperative for nurses providing moderate sedation to remember that while the goals and objectives of moderate sedation are important, the most critical part of patient care delivery is providing for patient safety during the time that the patient is sedated and recovering from sedation.

Moderate sedation is delivered in a number of settings. The reasons for sedation may vary, but the Joint Commission requires that the patient receive the same level of care regardless of the practice setting. The first reports of the use of moderate sedation can be found in dental literature. Many dental and oral surgery procedures are successfully accomplished on the sedated patient. The emergency department may deliver sedation for a number of reasons, including, but not limited to, the repair of complex lacerations, reduction of fractures and casting, wound care, and abscess incision and drainage. Some patients may require lengthy, uncomfortable radiologic studies necessitating sedation in the radiology suite. Many invasive and diagnostic measures are performed using moderate sedation, such as bronchoscopy, endoscopy, cardiac studies, and pacemaker placement. The outpatient setting has seen an increased use of moderate sedation. It is not uncommon for in vitro fertilization to be performed on a sedated patient. Additionally, moderate sedation has been used as an adjunct to local anesthesia. A vast number of procedures that are uncomfortable and/or painful can be performed safely using moderate sedation [4; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15].

As previously mentioned, the use of moderate sedation has increased tremendously. This increase in acceptance and popularity has occurred for a number of reasons. Due to healthcare reform, the financial impact of patient care is under daily scrutiny. Moderate sedation performed by trained nursing staff can greatly reduce the patient's hospital charges, as opposed to sedation performed by an anesthesiologist. A study of cardiac patients undergoing a six-hour electrophysiologic study found a reduction in costs of administering sedation ranging from $1,800 to $2,400 when a patient received moderate sedation administered by a nurse as compared to the patient receiving general anesthesia administered by an anesthesiologist [16]. This reduced cost reflected a number of factors, including shorter recovery times and a rapid return to the presedation state in the patient, thus requiring less expensive nursing care and shorter hospital stays [17; 18]. One study investigated the clinical and cost outcomes associated with moderate sedation in patients undergoing transcatheter aortic valve replacement [19]. Of 231 patients initially identified, 225 were included in the study. Compared with general anesthesia, moderate sedation was associated with significantly fewer intensive care unit (ICU) hours (30 vs. 96); fewer total hospital days (4.9 vs. 10.4); a 28% decrease in direct costs; and significant decreases in all cost categories [19].

Patient acceptance and demand for moderate sedation is another reason its use has become more prevalent. The reported rates of patient satisfaction after procedures with moderate sedation have been high [20; 21; 22]. A knowledgeable patient recognizes that there are medications and techniques available (i.e., moderate sedation/analgesia) that allow the patient to have a procedure performed with a minimal amount of disruption in his/her daily activities. Patients no longer stay overnight after many procedures, and if given short-acting medications, they can return to their jobs and home life within a relatively short period of time.

Additionally, parents and family members do not want to see their loved ones uncomfortable or suffering and will request medications to help ease the pain. This is especially true with the pediatric patient, as many of the invasive procedures performed can be achieved with much less difficulty and pain in a moderately sedated child. The results are improved and the parent is satisfied in knowing that his/her child is not being unnecessarily restrained.

Patient satisfaction varies according to the drug used. There are a number of good, short-acting drugs available that assist in achieving the goals and objectives of moderate sedation. Prior to the 1990s, diazepam had been the drug of choice in most practice settings; however, the side effects were intolerable to many, and patients had longer recovery times. With the advent of newer benzodiazepines and opioids, patients can experience the same benefits without the disadvantages of the older drugs.

Finally, increased use of moderate sedation can be traced to the advent of new technologic innovations. With the development of pulse oximetry and noninvasive blood pressure monitoring, moderate sedation can be delivered safely and noninvasively to provide for maximum patient comfort and care.

The subsequent discussion of moderate sedation will focus on safe patient care delivery. The administration of moderate sedation can be performed using either intravenous (IV) or transmucosal (i.e., oral, intranasal, rectal, sublingual) routes. Each route has advantages and disadvantages, which will be discussed in length at a later point in this course. The issues discussed in the Patient Care section will cover both routes of administration, with special attention to IV sedation when appropriate.

PATIENT CARE

Care of the patient receiving sedating medications includes three phases: presedation care (i.e., care prior to the procedure); care during the procedure, and postsedation care (i.e., care after the procedure). Administering moderate sedation/analgesia requires vigilant nursing assessment during all phases to ensure safe drug administration and positive patient outcomes.

PRESEDATION CARE

Patient selection and assessment prior to drug administration is critical to safe patient care both during and after sedation. The goals of presedation selection include the recognition of risk factors that may place the patient at increased risk of complications; the recognition of patients with a high level of anxiety who may not tolerate the sedation process easily; and the recognition of pre-existing comorbidities that will complicate care delivery. For elective procedures, a preprocedure assessment may be done days or weeks in advance; early assessment is essential for allowing time to make any necessary changes, such as the discontinuation of certain medications or herbal supplements [4; 6; 23; 24; 25]. Even when an early assessment has been done, the Joint Commission requires that a presedation assessment be performed on each individual prior to beginning moderate sedation and before anesthesia induction [26]. This assessment allows the practitioner to plan and administer sedation to ensure patient safety. The components of presedation assessment include the patient's age, height, weight, and existing medical diagnosis. A physical examination with a review of the cardiac, respiratory, and neurologic systems should be completed. Astute assessment is critical as medications administered during moderate sedation will most significantly affect these body systems, and the patient who may be at risk should be identified.

The patient's past medical history should be reviewed. A history of allergies should be documented, and if necessary, therapeutic reversal agents, such as diphenhydramine and epinephrine, should be prepared. The patient's current medical history should include the reason for sedation and other current factors, including medication(s), alcohol, illicit drug, and/or tobacco use. A review of the patient's history may help to identify patients at risk for complications (***Table 1***) [6].

Airway assessment should be conducted and is easily performed using the modified Mallampati scale [27; 28; 29]. The patient is placed in a comfortable sitting position and asked to open his/her mouth and protrude the tongue. The nurse then assesses the airway, noting the ability to visualize the fauces, anterior and posterior pillars, soft palate, and uvula. The patient with a Class 1 airway has all these structures visible. The pillars are masked by the tongue in a patient with a Class 2 airway. A patient with a Class 3 airway has only the soft palate and base of the uvula visible. A patient for whom only the hard palate is visible has a Class 4 airway [30]. The modified Mallampati scale allows the nurse to recognize which patients may be at risk for difficult airway management, including difficult intubations [29]. It has also been noted that obesity may contribute to airway difficulties [31; 32]. In addition to visualization of the airway, neck circumference and body mass index should also be assessed preoperatively and considered in the overall airway assessment.

USING HISTORY TO HELP IDENTIFY PATIENTS AT RISK FOR COMPLICATIONS	
Question	**Relevance to Moderate Sedation**
Is there a history of cardiovascular problems?	The patient may be at increased risk for complications and may require special monitoring.
Is there a history of respiratory problems (emphysema, asthma)?	Risk of complications is greater for patients with emphysema or asthma due to potential respiratory depression.
Is there a history of seizure disorders?	If disorder is treated with benzodiazepines, a benzodiazepine antagonist cannot be used as a reversal agent.
Is there a history of liver disease?	Liver damage may prolong and/or heighten sedative effects of drugs metabolized in the liver.
Is there a history of renal disease?	Potential for problems for patients with renal insufficiency if the sedation drugs used are ones that are excreted in the urine (such as benzodiazepines and opioids).
Is there a history of thyroid disease?	Altered rates of metabolism affect the effective doses of sedation drugs.
Is there a history of substance abuse?	A back-up plan should be made with an anesthesia professional in case the patient becomes combative or uncooperative or if sedation drugs have little effect.
Are there any piercings?	Piercings may need to be removed, depending on location.
What current medications are taken?	Many prescription medications and herbal supplements may increase the risk for complications related to sedation/analgesia and/or an invasive procedure.
Source: [6]	*Table 1*

Baseline vital signs should be obtained, taking into consideration that the patient's "normal" vital signs may be masked by anxiety, pain, and fear. A baseline assessment of the patient's level of consciousness should be achieved to allow for proper assessment during sedation as well as for assessment of readiness for discharge. Additionally, baseline pulse oximetry readings should be achieved prior to initiating oxygen therapy.

An anesthesia history should be obtained, focusing on previous surgical interventions and any known complications. Appropriate laboratory studies can be obtained prior to the procedure.

It is important to accurately and fully assess the patient without performing excessive, superfluous tests. An electrocardiogram (ECG) may be indicated for patients with positive cardiac histories, but not everyone older than 40 to 50 years of age will require a presedation ECG. The performance of unnecessary tests may increase the patient's out-of-pocket costs if, for example, the patient's insurance company determines that the tests were unnecessary and declines to pay for them. Not only is this expensive, it may cause the patient to question the necessity of other important tests that may have been performed at the same time. Therefore, preprocedural tests should be weighed but by no means considered requirements for every patient.

Finally, the setting in which sedation will be administered should be considered in the selection process. The ASA Committee on Standards and Practice Parameters recommends that patients who receive moderate sedation on a scheduled basis should not drink clear fluids for at least two hours or eat solid foods (a light meal) for at least six hours prior to the procedure [33]. However, meeting the fasting requirements for emergently performed procedures is difficult, and guidelines note that when urgent or emergent procedures must be done, recent food intake is not a contraindication for administering procedural sedation/analgesia in adults or children [4; 23; 25; 34; 35].

AMERICAN SOCIETY OF ANESTHESIOLOGISTS PHYSICAL STATUS CLASSIFICATION	
Physical Status Class[a]	**Definition**
1	A normal healthy patient with no systemic disease
2	A patient with mild-to-moderate systemic disease
3	A patient with severe systemic disease
4	A patient with severe systemic disease that is a constant threat to life
5	A moribund patient who is not expected to survive without surgical intervention
6	A declared brain-dead patient whose organs are being removed for donor purposes
[a]This number may be followed by an "E" if the surgery is considered an emergency	
Source: [36]	*Table 2*

The potential risks of sedation without fasting (e.g., aspiration) should be weighed against the benefit of performing the procedure promptly [4]. The ASA has developed a Physical Status Classification System to determine risk for complications among patients undergoing anesthesia (***Table 2***). This scale is frequently used in the moderate sedation setting and easily performed on all patients in all settings. Patients in Class 1 and 2 are considered good candidates for moderate sedation procedures; those in Class 3 and Class 4 carry higher risks. Nurses providing sedation should recognize that Class 3 and 4 patients may benefit from sedation and should not be excluded based upon their ASA classification. Sedation is frequently provided to ICU patients, most of whom are in Class 3 or 4, and these patients greatly benefit from the effects of the sedation.

A prime example of this dilemma would be a patient, 76 years of age, with a history of unstable angina who is being evaluated for sedation. His history shows that he lives alone and cares for himself. However, he is unable to walk a flight of stairs without stopping to catch his breath; thus, he would be classified as an ASA Class 3 patient. Withholding sedation because of his history may actually increase his risk of compromise if he is found to be extremely anxious about the intended intervention. His anxiety may increase his risk of developing chest pain; relieving this anxiety with sedation medications would reduce the risk of cardiac compromise.

Upon completion of the presedation assessment, a decision should be made as to the acceptability of the patient for moderate sedation. Every nurse providing sedation should recognize the patients who are at risk, and if extenuating circumstances arise, the nurse should be comfortable to say that he/she is not adequately trained in providing sedation to this particular patient. There should be no pressure on the nurse to provide sedation when suitability criteria are not met. If the criteria are met, the patient should be educated regarding the care he/she will receive during and after sedation. The patient should be told what he/she can expect during the procedure, and the nurse should inform the patient about the continuous monitoring that will occur throughout the sedation period. The techniques of noninvasive blood pressure monitoring should be explained, as this may cause momentary pain while the cuff is inflated to its highest level. The pulse oximeter probe should be explained, and the patient should be aware of its placement and use, recognizing that no pain should be experienced from its use. The vital sign assessment schedule should be explained and demonstrated, as patients will often be asked to take deep breaths. If the procedure is painful and a pain scale will be used to assess the patient's level of pain, the patient should be instructed on its use prior to beginning sedation.

SUGGESTED EQUIPMENT LIST	
Standard Equipment	Oxygen delivery system Method to summon help Cardiac monitoring system Policy and Procedure Manual readily available Pulse oximeter Documentation forms Blood pressure monitoring device Emergency supplies (see below) IV access equipment Gloves Medications appropriate to institution
Emergency Airway Supplies	Nasopharyngeal airways (appropriate sizes) Magill forceps (adult, pediatric) Oropharyngeal airways (appropriate sizes) Sterile lubricant Tongue blades Suction equipment Laryngoscope handle Yankauer suction catheters MacIntosh blades (appropriate sizes) Suction catheters (appropriate sizes) Miller blades (appropriate sizes) Oxygen supply Spare lightbulbs Bag valve mask device (appropriate sizes) Endotracheal tubes (appropriate sizes) Stylets (adults, pediatric)
Emergency Support Equipment	Defibrillator IV tubing IV catheters (appropriate sizes) Pediatric burette Tourniquets Extension tubing Gloves IV fluid Alcohol wipes 3-way stopcocks Adhesive tape Intraosseous needles (pediatric patients) Syringes (appropriate sizes)
Emergency Medications[a]	Glucose Dopamine Atropine Sodium bicarbonate Amiodarone Naloxone Epinephrine (1:1000 and/or 1:10,000) Flumazenil Lidocaine Methylprednisolone Ammonia spirits
[a]Choice of medications will vary by institution policy.	
Source: [6; 37]	*Table 3*

Finally, discharge instructions should be provided prior to the procedure; the nurse should recognize that the patient may not remember all that is told to him/her in the postsedation period. Reinforcing these instructions during the presedation period will greatly enhance patient compliance in the postsedation period.

Additional responsibilities in the presedation period include the preparation of the equipment to be used and available during the sedation period (***Table 3***). Patient support equipment, including oxygen and suction, should be tested to ensure proper functioning. If the nurse were to only check to make sure that the equipment is available, problems could ensue if something functioned improperly at a critical point in patient care. Monitoring equipment should be warmed up and calibrated, if necessary. Medications should be available, and determination of proper dosing should be precalculated. Reversal medications should be readily available; drawing an initial dose of the reversal agent is a wise and prudent move. These drugs can be drawn and the syringe labeled for future reference. In addition, medications used for advanced cardiac life support should be readily available.

A well-stocked crash cart should also be available and within easy access in the event of an emergency. A method to summon additional help should be within arm's reach and tested to ensure accurate functioning. It is also important to ensure that all equipment is age-appropriate and size-appropriate for the patient receiving sedation. Standard adult equipment may not be appropriate for a small female; large child sizes may be more appropriate for this patient. It is imperative that this equipment is located and checked to prepare for complications, should they develop.

Many patients scheduled for moderate sedation are undergoing a planned procedure. If this is the case, the patient should have received preprocedural instructions. These instructions should include the patient's NPO status (if any), the time for arrival, the estimated time for procedure performance, and the estimated time for discharge. If the patient will be discharged to the care of a responsible adult, this person should be notified of his/her responsibilities and time for arrival (if he/she does not accompany the patient to the facility). Additionally, procedure-specific guidelines should be reviewed, including such items as bowel preparations and administration of antibiotics.

Prior to the administration of any sedating agents, the patient should sign an informed consent. Guidelines note that the risks, benefits, and limitations of moderate sedation, as well as possible alternatives (no sedation), should be discussed with patients, enabling them to make an informed decision [38]. If a patient is undergoing a scheduled procedure, this may have been accomplished at the time of preprocedural patient teaching; if the patient is undergoing an emergent procedure, this may have been accomplished during registration in the emergency department. In either case, a separate consent is not necessary [4]. However, informed consent should be present and complete prior to beginning the procedure. It is often the nurse's responsibility to ensure its placement in the patient's chart.

One immediate presedation responsibility includes establishing IV access in the patient receiving IV sedation. (This is a controversial area in the arena of transmucosal sedation and will be addressed at a later point in this course.) If the patient was not NPO, as is the case in emergent patients, medications to decrease gastric contents and stomach acid should be administered. These drugs will help reduce the risk and complications of aspiration, one of the most prevalent complications of moderate sedation. Metoclopramide will speed passage of gastric contents into the bowel, thus reducing gastric volume. The histamine antagonists cimetidine, ranitidine, and famotidine will increase gastric pH, thus reducing complications, should the patient aspirate gastric contents into his or her pulmonary tree.

The Joint Commission requires that heart rate and oxygenation be continuously monitored by pulse oximetry in all patients undergoing moderate sedation [1]. If the patient is to receive supplemental oxygen therapy, a pulse oximetry reading on room air should be documented. After oxygen therapy is initiated, another pulse oximetry reading should be obtained.

The results of all elements of the preprocedure assessment should be clearly documented before sedation is started. A final set of presedation vital signs should be obtained as baseline measures, and the patient's level of consciousness should be evaluated and documented before initiation of sedation. In addition, the patient's name, birth date, and procedure should be confirmed prior to initiating sedation [4; 39].

Importance of Effective Communication

Because the history and informed consent are vital components of the preprocedure process and integral to patient safety and satisfaction, effective communication is key. Among the most important factors for effective communication are knowledge of the language preference of the patient, an awareness of the patient's health literacy level, and an understanding of and respect for the patient's and family's cultural values, beliefs, and practices (referred to as cultural competency) [40]. When the nurse and the patient speak different languages, the use of family members and/or friends as interpreters should be avoided if possible, as the patient may not be as forthcoming with information and the family member or friend may not remain objective [41]. Studies have demonstrated that the use of professional interpreters rather than "ad hoc" interpreters (e.g., untrained staff members, family members, friends) facilitates a broader understanding, leads to better outcomes, and is better aligned with patient preferences [42; 43; 44].

CARE DURING SEDATION

During sedation, the two most important responsibilities of the nurse are to ensure patient safety and monitor the patient's level of sedation. Documentation should be performed throughout the procedure as a record of patient care [45].

Throughout the sedation period, the nurse should remain with the patient at all times. There should be no other responsibilities for the nurse; assisting with the procedure should not be an expectation. It is imperative that all persons involved with moderate sedation be aware of this requirement. The nurse should never be asked to help out "just this once," thus compromising patient safety. The policy and procedure manual for moderate sedation delivery should clearly delineate the nurse's responsibilities and the right to refuse additional tasks during this period.

While the patient is receiving and recovering from sedation, the nurse should judiciously monitor the patient's airway [45]. It is the nurse's responsibility to ensure that during sedation, the patient's spontaneous ventilation is maintained without intervention [1]. Should the patient's level of consciousness deepen to the point that the airway is compromised, the physician should be informed and measures undertaken to reverse the effects of this untoward complication.

The American Society of Anesthesiologists recommends that periodic assessment of airway patency, respiratory rate, and oxygen saturation be done during emergence and recovery, with particular attention given to monitoring oxygenation and ventilation.

(https://www.guideline.gov/summaries/summary/43896. Last accessed June 22, 2017.)

Level of Evidence: Expert Opinion/Consensus Statement

OXYGEN THERAPY DEVICES			
Type	**Fraction of Inspired Oxygen (FiO_2)**	**Flow (L/min)**	**Comments**
Nasal cannula	24% to 40%	3–6	Comfortable, only increases O_2 level slightly, inexpensive, high flow rate increases problems
Simple face mask	25% to 55%	5–8	Poorly tolerated if too tight
Face tent	30% to 50%	4–10	Less confining, may provide humidification during long procedures
Nonrebreather mask	40% to 100%	6–15	Mask with reservoir and one-way valves, best noninvasive device, requires tight seal to achieve high %
Venturi mask	24% to 55%	2–14	Adjustable FiO_2
Bag valve mask	up to 100%	10–15	Self-inflating, may increase gastric distention

Source: [46] Reprinted from Litwack K. Post Anesthesia Care Nursing. 2nd ed. St. Louis, MO: C.V. Mosby Co.; 1995. With permission from Elsevier. *Table 4*

The patient may have supplemental oxygen supplied, although the use of prophylactic oxygen therapy is a debatable issue. Many institutions require that all patients undergoing moderate sedation have supplemental oxygen used throughout the sedation period. Other policies require that supplemental oxygen be applied if or when the patient's pulse oximetry reading drops to an unacceptable level, generally ranging from 90% to 94%. The ASA guidelines note that supplemental oxygen should be considered for moderate sedation [45].

Oxygen therapy devices are advantageous, but also disadvantageous, for a number of reasons. First and foremost, supplemental oxygen helps assure that the patient's oxygen level is adequate. However, the use of sedation medications blunts the response to falling levels of oxygen; thus, the patient may not institute compensatory measures during this period. Additionally, the application of oxygen therapy devices may be confining and can actually increase the patient's level of anxiety, which would be counterproductive to the objective of sedation. Whenever using oxygen therapy, it is imperative that the patient be educated regarding its use and purpose.

Oxygen therapy devices used in moderate sedation range from the simple (e.g., nasal cannula) to the more complex (e.g., non-rebreather and Venturi masks). The nurse caring for the patient should understand the importance of the proper application of each device used. For example, the flow rate on the simple face mask should be, at a minimum, 5 L/min. If the oxygen flow rate were less than 5 L/min, carbon dioxide (CO_2) could accumulate within the mask and the patient would rebreathe this CO_2. This would lead to a respiratory acidotic state with further compromise of the patient's ventilatory status. ***Table 4*** summarizes the various oxygen delivery devices used in the moderate sedation setting, and notations are made about each device.

During sedation, the patient will be monitored for his/her response to the medications used. If a patient demonstrates restlessness and agitation, the nurse should determine the cause and intervene to reverse any untoward events. Restlessness and agitation should always be considered signs of hypoxemia until proven otherwise. However, it is just as possible that these behaviors are secondary to inadequate analgesia, and further assessment should be performed. If the nurse considers hypoxemia as the primary cause and intervenes appropriately, the risk of further hypoxemia is eliminated.

MODIFIED OBSERVER'S ASSESSMENT OF ALERTNESS/SEDATION SCALE	
Responsiveness	**Score**
Agitated	6
Responds readily to name spoken in normal tone ("alert")	5
Lethargic response to name spoken in normal tone	4
Responds only after name is called loudly and/or repeatedly	3
Responds only after mild prodding or shaking	2
Does not respond to mild prodding or shaking	1
Does not respond to deep stimulus	0

Source: [39] Reprinted from Cohen L, Delegge MH, Aisenberg J, et al. AGA Institute review of endoscopic sedation. Gastroenterology. 2007;133(2):676-701. With permission from Elsevier. *Table 5*

Vital signs may be assessed as frequently as every five minutes and should also be assessed at one minute after each additional dose of IV sedative. This will ensure the recognition of developing cardiovascular and respiratory complications secondary to medication administration. It is also prudent to assess the patient's airway with each vital sign assessment and ask the patient to take a deep breath (unless contraindicated by the procedure). This will ensure safe patient care delivery throughout the procedure.

An additional concern during sedation is the accumulation of secretions in the airway. Certain medications (e.g., ketamine) are more likely to produce secretion formation, and the nurse should maintain constant vigilance of the airway to prevent airway obstruction. Suction should be done using a Yankauer-type device.

Finally, to ensure that the goals of sedation are being met, the nurse should assess the patient's level of consciousness and, again, document this throughout the procedure [4; 34; 45]. Although several scales and scoring systems have been developed to describe the level of consciousness, none are ideal. The sedation scale should be developed to decrease observer bias. The patient should be able to be assessed by a number of different individuals at the same time and receive the same score with each assessment. The scale should have graded changes that reflect different sedation levels, and similar changes should be noted with different sedating agents. The patient should experience no pain or discomfort, and the scoring should be noninvasive. Furthermore, the scale should be easy to use, interpret, and record.

One recommended tool is the Modified Observer's Assessment of Alertness/Sedation Scale (***Table 5***) [39]. The patient's response to verbal commands should be monitored routinely, except for patients who are unable to respond (e.g., young children, mentally impaired individuals) or during procedures in which the lack of patient movement is essential [18; 29]. For situations in which a verbal response is not possible (e.g., upper endoscopy), the patient and the nurse who is monitoring should determine hand signals before sedation is administered.

