Moderate Sedation Provider Course

San Antonio Regional Hospital

A Self-Directed Learning Module

TABLE OF CONTENTS

MODERATE SEDATION PROVIDER COURSE

A SELF-DIRECTED LEARNING MODULE

This learning material is prepared to assist non-anesthesiology Physicians, RNs, Dentists, and PA's who will be evaluated in administering and monitoring moderate sedation.

I. Objectives

- To learn the pre-, intra- and post-moderate sedation monitoring of the patient.
- To reduce the risks to patients receiving medications outside the operating room.
- To standardize the monitoring and care of patients receiving moderate sedation.
- To establish basic knowledge for physicians, RNs, Dentists, and PAs participating in moderate sedation.
- To learn the hospital policy for moderate sedation.
- To identify dosages, actions, complications of medications that are used during moderate sedation.
- To discuss the medications used for the reversal of opioids and benzodiazepines.
- Airway management and adjuncts to treat airway obstruction.
- Describe common complications of moderate sedation.
- Include the patient's physical status by the American Society of Anesthesiologists.
- Include the pre-conscious and inhalation sedation assessment of patients.

II. Definitions

Level of Sedation:

- **Minimal Sedation (Anxiolysis):** A drug-induced state during which the patient responds normally to verbal commands. Cognitive function and coordination maybe impaired. Ventilatory and cardiovascular functions are unaffected.

- **Moderate Sedation/Analgesia (Conscious Sedation):** The administration of medications resulting in a drug-induced depression of consciousness, during which the patient responds appropriately to verbal commands and physical stimulation either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway and spontaneous ventilation is adequate and cardiovascular function is maintained.

- **Deep Sedation/Analgesia:** A drug-induced depression of consciousness during which patient cannot be easily aroused, but responds purposefully following repeated or painful stimulation. The ability to independently maintain ventilatory function may be impaired. Patient may require assistance in maintaining a patent airway and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained.

- **Anesthesia:** Consists of general anesthesia and spinal or major regional anesthesia. It does *not* include local anesthesia. General anesthesia is a drug-induced loss of consciousness during which patient is not arousable, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. Patient often requires assistance in maintaining a patent airway and positive pressure ventilation may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired.

III. Purpose

Moderate sedation will be used to minimize patients discomfort and/or pain during diagnostic and therapeutic procedures. Moderate sedation will be used to reduce risks and complications that are associated with the use of general or major conduction anesthesia.

IV. Goals of Moderate Sedation

- Maintain consciousness
- Elevate the patients' pain threshold
- Alter the mood of the patient
- Provide sedation/mild amnesia
- Elicit patient cooperation
- Achieve control of patients' physiologic parameters

  - **Procedures to utilize moderate sedation may include but is not limited to the following procedures:**
    - Gastrointestinal endoscopy
    - Fiberoptic bronchoscopy
    - Central line placement
    - Chest tube insertion
    - Bone marrow aspiration and biopsy
    - Liver biopsy
    - Cardioversion
    - CT scans with interventional procedures
    - MRI scans with interventional procedures
    - Angiography
    - Sedation for uncooperative & pediatric patients undergoing procedures

  - **Examples of patients that are at increased risk for developing complications related to moderate sedation are:**
    - Uncooperative patients
    - Extreme of age
    - Severe cardiac, pulmonary, hepatic, renal or central nervous system disease
    - Morbid obesity
    - Sleep apnea/airway tumors
    - Pregnancy
    - Drug or alcohol abuse

V. ASA Physical Status Classification System

American Society of Anesthesia (ASA) definitions to determine if a patient is an appropriate candidate for a procedure by classifying them into one of five categories:

ASA I	A normally healthy patient
ASA II	A patient with mild systemic disease and no functional limitations
ASA III	A patient with moderate to severe systemic disease that results in some functional limitation.
ASA IV	A patient with severe systemic disease that is a constant threat to life and functionally incapacitating
ASA V	A moribund patient that is not expected to survive within 24 hours without surgery
ASA VI	A patient whose organs are being harvested
E	For emergency procedures

VI. Administration of Medications for Moderate Sedation

In the attached Medication Use Guidelines for Moderate Sedation there is a grid of the recommended drugs and dosages. It also includes the general precautions and procedures to administer drugs for moderate sedation.