Other commonly used scales include the Ramsay Sedation Scale, the Sedation-Agitation Score, the Richmond Agitation-Sedation Scale (RASS), and the Motor Activity Assessment Scale. All of these scales were developed for use in a variety of settings, including the ICU. The Ramsay Sedation Scale (***Table 6***) was developed for ICU patients and is one of the scoring systems most widely used during moderate sedation [47; 48]. The desirable level of sedation using the Ramsay Sedation Scale is a level of 2 or 3; however, upon inspection of

RAMSAY SEDATION SCALE	
Score	**Response**
1	Patient anxious, agitated/restless, or both.
2	Patient is cooperative, oriented, and tranquil.
3	Patient responds to commands only.
4	Patient exhibits brisk response to light glabellar tap or loud auditory stimulus.
5	Patient exhibits a sluggish response to light glabellar tap or loud auditory stimulus.
6	Patient exhibits no response.

Source: [48] *Table 6*

this scoring system, clarity is lacking between these two levels [6]. Many documentation forms use the Modified Aldrete Score for assessing the patient's level of functioning; however, this score was developed for monitoring the patient's readiness for discharge and is not recommended as a method of assessing the patient's level of sedation during the procedure. Other scoring systems exist, some of which include recommendations for frequency of drug administration [6].

POSTSEDATION CARE

After administration of the sedation medication is complete, patient monitoring should continue until the patient achieves his/her presedation level of consciousness and functioning. The ASA recommends that monitoring continue until the patient is near the baseline level of consciousness and is no longer at increased risk of cardiorespiratory depression [45]. If the patient is to be transferred to a separate recovery area, the nurse administering the sedatives should accompany the patient to the recovery area and give a complete, concise report to the nurse responsible for further patient care. This report should include information regarding the respiratory, circulatory, and neurologic function of the patient before and during the procedure. Measures to control the patient's pain should be shared, as well as the time and effectiveness of pain medications.

Other important items to reference in this report include the total amount of sedative drugs received and the time of reversal agent administration, if given. Information on any untoward complications should be provided, as well as measures undertaken to correct these problems. The patient's fluid status may be important to share, as knowledge of the patient's ability to take oral fluids or to void will impact the length of time for recovery. Finally, a preprocedural level of functioning should have been documented so that discharge can be based on these findings.

During the postsedation period, the patient's vital signs and pulse oximetry readings should be assessed on a regular basis. The time frame for these assessments can vary, depending on the drug, the route, the amount of drug received, and the time since the last dose. Generally, vital signs and pulse oximetry readings are obtained on a 15-minute cycle until stable and then on a regular basis until the time of discharge.

The patient may need reorientation to time and place. The amnesic effects of many of the medications administered will prevent the patient from remembering certain facts about his/her surroundings. As the medications wear off, the patient will need less reorientation.

Another measure that may be necessary in the postsedation period is limitation of stimuli to the patient. The risk of untoward reactions increases with certain medications (e.g., ketamine) and with certain forms of stimuli (e.g., loud noises). Limiting these exposures will ensure a safe, comfortable arousal for the patient.

Discharge of the patient after sedation is a critical part of postsedation care. There are a number of variables that affect discharge of the patient. Most critical is the location and type of the unit to which the patient will be transferred. Many patients are discharged to home, and care of the patient should be well-delineated so that both the patient and the caregiver are comfortable with the expectations of the remaining recovery period.

Other factors that impact discharge of the patient include the type of procedure performed, the type of monitoring used during the procedure, the type and amount of medication received, the patient's preprocedure health status, and the development of any complications. Many of the procedures performed under moderate sedation are those in which rapid recovery and discharge of the patient is an expectation. If a procedure is expected to be lengthy and requires in-depth monitoring and postsedation care, the patient may not be considered a candidate for moderate sedation provided by nursing staff. This decision is made during the presedation assessment.

Typical discharge criteria require that the patient return to his/her preprocedural status. The patient should have adequate respiratory function and stable vital signs. The preprocedural level of consciousness should be reached, without the risk of resedation and a return to a decreased level of functioning. Intact protective reflexes, including gag reflex, are imperative. The patient should have his/her pain under control, and the procedural site should be stable, without evidence of bleeding or other complications. Many facilities also delineate a time period since last receiving medications as a parameter for discharge. Finally, if a patient is to be discharged to home, a responsible adult caregiver should be present to accompany the patient [39; 45]. If the patient is a child who still uses a car seat, the American Academy of Pediatrics (AAP) suggests that at least two adults be available to take the child home, so one adult can sit with the child while the other drives [34]. Parents should be told that the child is at risk for airway obstruction if his or her head falls forward while in the car seat [45].

A number of discharge scoring systems are used to assist the staff with identifying patients who are ready for discharge, but there are no established standard discharge criteria; healthcare facilities should establish their own standardized criteria [34; 39; 45]. The scoring system should provide objective, measurable parameters for the patient to attain (e.g., stable vital signs, alert/oriented status, patent airway, adequate pain control) and should identify the score for discharge. The patient should meet the appropriate criteria to achieve that score [39; 45].

One of the most commonly used discharge scoring systems is the Modified Aldrete Score (***Table 7***). This scoring system is used on a daily basis by postanesthesia care nurses working with ambulatory patients. The easy-to-use, simple scoring mechanisms are very useful for patients undergoing moderate sedation. A score of 18 or higher indicates a patient's readiness for discharge [49; 50].

Other similar scoring systems are the Post-Anesthesia Discharge Scoring System (PADSS) and the Modified Post-Anesthesia Discharge Scoring System (MPADSS) [51; 52; 53; 54]. These systems have a maximum total score of 10; a patient with a score of 9 or greater is considered fit for discharge [54]. It is important to remember that whichever type of scoring system is used, individual patient requirements should be met to ensure a safe, continued recovery following discharge. Additionally, this score should be incorporated into the documentation record for the patient.

MODIFIED ALDRETE SCORE		
Domain	**Criteria**	**Score**
Activity	Able to move four extremities voluntarily on command	2
	Able to move two extremities voluntarily on command	1
	Able to move no extremities voluntarily on command	0
Respiration	Able to breathe deeply and cough freely	2
	Dyspnea or limited breathing	1
	Apneic	0
Circulation	Blood pressure (BP) + 20 of preanesthetic level	2
	BP + 22–49 of preanesthetic level	1
	BP + 50 of preanesthetic level	0
Consciousness	Fully awake	2
	Arousable on calling	1
	Not responding	0
Oxygen saturation	Able to maintain O_2 saturation >92% on room air	2
	Needs oxygen inhalation to maintain O_2 saturation >90%	1
	O_2 saturation <90% even on oxygen supplement	0
Dressing	Dry	2
	Wet, but stationary	1
	Wet, but growing	0
Pain	Pain free	2
	Mild pain	1
	Pain requiring parenteral meds	0
Ambulation	Able to stand up and walk straight	2
	Vertigo when erect	1
	Dizziness when supine	0
Fasting-feeding	Able to drink fluids	2
	Nauseated	1
	Nausea and vomiting	0
Urine output	Has voided	2
	Unable to void, but comfortable	1
	Unable to void, but uncomfortable	0

Source: [49] Reprinted from Aldrete J. Discharge criteria. Bailliere's Clin Anaesthesiol. 1994;8(4):763-773. With permission from Elsevier. *Table 7*

Discharge criteria are used in almost all environments in which moderate sedation is administered; however, these criteria are not without controversy. It is important for facilities to regularly review and update discharge criteria to ensure that current guidelines are being followed. The typical criteria of stable vital signs with a return to presedation values may not be attainable in all patients. Patients with a history of hypertension may not reach their "normal" systolic blood pressure due to the vasoactive effects of the sedating agents used. It may require 24 hours for the patient's vital signs to return to their presedation level. However, this should not prevent this patient from being discharged.

Although the ASA recommends that a mandatory minimum stay not be required, many facilities have a typical time requirement of 30 to 60 minutes after the last sedative dose and/or two hours after the last reversal dose as criteria for discharge [45]. Many healthy adult patients may awaken much faster than this, especially if the total sedative dose was small. On the other hand, elderly patients may need more time for monitoring, as circulation times are slower and the risk of slow release of sedative from the fatty tissue may develop.

The ability to achieve the presedation level of activity may be impossible in a small population. The patient who underwent arthroscopic surgery on a lower extremity and is now required to use crutches for ambulation will not achieve his/her presedation level of activity for a number of weeks.

The absence of nausea and vomiting is often used as a criterion for discharge; however, it should be recognized that certain procedures and medications may increase nausea (and possibly vomiting) for prolonged periods of time. For example, intravenous ketamine may cause vomiting in children for up to two hours after administration. Ensuring a good intact gag reflex so that the child can protect his/her airway is critical in this population. However, keeping the child for an extra two hours for monitoring is generally not accepted, either by parents or staff.

An additional discharge requirement may be to ensure that the patient has taken fluids orally; however, many facilities have eliminated criteria related to the ability to eat or drink before discharge, and the ASA states that this requirement may only be necessary for select patients [39; 45]. The problem of using oral fluid intake as a criterion for discharge is that many patients will willingly force fluids so that they may leave the facility. This may be done even though it is not in the best interest of the patient. As an example, patients who are experiencing bouts of nausea may drink fluids just so they can go home. This intake of fluids may be all that is necessary for the patient to vomit, which may, in turn, delay the patient's discharge. The requirement that all patients drink clear fluids prior to discharge has also been eliminated for many patients [45]. Guidelines recommend that toleration of fluids should only be required for specific populations, such as diabetics [51; 55]. Patients who are discharged prior to taking fluids should be advised to start drinking clear liquids when they feel ready.

Although it continues to be included in the Modified Aldrete Score, the requirement that all patients void prior to discharge has not been supported by research, and it may lead to delays in patient discharge. As such, many facilities have eliminated this requirement [39; 45; 51; 55; 56]. Assessment of urine output is useful in detecting some postoperative complications, and patients who are at high risk of urinary retention are generally required to void prior to discharge [45]. This includes patients who have had pelvic or genitourinary surgery, rectal or urologic procedures, hernia repairs, perioperative urinary catheterization, a history of urinary retention, or neuraxial anesthesia [51]. However, patients without an urge and no evidence of bladder distension (as shown by ultrasound) may be exempt from the voiding criteria [51; 56]. Patients who do not void prior to discharge should be given clear instructions on seeking medical attention if they remain unable to void eight hours after discharge [51].

SAMPLE DISCHARGE INSTRUCTIONS

Today you received medications to make you sleepy during your procedure. The medications you received are:

_____.

The following items are recommendations for your care during the next 24 hours.

1. Do not drive or operate heavy machinery for 8 to 24 hours.
2. Do not consume any alcoholic beverages for 24 hours.
3. Do not make any important decisions for 24 hours.
4. Describe pain management plan and medication use (if appropriate): You will experience pain for the next few hours (or specific time frame). Your doctor provided you with the name of medication to take every three to four hours for pain. If you did not receive pain medications, you can take... (List over-the-counter medications and instructions for use).
5. You may resume your regular diet unless instructed otherwise. If you feel sick to your stomach, you may begin with clear liquids and add items as you feel ready.
6. It is best to rest the remainder of the day.
7. Describe surgical site management (if appropriate).
8. If you are unable to reach your physician, you can call the emergency room at 555-5555.

(Note: These should be provided in written format and signed by the patient and caregiver.)

Source: [58] Reprinted from Odom J. Conscious sedation in the ambulatory setting. Crit Care Nurs Clin North Am. 1997;9(3):361-370. With permission from Elsevier. *Table 8*

EVIDENCE-BASED PRACTICE RECOMMENDATION

The American Society of Anesthesiologists states that the routine requirement for urination before discharge should not be part of a discharge protocol and may only be necessary for selected patients.

(https://www.guideline.gov/summaries/summary/43896. Last accessed June 22, 2017.)

Level of Evidence: Expert Opinion/Consensus Statement

Discharge criteria are simply measures that provide the practitioner with some parameters for discharge. Each individual patient should be evaluated based on a number of considerations, not just on meeting the outlined criteria [45]. It is the practitioner's responsibility to ensure patient safety at the time of discharge, and this should be documented in the patient's chart at the time the patient leaves the facility. If a patient is unable to meet the required discharge criteria but is discharged, these discrepancies should be noted in the patient chart at the time of discharge.

Prior to leaving, the patient and caregiver should receive postprocedural instructions (***Table 8***). These should be provided both verbally and in writing [39; 45; 57]. The instructions should be reviewed with the patient and caregiver, and a signed copy of these instructions should be included in the patient's chart. It is important to remember that not all patients go home immediately after sedation; many are returned to their nursing unit. The same type of discharge instructions provided to the patient and caregiver should also be given to the staff assuming care of the patient in a nursing unit. It cannot be assumed that the floor nursing staff fully comprehends the postsedation care required for moderate sedation recovery.

Information to include in discharge teaching includes postprocedural diet, level of activity, postprocedural care (e.g., wound care, dressing changes), and patient follow-up for both emergency and normal care. If medications are given, the purpose, name, dosage, route, frequency, duration of use, and significant or expected side effects,

if any, should be explained. It is also helpful to provide the patient with the name of the sedating agent(s) that he/she received. If the patient needs to contact someone for further information or emergency treatment, this information may be invaluable.

Discharge instructions provided to the patient should be reiterated to the responsible caregiver who is accompanying the patient from the facility. This individual should understand the importance of following instructions, whether it is to awaken the patient on a regular basis or monitor the patient's procedural site. The caregiver should be instructed how to obtain assistance in the event of an emergency.

As mentioned previously, providing discharge information during the presedation period will assist the patient with remembering and complying with the instructions provided. A patient in the postsedation period may remain slightly amnesic and many items may be forgotten. Reinforcing these instructions both prior to the procedure and in written format following the procedure will help to ensure good patient compliance.

Finally, postprocedural follow-up, in the form of a telephone call, can help improve future patient care. This telephone call should be placed within 24 hours of the patient's discharge and ascertain that the patient is safe and fully recovered from the effects of the medications administered. Information to obtain may include the incidence of complications related to the sedation and/or procedure, recovery time, adequate pain management, compliance with instructions, and patient satisfaction. This information should be recorded and evaluated on a regular basis. Compiling this information will allow for identification of trends in care and measures that can be instituted to improve care, if necessary.

PHARMACOLOGY AND DRUG ADMINISTRATION

Medication administration for moderate sedation incorporates a number of issues. The choice of medications depends on the type of procedure being performed and the estimated length of the procedure. The route of administration should be chosen for its efficacy, patient compliance, and method of action. The method of administration depends on the agent being administered, the route of administration, and the actions desired. Unfortunately, there is no one perfect agent that will meet these criteria.

The ideal moderate sedation agent should be one that is rapid acting with limited cardiorespiratory effects. A titratable medication would allow the practitioner to administer drugs in which the length of action is equal to the length of time required for sedation. Providing both analgesia and sedation would be beneficial in many situations and for many procedures. Furthermore, this ideal agent would be eliminated expeditiously for rapid return to the presedation state. And if complications were to occur, a drug that is readily and easily reversed would be optimal.

Because this drug does not exist, the following discussion will focus on the advantages and disadvantages of the routes and methods of administration and on the classes of medications.

ROUTE OF ADMINISTRATION

Transmucosal and intravenous moderate sedation produce sedation in the patient through somewhat different pathways. Most commonly, transmucosal administration includes oral, sublingual, and rectal administration. Other forms of administration include intramuscular, inhalation, subcutaneous, and topical administration. Intravenous sedation will be addressed separately.

Oral administration of moderate sedation agents is safe, economical, and convenient. It is accepted by many patients; however, it does require patient cooperation to ensure adequate drug delivery. Absorption from the oral route generally occurs in the small intestine secondary to its thin lining and large surface area. Thus, drugs must pass through the stomach and into the small intestine. Their absorption is dependent upon blood flow to these organs, the state of the drug (i.e., liquid or solid), and the contents of the gastrointestinal tract. Drug degradation may occur secondary to digestive enzyme activity, consequently limiting the dosage reaching the central circulation. Additionally, the practitioner should consider the level of the patient's anxiety; high levels of anxiety can delay gastric emptying time, delaying onset of action.

Oral administration may precipitate emesis in some patients, especially if the agent is foul tasting and/or smelling. This increases the risk of aspiration and should always be considered when preparing the patient and resuscitation equipment. Additionally, many drugs administered orally go through what is termed "first-pass effect." Once in the vascular space, drugs that are absorbed from the stomach and/or small intestine first pass through the hepatic circulation, where hepatic metabolism occurs. Hence, the amount of the drug undergoing first-pass effect that reaches the central circulation is lower than the actual dose administered by the oral route. Many drugs exhibit this first-pass metabolism; therefore, drug dosing for the oral route is frequently larger on a milligram per kilogram basis.

Sublingual administration is a convenient and easy method of drug delivery. With the advent of oral transmucosal fentanyl, sublingual administration is becoming more commonly used in the pediatric population. The advantage of this route is that no first-pass effect occurs; the blood supply from the oral cavity drains directly into the superior vena cava. The disadvantages are that sublingual absorption requires highly lipid-soluble drugs and patient cooperation. If a patient chews a medication that is to be administered via oral mucosa (e.g., a lozenge), absorption is compromised and total drug dosing is difficult, if not impossible, to calculate.

Another route that is becoming more frequently used is intranasal administration. Some medications can be mixed in normal saline and instilled into the nasal passage. This method is most frequently used when administering midazolam to pediatric patients. The patient rapidly achieves maximum effect, and the length of action is short. The disadvantages include the limit on the volume of medication that is tolerated by this route and the risk of the patient swallowing the medication, thus converting absorption to the oral route. Additionally, the patient may sneeze with this technique, and the volume of medication received is imprecise.

Rectal administration is used in a number of situations. Many adult patients find this route distasteful; however, it is used frequently with the pediatric population. It is also a useful route for patients experiencing significant nausea and vomiting. Drug absorption through the rectal wall is somewhat dependent on where the drug is actually deposited. If the drug is deposited into the proximal rectum, first-pass effect may occur. If the drug is deposited into the distal rectum, the drug will bypass hepatic circulation, thus avoiding the first-pass effect [59]. It is difficult to assess the patient's rectal anatomy to ensure proper placement of the drug. Furthermore, if the drug is irritating to the lining of the rectum, the patient may expel the drug prior to its absorption, hindering drug dosing.

As noted, rectal administration is used most commonly in the pediatric setting. This route provides practitioners with the ability to initially sedate a scared and/or combative child prior to insertion of an IV line.

Administering medications via the intramuscular route is often rejected by patients, if given the choice. Intramuscular injections can cause pain and irritation of the tissues. Intramuscular absorption is dependent on blood flow to the muscle, and the onset of sedation can be quite rapid if blood flow is adequate. However, if blood flow is compromised, onset is slow and length of action may be prolonged as the drug stays sequestered in the

muscle and is slowly released. Despite these disadvantages, certain medications, such as ketamine, are being administered more frequently by this route. One complication of intravenous ketamine use is emergence excitement, the incidence of which is greatly reduced with intramuscular or oral administration [60]. Emergence reactions also may be reduced by pretreatment with a benzodiazepine, use of ketamine at the lower end of the dosing range, and minimizing verbal and tactile stimulation of the patient during the recovery period [61].

Inhalation administration is currently limited to the use of nitrous oxide due to the fact that sedation drugs are not prepared in an appropriate form. The inhalation route is easily used, the drugs are rapidly absorbed, and the effects are rapid in onset. Improper use of the inhaler limits the ability to regulate drug dosage, but with minimal teaching, many patients, including children as young as 3 years of age, can be instructed on proper inhaler use. Even children younger than 3 years of age can receive medications by this route, with assistance of the care provider and the use of a spacer device.

Transdermal and subcutaneous administration is generally reserved for sedation and pain management in settings other than moderate sedation. Fentanyl is available for administration in a patch; however, the drug release is slow and the amount of medication is inadequate to achieve the level of sedation desired in moderate sedation settings. Transdermal absorption is dependent on the use of drugs that are lipid soluble, and the dose depends on how much medicine is exposed to the surface skin. Thus, this route is generally not used in the moderate sedation setting.

Finally, moderate sedation may be administered by the IV route. There are a number of controversies surrounding IV and transmucosal routes, and these are addressed in detail later in this course. It is important to remember that intravenous absorption and response is dependent, in part, on circulation times. Intravenous drugs achieve a rapid plasma level and do not undergo first-pass effect. However, the incidence of complications is greater, and these complications can occur immediately after IV administration. Intravenous administration requires careful monitoring to prevent untoward patient responses. The drugs can be delivered in large volumes and, if given by continuous infusion, provide continuous therapeutic drug plasma levels. All the drugs used for sedation are available in the intravenous form and administered by this route in very large numbers.

ADMINISTRATION OF INTRAVENOUS MEDICATIONS

Methods of administration of IV medications include single-dose injection, bolus technique, continuous infusion technique, and drug combination therapy. Each method has distinct advantages and disadvantages, and certain drugs can only be administered by one technique.

Single-dose injection is also known as "titration to effect." The patient is given frequent, small doses of the medication, and the effects are monitored prior to further drug administration. This method requires that the practitioner monitor the patient's vital signs and level of sedation after each drug dose and titrate subsequent doses based upon these responses. Single-dose injection provides for better control of the amount of drug delivered, although repeated doses may prolong the patient's recovery time. Additionally, this route requires more nursing time in order to prepare the drug, administer the drug, and monitor the effects. Yet, it is one of the safest methods for drug delivery. The risk of oversedation or undersedation is minimal.

The bolus technique is the administration of the entire dose, or a large percentage of the drug, all at once, causing a rapid onset of action and allowing the drug to reach a therapeutic level very quickly. Deep, rapid sedation is more common, and the risk of respiratory depression increases. The major disadvantage of this method is that the length of action of the drug may be shorter than the procedural time, causing the patient to be inadequately

sedated toward the end of the procedure. Another predicament that may develop with the bolus technique is a rapid onset of complications. This is most often seen with the rapid administration of high doses of fentanyl. Chest wall rigidity develops in these patients, rendering the patient unable to breathe. Efforts to support ventilations are difficult, if not impossible, and the patient must be administered a neuromuscular blocking agent, such as succinylcholine. The patient is then paralyzed for a short period of time, and ventilatory assistance must continue until the return of ventilatory function. In addition, naloxone should be administered to reverse the effects of the narcotics. This complication can be completely avoided with proper drug dosing and drug delivery techniques.

Continuous infusions are advantageous in that they provide a constant plasma level of the drug. Recovery time is often shorter, and the individual begins to awaken as soon as the drug is discontinued. Propofol is administered by this route, as its extremely short length of action makes other methods and routes impractical. This technique does require constant vigilance of the infusion to ensure adequate drug dosing and prevent accidental overdose.

Finally, combination drug therapy may be used. Most commonly, opiates and benzodiazepines are combined to achieve an appropriate level of sedation and pain control. As to be discussed next, benzodiazepines do not provide analgesia, and for any procedure that is painful, another agent should be used. A possible disadvantage of drug combinations is the synergistic, cumulative effects of drugs, producing the risk of profound, deep sedation. The likelihood of side effects increases, and the risk of cross reactions exists. However, with drug combination therapy, the goals and objectives of moderate sedation can be achieved with proper drug dosing.

DRUG CLASSES AND MEDICATIONS

The medications used for moderate sedation provide a number of different actions. Medication choice should be made with consideration of a number of factors, including the actions of the drugs, their relative length of action, and the bioavailability of each drug. The two most common medications administered for moderate sedation are midazolam and fentanyl. These drugs, as well as many others, are included in the following discussion. The reader is referred to ***Table 9*** for drug dosing.

BENZODIAZEPINES

Benzodiazepines are a class of drugs that is very familiar to most nurses. These drugs are used on a daily basis and have actions that are predictable and meet patients' needs. The benzodiazepines to be included in this discussion include midazolam, diazepam, and lorazepam. Other benzodiazepines used less frequently include triazolam, chlordiazepoxide, and alprazolam.