VII. Characteristics of Patients Under Moderate Sedation

- Patient cooperative
- Patient consciousness
- Mood altered
- Amnesia may be present
- Vital signs stable
- Protective reflexes are active and intact without reasonable expectation of loss of airway reflexes

VIII. Mechanism of Action for Medications Used in Moderate Sedation

- **Receptor Theory**

Like many drugs administered to patients, opiates and benzodiazepines interact with specific receptors within the human body. The effect of the drug is related to the receptor (or receptors). The drug and receptor complex initiates a cascade of intracellular events called secondary messengers that terminate with the end effect of the drug. Drug receptor theory is based on structural specificity (stereo-specific) schematized as a lock and key model. (Imagine a drug "the key" trying to fit into the receptor "the lock"). A drug with a specific biochemical structure will interact with a certain shaped receptor. Once the key fits into the lock, the actions of the drug become manifest.

Using the lock and key model, it is possible to understand how drug antagonists function. The antagonist may fit the lock mechanism in a slightly different way and cause difficulty in opening the lock or cause the lock not to open. Both the agonist and antagonist fit into the lock, but only the agonist is able to turn the tumblers and actuate an effect.

- **Opiate Receptors:**

  Opioids are exogenous substances that bind specifically to the opioid receptors and produce an agonist response. The affinity of most opioid agonists produces analgesic activity. Endogenous opioids known as endorphins also stimulate opioid receptors.

- **GABA Receptors:**

  Benzodiazepines (and barbiturates) exert their pharmacological effects by interaction with gamma aminobutyric acid (GABA) receptors. The anatomical location of GABA receptors are cerebral cortex, cerebellum, hippocampus, substancia nigra, inferior colliculus and olfactory bulb.

  Gamma-aminobutiryc acid (GABA) is the major inhibitory neurotransmitter located within the central nervous system. GABA modulates and counter-balances excitatory neurotransmitters such as norepinephrine or acetylcholine.

  Pharmacologic effects seem to be related to the percentage of bound receptors although benzodiazepine's amnestic or anticonvulsant manifestations remain poorly understood. Barbiturates enhance the effect of GABA at lower concentrations producing sedation and hypnosis. At higher concentrations, barbiturates mimic the GABA molecule.

- **Agonist-Antagonist:**

  Agonist-antagonist is a drug that is an agonist (stimulates) at one type of receptor, but an antagonists (inhibits) at a second. For analgesia, the goal of the drug is to stimulate mu1,

kappa and delta receptors without stimulating the mu2 (respiratory depression). Attempts at synthesis have been less than successful probably because mu1 does not exclusively produce pain relief and mu2 does not exclusively produce respiratory depression.

Clinically, agonist-antagonists are used as premedicants, analgesics, and anesthetic adjuncts. These drugs appear to have a ceiling effect on respiratory depression. After a certain amount is given, there is no further respiratory depression or it plateaus no matter how much additional medication is given. To further complicate matters, at higher dose levels (1-2.5 mg/kg for nalbuphine) for example, these mixed agonists-antagonists reverse their own analgesia.

- **Opioids**
  - Opiates may be classified as naturally occurring opioids (morphine, codeine), semi synthetic (heroin, buprenorphine), and synthetic (meperidine, fentanyl and nearly all other opiates used in clinical practice). A second method of classification is their stimulation (or non-stimulation) of opiate receptors. As such, they may be classified as agonists (morphine, fentanyl, and meperidine), mixed agonists (nalbuphine, butorphanol) and antagonists (naloxone). For the purposes of this learning module, the term opioids, opiate and narcotic analgesic may be used interchangeably.

    General properties of opioids include production of analgesia. Administration of an equianalgesic dose of codeine and meperidine will produce similar respiratory depression. Therefore, side effects which include respiratory depression, cough suppression, muscular rigidity, histamine release, itching, nausea and vomiting, constipation, biliary colic, urinary retention are equally likely to occur providing an equivalent dose of narcotics have been provided. The opiates do differ in their metabolism, duration of action, method of accumulation, and active metabolites. A few will have side effects that differ from the general effects listed above. All narcotics should be compared to morphine sulfate.

    Equivalent Doses (IV):
    108 mg codeine equals →
    100 mg meperidine which equals →
    15 mg nalbuphine which equals →
    10 mg morphine which equals →
    2.5 mg butorphanol which equals →
    100 mcg fentanyl

- **Hypnotics**
  - **General Characteristics of Hypnotics:**
    Hypnotic agents reduce activity of the brain and spinal cord. The agents are used clinically to promote sleep. Although hypnotic agents are used to promote sleep, all of the drugs used alter the normal sleep cycle.