Benzodiazepines facilitate the inhibitory action of gamma-aminobutyric acid (GABA) in the brain, thus reducing excitatory impulses. The drugs are lipid soluble; however, midazolam is available in a water-soluble suspension. The water-soluble suspension reduces the pain on injection that is experienced with diazepam, which is commonly administered in a propylene glycol suspension. Benzodiazepines are classified by their half-lives as short-acting (e.g., midazolam), intermediate-acting (e.g., lorazepam), or long-acting (e.g., diazepam) [66; 67].

Benzodiazepines are frequently used in moderate sedation due to their excellent amnesic properties, including antegrade amnesia. The patient's level of anxiety is reduced secondary to the anxiolytic action. Additionally, the patient may achieve some skeletal muscle relaxation [66; 68].

PHARMACOLOGY OF MODERATE SEDATION MEDICATIONS							
Agent	**Onset**	**Peak**	**Duration**	**Antagonist**	**Half-Life**	**Usual Dose[a]**	**Notes**
Benzodiazepines							
Midazolam (Versed)	IV: 3–5 mins IM: 5–15 mins Intranasal: <5 mins PO: 10–20 mins	IV: 3–5 mins IM: 30–60 mins Intranasal: 10 mins PO: 2–6 hrs	IV: <2 hrs IM: 1–6 hrs	Flumazenil	1–4 hrs	0.5–2 mg over 2 mins, Max 5 mg (Do NOT exceed 2.5 mg as initial dose or 1.5 mg initially in elderly) *Pediatric dose[b]:* *IV/PO: 0.25–0.5 mg/kg* *IM: 0.1–0.15 mg/kg* *Nasal: 0.2–0.4 mg/kg (not an approved route)*	Give slowly. MR every 5 mins w/ 0.5 mg; can be given by infusion. Adolescent/ pediatric patients may exhibit paradoxic excitement. Decrease dose by 30% (50% in the elderly) if patient is taking other narcotics or CNS depressants.
Diazepam (Valium)	IV: 1–5 mins PO: 15–60 mins	IV: 1 min	IV: 2–4 hrs	Flumazenil	20–50 hrs	2–10 mg, Max 20 mg *Pediatric dose:* *IV: 0.2–0.3 mg/kg/dose* *PO: 0.2–0.3 mg/kg/day (Max 10 mg)*	MR at 5–10 min intervals w/ 1 mg. Increased half-life in neonates, elderly.
Lorazepam (Ativan)	IV: 2–3 mins IM: 20–30 mins	Up to 2 hrs	6–8 hrs	Flumazenil	10–20 hrs	0.05 mg/kg, Max 2 mg IV, 4 mg IM *Pediatric dose:* *0.02–0.09 mg/kg*	MR at 5–10 min intervals for prolonged sedation, used in critical care setting.
Opioids (Narcotics)							
Fentanyl (Sublimaze)	IV: 1–3 mins IM: 7–8 mins TM: 5–15 mins	IV: 5–15 mins IM: 15–20 mins TM: 15–30 mins	IV: 30–60 mins IM: 1–2 hrs TM: 12 hrs	Naloxone	2–4 hrs (longer with TM route)	25–100 mcg IV *Pediatric dose: IV/IM: 0.5–2 mcg/kg/dose TM: 5–20 mcg/kg*	MR 25 mcg every 5 mins. Give slowly to prevent chest wall rigidity. Apnea may occur.
Morphine	IV: 5–10 mins IM: 10–30 mins PO: 20–40 mins	IV: 10–20 mins IM: 30–60 mins PO: 1–2 hrs	IV: 1–4 hrs IM: 4–5 hrs PO: 4–24 hrs	Naloxone	2–4 hrs	2.5–10 mg IV slowly *Pediatric dose:* *IV: 0.05–0.1 mg/kg* *IM: 0.15–0.3 mg/kg*	MR 2–5 mg every 5 mins. Give slowly. Assess patient's pain level, hypotension, nausea and vomiting.
Meperidine (Demerol)	IV: 2–5 mins IM: 10–15 mins PO: 10–15 mins	IV: 5–7 mins IM: 35–60 mins PO: 1 hr	2–4 hrs	Naloxone	2.5–4 hrs	25–50 mg IV over 2 mins, Max 150 mg *Pediatric dose:* *1–2 mg/kg/dose*	MR 10–15 mg every 5–10 mins. Use with caution in patients with liver disorders; avoid use in patients with renal impairment. Do not use in patients taking MAO inhibitors.
Remifentanil (Ultiva)	IV: 1–3 mins	3–5 mins	Dose dependent, 5–15 mins after discontinuing drug	Naloxone	10–20 mins	1 mcg/kg IV bolus followed by an infusion of 0.1 mcg/kg/min titrated for effect	Assess patient's pain after procedure secondary to short length of action.

Table 9 continues on next page.

PHARMACOLOGY OF MODERATE SEDATION MEDICATIONS *(Continued)*							
Agent	**Onset**	**Peak**	**Duration**	**Antagonist**	**Half-Life**	**Usual Dose[a]**	**Notes**
Sedative Hypnotics							
Propofol (Diprivan)	IV: 30–60 secs	1 min	4–8 mins	None	4–7 hrs	Initial: 1 mg/kg Maintenance: 150–200 mcg/kg/min *Pediatric dose:* *Initial: 1–2 mg/kg* *Maintenance: 125–300 mcg/kg/min*	May cause hypotension, bradycardia, or respiratory depression.
Etomidate (Amidate)	30–60 secs	1 min	3–5 mins	None	2–3 hrs	Initial: 0.1 mg/kg over 30–60 secs Maintenance: 5–20 mcg/kg/min	Solution may cause pain on injections. Preadministration of lidocaine may be considered.
Chloral hydrate	30–60 mins	30–60 mins	4–8 hrs	None	8–11 hrs (longer in neonates)	500–1000 mg, Max 2 g/day. *Pediatric dose:* *50–75 mg/kg/dose*	Induces sleep 1–4 hrs. Monitor airway, O_2 saturations. Sedation failure increases with age. Best used in children younger than 3 years of age.
Dissociatives							
Ketamine (Ketalar)	IV: 30–60 secs IM: 3–4 mins	IV: 1 min IM/Rectal: 12–25 mins PO: 30 mins Intranasal: 10–14 mins	IV: 5–10 mins IM: 12–25 mins Intranasal: Up to 60 mins	None	10–15 mins	IV: 0.5–1 mg/kg IM/Rectal: 2–5 mg/kg PO: 4–6 mg/kg *Pediatric dose:* *IV: 1–2 mg/kg/dose* *IM: 4–5 mg/kg/dose*	May cause emergence reactions, including vivid dreams, hallucinations, or delirium.
Barbiturates							
Methohexital (Brevital)	IV: 30 sec Rectal: 5–15 mins	IV: 45 sec Rectal: 5–10 mins	IV: 5–15 mins Rectal: 45–60 mins	None	1–4 hrs	*Pediatric dose:* *IM: 0.5–1mg/kg of a 5% solution* *Rectal: 25 mg/kg of a 1% solution*	May cause paradoxical excitement in children and elderly.
Thiopental (Pentothal)	IV: 30–60 sec	IV: 30–40 sec	IV: 5–30 mins	None	3–11.5 hrs	Initial: 3–5 mg/kg Maintenance: 25–100 mg/kg as needed *Pediatric dose:* *Initial: 5–6 mg/kg* *Maintenance: 1 mg/kg as needed*	Tissue necrosis with extravasation. Repeated dosing may cause cumulative effects.
Pentobarbital (Nembutal)	IV: 1 min IM: 10–15 mins	IV, IM: 10–15 mins	IV: variable	None	15–50 hrs	IM: 150–200 mg *Pediatric dose:* *IV: 2 mg/kg*	IV no faster than 50 mg/min. Allow time between IV doses for effect. Monitor for prolonged recovery.

Table 9 continues on next page.

PHARMACOLOGY OF MODERATE SEDATION MEDICATIONS *(Continued)*							
Agent	**Onset**	**Peak**	**Duration**	**Antagonist**	**Half-Life**	**Usual Dose[a]**	**Notes**
Antagonists							
Naloxone (Narcan)	IV: 1–2 mins IM: 2–5 mins	15–30 mins	30–120 mins	N/A	60–90 mins (3–4 hrs neonates)	0.4–2 mg IV May titrate for reversal (add 0.4 mg in 10 mL syringe: give 1 mL=0.04 mg) *Pediatric dose: 0.1–2 mg/kg*	MR every 1 min to max of 10 mg. Observe for resedation. May not reverse cardiovascular effects. May cause noncardiogenic pulmonary edema.
Flumazenil (Romazicon)	1–3 mins	6–10 mins	1 hr	N/A	40–80 mins	0.2 mg IV over 15 sec, Max 3 mg/hr. MR every 1 min to max 1 mg. *Pediatric dose: 0.01 mg/kg over 15 sec, MR every 1 min to max 2 mg.*	Observe for resedation. Use with caution in patients with a history of benzodiazepine abuse or seizures.
Nalmefene (Revex)	IV: 1 min IM: 5–15 mins	IV: 2 mins IM: 1.5 hrs	1–10 hrs (dose dependent)	N/A	12.5 hrs	0.25 mcg/kg, MR every 2–5 mins. Dose >1 mcg/kg has no added benefit.	Give over 60 seconds to patients with renal failure.

[a]Usual dose is a safe dose to begin sedation. Higher doses are frequently administered. The practitioner must be aware that the higher the dose, the greater the risk of complications.
[b]The pediatric dose is for children >6 months of age.
MR = may repeat, TM = transmucosal.

Source: [6; 61; 62; 63; 64; 65] *Table 9*

The major effect of these drugs is on the respiratory system of the patient. The patient may develop a depressed ventilatory response to increasing carbon dioxide levels with subsequent falling levels of arterial oxygenation. Each 0.1 mg/kg of midazolam is said to reduce the body's response to rising carbon dioxide levels by 50%. In addition, there is a rise in pulmonary airway resistance. As the patient's level of consciousness decreases, the risk of respiratory insufficiency increases greatly [68; 69].

Because the patient's compensatory responses are blunted, carbon dioxide levels will continue to rise and oxygen levels will continue to fall unless additional therapeutic measures are undertaken. It is imperative that the nurse administering these drugs is aware of this risk and continuously monitors the patient's respiratory effort and oxygen saturations. With the development of easy-to-use end tidal CO_2 meters, the practitioner is better prepared to monitor for this developing complication.

Benzodiazepines produce a slight decrease in cardiovascular function. The patient may experience a decrease in peripheral vascular resistance and a subsequent drop in blood pressure and cardiac output. Patients with low cardiac output require slower loading times for benzodiazepines to reduce the risk of profound respiratory and cardiovascular depression [70].

The central nervous system effects include a reduction in cerebral blood flow, a decrease in cerebral oxygen consumption, and an elevation in the seizure threshold. The hypnosis provided by this class of drugs helps achieve the relaxation and amnesia for which these drugs are known.

The benzodiazepines should be used with caution in patients with [70]:

- A history of chronic obstructive pulmonary disease or sleep apnea

- Known cardiovascular depression
- Drug and/or alcohol intoxication
- Liver and/or renal disease
- Difficult airways

Furthermore, precautions should be taken for the very young, elderly, and pregnant or lactating patient. Patients on heparin may experience prolonged bleeding times with midazolam use [71]. Certain medications, including metoprolol, propranolol, and digitalis, will have an increased effect of action. Thus, the patient with a slow heart rate secondary to the negative chronotropic effects of digitalis should be closely monitored for the development of symptomatic bradycardia while receiving any of the benzodiazepines.

All the benzodiazepines used in moderate sedation are 97% to 98% protein bound [61]. This is an important consideration in many elderly patients with decreased protein stores. The less body proteins available, the more free-circulating drug exists. Thus, the effects of action are potentiated. It is recommended that long-acting benzodiazepines not be used in elderly patients due to the increased risk for drug metabolite accumulation resulting in excessive sedation, cognitive impairment, and falls [70; 72]. If possible, benzodiazepines should be avoided altogether for this population.

Benzodiazepines have the advantage of being reversible with flumazenil. However, this antagonist should be administered intravenously, which limits its use in patients sedated with benzodiazepines by transmucosal routes. (Further information on flumazenil can be found in the Antagonists section).

Midazolam

Midazolam is a drug that is easily administered by a number of routes (i.e., intramuscularly, orally, rectally, intranasally) [73]. Intravenous administration provides rapid onset of action (i.e., three to five minutes), with a duration of less than two hours. It is easily titrated and associated with less pain at the injection site [61; 73]. Intranasal midazolam has become popular as a method of achieving moderate sedation in the pediatric population, although this is an off-label use [61; 73; 74]. This method may also be used to achieve initial sedation in a child prior to insertion of an IV line. Additionally, midazolam can be administered by continuous infusion. The loading dose is 0.05–0.2 mg/kg, followed by an infusion of 0.25–2 mcg/kg/minute [61].

Because midazolam can be expensive for sedation by continuous infusion, other benzodiazepines may be preferred to reduce the medication costs. One systematic review found no high-quality evidence supporting the use of midazolam over other medications for preprocedural sedation. The authors also found moderate-quality evidence suggesting that oral midazolam produces less effective sedation than chloral hydrate for children undergoing noninvasive diagnostic procedures [75].

Diazepam

Diazepam is the benzodiazepine to which all others are compared. Its long length of action (i.e., two to four hours) may preclude its use for short-term moderate sedation. However, it has the efficacy of a single-dose injection with good outcomes in many patients. Diazepam may be given intravenously, orally, and rectally. Intramuscular injection is quite painful, and this route is avoided. The half-life of diazepam is long, varying from 20 to 50 hours in healthy adults [61]. The elderly, neonates, and those with severe hepatic disorders are more at risk for prolongation of action, and the dosage administered should be reduced in these populations.

Lorazepam

Lorazepam is an intermediate-acting benzodiazepine with a length of action ranging from six to eight hours [61]. It is a popular drug for prolonged sedation and is frequently encountered in the intensive care environment.

OPIOIDS (NARCOTICS)

Opioids, also referred to as narcotics, bind with specific receptors in the central nervous system. These receptors include the mu, kappa, delta, and sigma subtypes. The actions of each receptor type varies; the mu, kappa, and delta receptors all provide some level of analgesia, while the sigma does not. Additionally, narcotics can produce sedation, and in higher doses, will produce a profound decrease in the patient's level of consciousness and a risk of respiratory arrest [76].

The cardiovascular system is significantly affected by this class of drugs. All narcotics, with the exception of meperidine, produce bradycardia. (Meperidine produces tachycardia secondary to its vagolytic effect.) Blood pressure is affected by this decrease in heart rate; the patient may experience a drop in his/her systemic pressure. Morphine and meperidine also induce the release of histamine, leading to a decrease in systemic vascular resistance [76].

The respiratory system is most affected by the narcotics that release histamine (i.e., morphine, meperidine). This histamine release can produce bronchoconstriction in the patient; thus, these drugs should be used with caution in the patient with a history of asthma. Additionally, opioids depress respiratory rate and volume. As with benzodiazepines, a similar, although not as profound, depressed response to rising carbon dioxide levels occurs. As the dose increases, the risk of respiratory depression and apnea increases [76].

Chest wall rigidity is an uncommon, but life-threatening, complication that can occur with the rapid intravenous administration of narcotics, especially fentanyl. The chest wall muscles become tight, and the patient is unable to be ventilated. To successfully resuscitate the patient, the administration of succinylcholine should be performed rapidly and the patient ventilated with a bag-valve-mask device until the respiratory drive returns. Additionally, naloxone should be administered to combat the effects of the narcotics and repeated if necessary. Obviously, with this development, the goals and objectives of moderate sedation are no longer being met and other actions should be undertaken if the procedure is to be continued [76].

Narcotics also impact the central nervous system by producing an increase in cerebral metabolic rate and blood flow. Intracranial pressure may rise, increasing the risk to the neurologically compromised patient. The vomiting center in the brain may be stimulated. Many patients complain of nausea after administration of these drugs, and some may begin to vomit.

Careful administration of narcotics should be considered in any neurologically compromised patient or any patient with a history of chronic obstructive pulmonary disease, asthma, cardiovascular depression, a difficult airway, or morbid obesity. Patients with symptomatic bradycardia should be placed on a cardiac monitor and continually monitored for the cardiovascular depressive effects of these medications [76].

Fentanyl

Fentanyl is a popular narcotic for moderate sedation due to its short length of action. The patient achieves the benefits of sedation and analgesia but is arousable within a short period of time. The drug can be administered intravenously, intramuscularly, and transmucosally. It is reversible with naloxone. The analgesic activity of 100 mcg of fentanyl is equivalent to approximately 10 mg of morphine [61].

Oral administration of fentanyl is available in lozenge, buccal film, buccal tablet, or sublingual tablet form. Fentanyl lozenges were first developed for use in pediatric oncology and have become a popular and desirable method for achieving moderate sedation in children [77]. The lozenge, film, and tablets all have a premeasured dose of fentanyl and are scored to allow administration of varying dosages. The child should be instructed to suck on the medication; if the child chews it, the medication absorption converts from sublingual absorption to gastric absorption and first-pass effect will limit the amount of drug available [61].

Morphine

Morphine is one of the least expensive and most popular of all the medications used for moderate sedation. Nurses and physicians are comfortable with the actions of morphine, the effects are well known, and untoward complications can be avoided with proper administration. The risk of hypotension is great with morphine secondary to the action of histamine upon the vascular system. Therefore, the patient should be continually assessed during administration for profound cardiovascular depression. With slow titration of the drug, these effects can be negligible.

Meperidine

Meperidine was previously used for its analgesic properties. However, the American Pain Society and Institute for Safe Medication Practices (ISMP) do not recommend the use of meperidine for its analgesic properties, unless the patient experiences acute pain. If the patient experiences acute pain, it is recommended that treatment with meperidine be limited and used with caution in patients with liver and renal disease [61].

Remifentanil

Remifentanil has a very short length of action that is dose dependent and varies from 3 to 10 minutes [61]. It is important to remember that the length of analgesic action is also short, and the patient should be assessed for adequate pain control after the normal length of action time has been surpassed [78].

Other Opioids

There are several other opioids that may be used to induce moderate sedation. For example, hydromorphone has been found to be safe and effective, with a low risk of adverse effects, such as excessive sedation or respiratory depression [79]. The opioids are popular drugs for a number of reasons, as many practitioners feel comfortable with administering these drugs, and their actions are well defined and predictable. The analgesic properties are the best of any of the drugs used in sedation, and whenever a painful procedure is initiated, these drugs should be at the top of the consideration list.

BARBITURATES

Barbiturates have been available for a number of years, and their actions are well known. Ultrashort-acting barbiturates are used in the moderate sedation setting and include methohexital. Thiopental and thiamylal are no longer available in the United States [80]. Pentobarbital, a short-acting barbiturate, is used in young children undergoing radiologic procedures. These drugs are highly lipid soluble and can become rapidly sequestered in fatty tissues. Repeated doses can lead to accumulation of the drug and subsequent prolongation of the length of action.

The actions of the barbiturates include sedation, hypnosis, and anticonvulsant properties. There is no analgesia achieved with these medications; therefore, their use is limited to interventions that are not painful [61].

One of the most profound effects of barbiturates is the precipitous drop in systemic vascular resistance upon intravenous administration. This decreased resistance leads to a significant drop in blood pressure, compensatory tachycardia, and decreased venous return. The patient with a sensitive cardiovascular system or hypovolemia should be closely monitored during drug administration [61].

Respiratory effects include the development of a decreased ventilatory response to falling oxygen and rising carbon dioxide levels, as seen with the benzodiazepines. If the drugs are administered rapidly intravenously, there is a moment of apparent apnea in many patients [61]. This will often be followed by a large gasping respiration, and then the patient begins to breathe normally and comfortably on his/her own. However, there is a moment when the nurse administering these drugs feels uncomfortable with the ominous feeling of having significantly oversedated the patient. Fortunately, this apparent cessation of breathing is short lived, and by the time the nurse is beginning to act, the patient is breathing again. Regardless, it is one of the scariest moments in the moderate sedation setting.

Methohexital can produce bronchospasms in many patients, especially those with a history of asthma or reactive airway disease [61]. Pentobarbital is most commonly used in the radiology setting when a motionless patient (most commonly a child) is necessary to achieve a good study. Administration of this drug requires vigilant assessment, as airway compromise is a common consequence [61].

Central nervous system effects include a decrease in the cerebral metabolic rate, a decrease in cerebral blood flow, and a subsequent drop in intracranial pressure. In low doses, the barbiturates may cause disorientation or excitement, and the patient should be monitored for these effects [61]. Safety measures should be instituted to protect the patient from harm.

The practitioner should be careful in administering these drugs to patients with [61]:

- Hepatic dysfunction
- Cardiovascular depression
- Hypovolemia
- Seizure disorders
- Chronic obstructive pulmonary disease
- Difficult airways
- Alcohol intoxication
- History of sleep apnea
- Morbid obesity

The use of barbiturates is common in many situations. A barbiturate may be administered as a single-dose injection for a short-term procedure, such as cardioversion. The patient is sedated, cardioverted, and arouses within minutes. In many cases, the patient will be completely unaware that the procedure has been completed upon arousal.

Barbiturates can also be useful in combination drug therapy. A dose of 10–20 mg of methohexital may be added to benzodiazepine administration to achieve further sedation. Care should be used in this setting, as the cumulative sedative effects can be compromising to the patient, producing deep sedation [61].

Another concern with the barbiturates is the significant tissue damage that occurs if the drug extravasates into the local tissues. The pH of this class of drug is very high, leading to profound tissue necrosis at the extravasation site [61]. In this event, the affected area should be immediately infiltrated with 5–10 mg of phentolamine, diluted in 10 mL of normal saline [61]. It is imperative that if barbiturates are being used in a facility, one or two vials of phentolamine are available for this untoward complication.

Finally, it is important to remember that there is no antagonist available for the barbiturates. Any complications that develop should be managed with supportive therapies until the sedative effects are cleared.

OTHER SEDATIVE HYPNOTICS

Sedative hypnotics as a class encompass many agents, the most common being barbiturates and benzodiazepines. An additional two medications, propofol and etomidate, are also used in moderate sedation. These ultra-short-acting agents provide no analgesic effects, and pain management requires concomitant use of analgesic agents [61].

Propofol is a sedative hypnotic that is being used more frequently in the moderate sedation setting. It produces a cortical depression of very short action; the patient awakens very rapidly upon discontinuation of its administration. The drug also has an antiemetic effect, although there are no analgesic properties [61]. Propofol produces negative inotropic effects on the cardiovascular system, leading to a significant drop in the patient's blood pressure after administration. This hypotension is associated with a decrease in cardiac output and arrhythmia development [61]. The therapeutic index of propofol is narrow and the risk for deep sedation is high. Therefore, the ASA recommends that patients who receive propofol (by any route) should receive care that is consistent with that required for deep sedation. Additionally, clinicians who administer propofol should be qualified to rescue patients from any level of sedation, including general anesthesia [81]. Propofol has no antagonist [61].

EVIDENCE-BASED PRACTICE RECOMMENDATION

According to the American College of Emergency Physicians, propofol can be safely administered to children and adults for procedural sedation and analgesia in the ED.

(https://www.guideline.gov/summaries/summary/47772. Last accessed June 22, 2017.)

Strength of Recommendation: A (Generally accepted principle for patient care that reflect a high degree of clinical certainty)

Respiratory system effects include a dose-dependent respiratory depression, progressing to apnea in higher doses [61]. The patient may experience hiccoughs, wheezing, and coughing [61]. While these effects are not life-threatening, they may be very uncomfortable for the patient.

The patient receiving propofol may complain of a headache or appear confused and/or euphoric. There are a small number of reports from patients describing very sexually explicit dreams while sedated with propofol [82]. Some patients may verbalize these sexual fantasies, and many practitioners who have administered this drug can relate tales of patient's fantasies.

The peak effect of propofol can be achieved within one minute and lasts four to eight minutes; thus, the drug is administered by continuous infusion [61]. It is important to remember that special handling of the drug is required to prevent the risk of multi-system sepsis. Propofol is available as an oil-in-water emulsion that contains egg lecithin, glycerol, soybean oil, and very small amounts of preservative. It is recommended that the drug be used and completed within 6 hours if transferred to a syringe or other container prior to administration, and 12 hours if used directly from a vial or prefilled syringe. When preparing the drug, strict aseptic technique should be used [61]. The vial top should be disinfected with 70% alcohol, a sterile vent spike should be used to withdraw the drug, and the medication should be drawn up into a sterile syringe. Once drug administration is completed, the IV solution and IV tubing should be discarded and replaced with new solutions. If the drug is used for continuous sedation (e.g., as used in an ICU), it is recommended that the IV line and solution be changed every 12 hours [61]. Any patient who receives prolonged sedation with propofol should be monitored for developing signs of infection [61].

It should be noted that in 2010 the manufacturer of propofol, Hospira, announced a voluntary recall of the drug to all healthcare professionals [83]. This recall was related to concerns of particulate matter (i.e., subvisible inert stainless steel particles) that would not dissolve in the patient's blood, potentially blocking blood flow. The recall affected propofol that was distributed both in and outside the United States between March 2008 and April 2010. Healthcare professionals were urged to immediately discontinue use of the drug and monitor patients who may have received it [83].

Propofol has also been associated with several iatrogenic infections [84]. Researchers identified 20 propofol-related outbreaks that occurred during 1989–2014. The outbreaks affected 144 patients and resulted in 10 deaths. Contributing factors included reuse of syringes for multiple patients and prolonged exposure to the environment when vials were left open. Some countries have begun adding antimicrobial drugs to the emulsion to prevent further outbreaks, but no comprehensive information exists on the effectiveness of these measures [84; 85].

Etomidate is another ultra-short-acting sedative hypnotic used to induce moderate sedation. Intravenous etomidate has a very rapid onset of action, with peak effect reached within one minute [61]. The sedating effect lasts 5 to 15 minutes. Although this rapid onset and duration of action is similar to propofol, administration of etomidate via continuous infusion has been associated with increased morbidity and mortality as a result of its adrenal suppression [61; 86]. This effect on adrenal function is dose dependent and cumulative. Therefore, etomidate is only recommended for short-term sedation, and the patient should be monitored for adverse effects [61].

Etomidate has been found to have a relative lack of significant hemodynamic and respiratory effects, making it an appropriate drug for use in patients with unstable heart disease, difficult airways, or asthma [61; 87]. Etomidate has been associated with an increased risk for myoclonus and nausea and vomiting upon emergence from sedation [61; 88]. Pretreatment with midazolam has been shown to effectively prevent and lessen the degree of etomidate-induced myoclonus [85].

Etomidate's rapid onset and duration and favorable side effect profile make it especially desirable for procedural sedation in emergency situations, particularly for cardioversion, intubation, dislocation or fraction reduction, and abscess incision and drainage [61; 88; 89]. When compared to propofol in a randomized trial, etomidate showed comparable safety but a lower rate of procedural success and a very high rate of induced myoclonus in 20% of patients [90]. Intravenous etomidate administered after fentanyl has been shown to be effective for short-duration, painful emergency department procedures in children [35].

Another consideration of administration is that both propofol and etomidate are painful on injection. This can be combated by administering lidocaine. Lidocaine administration can precede the propofol or etomidate (the patient is administered 0.5 mg/kg IV) or lidocaine can be added to the IV solution [61].

Propofol and etomidate have no antagonists. However, the advantage of their use is their short length of action. Should a patient develop complications, these are generally short lived due to the rapid metabolism. Regardless, during this time period the patient should be supported with appropriate therapeutic interventions.

DISSOCIATIVE AGENTS

Ketamine is an agent that "dissociates" the thalamus from the limbic system [61]. The drug produces a cataleptic state, and onset of sedation is noted when nystagmus and an open-eye gaze develops. During administration of ketamine, the individual remains responsive but not always appropriately so. The drug provides both analgesia and amnesia [61]. Other than the narcotics mentioned earlier, this is one of the few drugs used for moderate sedation that provides for pain control. Another action that may be undesirable in some patient populations is the skeletal muscle movement that can occur. A patient who is required to lie completely still, like those undergoing MRI, should in most cases not receive ketamine for sedation.

Unlike other sedatives, ketamine produces a stimulation of the sympathetic nervous system, resulting in excitation of the cardiac system. This leads to an increased heart rate, cardiac output, and blood pressure. Myocardial oxygen consumption increases; therefore, patients with a history of coronary artery disease, hypertension, or congestive heart failure are not considered good candidates for its use [61].

The benefit of this drug is on the respiratory system, as it produces bronchodilation and has a minimal effect on the patient's respiratory drive. Therefore, this may be the sedative of choice (assuming there are no other contraindications) for the asthmatic patient [61]. Ketamine is commonly used for procedural sedation and analgesia in children. One systematic review of seven studies evaluated the use of intranasal ketamine in 264 children 0 to 14 years of age [91]. In four of the seven studies, intranasal ketamine provided superior sedation to comparators and resulted in adequate sedation for 85% of the participants. Vomiting was the most common adverse effect (occurring in 10% of patients) [91]. Saliva and mucus production are increased, especially in the pediatric patient. These effects are usually tolerable in the adult, but the child may require the administration of an antisialagogue or an anticholinergic agent to help dry these secretions [61]. Prophylactic anticholinergics were once recommended for adults to reduce the risk of airway-related adverse events (by preventing oral secretions), but studies showed no benefit to this prophylaxis [64].

Cerebral vasodilation occurs with ketamine use, leading to an increase in cerebral blood flow, an increase in intracranial pressure, and an increase in cerebral oxygen consumption. Therefore, ketamine use in the patient with a history of intracranial pathologies should be avoided [61].

An additional central nervous system effect is the development of emergence delirium in the patient awakening from ketamine sedation. This complication occurs in approximately 10% to 30% of adults who receive ketamine [64]. These reactions range from vivid dreams to hallucinations and delirium [64]. Because of the risk for emergence reactions, ketamine is not usually used alone in adults [92]. The concomitant use of midazolam may help reduce this risk [61; 64]. Benzodiazepines were once recommended to combat emergence reactions in children, but reactions in this population are rare and prophylaxis is no longer recommended [93].

In the emergency department setting, intravenous administration of ketamine is preferred for adults because of the ease of repeated doses and reduced risk for vomiting [93]. In the event of an inadvertent overdose, no antagonist exists and the effects cannot be reversed [94].

ANTAGONISTS

Antagonists, also known as reversal agents, act on the receptors in the central nervous system to reverse the pharmacologic effects of the medications administered. They have no other pharmacologic properties. Generally, their length of action is short, usually shorter than the length of action of the drug being reversed. Thus, administration requires repeat dosing.

Opioids and benzodiazepines both have antagonists available to reverse their actions. Naloxone is the opioid antagonist, and flumazenil is the benzodiazepine antagonist [61].

The advantage of the antagonists is that they can be administered in small doses, with a goal of reversing deep sedation and respiratory depression. By administering the drugs in this manner, the patient's respiratory drive increases but the effects of the sedative are not completely reversed. In other words, the intervention can proceed and the patient can remain, by definition, moderately sedated. This is more easily achieved with naloxone. Titrating small increments of the drug can be easily accomplished by adding the naloxone to a syringe and giving 1 or 2 mL as needed. (See ***Table 9*** for more specific preparation.)

To reverse sedation, flumazenil is administered in 0.2 mg increments, repeating the dose (maximum four doses) at one-minute intervals to a maximum of 1 mg [61]. Eighty percent of the response will be achieved within the first three minutes after administration [61]. If the patient remains in a deep sedated state, additional drug may be necessary [61]. After administration of flumazenil, the patient may complain of flushing, headache, and fatigue. A transient hypertensive episode may be evident [61].

Although these agents are said to have no pharmacologic effect, there is a risk associated with rapid administration, especially with higher doses. Naloxone given rapidly can produce a noncardiogenic pulmonary edema, evidenced by increasing shortness of breath, rales and rhonchi on chest auscultation, and decreasing blood oxygen levels [61]. In acute cases, ventilatory support will be required.

Flumazenil can precipitate seizure activity in the patient with a history of benzodiazepine use or abuse. Many patients under-report their drug use and may falsify their benzodiazepine intake. If flumazenil is administered to these patients, it may produce seizure activity. When administering flumazenil, seizure precautions should be considered [61].

Although the use of antagonists in moderate sedation is a debatable issue, the ASA recommends that, whenever possible, antagonists should be on hand during the use of moderate sedation [45]. Some physicians will order naloxone or flumazenil at the end of the procedure in an effort to rapidly reverse the effects of sedation. In some instances, this is warranted to allow for further evaluation of the patient's neurologic status. On the other hand, reversal for the sake of reversal is not considered by many to be acceptable. Reversal of narcotics will reverse the analgesic effects, and if reversal is abrupt, the patient is not allowed time to slowly reorient to his/her surroundings. In addition, reversal agents are not without complication (as noted previously); the risks of reversal should be considered.

As reversal has a number of detrimental effects, many institutions and practitioners now utilize antagonists as rescue medications. The antagonist is administered in small doses to "rescue" the patient from an unintended deep level of sedation. This allows the patient to return to the moderately sedated level and allows for procedure completion.

Many practitioners think that it is safer for the patient to arouse slowly and comfortably at the end of the procedure. If a drug with a length of action equal to the length of the procedure was chosen and used, arousal should not take long. Patients will appreciate the care they receive and be satisfied with the results. Additionally, many institutions have the requirement that if a patient receives a reversal agent, that patient should be monitored for two hours prior to discharge. Therefore, the patient who is not reversed can be discharged earlier, when he/she is capable of meeting the appropriately assigned discharge criteria.

The ASA guidelines note that other steps should be taken before or concomitantly with pharmacologic reversal in patients who become hypoxemic or apneic during sedation, including [45]:

- Encouragement or stimulation of deep breathing
- Supplemental oxygen
- Positive pressure ventilation if spontaneous ventilation is inadequate

The ASA also recommends that patients be closely monitored after pharmacologic reversal to ensure that sedation and cardiorespiratory depression do not recur [45].

Knowledge of the drug therapy used in moderate sedation is imperative to delivering safe patient care. Until the advent of the ideal agent, nurses should be aware of the uses, contraindications, and considerations of the moderate sedation medications in their facility's formulary.

PATIENT MONITORING DURING MODERATE SEDATION

PULSE OXIMETRY

Pulse oximetry monitoring has become the standard for monitoring patients undergoing moderate sedation. The ability to assess oxygen desaturation greatly improves patient care and helps to ensure patient safety. The Joint Commission requires that all patients undergoing moderate sedation be continually monitored with pulse oximetry [1].

Pulse oximeters provide a noninvasive estimation of arterial oxyhemoglobin saturation [95]. A saturation of 90% is equivalent to an arterial oxygen blood gas value of 60 torr. During moderate sedation, many patients develop respiratory insufficiency secondary to sedating medications. If this respiratory compromise continues unchecked, significant tissue hypoxia will develop. The pulse oximeter allows the practitioner to monitor the hemoglobin saturation as a method of early detection of impending hypoxia [63]. Studies have shown that monitoring pulse oximetry greatly improves the practitioner's ability to assess changes in the early stages of hypoxia and initiate interventions to reverse developing complications. It has not been shown to affect the outcome of sedation or length of hospital stay [96; 97; 98].

An additional advantage of pulse oximetry is the rapid response time between changes in patient status and the reading on the monitor. Monitoring is noninvasive and does not require that the patient be cannulated for a blood gas sample. Furthermore, the advantage of being able to assess the patient who is draped or in a darkened room is clearly optimal to providing safe patient care. Pulse oximeters are said to be accurate within the range of 65% to 95% saturations, with only a 1% to 2% error. A number of patient variables (e.g., hemoglobin level, patient's oxygenation ability, percentage of inspired oxygen) may impact the accuracy of saturation values [99].

Pulse oximeter probes may be placed in a number of locations, including the fingers, toes, earlobes, nose, or forehead. Repetitive research studies have evaluated pulse oximetry monitoring and the results consistently demonstrated that the probes placed on the patient's earlobe are more accurate and have faster response times than probes placed elsewhere [100]. With this in mind, the practitioner should assess the earlobe site for use in probe placement. In certain procedures, as when the patient's head is draped, this location would not be considered appropriate. Proper positioning of the oximeter probe is essential to prevent production of artifactual data (e.g., underestimation or overestimation of oxygen saturation) [5].

Prior to application of the probe, it is critical to ensure that the site is prepared properly. Fingernail polish will prevent accurate measurements and should either be removed or the fingertip ruled out for probe placement [101]. The skin may be gently cleansed to remove accumulated dirt and body oils. The area of probe placement should be checked for proper circulation with good capillary refill. Patients with poor capillary refill secondary to peripheral vascular disease will be better monitored using the earlobes, nose, or forehead locations. After good venous circulation is assured, the probe may be placed. There are a number of types of probes, both permanent and disposable. The practitioner should be able to demonstrate competency in pulse oximetry monitoring prior to using this technique.

LIMITATIONS OF PULSE OXIMETRY
Significant hypotension
Anemia poisoning
Vasoconstrictive drug use
Carbon monoxide
Severe hypothermia
Methoglobinemia
Arterial compression
Intravascular dye use
Pulsating venous blood
Muscular contractions

Source: Compiled by Author *Table 10*

It is important to recheck the probe location for good capillary refill, both immediately after probe placement and intermittently during patient monitoring. The probe should not be placed on the same extremity in which blood pressure will be measured. When the cuff inflates, the blood flow to the extremity may be compromised, producing an inaccurate saturation reading.

Disadvantages of pulse oximetry include the fact that there is no information on the patient's ventilatory status, as measured by the partial pressure of carbon dioxide ($PaCO_2$). In cases when the oxygen saturation is below 65%, the monitor will overestimate the saturation, providing an inaccurate measurement. Pulse oximeters are also prone to motion artifact, which creates a high rate of false alarms. Newer models reduce motion sensitivity, which may result in an increased frequency of missed true alarms [102]. There are a number of situations in which pulse oximetry use is limited, and practitioners should be aware of these drawbacks (***Table 10***). However, the advantage of monitoring the patient in the moderate sedation setting is that these situations are rarely encountered. If a patient were to be severely hypothermic, for example, he or she would most likely not be considered a good candidate for moderate sedation in the first place. However, there is one consideration that is encountered relatively frequently, as there are a number of situations in the radiology setting in

which the patient receives intravascular dyes for various studies. Although the impact of intravascular dyes on pulse oximetry reading is generally considered to be short-lived, it is imperative that the practitioner caring for this patient recognize the possibility of inaccurate readings and use other methods of physical assessment to ensure adequate patient oxygenation [101; 103].

The anemic patient should always be evaluated for signs of hypoxia in addition to the oxygen saturation reading [104]. A patient with a hemoglobin of 8 that is 95% saturated will have a pulse oximetry reading of 95%. Another patient with a hemoglobin of 16 that is 95% saturated will also have a pulse oximetry reading of 95%. Monitoring these two patients will produce the same reading; however, the second patient has twice as much hemoglobin and therefore twice as much oxygen-carrying capacity. The first patient may exhibit signs of tissue hypoxia much more rapidly than the second patient, despite the same pulse oximeter readings.

The practitioner should also be aware that the oxygen-hemoglobin saturation is dependent on the oxyhemoglobin curve. In situations in which the oxyhemoglobin curve is shifted to the left (with an increase in pH, a decrease in body temperature, or a decrease in $PaCO_2$), the hemoglobin's affinity for oxygen increases. This translates to less oxygen available at the tissue level. Conversely, if the curve is shifted to the right (with a decrease in pH, increase in body temperature, or an increase in $PaCO_2$), the affinity for oxygen decreases, and more oxygen is readily available at the tissue level. This can be demonstrated in the following example: A patient with an alveolar oxygen partial pressure (PaO2) of 45 torr has a measured pH of 7.25. This patient's oxygen saturation reading would measure 80% [104]. If this same patient were given sodium bicarbonate (as an example) to elevate the pH to 7.4, but no interventions were undertaken to correct the PaO2 of 45, the oxygen saturation reading would increase to 88% by simply correcting the pH. A practitioner monitoring this patient would see the improved oxygen saturation and may be inappropriately comforted by this improvement. However, the patient's oxygen level did not change, meaning that the level of hypoxemia was unchanged.

Pulse oximetry has become the standard for monitoring patients undergoing moderate sedation, despite the aforementioned limitations. In the vast majority of patients receiving sedating agents, these limitations are not problematic. However, nurses should remember that even though this monitoring technology exists, physical assessment skills cannot be disregarded. Pulse oximetry is not considered a replacement for direct observation of patient ventilatory function [105].

END-TIDAL CARBON DIOXIDE MONITORING

End-tidal CO_2 monitoring measures expired carbon dioxide and provides information about the patient's ventilation. This type of monitoring is most commonly used with deep sedation and general anesthesia but is becoming commonplace in monitoring patients undergoing moderate sedation [106]. The advantage of this type of monitoring is that it allows early detection of developing hypoventilation and possible airway obstruction. Additionally, if the patient is developing the early stages of malignant hyperthermia, this can be recognized by rising CO_2 levels.

Two techniques are used for measuring expired carbon dioxide. The first uses a photo detector that calculates the CO_2 value as it passes through a transducer. The second method, capnography, actually obtains a sample of expired air and diverts it to a machine (i.e., capnograph) that directly measures the carbon dioxide level. Both techniques are easily accomplished on intubated patients. Measurement of end-tidal CO_2 levels in nonintubated patients is also possible [106]. Using microstream technology, a nasal cannula-type device can be applied to the patient's nares to allow for end-tidal CO_2 measurements. These devices are comfortable for patients and provide the practitioner with additional information regarding the patient's ventilatory status.

Recommendations about noninvasive monitoring of end-tidal carbon dioxide with capnography have evolved. At the time of their guidelines on monitoring during moderate sedation, the ASA, the American Society for Gastrointestinal Endoscopy (ASGE), and the American Gastroenterological Association (AGA) Institute found insufficient evidence to recommend the routine use of capnography, and the American College of Emergency Physicians (ACEP) noted only that procedural monitoring "may include" capnography [4; 39; 45; 57]. However, since the publication of those guidelines, several studies have demonstrated that capnography readings are a more sensitive measure of ventilatory function, detecting hypoventilation earlier than changes in vital signs, clinical observations, or pulse oximetry [107; 108; 109; 110]. In a study in the emergency department setting, capnography had a sensitivity of 100% (specificity 64%) in detecting hypoxia before onset [109]. In addition, a meta-analysis (five studies) demonstrated that respiratory depression was more than 17 times more likely to be detected during procedural sedation when capnography was used than when it was not used [110]. In 2010, the ASA issued updated standards for anesthetic monitoring, stating that monitoring for the presence of exhaled carbon dioxide should be carried out during moderate (or deep) sedation [111]. Use of capnography during sedation is also recommended by the Emergency Nurses Association, and, in a joint position statement, the ASGE, the American Association for the Study of Liver Diseases (AASLD), the ACG, and the AGA Institute acknowledge that capnography reduces the occurrence of apnea and hypoxemia during gastrointestinal endoscopy with propofol sedation [112; 113]. In the 2014 revision to its clinical policy on procedural sedation and analgesia in the emergency department, the ACEP states that capnography used as an adjunct to pulse oximetry and clinical assessment may detect hypoventilation and apnea earlier than pulse oximetry and/or clinical assessment alone in patients undergoing procedural sedation in the emergency department [35]. A multisociety-developed curriculum on sedation during gastrointestinal endoscopy notes that proper training should include interpretation of capnography readings [64].

The American College of Emergency Physicians states capnography may be used as an adjunct to pulse oximetry and clinical assessment to detect hypoventilation and apnea earlier than pulse oximetry and/or clinical assessment alone in patients undergoing procedural sedation and analgesia in the ED.

(https://www.guideline.gov/summaries/summary/47772. Last accessed June 22, 2017.)

Strength of Recommendation: B (Recommendation for patient care that reflects moderate clinical certainty)

Guidelines from the AAP/American Academy of Pediatric Dentistry support the use of capnography during pediatric sedation. However, it was used by less than half (45%) of practitioners in a large study of high-functioning pediatric sedation systems [34; 114].

CARDIAC MONITORING

Cardiac monitoring of patients undergoing moderate sedation provides information regarding heart rate and rhythm. The Joint Commission requires continuous cardiac assessment in all patients undergoing moderate sedation [1]. Cardiac monitoring allows for the early detection of arrhythmias and the development of myocardial ischemia. In some patients, pacemaker function can also be continually assessed. Many policies and procedures recommend cardiac rhythm monitoring for all patients with an ASA Physical Status of 2 or higher [25; 115]. Other policies require cardiac rhythm monitoring in all patients receiving intravenous moderate sedation, as the incidence of complications increases with this route of medication administration.

Lead placement techniques vary by institutional guidelines as well as what information is to be obtained. Modified lead II placement provides a waveform that is predominantly upright and easily recognized by most healthcare providers [116]. With modified lead II placement, the positive electrode is placed over the lowest palpable rib in the left midclavicular line. The negative electrode is placed at the first intercostal space at the right sternal border in the midclavicular line. The ground electrode is placed in the first intercostal space at the left sternal border in the midclavicular line. This allows for easy identification of P waves and the development of atrial arrhythmias. The disadvantage of modified lead II is the difficulty in visualizing bundle branch block. However, for the majority of patients who do not have a cardiac history with arrhythmia risk, modified lead II is an easy, recognizable method of cardiac monitoring.

Placement with modified chest lead using V1 (MCL1) produces a waveform that is normally negative; however, with right bundle branch block, the waveform will be upright. Many practitioners do not feel comfortable with this waveform view and therefore have difficulty in recognizing cardiac developments such as ischemia and/or arrhythmias. MCL1 placement requires that the positive electrode be placed in the fourth intercostal space to the right of the sternum. The negative electrode is placed below the left clavicle in the midclavicular line. The ground electrode may be placed in any convenient position [117].

The major advantage of monitoring the patient in MCL1 is that right and left bundle-branch block may be easily identified. Additionally, differentiation of ventricular tachycardia and supraventricular tachycardia with aberrancy is possible [117]. Premature ventricular contractions can be evaluated to determine their origin, either in the right or left ventricle. MCL1 is used frequently in intensive care units as it is equivalent to lead V1 on the 12-lead electrocardiogram. However, it has been shown to differ in QRS morphology in 40% of patients with ventricular tachycardia and is, therefore, not recommended for diagnosing wide QRS complex tachycardia [117].

Modified chest lead using V6 (MCL6) is another lead that may be used. The waveform produced is upright, and it allows identification of intraventricular conduction defects. MCL6 is equivalent to lead V6 on the 12-lead electrocardiogram [118]. With this lead, the positive electrode is placed at the fifth intercostal space in the left midaxillary line. The negative electrode is placed below the left clavicle in the midclavicular line, and the ground electrode is placed in the midclavicular line below the right clavicle.

Cardiac monitoring can be a useful adjunct to patient monitoring, particularly for high-risk patients. Detection of developing hypoxia as evidenced by arrhythmia development is beneficial to all patients, especially the patient with a positive cardiac history. Patients at risk of developing arrhythmias include the elderly, patients with abnormal electrolyte values, patients with a positive cardiac history, and patients experiencing significant hypoxic intervals. The most common arrhythmias that develop during moderate sedation include premature ventricular complexes and atrial dysrhythmias, such as atrial flutter and atrial fibrillation. Fortunately, for the vast majority of patients, these arrhythmias are readily reversed with oxygen therapy and present little danger to the patient's outcome.