  - **Hypnotic Specific Precautions:**
    Major side effects of the hypnotics include excessive sedation, dizziness, additive or sometimes potentiating action with alcohol, coma, respiratory depression, and death. The lethal effects are especially prominent with barbiturates and have led to marked reduction in the general use, concomitant with an increased in the use of benzodiazepines.

  - **Classification of Hypnotics:**
    Hypnotics for moderate sedation can be classified into Benzodiazepines, Barbiturates and others. In moderate sedation Benzodiazepines are most commonly used. They have a rapid onset and short duration of action. Benzodiazepines do **not** have analgesic (pain relief) properties. Benzodiazepine produces amnesia, anxiolytic, anticonvulsant and hypnotic (sleep).

Given in equipotent doses, benzodiazepines have comparable effects. Benzodiazepines and opiates have synergistic effects. When used together they increase the incidence of airway obstruction and apnea. All benzodiazepines undergo hepatic biotransformation. Flumazenil (Romazicon) is a benzodiazepine antagonist that rapidly reverses the effects of benzodiazepine.

IX. Drugs used in Moderate Sedation

Characteristics of Opioid Overdose

- Altered level of consciousness
- Respiratory depression
- Muscle flaccidity, especially the airway
- Miotic pupils, unless pupils are more dilated secondary to hypoxia

- ***Demerol (Meperidine)***
  - Meperidine is about one-tenth as potent as morphine. It is a synthetic opiate with atropine-like properties.
  - Its effect on respirations and ventilation are similar to morphine. It produces moderate effects on tidal volume and slows respiratory rate.
  - In large dosages, it can produce tachycardia because of its chemical similarity to atropine and causes negative inotropic effect.
  - Meperidine has an active metabolite (nor-meperidine) which, when accumulated, produces convulsions. In large doses, meperidine can produce tremors, muscle twitching, and seizures.
  - Meperidine should not be used in patients with renal failure since normeperidine is excreted renally.
  - Meperidine should not be used in patients taking MAO inhibitors. Meperidine may be safe to use in patients who have discontinued MAO inhibitors for at least two weeks.

- ***Morphine***
  - Produces sedation, analgesia, and mood alteration.
  - Analgesia can occur without loss of consciousness but large doses can produce obtundation and even coma.
  - Morphine can produce prolonged postoperative somnolence, respiratory depression, nausea, vomiting, and itching.
  - Histamine release and some reduction in sympathetic tone can produce hypotension. Healthy, supine, normovolemic patients can develop orthostatic hypotension with large doses of morphine. Opioids can produce elevation of $PaCO_2$ resulting in an increase in cerebral blood flow and elevation of intracranial pressure and arrhythmias.
  - Biliary spasm of smooth muscle may be confused with angina pectoris.
  - Other GI effects are decreased peristalsis and increased pyloric sphincter tone.

- ***Fentanyl (Sublimaze)***
  - Fentanyl has more rapid onset and shorter duration than morphine. It is 100 times more potent than morphine.
  - Fentanyl, Sufentanil, and Alfentanil in moderate dose of 2-10 microgram/kg or higher doses when given rapidly intravenous can produce skeletal muscle rigidity called “stiff chest syndrome”. Sometimes this syndrome is so severe that it is impossible to adequately ventilate the patient. In this case, succinylcholine or other muscle relaxants may be required. If succinylcholine or other muscle relaxants are administered, the personnel should be ready to ventilate the patient with an Ambu bag through a face mask.
  - Fentanyl does **not** have an amnesic effect. High dose fentanyl can produce respiratory depression but has no direct myocardial depression effect. It suppresses stress response associated with surgery. Fentanyl depresses the respiratory center in the brainstem. The normal response to hypoxia and hypercarbia is reduced.

- IV bolus can cause a patient to cough and the nose to itch.

- ***Versed (Midazolam)***
  - Midazolam is twice as potent as and shorter acting than diazepam and ativan. Because of its shorter half-life and lack of active metabolites, midazolam is preferable to diazepam for moderate sedation.
  - It has sedative, amnesic, anxiolytic and anti-convulsant properties (ceiling effect).
  - Elimination half life could be longer in elderly and obese patients.
  - Benzodiazepines and opioids have synergistic effects.
  - Midazolam produces dose related depression of the central respiratory system.
  - Respiratory depression is more pronounced in geriatric and COPD patients.
  - Midazolam produces significant episodes of apnea secondary to its potency.
  - Benzodiazepines do not have analgesic effects.
  - Midazolam crosses the placenta, although the effects to pregnancy are not known, it is not recommended for obstetrical patients. (Pregnancy category "D"—use with caution in nursing mothers in first trimester.)