Additionally, recognition of myocardial ischemia formation can allow the practitioner to determine if developing ischemia and myocardial injury is occurring. T-wave inversion is seen first with myocardial ischemia. The patient subsequently develops tall, peaked T waves, which are asymmetrical with a wide base. The ST segment becomes elevated, indicating myocardial injury. At this point, the extent of long-term myocardial damage can be reversed with oxygen and nitrate therapy. The development of Q waves can occur at any time, within a few hours or up to days after the infarct. The practitioner monitoring the patient receiving sedation can use the cardiac abnormality to determine the extent of ischemia, and consequently, a decision can be made regarding the necessity of discontinuing the procedure or correcting the ischemia (e.g., with oxygen therapy, nitrates).

AMERICAN HEART ASSOCIATION RECOMMENDED SIZES FOR BLOOD PRESSURE CUFFS	
Patient Parameter	**Recommended Cuff Size**
Adults (By Arm Circumference)	
22–26 cm	12 x 22 cm (small adult)
27–34 cm	16 x 30 cm (adult)
35–44 cm	16 x 36 cm (large adult)
45–52 cm	16 x 42 cm (adult thigh)
Children (By Age)[a]	
Newborns, premature infants	4 x 8 cm
Infants	6 x 12 cm
Older children	9 x 18 cm
[a]A standard adult cuff, large adult cuff, and thigh cuff should be available for use in measuring a child's leg blood pressure and for children with larger arms.	
Source: [120]	*Table 11*

The controversy regarding cardiac monitoring lies in the fact that many patients receiving moderate sedation are healthy, and continuous cardiac rhythm monitoring may be unnecessary in a large population of patients. Guidelines from the ASA, the AGA Institute, and the ASGE note that ECG monitoring is not needed for low-risk patients [39; 45; 57]. The ASA guidelines suggest ECG monitoring to decrease risks for patients who have significant cardiovascular disease or dysrhythmia, and the AGA Institute and the ASGE state that ECG monitoring should be considered for high-risk patients, such as patients with a history of significant cardiac or pulmonary disease [39; 45; 57]. The AAP recommends that an ECG monitor be readily available [34]. Each institution should develop its own policies and procedures as to which patients are candidates for monitoring and which patient populations do not require this level of care.

NONINVASIVE BLOOD PRESSURE MONITORING

Noninvasive blood pressure monitoring allows for repetitive evaluation of the patient's blood pressure with a minimal amount of nursing time. The monitor will cycle at a preset interval to obtain blood pressure readings and is accurate in a wide variety of settings.

The blood pressure cuff is placed over the brachial artery with the lower edge of the cuff one inch above the antecubital fossa. In a patient with fragile skin, a single layer of cotton padding may be placed around the arm prior to application of the blood pressure cuff. This will protect fragile tissue from repeated injury that may occur with each cuff inflation.

It is important that the practitioner place the cuff appropriately and ensure that the appropriate size cuff is used. A cuff that is too wide will provide a blood pressure reading that is inaccurately low. Conversely, a cuff that is too narrow will provide an inaccurately high reading. A proper cuff is approximately 40% of the circumference of the arm to which the cuff is applied [119]. The American Heart Association has provided recommendations for appropriate cuff sizes based on upper-arm circumference (***Table 11***).

Patients may complain of pain as the cuff inflates. Many machines now allow the practitioner to set the maximum cuff inflation pressure. This prevents overinflation of the cuff every time the cuff is used. With this ability to monitor the patient without inflicting undue pain, patient care is maximized.

Many blood pressure monitoring devices provide a digital read-out of the patient's vital signs. These are important records and should be incorporated into the patient's chart. However, it is important to remember that these attachments may become lost and separated from the chart. It is always advisable to document a set of vital signs in the chart and state that the digital read-out is attached. If legal action was to occur and no vital signs recorded and no print-out found, the nurse could face serious consequences for not obtaining vital signs. For example, if no record exists, an attorney may make the assumption that vital signs were not obtained. Additionally, the read-out may fade over time and become illegible. Also, if tape is placed over the ink when attaching the monitoring strip to the chart, the tape has the tendency to make the recording "disappear," and the readout is no longer visible.

Many blood pressure monitoring machines also allow for cardiac monitoring of the patient. Some provide a rhythm strip, and others simply monitor the heart rate. Combining these assessments ensures safe patient care without extra costs incurred for additional pieces of monitoring equipment.

BISPECTRAL INDEX

The bispectral index (BIS) has been developed as a method of objectively determining sedation status via electroencephalogram (EEG) recordings [121]. Based on the index, the sedation level can be determined mathematically based on the patient's EEG pattern. An alert adult would receive a score of 100, while a score of 0 is characterized by an isoelectric EEG pattern [121]. The bispectral index score is a relatively new tool, and research has indicated that it is a valid measure of depth of sedation, in addition to nursing evaluation [45; 122; 123; 124]. However, some studies have found its use to be questionable among some populations, such as pediatric patients, and both the ACEP and the ASGE have found insufficient evidence to recommend routine use of BIS [4; 57; 64; 125; 126; 127; 128].

DOCUMENTATION OF MODERATE SEDATION

Critical to the success of moderate sedation is appropriate documentation of the procedure. Documentation provides other healthcare practitioners with information regarding the patient during the intervention. Additionally, chart reviews can be performed as a component of quality monitoring. Good documentation allows for a review of the medications, patient responses, and any adverse complications that may have developed during the procedure [129; 130].

The ideal flow sheet should have three basic sections: the presedation assessment, the intrasedation record, and the postsedation record, which includes the discharge status of the patient. The format of the flow sheet should allow a reviewer to easily determine how the patient responded to therapy and sedation. Graphic flow sheets, which allow for vital sign charting next to medication administration times, allow rapid assessment of the patient and the patient's responses to medications [130].

When developing a flow sheet, input should be obtained from all users of the form. A sample form can be developed and critiqued, with changes made as appropriate. When a sample form is deemed acceptable, the form should be put into use and re-evaluated on a regular basis. It is not often that the ideal form is created during the first phase of development. Usually, it requires refinement a number of times. Unfortunately, too many individuals are resistant to change, and once a form is put into daily use, users do not want to see it changed, regardless of whether it meets their needs.

Current practice allows documentation of moderate sedation in a number of ways. The Joint Commission standards do not specify the elements required for sedation documentation but rather leave this responsibility to each individual organization, which is free to determine its documentation format [129].

The components of the presedation assessment should be easily identified to facilitate review [130]. Because the assessment of cardiac, respiratory, and neurologic components are critical in this phase of care, a section that allows for easy recording of these findings will ensure that the patient is appropriately assessed. A checked box format allows the recorder to document function and lessens the time required to complete the form.

Presedation baseline vital signs and oxygen saturations should be readily identified. If another individual is recovering the patient after sedation, he or she will need to be able to identify the patient's baseline parameters to evaluate readiness for discharge. The patient's ASA physical status and any important history, including medication use, allergies, diagnostic data (e.g., laboratory, ECG, X-ray) and last oral intake, should be included as well [25; 130].

Monitoring equipment used may also be documented in a checked box format. If a patient is placed on the cardiac monitor, pulse oximeter, and noninvasive blood pressure monitor, a simple check system will expedite charting as well as act as a reminder to the care provider that these monitors should be considered.

Additional information in the presedation section could include a checklist of tasks to be accomplished during this phase of care. For example, a checklist may include such items as: informed consent obtained; emergency supplies readily available; oxygen and suction present and functional; history and physical reviewed [130]. These act as reminders and ensure that patient safety is always foremost.

The intraprocedural section should include a time-based record of patient assessment information as well as a medication section [130]. The medications should be documented according to their time of administration, the dose administered, the route of administration, and the patient's response. Vital sign assessment obtained one minute after sedative administration may be coordinated to show the effects of medications upon the patient's vital signs. All medications administered should be documented, including premedicants, sedating agents, and reversal agents, and the summary totals of their dosages should be easily identifiable [130].

If the patient is receiving intravenous solutions, these should be documented [130]. Any blood loss should be reported. A postprocedural intake and output calculation may be valuable for a number of patients.

During the procedure, the use of monitoring equipment should be documented [130]. Many noninvasive blood pressure monitors produce a paper strip with a vital sign and heart rhythm summary. These are acceptable methods of documentation. However, as discussed, the nurse should be aware that if the strip is lost or misplaced, there will be no record of vital signs on this patient, which may result in negative legal consequences. Therefore, as previously noted, it is prudent for the nurse caring for the patient to physically write in a set of vital signs and indicate that the rhythm strip is attached. Although this still does not show complete evidence of patient assessment, the nurse is able to demonstrate that he/she obtained vitals as appropriate.

Another important part of the intraprocedural form is the documentation of the patient's level of sedation. Many institutions use sedation scales as a method of documenting changes in the patient's level of responsiveness. This is a widely accepted method of documentation, and one which will stand up under legal scrutiny. The sedation scale selected should be easy to use and document. Many facilities use the Ramsay score; however, as previously discussed, this score lacks clarity in some areas [6]. Many hospitals now use the Modified Observer's Assessment of Alertness/Sedation Scale [39].

Pain assessment should also be included in the intraprocedure section. The Joint Commission requires that all patients be assessed for pain and have their pain managed appropriately. An additional box for documenting a pain score may be added to the vital sign section to ensure that the practitioner is including pain as the "fifth vital sign." If the procedure is not painful, this too should be documented. (It is imperative to remember that if pain continues into the postsedation period, these pain assessments should be continued and documented.)

A summary of the procedure may be included in this intraprocedure section. The start and stop time of the procedure and the condition of the patient at the end of the procedure may be documented. The occurrence of any unusual events during the administration of sedation should be documented. Medication summaries should also be tallied [130].

The last section of the document is the postsedation care section. This includes assessment of the patient during the postsedation period as well as information regarding the patient at the time of discharge. Regular vital sign and pain assessments should be documented, including the patient's level of sedation. A reviewer should be able to identify the progression of the patient's arousal from the sedated state. Any complications should be described, and interventions undertaken should be documented. Pain medications, if administered, should be charted, including an assessment of the effectiveness of such medications [130].

The discharge of the patient should also be included. Depending on the location to which the patient is discharged, varying information should be documented (as previously presented). The location to which the patient is discharged should be clearly identifiable. The discharge criteria used to assess the patient's readiness for discharge should be clearly delineated. If a discharge scoring system is used, the patient's score should be noted, as well as a notation regarding the acceptable score for discharge. The condition of the patient at the time of discharge should be documented. If a patient is being discharged to home, the individual who is accompanying the patient should be identified.

Finally, discharge instructions should be charted [130]. Many facilities use standard discharge instruction worksheets that require signatures from both the patient and the nurse providing these instructions. After review, a copy of these instructions should be signed by both individuals and attached to the patient chart. The nurse(s) caring for the patient should sign the flow sheet prior to inserting the documentation record into the patient's chart.

In summary, documentation of the patient undergoing moderate sedation is an important aspect of good nursing care. The sedation assessment document should be user-friendly for the staff using the form during sedation, as well as any other individuals who may be reviewing the document at a later point. Without documentation of all aspects of the procedure, the assumption is that these activities were not completed. Therefore, it is imperative that documentation be complete, thorough, and easily legible.

COMPLICATIONS DURING MODERATE SEDATION

Moderate sedation is not a treatment without consequence. Although the incidence of complications is low, there are risks (***Table 12***). In many cases, complications are related to pre-existing comorbidities in the patient. With good presedation assessment and selection, the incidence of these problems can be kept to a minimum.

OVERSEDATION AND UNDERSEDATION

Most complications occur because of sedation becoming deeper than intended (oversedation), rather than not reaching adequate sedation [45]. This is especially important for children, as studies have indicated that children often reach a level of sedation that is deeper than intended [34]. Clinicians who administer moderate sedation must be qualified to rescue patients who reach a deep level of sedation [45].

COMPLICATIONS OF MODERATE SEDATION
Over- or undersedation
Cardiac arrest
Respiratory insufficiency
Pain
Airway obstruction
Nausea and vomiting
Aspiration
Malignant hyperthermia
Hemodynamic instability
Paradoxical reactions
Dysrhythmias

Source: Compiled by Author *Table 12*

Another common complication of moderate sedation is nonoptimal sedation (undersedation) of the patient [131]. The nurse newly trained in moderate sedation administration may undersedate the patient in an effort to reduce the risk of oversedation. Although undersedation may seem beneficial as compared to oversedation, the effects of undersedation can be just as undesirable. The patient who is undersedated experiences an increased amount of stress, leading to an increased autonomic response [132]. The patient experiences an increase in heart rate and blood pressure, both of which can be detrimental in a variety of patient populations.

Certain populations are at increased risk of oversedation and undersedation, particularly the young, the old, the critically ill, and the obese [25]. Patients with liver and/or renal disease are also at increased risk, especially for oversedation [133]. Patients with high preprocedural levels of anxiety may also be at risk; the heightened anxiety state can prevent the patient from achieving the full benefits of the drug administered. As an example, a patient with a high level of anxiety is scheduled for an MRI. The patient has heard a great deal from friends and family about the claustrophobic environment of the scanner. This patient has a fear of enclosed spaces and becomes fearful that he/she will be unable to tolerate the closed-in feeling in the scanner. The nurse caring for this patient administers a low-dose benzodiazepine in an effort to relax the patient and relieve his/her anxiety. The preprocedural instructions provided to the patient explained the type of sedation and that these medications are administered to relieve the patient's heightened level of anxiety. However, the dosage administered is inadequate to achieve these goals, and the patient enters the scanner without feeling relief. The patient believes that the medication should be working but remains unable to relax. This only further increases the patient's anxiety, and the physiologic responses of an increased heart rate and blood pressure become evident.

Both oversedation and undersedation can be prevented with proper drug dosing, dosing techniques, and recognition of at-risk patients. Administering drugs in small doses on a more frequent, as-needed basis can all but eliminate these problems. Should overdosage become a problem, administration of a reversal agent (if available) may be used.

RESPIRATORY INSUFFICIENCY

Differentiating oversedation from respiratory insufficiency can be challenging. Respiratory insufficiency is a known effect of sedation agents and should also be considered a potential complication of oversedation. Clinical signs of respiratory insufficiency include decreased, shallow, or labored respirations; rocking motion of chest; weak cough; high-pitched noise during inspiration (partial obstruction); no movement of air (complete obstruction); and decreased oxygen saturation [9]. Patients with high respiratory rates, such as the pediatric patient and the obese patient, are at increased risk of respiratory insufficiency secondary to their high minute volumes. If a patient's normal respiratory rate is 30 and drops to a rate of 15/minute, there is a 50% drop in the patient's minute volume. On the other hand, if an adult whose normal respiratory rate is 20 drops to 15/minute, there is only a 25% drop in minute volume.

It is clear that the patient with the higher resting respiratory rate is at increased risk for hypoxemia.

Complicating the respiratory insufficiency expected with sedative administration is the response to a developing hypoxemia. Many sedating agents blunt the patient's response to impending hypoxemia, and a vicious cycle is set in motion, the end result being a patient whose respiratory drive is insufficient to meet his/her tissue oxygen demands.

Preventing respiratory insufficiency can be accomplished by monitoring the patient's respirations and oxygen saturations every five minutes. Stimulating the patient to breathe with each vital sign assessment can also ensure adequate ventilatory effort, assuming that such behavior does not adversely interfere with the procedure being undertaken. Providing supplemental oxygen to patients at risk of decreased respiratory effort will prevent the further development of significant hypoxemia [9].

Oximetry has been shown to effectively detect oxygen desaturation and hypoxemia in patients who are administered sedatives. Early detection of hypoxemia through the use of oximetry during sedation can decrease the likelihood of adverse outcomes (e.g., cardiac arrest). Supplemental oxygen also decreases patient risk during moderate sedation [25]. In severe situations, administering a reversal agent (if available) or terminating the procedure may be necessary to reverse this problem [9].

COMPROMISED AIRWAY

Airway obstruction is another common complication that can be prevented with close monitoring. Obstruction of the airway is more common in the young child, whose tongue is larger in proportion to the size of his/her mouth. The modified Mallampati Scale is a useful tool in evaluating patients at risk for airway compromise [27; 28; 29; 32]. The scale classifies the patient's airway as Class 1, 2, 3, or 4. The patient with either a Class 3 or 4 airway has an increased risk of airway obstruction in comparison to a patient with a Class 1 airway, as outlined previously. Any patient with a Mallampati Class 2 airway may also be at increased risk.

Additionally, the airway may become compromised from accumulated vomitus, blood, or oral secretions. Patients who are sedated without the benefit of gastric emptying will be at increased risk of aspiration. Controlling secretions with suction and head positioning is imperative in this group of patients.

Finally, in the event of developing deep sedation, the patient will lose submandibular muscle tone causing a slack jaw and unprotected airway. It is important to remember that sedation is a continuum; the progression to deep sedation is varied and individualized. The development of a slack jaw can occur at any time, and the patient's muscle tone and airway should be monitored at all times.

In most adult patients, the head-tilt/jaw-thrust maneuver is all that is necessary to open the airway. (Note: It is imperative to remember that in the pediatric patient, a head-tilt is NOT an appropriate airway maneuver; the child should be placed in the sniffing position with the jaw forward.) Insertion of an oral airway is generally contraindicated, as the patient's level of consciousness is not deep enough to allow placement. Placement of an oral airway may actually precipitate laryngospasm in many lightly sedated patients, necessitating intervention [9].

If the airway is compromised with accumulated particulate material, insertion of a nasal trumpet and suctioning will be required. Again, care should be taken to prevent laryngospasm that may occur with vigorous suctioning.

ASPIRATION

Aspiration is the most common cause of death secondary to intravenous moderate sedation [6]. Although the risk of death is increased, the incidence of aspiration remains lower in moderate sedation than in general anesthesia [134]. The most common cause of aspiration is the relaxed cardiac sphincter tone that develops with deeper levels of sedation. Any patient with a history of reflux is at risk, as are obese, obstetric, and elderly patients [6; 57].

Risk of aspiration may be reduced by administering medications to decrease gastric contents or medications to increase gastric pH. Elevation of the head of the bed may decrease the patient's risk, assuming that such positioning is not contraindicated by the procedure being performed. Finally, if the patient does aspirate, suctioning and airway protection with intubation may be required. The patient may be started on antibiotic therapy and vigorous pulmonary toilet will be instituted. Postaspiration pneumonia carries a high mortality if not recognized and treated early [35; 136].

CARDIOVASCULAR COMPLICATIONS

Hypotension

Hemodynamic instability is a common cardiovascular complication occurring during moderate sedation [6]. The direct cardiodepressant effect of many of the sedating drugs causes hypotension in the patient. The patient with a pre-existing compromised circulatory volume is at greatest risk for this complication [57]. Hypovolemia and hemorrhage require aggressive volume and blood replacement to prevent dangerously low circulating pressures. In acute cases, vasoactive drugs may be required to supplement hemodynamic status. Recognition of the patient at risk for hypotension will allow the practitioner to supplement the patient's volume status prior to sedation, thereby circumventing this problem. Hypotension may be an early sign of oversedation.

Other causes of hypotension include pain and the histamine release that occurs with a number of depressant agents. It is imperative that the cause of the hypotension be identified so that proper therapy can be instituted to reverse the cause and correct the problem.

Dysrhythmias

Another cardiovascular complication is the development of dysrhythmias, most commonly in the elderly individual. Most dysrhythmias occur secondary to hypoxia and can be prevented or treated with increasing oxygen percentages; other causes of dysrhythmias include fluid overload, pain, and hypovolemia [137]. The patient at risk should be placed on continuous cardiac monitoring prior to the start of the sedation and continuously monitored both throughout the sedation period and during the recovery phase [39; 45; 57]. Supplemental oxygen may be recommended prior to beginning the procedure. Antidysrhythmics and defibrillation are rarely required; however, access to these interventions should be readily available.

The type of agent used will affect the type of dysrhythmia that develops. Fentanyl and the barbiturates are associated with bradycardia, while dissociative agents such as ketamine are more commonly associated with tachycardia, myocardial depression, and ventricular ectopy [61; 137].

Cardiac Arrest

In the event of significant cardiovascular compromise, the risk of cardiac arrest exits. With good presedation evaluation and risk assessment, the advent of cardiac arrest is rare. However, should this life-threatening event occur, the team caring for the patient should cease procedural interventions and immediately begin full resuscitation efforts. The facility's "code team" may be activated to provide expert back-up assistance in resuscitating the patient; however, the Joint Commission standards require that individuals who administer moderate sedation must also be competent to perform the rescue. A "code team" is considered an additional resource [138]. Those caring for the patient should be well versed in the American Heart Association's cardiac arrest protocols [139]. Airway, breathing, and circulation should be managed and drug therapy instituted.

PAIN

Pain is a complication that should rarely present itself if the nurse caring for the patient is performing his/her responsibilities. It is an important preprocedural responsibility to instruct the patient regarding pain. The use of pain scales should be demonstrated so that the patient is aware of his/her responsibilities in informing the nurse of any pain. Another important teaching point to address is that there is a difference between pain and discomfort. Analgesics may be provided for pain control; however, discomfort may be a part of the procedure that cannot be eliminated. As an example, a patient undergoing a colonoscopy with moderate sedation may experience discomfort while the abdomen is assessed. This type of discomfort cannot be treated with analgesic therapy. The patient should be aware of these differences, and a path of open communication should be established. Often, nonpharmacologic interventions may be instituted to relieve discomfort, such as padding under the back (if allowed) to relieve pressure and discomfort over the sacral area.

A known painful procedure should be performed using sedating agents that have known analgesic properties. Assessing the patient's level of pain is imperative to provide safe, patient-oriented care. If a patient is experiencing a significant amount of pain, the nurse may be wary of administering further pain medications due to their synergistic effects upon sedation. This issue should be addressed with the physician, and consideration of nonsteroidal anti-inflammatory agents may be considered.

NAUSEA AND VOMITING

Nausea and vomiting are additional complications that put the patient at risk and increase the patient's discomfort. Increased vagal tone can produce the sensation of nausea and potential vomiting. Opiate use is known to produce nausea and vomiting in some cases. Other patients at risk for experiencing these complications include those that are hypovolemic, obese, or in pain. Certain procedural interventions are known to increase the complaints of nausea and vomiting; therefore, assessment for increased risk should take place in the preprocedural period.

Administering antiemetics may be of benefit. However, these drugs can produce additional sedation, and the nurse should exercise caution when giving these drugs to the sedated patient. In the event of significant gastric distension, the use of a nasogastric tube to suction may help reduce the risks. Hypovolemia should be corrected, and pain may be treated with additional analgesics; however, the practitioner should be aware of the synergistic effects of additional analgesics already presented.

According to the American Society of Anesthesiologists, multiple antiemetic agents may be used for the prevention or treatment of postanesthesia nausea and vomiting, when indicated.

(https://www.guideline.gov/summaries/summary/43896. Last accessed June 22, 2017.)

Level of Evidence: Expert Opinion/Consensus Statement

MALIGNANT HYPERTHERMIA

Malignant hyperthermia (MH) is another rare but potentially life-threatening complication [140; 141]. Once again, taking good presedation history, including risk assessment for MH, can prevent this problem from developing [142]. Patients at risk for developing MH include children and those with a history of anesthetic complications [137; 140]. Agents that can precipitate MH include anesthetic gases and succinylcholine [61; 143]. Although the majority of these drugs are not used in the moderate sedation realm, the risk of this complication developing should not be overlooked.

The onset of symptoms of MH may begin with the development of masseter muscle spasm (also known as masseter muscle rigidity) and rising CO_2 levels. The patient can develop tachycardia and other ventricular dysrhythmias [137; 142]. The patient's core temperature remains normal in the early stages; however, the skin appears flushed and may feel warm to touch. It is imperative that the care provider recognize these symptoms in this early stage. If the syndrome progresses to the state of high fever and muscle rigidity, the incidence of death and long-term sequelae increases [137].

If MH develops, the procedure should be terminated immediately and interventions undertaken to prevent its progression [143]. The patient may be administered dantrolene, and cooling measures should be instituted [137; 140]. The Malignant Hyperthermia Association of the United States (MHAUS) recommends that a full supply of dantrolene be available on site to allow for initial stabilization and treatment while more vials are acquired to continue treatment, as needed [143]. Administration of dantrolene requires additional support personnel, as drawing up an adequate dose is time consuming and difficult to perform while instituting other supportive measures.

Children will respond to external cooling measures, such as ice packs to pressure points and cool cloths. The adult patient may require internal cooling, with iced lavage of the peritoneal, gastric, bladder, and rectal cavities [61]. In the event of significant hyperthermia (i.e., temperature greater than 42°C), placing the patient on the heart-lung bypass machine to institute extracorporeal cooling may be required.

Subsequent complications, such as ventricular dysrhythmias, should be treated according to standard protocols. The patient will require increased fluids to prevent the development of acute renal failure secondary to myoglobinuria. Sodium bicarbonate may be administered for severe acidosis, and diuretics may be given to prevent developing renal failure. If the patient is at increased risk of hyperkalemia, a glucose-insulin drip may be ordered to reduce the serum potassium level [61; 137].

Additionally, the risk of recurrence exists. The patient should be monitored for up to 48 hours for recurring signs and symptoms. MHAUS guidelines recommend that 2.5 mg/kg of dantrolene be administered with an upper limit of 10 mg/kg [61; 143]. It is also imperative that the patient and his/her family be made aware of the complication and further education instituted so that it may be prevented in the future.

PARADOXICAL REACTIONS

Finally, the risk of paradoxical reaction exists. The patient who experiences agitation, dysphoria, and/or confusion, either during sedation or upon recovery, is at risk for self-inflicted injury. These types of reactions are more common in the pediatric and elderly populations and are known side effects of certain medications (e.g., midazolam use in the elderly, benzodiazepine use in children) [144]. Other causes include hypoxia and undermedication. Hypoxia should always be considered as the primary cause, and measures should be undertaken to reverse this problem. As discussed, undermedication can lead to an increased level of anxiety or provide an inadequate amount of analgesia for the patient, thus precipitating this type of reaction [144].

Treating hypoxia with oxygen administration in this combative patient may be difficult and may only increase the patient's agitation. In this case, blowing oxygen at the patient's face may help reverse the hypoxia. Administering pain medications may help ease the response, but additional sedation may develop.

Another suspected cause of paradoxical excitement is the administration of reversal agents. The rapid arousal of the patient may bring on fear, which subsequently leads to a paradoxical response. If administering a reversal agent to a patient, slow administration and reversal have been found to help decrease the risk of excitement in many patients. Titrating the reversal medications can help achieve this goal.

The risk of complications exists with any type of moderate sedation procedure but can be reduced, if not prevented, with recognition of the patient at risk and vigilant monitoring to detect early signs of patient deterioration.

MODERATE SEDATION OF THE PEDIATRIC PATIENT

Administering moderate sedation to the pediatric patient is a safe and effective method of controlling agitation and discomfort in the child. However, a child's ability to control his/her own behavior for purposes of cooperating for a procedure depends on the child's chronologic and developmental age. Children younger than 6 years of age and those with developmental delay often require deep levels of sedation to affect adequate behavior control. It is important to anticipate the need for deep sedation as studies have shown that children commonly pass from the intended level of sedation to a deeper, unintended level [5; 145; 146; 147]. Also, the sedation medication used has a more profound effect on the respiratory drive, patency of the airway, and protective reflexes of a child in this age group. Administration of drug therapy and care of the patient should be modified to take into consideration the anatomic and physiologic differences in children. Institution of appropriate measures will ensure safe drug delivery with successful outcomes. The concept of rescue is particularly essential to the safe sedation of children [5].

ANATOMIC AND PHYSIOLOGIC DIFFERENCES

The child's airway is anatomically different than the adult airway. The larynx is located more cephalad and anterior; thus, head positioning is different in the child. Airway diameter is narrow, with the narrowest section of the trachea located at the cricoid ring. Airway compromise is always a consideration secondary to the large tongue, which can relax and fall back into the airway, causing obstruction.

Children's breathing effort is different in that there is less alveolar space for gas exchange with fewer collateral ventilatory pathways. Oxygen demands are higher secondary to the child's high minute volume. Normal respiratory rates in children are faster than adults; therefore, a decrease in the child's respiratory drive secondary to drug administration can cause significant respiratory insufficiency. Additionally, the sternum and the ribs are more cartilaginous and pliable in the child, making signs of respiratory distress visually identifiable by chest wall retractions and abdominal muscle use.

Heart rate and blood pressures vary by age of the child, and the evaluation of changes should take these variables into consideration. Children's cardiac output is controlled by increasing heart rate, and drugs that slow the heart rate will cause a drop in cardiac output with a subsequent decrease in circulation times. This drop in cardiac output translates into a longer onset and a prolonged length of drug action. Additionally in children, the circulatory response to hypoxia is the development of bradycardia. Therefore, heart rate becomes an important assessment parameter.

Assessing the level of consciousness and arousal in the child should take into consideration the development age of the child. The neurologic system is not well developed until 8 to 10 years of age. Recognizing normal, age-appropriate behaviors in the child will allow the care provider to identify changes in the child's level of functioning.

The hepatic and renal function of a child is not well developed, and this will impact drug metabolism and clearance. The child may have longer length of action of drugs secondary to reduced hepatic function. On the other hand, the child may have a faster clearance time due to the higher circulating volumes. Monitoring the child for drug response is imperative due to this unpredictable medication response.

PEDIATRIC MAINTENANCE FLUID CALCULATIONS
100 mL/kg for 1st 10 kgs (Ex: 10-kg child = 1,000 mL)
50 mL/kg for 2nd 10 kgs (Ex: 20-kg child = 1,500 mL)
20 mL/kg for each additional kg (Ex: 26-kg child = 1,620 mL)
Total calculated volume is divided equally over 24 hours.
Fluid of choice is generally 5% dextrose with 0.25% normal saline.
Source: [62] *Table 13*

Additional considerations include fluid volume differences and differences in the distribution of these body fluids. Children have a large body surface area to body mass and are at increased risk for developing hypothermia. While circulating volume is calculated at 80 to 90 mL/kg, children will require additional maintenance fluids for circulatory support. Maintenance fluids are frequently required for children younger than 8 years of age, as well as children who have been NPO for a significant length of time. ***Table 13*** outlines the formula for pediatric maintenance fluid administration. Typically, the choice of fluids includes a dextrose containing solution, such as 5% dextrose with 0.25% normal saline. This provides the child with the supplemental glucose that is required during times of stress.

PHARMACOLOGIC CONSIDERATIONS

Techniques for the pediatric patient receiving moderate sedation are different from adult patients. Internal factors (i.e., child's age, developmental level, previous experience) and external factors (i.e., parental interactions with the child, preparation, clinical skill, physical setting where procedure is performed) determine how the child will respond. Individualized dosing and titratable agents are, therefore, often necessary [73].

It is more common for children to receive transmucosal medications with excellent results. The oral route is advantageous due to its ease of administration. However, a risk of aspiration may occur, especially with foul-tasting medications. Usually, the taste of these medications is disguised in a sweet, syrupy concoction that greatly improves patient compliance. Many medications are metabolized by first-pass effect, and dosing by the oral route should be increased on a milligram per kilogram basis to achieve the same level of sedation achieved by the intravenous route.

Sublingual administration, such as fentanyl lozenges, is an easy and desirable method. The child should be able to cooperate with instructions to suck on the lozenge rather than chewing it, as chewing prevents complete absorption and compromises proper drug dosing. The advantage of sublingual administration, as previously mentioned, is the lack of first-pass effect.

Nasal administration of sedating agents is gaining popularity, especially for the pediatric population; however, not all agents are approved for this route of administration [148; 149]. Midazolam can be mixed with normal saline and dripped into the nasal passages. Many children, especially younger children, tolerate this route quite well [148]. Onset of sedation is rapid, and return to a presedation state is comfortable and quick. The disadvantage of this route is that medications may produce sneezing in the child, making the volume of medication received uncertain [150]. Additionally, if the volume of saline instilled into the nasal passage is large, the child may swallow the medication, converting absorption to the oral route. A study that compared oral midazolam syrup with intranasal midazolam spray for pre-anesthetic sedation in pediatric patients found that the two routes of administration produced similar anxiolysis and sedation, but better drug acceptance and response was noted with oral midazolam [151].

Rectal administration of medication is utilized frequently in the child, especially the child who is resistant to intravenous line placement. Initial doses of medications can be given rectally. Once the sedating effects occur, an intravenous line can be placed and further drug dosing accomplished by the intravenous route. The disadvantage of rectal administration in the child is the lack of retention of the drug in the rectum. Some children may bear down and dispel the medication prior to its absorption.

Intramuscular administration is the least desirable route of administration in all populations, especially with the pediatric patient. The advantage of the longer length of action should be weighed against the pain and delayed onset that occurs with this route. Furthermore, if this is the sole route for drug delivery, repeat injections may be required for further sedation, causing additional pain and discomfort in the child.

Intravenous administration has the advantage of providing the most controlled route for drug dosing. There is no question regarding the amount of drug that was administered, which may not be the case with other routes of administration. The risk of rapid onset of complications does exist but can be controlled by the titration of drugs to allow for monitoring of response to medications. Intravenous drug therapy does require intravenous line placement, which is traumatic for a large percentage of children. Thus, use of combined techniques (i.e., rectal, oral, nasal administration) for initial sedation followed by intravenous administration (for prolonged effect) is very beneficial in this population. It is important to note that the potential for adverse outcomes increases when three or more sedating agents are administered. Knowledge of the time of onset, time to peak, duration of each agent, and whether a previous dose of an agent has taken full effect is essential. An agent with a long duration of action requires a longer observation period, even if the child has achieved recovery and discharge criteria. This is especially important for infants and toddlers who are transported home in car seats. These children are at risk of resedation due to residual prolonged drug effects with the potential for airway obstruction [5]. It is essential that the nurse consider the effects of these techniques and choose the most appropriate route or methods based on each individual child's needs.

Pharmacologic effects of drug administration are affected by the higher cardiac outputs and metabolic responses in children. Drug dosing is on a higher milligram per kilogram dosage in children than in adults. The risk of this type of drug dosing is the sequestration of drugs in the fat or muscle of the child, leading to prolonged length of action and risk of resedation as the drug is slowly released from these tissues. The nurse providing sedation should always be aware that the potential for complications is higher in children and have readily available reversal agents, medications, and equipment.

Additionally, certain medications are used exclusively in the pediatric population. Thus, nurses caring for children should be aware of the pharmacology of these drugs. Fentanyl lozenges are most commonly utilized in children.

Chloral hydrate and pentobarbital are used in children undergoing radiologic procedures when a motionless patient is required, as during the MRI. These drugs have different actions in young versus older children. Chloral hydrate has a long duration of action, and residual effects (e.g., motor imbalance, agitation, restlessness) are common and may occur after the child is discharged to home. Most institutions limit the use of these two drugs to children younger than 3 years of age [152]. The nurse administering either of these drugs in the older child should carefully monitor the child for untoward effects.

NURSING CARE

Nursing care of the child receiving moderate sedation requires vigilant monitoring of the child at all times. The onset of complications may be more rapid, and the risk of untoward events is higher. However, careful assessment of the child throughout the procedure ensures that drug administration is safe and the child is comfortable.

Airway management in the child requires head positioning with consideration of anatomic variables. The child with airway compromise should be placed in the "sniffing" position, with the jaw lifted upward and forward. Placing a child in the standard head-tilt/jaw-thrust maneuver can cause inadvertent collapse of the child's airway. Signs of airway obstruction should be evaluated whenever unusual airway sounds are identified, including inspiratory stridor and/or snoring. Additional signs include restlessness secondary to developing hypoxia, intercostal muscle use, tachypnea, and bradycardia. In children 5 years of age and older, presedation assessment should include looking for loose teeth that may fall out and lead to airway obstruction. Immobilization devices (e.g., papoose boards) should be used so as to avoid airway obstruction or chest restriction. If an immobilization device is used, a hand or foot should remain exposed, and the child should never be left unattended [5]. Airway management in children with abnormal airway anatomy or airway obstruction may be accomplished with the use of devices, such as the laryngeal mask airway (LMA). The LMA device is available in a variety of sizes and may even be used in neonates [5].

The child should be administered supplemental oxygen secondary to his/her high oxygen demands. Cooperation with oxygen mask placement can be challenging in the combative and restless child. Enlisting a parent to hold an oxygen mask and blow oxygen at the child's face may be beneficial in the early stages. After the child is adequately sedated, the use of oxygen therapy devices should be continued and is usually easily accomplished.

The use of capnography for sedated children is recommended, particularly when other means of assessing the adequacy of ventilation are limited. As noted, guidelines from the AAP/American Academy of Pediatric Dentistry support the use of capnography during pediatric sedation [34; 114]. Several manufacturers have produced nasal cannulae that allow simultaneous delivery of oxygen and measurement of expired carbon dioxide values [5].

The child should be placed on a cardiac monitor so that signs of bradycardia are readily identified. If cardiac monitoring is not performed, frequent vital sign assessment of heart rate is imperative to recognize changes from the status quo. If anticholinergic medications, such as atropine, are given to reduce secretion formation, it is imperative that the nurse monitor for additional signs of hypoxia, as bradycardia development will be blocked by these medications.

Children may require additional fluids, especially if the child has been NPO. Generally, children receiving sedation for elective procedures should follow the same fasting guidelines as children receiving general anesthesia. The American Society of Anesthesiologists has developed guidelines for appropriate food and liquid intake for children prior to elective sedation (***Table 14***). For the child who undergoes sedation for an emergent procedure, the benefits and risks should be evaluated, with consideration given to the amount and type of liquids or solids ingested [33]. Routine preoperative administration of pharmacologic treatment to reduce gastric volume and increase gastric pH in patients who have no apparent increased risk for pulmonary aspiration is not recommended by the ASA [33].

Additional considerations for nursing care include keeping the child warm during the procedure. Children should also be monitored for the increased risk of paradoxical excitement and emergent reactions.

APPROPRIATE INTAKE OF FOOD/LIQUIDS BEFORE ELECTIVE SEDATION FOR CHILDREN	
Ingested Material	**Minimum Fasting Period**
Clear liquids (i.e., water, fruit juices without pulp, carbonated beverages)	2 hours
Breast milk	4 hours
Infant formula	6 hours
Nonhuman milk: Because nonhuman milk is similar to solids in gastric emptying time, the amount ingested should be considered when determining an appropriate fasting period.	6 hours
Light meal: A light meal typically consists of toast and clear liquids. Meals that include fried or fatty foods or meat may prolong gastric emptying time. Additional fasting time (e.g., eight hours or more) may be needed in these cases. Both the amount and type of foods ingested should be considered when determining an appropriate fasting period.	6 hours
Source: [33]	*Table 14*

Parental presence during the recovery phase commonly helps to reduce the severity of emergent excitement in children. However, prior to having a parent present in the recovery area, the nurse should evaluate the parent's level of comfort in dealing with a potentially confused and combative child. Many parents do not feel comfortable watching their child experience these types of reactions, and they should not be forced to do so under the auspices that it is helpful to the child.

Finally, discharge of the child should take into consideration the age-appropriate behaviors in children. Meeting the preprocedural level of functioning is the aim of discharge criteria in the child. A number of children undergoing sedation may not be ambulatory or able to sit without support; however, they should be able to perform those developmental tasks that they were able to accomplish in the preprocedural phase prior to discharge.

It is more common for children to vomit in the postsedation period. The caregiver should be aware of this risk and undertake measures to reduce the risk of aspiration. In addition, the caregiver should be instructed that it is not common for the child to keep vomiting. If this were to occur, the child should be returned to the institution or a follow-up telephone call should be placed.

Discharge instructions for the pediatric population should be given to both the child and the caregiver. Dependent on the age of the child, he or she may not be able to fully comprehend the need to adhere to these instructions.

The challenge in sedating the pediatric patient is achieving an appropriate level of sedation while preventing oversedation and other complications. Appropriate techniques of drug dosing and vigilant monitoring of this patient population will assure competent drug delivery.

MODERATE SEDATION OF THE GERIATRIC PATIENT

Sedation of the geriatric patient can provide a calm, comfortable environment for the patient who may be experiencing a high level of anxiety. However, the psychologic needs of this population are great, and the increased risk of complications is readily known to practitioners as well as patients. Allowing for adequate history taking and patient instruction is imperative to providing safe delivery of care.

ANATOMIC AND PHYSIOLOGIC DIFFERENCES

As individuals age, there is a decrease in both laryngeal and pharyngeal reflexes; thus, the patient is at increased risk for airway compromise. The loss of dentition changes the shape of the mouth, and it may become a challenge to achieve proper placement and seal with ventilation masks. Should airway compromise develop, osteoarthritis of the neck may preclude placing the patient in the standard head-tilt/jaw-thrust maneuver. In this instance, positioning the elderly patient's head becomes a formidable task that requires the practitioner to be adaptable and able to work within the confines of the situation. If the head-tilt maneuver is not possible, placing the patient in the left lateral decubitus position may decrease the risk of inadvertent aspiration.

One of the major complications of aging and the use of moderate sedation occurs when benzodiazepines and/or opiates are used. Both of these drug classes produce enhanced depression of the patient's respiratory drive, which is a normal change that occurs with aging. With rising levels of CO_2 and falling levels of oxygenation, the younger person will increase the depth and rate of respirations to ensure adequate tissue oxygenation. This ability to respond to these changes is dampened in the elderly, putting the individual at risk for profound hypoxemia [153]. Concurrently, the blood oxygen levels decrease with age; it is not uncommon for the elderly individual to have blood oxygen levels of 80 torr with oxygen saturations of approximately 93% to 95% [153]. These compounded problems lead to a patient who is at increased risk for hypoxia and hypercapnia, which requires judicious monitoring to prevent their occurrence.

The aging process produces a decrease in cardiac output, leading to decreased renal and hepatic blood flow. By the time an individual is 80 years of age, it is said that their cardiac output is one-half that of an individual 20 years of age [154]. This drop in cardiac output requires slower loading times in the elderly, especially with barbiturates.

In addition, the cardiac conduction system deteriorates, enhancing the risk of dysrhythmia development. Combined with developing hypoxia, it is not uncommon to see dysrhythmias in this patient population [154].

Sedation drugs utilized for moderate sedation affect the central nervous system. For the elderly patient, there is an increased sensitivity to these medications. It is highly recommended that the dosage of sedating agents be decreased in the elderly person to prevent profound, deep sedation [153]. Assessing this individual may also be challenging; as individuals age there may be a decrease in cognitive abilities, memory, and data acquisition. The standard neurologic testing should be done with consideration of these changes.

It is estimated that a large percentage of the elderly population is chronically volume depleted. The frequent use of diuretic therapy presupposes these individuals to circulating volume deficits. Drugs that are water soluble have an enhanced action potential in these volume depleted patients.

Additionally, approximately 6% to 11% of older adults are heavy users of alcohol, many of whom under-report their alcohol ingestion [155]. Furthermore, an estimated 7.5% to 70% of older persons in hospitals or other healthcare facilities evidence either illness or other serious consequences of alcohol abuse [156]. It is these patients who can present a unique challenge when they decompensate during sedation due to combined effects of the residual alcohol in their blood stream and the sedating medication [155; 156].

PHARMACOLOGIC CONSIDERATIONS

Decreases in both hepatic and renal function, which naturally occur with aging, lead to a longer half-life and longer clearance of most medications. This translates to a longer length of action; therefore, recovery from moderate sedation is longer in the elderly than it is in other adult populations [61; 154]. Additionally, the elderly patient is at risk for cumulative drug effects, causing altered function of the sedating drugs. This is commonly seen when this patient population is given benzodiazepines and opiates concurrently.

Drug binding is also altered in the elderly patient. Protein-bound drugs attain an increased concentration of circulating drug secondary to the decrease in albumin that occurs with aging [154]. With more circulating drug available, the more profound the drug effects will be. Hence, any sedating drug that is protein bound will produce more profound sedation, increasing the risk of oversedation. The amount of body protein in an individual can be assessed by evaluating the patient's serum albumin level. The lower the albumin level, the lower the amount of body protein. Any patient with a decreased serum albumin would be expected to have the aforementioned risk of profound sedation.

Water-soluble drugs will have a greater amount of drug available at the target site, as the amount of total body water decreases with age [154; 156]. As with protein-bound drugs, the risk of increased drug effects occurs. Coupled with the chronic volume-depleted state, the risk of oversedation occurring with water-soluble drugs is greatly increased.

Conversely, fat-soluble drugs have less drug available at the target site secondary to the increase in body fat that accumulates during aging. These drugs are sequestered in the fat and will have a slower release and, therefore, a longer length of action. Any fat-soluble drug given to an elderly individual can be expected to produce a slower, lengthier recovery period [154].

Adverse drug reactions and interactions are more common in this population due to the fact that the number of over-the-counter and prescription drugs and herbal supplements ingested is much higher [156]. Elderly patients should be monitored for adverse drug reactions, and these should be reported to the appropriate agencies. Cardiovascular medications can cause significant compounded cardiovascular instability in the elderly by producing significant bradycardia and hypotension.

Recommended drug dosing in the elderly patient should be done with the following statement in mind: Start Low and Go Slow. Adherence to this advice will greatly reduce the risk of complication development. Dosing of benzodiazepines is generally reduced by 30% to 50% from the normal adult dosage [61]. Barbiturates should be administered slowly due to decreased cardiac output and circulation times. If given too rapidly, profound hypotension and a decreased level of consciousness will occur. Sedative hypnotic doses should also be decreased, and the risk of paradoxical excitement/delirium is more common with these medications [61].

Titrating drug dosages in the elderly should be considered standard practice [61; 154]. The risk of complications is high in this population, and the practitioner should undertake measures to reduce these risks.

NURSING CARE

The practitioner providing sedation to the elderly patient should adjust care during the presedation, intrasedation, and postsedation phases. Initially, thorough preprocedural assessment is imperative, including a full evaluation of the patient's airway. Recognition of comorbidities is essential to decrease the risk of complications.

Presedation vital signs and oxygen saturations should be attained, noting that anxiety and fear may cause these to be inaccurate. Once these parameters are attained, oxygen should be administered, with consideration of the patient with a history of pulmonary disease, which may preclude the use of high oxygen percentages. Cardiac monitoring should be instituted prior to sedation and continued throughout the sedation and recovery periods. Volume replacement may be necessary; however, it is just as important to prevent volume overload in the patient with a positive cardiac history. It is also important to remember that the elderly patient is at risk for developing hypothermia, and the patient should be kept warm during long procedures, especially those interventions with large body surface exposure.

EVIDENCE-BASED PRACTICE RECOMMENDATION

The American Society for Gastrointestinal Endoscopy Practice Committee recommends standard monitoring procedures in the elderly during moderate sedation with heightened awareness of this population's increased response to sedatives.

(https://www.guideline.gov/summaries/summary/46943. Last accessed June 22, 2017.)

Level of Evidence: +++O (Moderate quality)

Discharge criteria for the elderly patient may require an adjustment in the ability to meet presedation values. The normally hypertensive patient may remain slightly hypotensive secondary to prolonged cardiovascular effects of the drugs administered. This hypotension may last as long as 24 hours and should not prevent the patient from being discharged.

It is important in managing sedation in the elderly to remember these criteria to deliver safe care. With the increasing incidence of moderate sedation procedures being performed in this population, the practitioner will continue to see these patients on a regular basis.

MODERATE SEDATION OF THE OBSTETRIC PATIENT

Moderate sedation in the obstetric setting can be done for a variety of reasons. It is imperative that the pregnant woman be monitored for the effects of sedation on her fetus as well as herself. Many of the changes that occur with pregnancy occur over time; others can occur as soon as the woman conceives. In moderate sedation, these anatomic and physiologic responses should be addressed.

ANATOMIC AND PHYSIOLOGIC DIFFERENCES

Airway changes in the pregnant woman include engorgement of the nasal and mucous membranes leading to a narrowing of the airway. Tidal volume increases by 30% to 35%. The respiratory rate remains relatively constant or increases slightly. In order to meet her and her fetus's oxygen demands, there is a compensatory and significant increase in minute ventilation. However, the patient's vital capacity decreases as the diaphragm becomes elevated [157].

Hemodynamic changes occur during pregnancy as well. There is an increase in heart rate, which reaches a maximal value of 10% to 30% above baseline values by 32 weeks. Cardiac output increases 30% to 50% above baseline levels by 25 weeks and may be affected by position [157]. Systolic blood pressure may drop, and the patient is at risk for developing supine hypotension [157]. It is imperative that the practitioner be aware of these changes as assessment parameters are altered and the recognition of hemodynamic instability is more challenging [158].

In addition, during pregnancy there is an increase in circulating volume. The majority of this increase is in plasma volume. This blood volume increases progressively, peaking at a value of approximately 40% above baseline by the third trimester [157].

PHARMACOLOGIC CONSIDERATIONS

Sedation medications are like any other drug given during pregnancy, and considerations should be made as to the effects of the drug on both the mother and the fetus. The greatest risks occur during the first trimester, when fetal development is most adversely affected. Additional risks occur at the time of delivery, as certain medications can cross the placental barrier, leading to a sedated newborn [61].

Drug dosing in the pregnant patient is the same as for a nonpregnant female. However, the increased circulating volume will affect how water-soluble drugs are distributed and absorbed [158]. These drugs become less concentrated; therefore, onset of action is somewhat slower, although not significantly. The dosage of the drug may need to be increased, although it is safer to start at the normal recommended dosage for a nonpregnant female and increase dosage as needed.

NURSING CARE

The risk of airway compromise is increased in the pregnant patient and astute airway assessment is critical. Statistics show that 1 in 300 pregnant women will have an airway that is difficult to manage [159]. When checking for emergency support supplies, ensure that a smaller-than-anticipated endotracheal tube is available. A pregnant woman with engorged tissues may require an endotracheal tube as small as a 6.0; many of these tubes may not be cuffed, as they are usually used in the pediatric population. Therefore, it is necessary to check that the appropriate equipment is available.

Supplemental oxygen should be readily available and used early. The developing hypoxia affects not only the mother but the fetus as well [158]. Additionally, it is known that hypoxia can precipitate contractions, which should be avoided if at all possible.

Dehydration can also precipitate contractions. Therefore, ensuring adequate volume replacement for the patient who has been kept NPO is imperative. If sedation is performed emergently, assessment of the patient's food and fluid intake should be done with consideration of the fact that gastric emptying time is prolonged during pregnancy. The use of histamine blockers is recommended in this population to reduce the risk of gastric reflux and aspiration [76; 158].

Positioning the patient in the left lateral decubitus position will help ensure adequate blood return to the heart. If the patient must be in the flat-lying, recumbent position for the intervention, placing a towel or blanket under the right hip to rotate the hips to the left will help achieve the same objective [76].

Fetal monitoring should be considered in all high-risk patients [158]. Instituting fetal monitoring should be performed by someone skilled in monitor use and the detection of subtle changes. Unless the nurse commonly works in the obstetric setting, an additional individual to monitor the mother and the fetus would be most helpful. When monitoring the fetus, observation of changes in heart rate and rhythm are the most sensitive indicators of fetal well-being. Decelerations in fetal heart rate that are spontaneous or in response to uterine contractions are considered signs of fetal distress [158]. In most instances, administration of oxygen and repositioning the mother may correct this untoward complication.

Although utilized infrequently in the obstetric patient, moderate sedation can be a very beneficial therapy. The mother who is comfortable and anxiety-free can provide the fetus with a safe, supportive environment. It is the nurse's responsibility to ensure that the mother is also in a safe and supportive environment throughout the intervention.

SEDATION OF THE CRITICALLY ILL PATIENT

Sedation in the critically ill patient has changed dramatically over time. For many years, the patient in the ICU was deeply sedated and immobile. After years of research, it was concluded that this deep sedation was not beneficial for the patient; in fact, it produced a number of complications.

The deeply sedated patient was unable to move or shift positions, leading to an increased risk of pressure sore development. Patients who were mechanically ventilated in the control mode were difficult to wean from the ventilator when the appropriate time came. In addition, family members were unable to interact with their loved ones, leading to significant emotional impact upon these individuals.

Today, the patient in the ICU is lightly sedated, and sedation is used as an adjunct to achieve therapeutic results. Patients are sedated in order to minimize patient discomfort, alleviate anxiety and agitation, attenuate the stress response, facilitate mechanical ventilation, and decrease physiologic demands. Sedation is generally for longer time frames and may be delivered by continuous infusion.

A number of interventions in the ICU are painful and/or produce discomfort. Placement of invasive monitoring lines, endotracheal tube intubation, and Foley catheter placement all increase patient discomfort. Sedatives with analgesic properties, such as narcotics, can help alleviate this pain of intrusion.

Patient's senses in the ICU are assaulted by a number of stimuli, including lights, sounds, and activities. These assaults can greatly increase the patient's level of anxiety and agitation, often leading to an increase in heart rate and blood pressure. Mild sedation can attenuate this response, decreasing the stressors upon the individual's metabolic demands. Patient comfort should be a primary concern [160].

Many modes of ventilatory support are uncomfortable to the patient and may cause the patient to fight the respirator. As an example, permissive hypercapnia is accomplished over the course of a few days, allowing the patient's CO_2 level to rise to higher than normal levels. The normal compensatory response in the healthy individual would be to increase the respiratory rate to express this excess CO_2. The patient is sedated to avoid this compensatory response.

It is well known that the stress response that occurs in an ICU patient greatly increases the patient's physiologic demands. These increased demands have a number of negative outcomes; as an example, wound healing is compromised. In an effort to reduce this stress response, the patient may be sedated to improve physiologic functioning and a return to a normal state of health.

Continuous infusion of medications is a highly popular method of ICU sedation [160]. Some patients may still be sedated on an every four-to-six-hour basis, which, if medication administration is delayed, will produce peak and trough levels of drugs. As patient and family demands are being encouraged and valued, preventing these highs and lows in sedation responses is becoming more important, making drug bolusing a less popular method of drug dosing. However, the practitioner should be aware that prolonged continual infusion of certain drugs can extend the half-life and length of action of these medications. For example, the half-life of morphine sulfate in the non-ICU patient ranges from 1.5 to 4 hours [61]. In the patient on a continuous morphine infusion in the ICU, the half-life can extend to 5.9 to 13 hours [6]. This longer length of action can delay recovery from sedation, prolonging ICU stays. Trying to meet the patient's needs without oversedation is a continual challenge in providing sedation to this population [160].

Concomitantly, sedation in the ICU may be accompanied by the use of neuromuscular blockade [161]. The level of paralysis may vary depending upon patient need and condition. However, the use of blockade may prevent full evaluation of the patient's level of response. Additionally, neuromuscular blockade will prevent using certain sedation scales as patient responses are compromised by the paralysis [161].

It has been recommended that, in addition to the necessity for evaluation in the postsedation period, ICU patients be monitored for sedation status while receiving medications [160]. One study evaluated the use of the RASS to evaluate changes in sedation and analgesia over consecutive days in the ICU. The researchers determined that the RASS was an effective tool and assisted in guiding goal-oriented sedation [160]. Other scales that have been tested for validity in ICU patients include the Ramsay Sedation Score, Sedation-Agitation Scale (SAS) Glasgow Coma Scale, Motor Activity Assessment Scale, Auditory Evoked Potentials, and the Nursing Instrument for the Communication of Sedation [162; 163; 164]. The use of sedation scales and protocols designed to minimize sedative use are associated with improved ICU patient outcomes, including shortened duration of mechanical ventilation, shortened ICU stay and length of hospital stay, and decreased incidences of delirium and long-term cognitive dysfunction [164].

Many institutions using sedation in the critically ill develop guidelines specifically for this patient population. The goals and objectives of ICU sedation do vary from those previously discussed. If sedation in the ICU is considered "moderate sedation," the policy and procedure for sedation should reflect this change in patient outcomes.

PATIENTS UNDERGOING PROCEDURAL INTERVENTIONS

Many patients receive moderate sedation when undergoing procedures in a number of settings, including, but not limited to, cardiac catheterization laboratories, endoscopy settings, gastroenterology settings, radiology settings, and other ambulatory departments. If these patients are young or elderly, the parameters previously discussed should be considered. However, in certain situations with certain procedures, there are other issues that should be addressed, and a brief discussion of these issues will be presented here.

RADIOLOGIC INTERVENTIONS

The patient undergoing radiologic procedures may be administered contrast media that has the potential to alter pulse oximeter readings [101; 103]. The dye prevents the passage of the light through the tissues, thus giving inaccurate readings. These effects may last for only a brief period; however, in other situations they may last minutes to hours. Variables include the volume of dye administered, the size of the vessel in which the dye was injected, the patient's cardiac output and circulation time, and the renal function of the patient [101]. The longer the dye is on board, the longer this effect upon pulse oximetry monitoring will be experienced. The disadvantage is that the practitioner is not always able to ascertain when the dye is cleared from the body. Thus, the nurse caring for this patient should use other physical assessment tools to evaluate the oxygenation status of the patient [101].

Additionally, contrast dyes may have high sodium levels that produce a transient hypertensive period, usually followed in 15 to 20 minutes by a diuretic phase. Furthermore, during this time the patient has an increase in cardiac filling pressures. For the patient with a compromised cardiovascular system, these changes in vital signs and cardiovascular volume may not be well tolerated. It is imperative that the practitioner continually monitor these patients and intervene, should the effects be detrimental and/or lengthy in the patient.

Another complication occurring in this setting is the development of allergic or adverse reactions. Although these reactions are characterized by activation of mediators typical of allergic response, they are not antigen mediated and, therefore, are not true allergies [165]. The nurse should monitor the patient for the initial signs of developing anaphylactoid response: flushing, chills, nausea and/or vomiting, and urticaria. Epinephrine and diphenhydramine should be readily available in the setting for management of this complication [165].

For patients undergoing MRI, there are a number of important considerations. The equipment that is used should be determined to be magnetic resonance-compatible. All cables and coils should be checked to insure that there are no loops of cable or wire that can burn the patient or distort the image. Imaging is done inside a large magnet, and access to the patient is minimal. Coupled with this limited access, visibility is compromised; the room lighting is altered, and the observation window is covered with a copper mesh screen. Noise levels can reach 95 decibels and may affect the ability to hear equipment alarms. It is critical that these patients receive diligent monitoring throughout the procedure.

Medications used in children undergoing magnetic imaging require astute patient assessment, which, as noted, is challenging while the patient is in the scanner. Additionally, combination chloral hydrate and pentobarbital can produce profound sedation in the child with the risk of airway compromise and deep sedation. Nurses administering these drugs should be well versed in their actions and uses and provide vigilant monitoring during performance of the study.

Finally, many patients are anxious while undergoing studies in the radiology suite. The procedures may cause pain and discomfort, some of which can be treated with analgesics. Patients who are claustrophobic become highly anxious when an MRI is performed. Continual reassurance and support, in unison with adequate sedation, will help reduce these factors.

CARDIAC CATHETERIZATIONS AND ELECTROPHYSIOLOGIC STUDIES

Patients undergoing cardiac interventional procedures are generally cardiovascularly compromised prior to the start of the procedure. Many of these interventions are done on an elective basis to allow time for optimizing cardiovascular function. However, the patient may require emergent intervention without adequate time for stabilization. Therefore, it is imperative that presedation assessment be thorough to recognize patient risks. Patients with a history of hemodynamic instability may be at risk for significant hypotension immediately after administration of sedation agents, especially narcotics. For this reason, the sedating drug administered should be chosen with consideration of this risk.

Many cardiac studies are quite lengthy and sedation of the patient can last up to six hours or more. Obviously, with this length of procedure, nursing care and documentation is more in-depth. Providing sedation throughout the procedure can be challenging. Administering sedation with continuous infusions can ensure a therapeutic blood level that is difficult to maintain with the bolus technique of administration.

A number of sedating medications affect the cardiac conduction system, and this should be a consideration for any patient undergoing an electrophysiologic study. Also, most antidysrhythmics are discontinued prior to the start of this type of procedure to allow for drug effect evaluation. Therefore, cardiac monitoring of rate and rhythm is imperative to providing safe patient care.

ENDOSCOPIC PROCEDURES

The advantage of the majority of endoscopic procedures is their short procedural time. The use of short-acting sedatives is efficient in this population; thus, repeat drug dosing may not be required. This translates to short recovery times with early discharge [148].

During these procedures, patients may be asked to cooperate with position changes, etc. It is important that the patient's level of consciousness be appropriate to allow the patient to cooperate with these requests. As an example, during endoscopic retrograde cholangiopancreatography (ERCP) the patient is commonly placed in the prone position, which presents additional challenges in the ability to monitor the patient's airway [97; 166]. Oversedation of this population is not recommended, as patient compliance and the patient's protective mechanisms are compromised [166].

Manipulation of the endoscope while in the lower esophagus may lead to cardiac dysrhythmia development. Continual cardiac rhythm monitoring should be required for all these patients. If dysrhythmias do develop, repositioning of the scope may avert their progression.

CASE STUDIES

The radiology department occasionally performs moderate sedation on patients who exhibit a high level of anxiety prior to a procedure. On today's schedule, there are two patients requiring MRIs. Both patients will require moderate sedation to allow the radiologist and technician to obtain an accurate study.

A nurse from the emergency department is scheduled to administer the moderate sedation agents as no registered nurse is routinely staffed in radiology. Upon arrival, the nurse begins to prepare the radiology suite for the procedure and review the patients' histories and physicals.

PATIENT J

Patient J is a young girl, 2 years of age, with a history of hydrocephalus since birth. She has been brought to the hospital with complaints of continuous vomiting, lethargy, and inappropriate behavior for her age. The pediatric neurologist orders the MRI to evaluate the current status of her cerebral spinal fluid circulation.

The neurologist orders the procedure to be performed under moderate sedation, as Patient J is not cooperative and is easily agitated. The nurse reviews her history, which is otherwise unremarkable. She is not taking any current medications at home, either prescribed or over-the-counter. She had previously been on anticonvulsant medication, which was discontinued more than a week prior to the procedure.

Upon arrival of Patient J in the radiology suite, the nurse performs a presedation assessment. Her cardiac and respiratory systems are within normal limits for her age. However, neurologic assessment of Patient J is challenging due to her decreased mental status. The nurse notes that Patient J responds to her mother, who accompanies her to the department. Although Patient J has had previous MRIs, the nurse discusses the procedure with the mother and patient. She explains what will be happening and that she will be asked to lie still for a number of minutes. Additionally, the nurse explains the use of moderate sedation to the mother and patient, ensuring the mother that Patient J will be comfortable and everything will be done to try and reduce her fear of separation from her mother. When the mother asks to stay in the room with Patient J, the nurse explains that this is neither safe nor allowed.

Additional review of Patient J's chart shows that she was admitted yesterday afternoon and received antiemetics upon admission. Upon admission, her blood pressure was low for her age. Her admission vital signs were: blood pressure, 84/68 mm Hg; pulse, 104 bpm; respiratory rate, 30 breaths/minute; and temperature, 99.7°F. Currently, her blood pressure is 92/64 mm Hg; pulse, 100; and respiratory rate, 30 breaths/minute. She has an IV line infusing 5% dextrose in 0.25% normal saline at a rate of 45 cc/hr. Her admission weight was 25 pounds (approximately 11 kgs). Upon questioning, her mother states that she has lost some weight; her normal weight is about 28 pounds. She has not taken anything by mouth since admission.

After obtaining the presedation assessment, the nurse must prepare the room, equipment, and medications for Patient J. The nurse ensures that a crash cart is located in the radiology department and checks the defibrillator for proper functioning.

The oxygen set-up in the scanner is checked, as is the suction. The pulse oximeter and noninvasive blood pressure monitor are warmed up to assure that they will be ready when the sedation is to begin. Furthermore, all equipment should be determined to be MR-compatible to prevent burns during the procedure.

The medication ordered for Patient J includes midazolam 0.02 mg/kg IV or a dose of 0.5 mg/kg orally. (As Patient J has a history of vomiting, the nurse chooses to administer the midazolam via the intravenous route to ensure proper drug dosing and reduce the risk of vomiting.) Also ordered is fentanyl 0.5 mcg/kg, to be given in the event that the midazolam is inadequate in achieving the appropriate level of sedation. The nurse first calculates the correct dose based upon Patient J's weight of 11 kgs. Thus, the dose of midazolam is 0.2 mg, and the dose of fentanyl is 5 mcg. These medications are drawn into syringes and labeled. Additionally, the nurse draws 0.5 mg of naloxone (based on a dose of 0.05 mg/kg); this syringe is also labeled and placed off to the side, where it is easily accessible in the event of oversedation or other complications.

Finally, Patient J is brought into the room with the scanner and hooked up to the oxygen, pulse oximeter, and noninvasive blood pressure monitor. A presedation set of vital signs are obtained, including oxygen saturation measurements before and after oxygen therapy is initiated. The patient's IV is checked for patency and another set of vital signs is obtained. At this point, the mother is asked to leave the room, and Patient J becomes quite agitated. The radiologist orders the nurse to begin administering the sedation medications immediately in order to relax Patient J and prevent any further agitation.

The nurse administers the 0.2 mg of midazolam and monitors Patient J's response to the medication. After one minute, her blood pressure is noted to fall to a systolic pressure of 84 mm Hg. Neurologically, she is less agitated and appears to be relaxing. When asked her name she answers appropriately, but also asks again for her mother. The blood pressure decline is of concern; in response to this, the nurse increases the IV rate to 50 cc/hr. Within five minutes, her blood pressure is back up to its presedation level.

The radiologist is ready to start the scan; however, Patient J continues to move on the scanner table. The radiologist requests the nurse to administer additional medication, and the nurse administers an additional 0.2 mg of midazolam. Within two minutes, Patient J is quiet and calm and the procedure is initiated.

During the procedure, the nurse must leave the room and monitor the patient from the outside viewing area. Patient J's vital signs are continually monitored via the blood pressure monitor cycles. The nurse also observes the pulse oximeter reading as part of the patient assessment. After 10 minutes, the nurse notes that Patient J's pulse oximeter reading has fallen to a level of 91%. The radiologist is informed, and the scan is momentarily terminated to allow the nurse to enter the room and evaluate the patient. The patient's respiratory rate is now 15 breaths/minute, and the pulse oximeter reading has fallen further to 90%. The nurse immediately places Patient J's head into the sniffing position to open her airway and increase the oxygen flow rate. The patient's pulse oximeter reading increases to only 91% with this maneuver, and the nurse decides to administer a reversal agent to prevent the respiratory insufficiency from progressing further.

It is at this point that the nurse realizes that naloxone has been drawn as an antagonist. As the patient has only thus far received midazolam, the naloxone will be ineffective at reversing a benzodiazepine, as it is a narcotic antagonist. Immediately, the nurse draws up a dose of 0.1 mg of flumazenil and administers this through the IV line. Within two minutes, Patient J is breathing at a rate of 25 breaths/minute, her pulse oximeter reading has increased to 94% saturation, and her other vital signs remain within normal limits. However, she is starting to move on the table and the scan cannot be completed until she is sedated adequately to prevent body movement.

Patient J is allowed to stabilize for another five minutes, at which time the radiologist requests further sedation so the scan can be completed. The remaining time to perform the scan is approximately 10 to 12 minutes. The nurse now chooses to administer 2.5 mcg of fentanyl to Patient J and to monitor the drug effects. Although a dose of 5 mcg was ordered, the nurse is concerned that the patient will develop a second episode of respiratory insufficiency. After three minutes, Patient J remains agitated and a second dose of 2.5 mcg of fentanyl is administered.

Throughout administration of the fentanyl, Patient J's vital signs and oxygen saturations remain within normal limits. After the second dose of fentanyl (for a total of 5 mcg), the procedure can continue and is able to be completed without further complication.

Upon completion, Patient J's mother is allowed to return to her daughter's bedside and the effects of the medication are allowed to wear off. No further reversal agents are administered. Based upon the length of action of the midazolam and fentanyl, it is expected that Patient J will remain sedated for another 20 to 30 minutes. During this recovery period, the nurse continues to assess the patient's vital signs and oxygen saturations, and all parameters remain within normal limits.

Due to the fact that Patient J is an inpatient, the recovery and discharge is different than for a patient who is being discharged to home. After 30 minutes, Patient J remains sleepy but opens her eyes and recognizes her mother. When asked her name she answers appropriately. At this point, the nurse finishes documenting the procedure and Patient J is returned to her bed on the pediatric unit.

Discussion

The nurse caring for Patient J performed quite well. The presedation assessment was very thorough; it was important to consider the fact that continuous vomiting can lead to protracted volume status in children, and this could impact her response to medications. The nurse recognized that the intravenous route of medication administration is far more appropriate in this patient than the oral route. Her history of a decreased level of consciousness could hinder oral administration. Additionally, with the patient's history of vomiting, oral drug administration could precipitate a further bout of vomiting.

Preparing the medications was critical to the success of this procedure. The biggest error was in not drawing up a dose of flumazenil. The nurse chose to prepare the naloxone, without considering that the fentanyl may not have been utilized at all. It would have been to everyone's benefit had both the naloxone and flumazenil been prepared initially. However, the outcome was good; this delay did not harm the patient in any manner.

When the radiologist asked to continue the procedure, the nurse administered a dose of fentanyl that was one-half of the ordered dose, most likely based on the fact that Patient J had experienced the previous episode of respiratory insufficiency. This choice was not inappropriate, but in review of the case, it was probably inadequate due to the length of time since the initial administration of the midazolam. Had the nurse recognized that the

duration of the midazolam was reached, administering the full 5 mcg of fentanyl most likely would have been safe. However, in this instance, the nurse chose to act cautiously, and no one should find fault with this action.

Finally, the recovery of this patient was uneventful. The patient reached her presedation level of functioning. As she had an altered level of functioning to begin with, this was an appropriate way to evaluate her neurologic status. However, had the nurse not performed a good presedation assessment, recognition of the patient's return to her presedation level of functioning would have been challenging.

PATIENT D

The next patient scheduled for the MRI scanner is Patient D, a man 76 years of age, who fell at home yesterday and has a history of falling. There is point tenderness at the hip joint, and the patient is unable to ambulate. The orthopedic surgeon requests an MRI of the hip and pelvic area to determine what, if any, injury could be causing this pain and dysfunction.

Patient D states that he is very claustrophobic and initially refused the MRI because of the fear of the "tube." After discussion with the surgeon, with a guarantee that he would be sedated and comfortable, Patient D agreed to the scan.

Upon review of the patient's history, it is determined that he has a history of congestive heart failure, smokes two packs of cigarettes a day, and denies alcohol ingestion. The nurse performs a presedation assessment, obtaining baseline vital signs and auscultates the patient's heart and lungs. The patient is asked to open his mouth wide, and a Mallampati score of 2 is assigned to the patient. The patient is questioned about any dentures or partials, which he denies. An anesthesia history is obtained; the patient has had two previous surgeries under general anesthesia. He denies any complications with either procedure.

Due to the patient's history of congestive heart failure, the nurse reviews the chart for a current 12-lead electrocardiogram and finds that one was obtained yesterday on admission. Additionally, Patient D's admission laboratory values are reviewed. The only abnormality is a potassium level of 3.3 mEq. The nurse determines that the patient is a Class 3 on the ASA Risk Classification score. The nurse also reviews the patient's current medication use, which includes digoxin, furosemide, and naproxen for arthritic pain control.

Although the surgeon reviewed the moderate sedation procedure with the patient, the nurse conducts patient education as well. The nurse explains that the patient will be receiving medications to help him relax and decrease his fears about the scanner. Patient D responds, "Just knock me out. I don't want to remember or feel a thing!" The nurse then proceeds to offer further information; it is imperative that the patient recognize that he will not be asleep. The patient may be asked to respond to questions throughout the procedure to adequately assess the level of sedation. Additionally, the nurse explains that the medications can help alleviate some of the patient's pain, but there is discomfort that is experienced from lying on a hard table. The patient is assured that everything will be done to make the patient as comfortable as possible, but the procedure is not discomfort-free.

At this point, Patient D reconsiders his decision to have the procedure performed. When he agreed to the procedure it was his understanding that he would be asleep, similar to what occurs with general anesthesia. It is unfortunate that the surgeon allowed the patient to develop this misunderstanding; it not only delayed the start of the procedure but backfired in that the patient's level of anxiety was heightened. It took the nurse more than 20 minutes to educate the patient and receive his permission to continue with the scan.

In preparing the room for Patient D, the nurse has only recently finished sedating the first patient and knows the equipment was functional. She places the patient on the monitor, pulse oximeter, and oxygen by face mask. Presedation vital signs are obtained and compared to the vital signs obtained on the inpatient unit. An oxygen saturation of 91% is obtained prior to initiating oxygen therapy, as is expected. With oxygen, the saturation increases to only 93%. The existing IV line is checked for patency.

The medications ordered for Patient D include midazolam 2 mg IV, fentanyl 50 mcg IV, and methohexital 10 mg IV, as needed. The nurse draws the appropriate dosages into syringes and labels each. Learning from the first patient, the nurse draws both flumazenil (0.2 mg) and naloxone (1 mg) and labels these syringes as well.

The radiologist orders the sedation to be initiated, and the nurse administers 2 mg midazolam IV over one minute. The patient demonstrates a slight drop in blood pressure; however, it is within acceptable limits. The patient remains quite agitated, asking when the medication is going to work. At this point, the nurse administers 25 mcg fentanyl IV. Patient D's blood pressure starts to fall after the dose of fentanyl, and the IV rate is increased. The patient continues to complain of discomfort and fear. His heart rate increases to a rate of 90 bpm (from a normal of 62 bpm). The radiologist requests additional sedation medication in an attempt to achieve an appropriate level of sedation in this patient.

The nurse then administers an additional 2 mg IV of midazolam. Patient D appears to relax, and he is moved into the "tube." Immediately upon entering the tube, the patient becomes severely agitated, asking to get out, and calling out, "Somebody help me." It is obvious that the patient's level of sedation is inadequate at this point, and the patient is removed from the scanner. The nurse enters the room and notes that the patient is very confused; he is unable to answer appropriately to his name, he is calling for his wife (who had died three years before), and his blood pressure, pulse, and respiratory rate are all quite high.

The radiologist orders an additional 3 mg IV of midazolam, which the nurse administers. At this point, Patient D appears more relaxed; however, when the nurse approaches the patient to listen to his heart and lungs, the patient starts thrashing about on the table. Obviously, Patient D is at risk of further injury, especially at the injured hip joint. The radiologist orders an additional 3 mg IV midazolam. However, the nurse refuses to administer this dose based upon concern of oversedation, common to the elderly individual. The nurse expresses this concern, and the order is changed to fentanyl 50 mcg IV. The nurse agreed to administer the fentanyl, and upon administration, the patient experiences a short burst of ventricular tachycardia that spontaneously converts to the patient's normal rhythm.

At this point, the radiologist decides to cancel the procedure until such time that the patient can be appropriately sedated. It is obvious that the radiologist blames the nurse for the patient's deterioration.

Despite the apparent animosity, the nurse's responsibility is to stay with Patient D and provide for his safety. The patient's oxygen flow rate is increased, after which the patient becomes quite agitated and removes the oxygen mask. While the nurse is preparing an amiodarone bolus to prevent further episodes of ventricular tachycardia, the patient becomes agitated to the point of requiring restraints. The nurse looks for assistance from other staff members but has been left alone with Patient D.

At this point, the nurse remembers the naloxone and administers 1 mg IV, hoping to see a reduction in the patient's level of agitation. However, this is not accomplished. Subsequently, flumazenil (0.2 mg IV) is administered, and the patient begins to appear more relaxed, with improving vital signs.

After three minutes, the nurse administers a second dose of flumazenil, and Patient D is able to answer questions appropriately. Throughout this time period, the nurse continues to assess Patient D's vital signs, which are slowly returning to normal.

Once the patient reaches his presedation level of functioning, the nurse transfers the patient back to the inpatient unit. Upon moving the patient into his bed, he asks, "What did they find?" Patient D is unaware that the procedure had not been completed.

Discussion

A number of mistakes were made in preparing and sedating Patient D. However, the nurse did perform a good presedation assessment. All the appropriate information was obtained from the patient, and the patient was assessed fully. One omission was putting the information to use. Elderly patients with a history of cardiac disease, especially congestive heart failure, are at increased risk of poor circulation and low cardiac outputs. These patients need special care when administering sedating agents. Additionally, the patient was on digoxin with a low potassium level, increasing the risk of dysrhythmia development. Had the nurse considered the risks involved in this patient, the incidence of ventricular tachycardia may have been avoided by further stabilization measures prior to the start of the sedation.

It was an error on the surgeon's part to assure Patient D that he would be comfortable throughout the procedure. With this false assurance, the patient was at risk for agitation when his expectations were not met. As soon as Patient D entered the scanner, this anxiety level was enhanced. Thus, the medication effects were inadequate to meet the patient's needs.

In preparing the room for this second patient, the nurse assumed that the equipment was functioning properly because it had done so during the last case. This assumption can be deadly; the equipment should always be re-tested prior to the start of a subsequent procedure. In this case, there were no apparent equipment failures, but had this occurred, the outcome could have been disastrous.

The medications ordered for Patient D were probably not the best for an elderly patient with a history of congestive heart failure. Midazolam is known to precipitate an episode of paradoxical excitement in the elderly, which became quite apparent throughout this case study. Of all the narcotics, fentanyl has the least effect upon the cardiovascular system; however, patients with a history of cardiac disease are at risk of hemodynamic instability with any of the sedating drugs. Methohexital, a barbiturate, can precipitate a profound drop in the patient's blood pressure, and although the dosage ordered was quite low, this may have been a risk for Patient D had he received this medication.

Throughout the procedure, the sedating drug of choice was midazolam. The initial dose was tolerated by the patient; however, subsequent doses caused further patient compromise. After the second dose of midazolam, Patient D was moved into the scanner, and this is when he began to exhibit signs of paradoxical excitement and confusion. Rather than treating this with flumazenil, Patient D was administered an additional 3 mg of midazolam, which caused a further decline in his level of functioning and his vital signs.

The nurse was appropriate in refusing to administer the next 3 mg dose of midazolam. However, in its place, fentanyl was administered. Prior to administering the fentanyl, the patient should have been evaluated and the cause of his agitation further investigated.

This dose of fentanyl most likely precipitated a fall in the patient's blood pressure, leading to a decreased coronary artery blood flow and precipitating the run of ventricular tachycardia. Fortunately, the dysrhythmia was self-limiting and the patient did not experience further cardiac failure, including ventricular fibrillation or asystole.

It was at this point that the radiologist canceled the procedure and left the room. Patient D was definitely not stable at this point, and additional backup should have been called. Instead, the nurse continued to support the patient alone. Fortunately, the nurse was able to handle the developments as they arose; however, had the patient developed a second bout of ventricular tachycardia or other life-threatening complications, it would have been difficult to access additional backup support.

Eventually, the nurse remembered the antagonists that were available. The dose of naloxone was appropriate to reverse the effects of the fentanyl; however, Patient D's greatest problem was the agitation secondary to the midazolam. It may have been wiser to administer the flumazenil first, followed by the naloxone, if needed.

During this difficult period, the nurse and the radiologist's relationship deteriorated to the point of becoming ineffective. Early attempts at communication and a collegial discussion of why the patient was deteriorating may have reduced the number of complications experienced by Patient D. It is imperative that the nurse and physician in charge of the procedure communicate regarding patient condition and work together to achieve a successful outcome.

When Patient D returned to his inpatient unit, he did not remember that the MRI was not performed. This is a common occurrence after the administration of benzodiazepines. The antegrade amnesia prevents the patient from remembering details. In many cases, this is a desirable effect; in this case, it may only lead to further patient mistrust. He was told that he would not remember, but at the same time, the procedure was not accomplished.

This case study demonstrates a number of the risks involved in providing moderate sedation to the elderly. This patient population is at increased risk of complications. In addition, they exhibit varying responses to the "typical" sedating medications. Prior to initiating sedation in this population, it is wise to review the risks, consider the causes, and evaluate the potential effectiveness of interventions. Then, if the patient does develop untoward complications, the cause can be more easily identified and therapies instituted earlier.

PRACTICE ISSUES

There are a number of issues that remain unresolved regarding the delivery of moderate sedation by nurses. Nurses are concerned about their legal status, training, competencies, and moral obligations in providing safe and competent care. With time and experience, many of these issues will resolve themselves. Others should be evaluated and policies and procedures developed to protect nurses' rights and responsibilities.

The following discussion will focus on these practice issues. At the present time, there is no right or wrong answer in solving these questions; nurses administering moderate sedation should make it their responsibility to determine what they believe to be safe care and adhere to these standards.

ADVANCED CARDIAC LIFE SUPPORT TRAINING

Many questions frequently arise when developing a moderate sedation program. *Do nurses need to be Advanced Cardiac Life Support (ACLS) certified? If indeed life-threatening complications arise, should the nurse administering sedating medications be trained in the advanced management of these risks?*

Many professional organizations, hospitals, and State Boards of Nursing have examined the issue of cardiac life support training. Some states and institutions have developed policies that clearly state that nurses administering moderate sedation must maintain current ACLS certification or equivalent [167; 168]. The advantages of this training are far-reaching. The patient who develops a complication, such as loss of airway or dysrhythmia development, will receive immediate corrective action performed by a trained, certified nurse. It is well documented that the faster the corrective action is undertaken, the better the chance of achieving a full and complete recovery.

Additionally, the algorithms used in ACLS offer a framework for interventional guidelines. Interventions are clearly spelled out and sequenced in a step-by-step manner to alleviate the anxiety that develops when an untoward event occurs. The nurse knows immediately which actions should be performed, and there is no doubt or question as to the course of action.

Despite the apparent benefits of ACLS training, mandatory certification is not supported by a number of organizations. The ASA states that "an individual with advanced life support skills should be immediately available (within five minutes)" [25]. The Joint Commission minimally requires that the physician responsible for prescribing and ordering moderate sedation be competent in managing the patient in the event of complications; basic cardiac life support (BCLS) is required [1]. ACLS certification of the responsible physician is strongly encouraged by the Joint Commission [1]. Neither organization supports the need for ACLS certification by all members of the moderate sedation team. The "scope of practice" for certified sedation registered nurses outlined by the American Association of Moderate Sedation Nurses (AAMSN) states that ACLS training "may" be included as an additional responsibility within the expertise of the individual certified sedation registered nurse [168]. Institutions that require certification in ACLS skills should provide this type of training. The costs of producing an ACLS course are high, training the staff is expensive, and many institutions find this type of training to be unnecessary in providing safe care during moderate sedation.

In response to those who desire ACLS training, an ACLS equivalent training program can be instituted. This course would provide similar information that could be attained in an ACLS course but without providing the certification from the American Heart Association. This ACLS equivalent course would require the individual to demonstrate competency in the following areas: advanced airway management, identification of dysrhythmias, pharmacologic therapy for life-threatening dysrhythmias, and the use of a defibrillator to defibrillate, cardiovert, and institute external pacing, if appropriate. Such a course could be tailored to the institution providing the training to ensure safe care throughout the facility.

The advantage of equivalency training is that, in order to successfully pass the course, the individual must demonstrate competency in the defined areas. ACLS training also requires a demonstration of learned behaviors; however, as those who have previously attained ACLS certification know, the quality of ACLS courses can vary greatly. Learning to intubate a mannequin is nothing like intubating an individual with a compromised airway. Therefore, this equivalency training can be even more favorable to successful outcomes if it is presented appropriately.

These issues will most likely continue to be a source of debate. Those who strongly believe that ACLS certification is beneficial are not inappropriate in striving for certification. On the other hand, equivalency training may be adequate for the vast majority of moderate sedation providers. Regardless of the type of training, the important issue that should always be considered prior to the start of any sedating procedure is the immediate availability of backup assistance.

MEDICAL-LEGAL CONSIDERATIONS

In determining the nurse's scope of practice in regards to sedation administration, a number of resources should be accessed. The State Board of Nursing should be consulted as to nurses' legal scope of practice [169]. The State Boards of Nursing in all 50 states address the administration of moderate sedation, and it is imperative that the nurse be aware of these legal limitations. Some Boards of Nursing have developed fairly stringent guidelines for sedation administration. Others have more loose definitions of nurses' responsibilities that allow the nurse and the institution to develop their own policies regarding drug delivery.

Another organization that should be consulted prior to developing a moderate sedation policy is the Joint Commission. Historically, in each subsequent yearly manual, more rules and regulations regarding the delivery of moderate sedation are delineated. The Joint Commission states that the same standards of care should be met throughout the healthcare facility [1]. In other words, moderate sedation delivery in the operating room should meet the same standards as moderate sedation delivery in the radiology suite. The need to maintain current practice is critical to maintaining accreditation.

Additionally, a number of professional organizations have developed position statements regarding nursing delivery of sedation medications. The American Nurses Association first published their position statement in September 1991, and this position statement has been endorsed by twenty-three other nurses' organizations [170]. The AAMSN was founded in 2008 to foster patient safety through education for nonanesthetist RNs and to promote adherence to ANA, AANA, and ASA standards and guidelines for RNs who practice moderate sedation [171]. A number of medical organizations have also developed position statements. The American Academy of Pediatrics (AAP) has published guidelines for pediatric sedation [5]. Many, including the Joint Commission, consider these AAP guidelines as the standard for pediatric sedation delivery.

Determining the scope of practice for sedation delivery is not an easy task. Variations in practice settings, procedural interventions, and clinical situations can all present challenges to developing one set of guidelines. However, it is critical that these guidelines be well thought out and detailed in order to protect the legal practice of the nurses delivering moderate sedation.

POLICIES AND PROCEDURES

The scope of practice should be spelled out in the facility's policies and procedures for moderate sedation. These policies and procedures should be developed by a multidisciplinary team. They should identify the methods of authority, responsibility, and accountability for safe sedation care. Areas to be addressed include nursing care, patient care, and administrative concerns. The policies and procedures should be readily available in the unit where the sedation is being administered in the event that questions concerning responsibilities of care arise.

The policy should begin with a definition of the scope of practice. The intent of sedation should be detailed, including a definition of moderate sedation. The purpose of the policy should be clearly outlined.

Sample Moderate Sedation Policy

Policy

University Medical Center provides moderate sedation to patients in multiple settings, including but not limited to: the operating room, the endoscopy laboratory, the cardiac catheterization laboratory, cardioversion, the emergency department, the diagnostic imaging department, and the obstetric department. In all of these locations, a patient with the same health status can expect a comparable level of preprocedure, intraprocedure, and postprocedure care provided by equivalently trained personnel.

Purpose

1. To provide patient safety and early detection of problems that may arise during and after the administration of moderate sedation.
2. To outline responsibilities for monitoring and caring for the patient receiving moderate sedation.
3. To provide that only professionals who have demonstrated competency in moderate sedation may administer medications, including IV, and monitor patients receiving said medications.

Definitions

1. ***Moderate sedation/analgesia***: a drug-induced depression of consciousness during which the individual responds purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained.
2. ***Loss of protective reflexes***: the inability to handle secretions without aspiration or to maintain a patent airway independently.
3. ***Deep sedation***: loss of protective reflexes induced by sedation medications.

Guidelines

These guidelines are designed to provide specific recommendations for the safe care of patients during the delivery of medications for sedation and analgesia by nonanesthesiologists during medical procedures.

These guidelines are ***NOT*** *intended to apply to the routine administration of narcotics or sedative medications for pain or anxiety relief in an ICU, post-anesthesia care unit, or emergency department.*

The policies and procedures should then continue with sections regarding patient care, including but not limited to: patient selection; patient assessment criteria; patient care preprocedure, intraprocedure, and postprocedure; patient monitoring; and criteria for discharge. Classification systems, if used, can be presented as either part of the policy or as attachments. Additionally, documentation of the procedure should be outlined, specifically addressing the minimum time between vital sign and level of sedation assessment. These minimally delineated times should be strictly adhered to; however, it is always acceptable to assess and document on a more frequent, as-needed basis.

The medication section of the policies and procedures should include a listing of the medications that are considered acceptable at the institution. As discussed previously, there is a great deal of debate regarding the use of specific medications (i.e., ketamine, propofol). Drug dosing should be clearly delineated for those medications approved for moderate sedation use. A drug table can be developed and attached to the policy. It is important to remember that this drug table will be used throughout the facility and parameters of drug dosages should be acceptable in all settings.

Some of the best sedation policies include not only the drugs and appropriate dosing, but the maximum dose allowed within a set time frame. One of the more common conflicts that develop during sedation is that the physician will ask for additional sedation medication to be administered prior to the time in which the nurse administering the drug thinks it is safe to do so. For example, a patient has received 100 mcg of fentanyl for a bronchoscopy.

The nurse is assessing the patient's vital signs and level of sedation and notes a quiescent patient with a blood pressure that has dropped greater than 20 points below baseline. The nurse continues to monitor the patient for loss of protective reflexes to ensure that a deeper level of sedation is not developing. However, during the procedure, the patient moves during manipulation of the scope and the physician requests that an additional 50 mcg of fentanyl be administered. The nurse is uncomfortable with administering this additional sedative at the present time. If the policy outlines that no more than 100 mcg of fentanyl may be administered within a 10-minute time frame, the nurse can refuse to administer the sedation until that time window has passed. However, if the policy has no such time frame, the nurse should either choose to administer the drug or refuse to do so and accept the consequences for refusal. In the best of all worlds, the physician will accept this limitation on drug delivery and wait until the patient is appropriately and safely sedated. Unfortunately, what often occurs is that the physician will order the medication, the nurse will refuse to administer, and the physician will then pre-empt the nurse and take the syringe in hand and administer the additional sedation. The nurse should then continue to monitor the patient and prepare for the development of oversedation, loss of airway, or any other potential complication that can develop secondary to administration of large doses of narcotics in a short time frame. Regardless of who administered the drug, the nurse caring for the patient is responsible for continuing to provide safe care. With a detailed drug chart developed by physicians, nurses, and anesthesiologists together, these problems can be diminished.

Administrative concerns should also be presented in the policies and procedures. The standards of care should be clearly outlined, ensuring that both state and Joint Commission standards are maintained. Personnel requirements can be addressed, as well as training and competencies of the personnel administering moderate sedation.

One standard of care that is critical to safe drug delivery is that the physician be physically present in the room prior to drug administration. Many institutions neglect to spell out this requirement, and the nurse is asked to administer sedation without appropriate backup personnel. As an example, a physician telephones the endoscopy suite and orders the nurse to administer 5 mg IV midazolam, informing the nurse that he/she would like the patient sedated and ready to begin the procedure when he/she arrives in three to four minutes. The nurse may administer the drug as ordered; however, the physician may be inadvertently delayed by a telephone call, a stuck elevator, or for any number of reasons. The nurse is now caring for a sedated patient without sufficient backup. If the policy states that the medications will only be administered once the physician is present, this risk will be avoided. The Joint Commission requires that, in addition to the individual performing the sedation procedure, sufficient numbers of qualified staff be present to evaluate, monitor, administer medication, assist with the procedure, and recover the patient, if needed [129].

Finally, the policy should finish with a section concerning continuous quality improvement measures. Each department's responsibilities in record keeping and evaluation of care delivery should be clearly stated. Any adverse patient outcomes should be documented, addressed, and subsequently reviewed at a quarterly review of moderate sedation patient care.

The more comprehensive the policies and procedures, the better protected the facility and nursing staff is from legal action, should a problem arise. The policies will allow the nurses to deliver safe care before, during, and after the procedure. The policies and procedures should be updated on an annual basis to ensure compliance with changing standards of care and standards outlined by changing Nurse Practice Acts and Joint Commission requirements.

ISSUES IN INTRAVENOUS VS. TRANSMUCOSAL ADMINISTRATION OF MODERATE SEDATION

There are many issues that arise in considering the method of drug delivery, either by intravenous or transmucosal administration. It would seem to be a straightforward issue; however, on a daily basis there are a number of questions that arise. The Joint Commission moderate sedation standards state that the care standards apply "in any setting, for any purpose, and by any route" [1]. This may help to resolve some of the previous dilemmas. However, a well-developed policy and procedure manual can help resolve other specific issues, a few of which will be discussed here.

If a patient receives medications by the transmucosal route, does that patient require a patent IV line or heparin lock? Or, should the patient be cared for by someone with IV skills? Flumazenil, the benzodiazepine antagonist, should be administered intravenously. If a patient receives transmucosal midazolam, as an example, and requires an antagonist and no line has been placed, the administration of this drug is delayed while IV access is secured. Therefore, any patient receiving moderate sedation should have a patent IV line, regardless of the method of original administration.

Is the length of observation time shorter (or longer) for patients receiving transmucosal medications? Many individuals inappropriately believe that if a patient receives transmucosal medications, their recovery time is shorter. In fact, the length of action of the drug may be longer due to slower absorption.

Can individuals who receive transmucosal medications go home earlier than patients receiving intravenous medications? Can they drive themselves home and go home alone? Do they need the same type of discharge instructions as does the patient receiving intravenous medications? The answers to these questions are well accepted if the patient receives intravenous medications. There are well-developed standards of practice for intravenous drug delivery. The nurse administering sedation by the transmucosal route should answer these questions prior to drug delivery.

One of the most important things to remember is: *What are the goals and objectives of moderate sedation? If the goals and objectives are the same whether the patient is receiving the sedation by the intravenous or the transmucosal route, is there a difference in care?* It is definitely a point to ponder and one that should be answered by the individual and the institution and delineated in the policy and procedure for moderate sedation.

COMPETENCY ISSUES

Competency verification is a critical part in the delivery of safe patient care. A mechanism for the evaluation of the nurse's skills and knowledge should be an integral part of the moderate sedation program. Areas for moderate sedation competency evaluation include [6; 168]:

- Scope of practice
- Presedation assessment
- Pharmacology of moderate sedation medications
- Intraprocedural and postsedation care
- Monitoring skills
- Complication recognition
- Complication management
- Documentation
- Discharge criteria
- Patient education
- Emergency resuscitation techniques
- Special considerations for specific populations

This is by no means considered to be a comprehensive listing; additional items can be added to it as facility policy dictates.

Ensuring competency should be done on a regular basis. Knowledge performance measures usually require that the individual meets the criteria 90% of the time, at a minimum. All nurses should strive to meet these criteria 100% of the time; however, there are times when perfection is a goal and not an achievable endpoint.

Achieving competency varies with the frequency of moderate sedation administration. Some larger institutions have a moderate sedation team whose sole responsibility is to provide sedation in various settings throughout the institution. The individuals who work on this team are able to perform a number of sedation procedures on a regular basis. Their level of competency is commonly high. However, just because an individual performs sedation frequently does not guarantee competency. On the other hand, the staff of the emergency department may be trained in moderate sedation but only perform the procedure on an as-needed basis, with the possibility of long time periods between procedures. Regardless of the frequency of sedation administration, the same standards should be met by all individuals performing sedation.

Annual or biannual evaluations should be undertaken for all individuals administering sedation, including nurses and physicians. Commonly, physicians are verified by the Department of Anesthesiology. The same stringent guidelines met by the nurses should also be met by the physicians.

Ensuring safe care delivery during sedation is paramount to a successful moderate sedation program in any facility. All the issues discussed here should be addressed and can provide an opportunity for expansion in policy development. The answers may not be readily apparent at the present time; with more experience and practice, many of these issues may become moot points as moderate sedation practice becomes more sophisticated.

SUMMARY

Moderate sedation is an exciting field for nurses. As newer, safer sedation medications become available, nurses will be asked to provide moderate sedation on an increasingly frequent basis. Recognition of the goals and objectives of moderate sedation is the first step in providing safe care. Medication administration and knowledge of pharmacologic principles are paramount prior to drug delivery. Providing for patient safety should be the most important aspect of nursing care delivery. Recognition of the nuances of care delivery to specific patient populations should not be overlooked. If these aspects are adhered to throughout moderate sedation, the patient will be provided with safe care before, during, and after sedation.

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