- ***Ativan (Lorazepam)***
  - Lorazepam is similar to Midazolam.
  - It has a longer duration of action 8-12 hours; ½ life 14 hours.
  - No ceiling effect making it better for controlling seizure activity.
  - Benzyl alcohol or propylene glycol additives should be avoided in neonates.

- ***Valium (Diazepam)***
  - Diazepam is longer acting than Midazolam and Ativan. Two major metabolites of diazepam, dismethyldiazepam and oxazepam, contribute to its long duration of action.
  - Diazepam can produce depression of ventilatory response to carbon dioxide. Sometimes, even small doses of diazepam may result in apnea particularly in elderly and sick patients. Diazepam may have a half-life of up to 96 hours in a geriatric patient.
  - Intravenous diazepam in doses of 0.05 mg/kg-0.1 mg/kg can cause mild reductions in blood pressure, cardiac output and peripheral vascular resistance. Occasionally, even small doses can produce hypotension.
  - Diazepam reduces skeletal muscle tone. At 0.1 mg/kg dose diazepam has an anticonvulsant effect.
  - Alcohol and opiates when used with diazepam cause increased central nervous system depression.
  - In low dosages, benzodiazepines are associated with stable cardiac function.
  - Cimetidine increases elimination half life of diazepam.
  - Diazepam crossed the placenta easily. Diazepam is associated with increased risk of congenital malformations when administered during pregnancy. (Pregnancy Category "D"—use with caution in pregnant women)
  - Intravenous diazepam can cause phlebitis.

- ***Nembutal (Pentobarbital)***
  - Pentobarbital is a short acting Barbiturate.
  - IV onset is 10–15 minutes. IV duration is 15 minutes.
  - IM onset is 1-4 hours duration of effect.
  - Do not use in pregnancy as fetal effects are documented.

- ***Ketamine***
  - Clinical Pharmacology - Ketamine is a rapid-acting general anesthetic producing an anesthetic state characterized by profound analgesia, normal pharyngeal-laryngeal reflexes, normal or slightly enhanced skeletal muscle tone, cardiovascular and respiratory stimulation, and occasionally a transient and minimal respiratory depression.

    The anesthetic state produced by ketamine has been termed "dissociative anesthesia" in that it appears to selectively interrupt association pathways of the brain before producing somatesthetic sensory blockade. It may selectively depress the thalamoneocortical system before significantly obtunding the more ancient cerebral centers and pathways (reticular-activating and limbic systems).

    Ketamine has a wide margin of safety; several instances of unintentional administration of overdoses of ketamine (up to ten times that usually required) have been followed by prolonged but complete recover.

  - Emergence reactions have occurred in approximately 12 percent of patients. The psychological manifestations vary in severity between pleasant dreamlike states, vivid imagery, hallucinations, and emergency delirium. In some cases these states have been accompanied by confusion, excitement, and irrational behavior which a few patients recall as an unpleasant experience. The duration ordinarily is no more than a few hours; in a few cases, however, recurrences have taken place up to 24 hours postoperatively. No residual psychological effects are known to have resulted from use of ketamine.

    The incidence of these emergence phenomena is least in the elderly (over 65 years of age) patient. Also, they are less frequent when the drug is given intramuscularly and the incidence is reduced as experience with the drug is gained.

    The incidence of psychological manifestations during emergence, particularly dream-like observations and emergence delirium, may be reduced by using lower recommended dosages of ketamine in conjunction with intravenous diazepam during induction and maintenance of anesthesia. Also, these reactions may be reduced if verbal, tactile, and visual stimulation of the patient is minimized during the recovery period. This does not preclude the monitoring of vital signs.

    In order to terminate a severe emergence reaction, the use of a small hypnotic dose of a short-acting or ultra short-acting barbiturate may be required.

    When ketamine is used on an outpatient basis, the patient should not be released until recovery from anesthesia is complete and then should be accompanied by a responsible adult.

  - Contraindications - Ketamine hydrochloride is contraindicated in those in whom a significant elevation of blood pressure would constitute a serious hazard and in those who have shown hypersensitivity to the drug. It is also typically avoided in patients with seizure disorder.

- ***Etomidate***
  - Clinical Pharmacology - Etomidate is a hypnotic drug without analgesic activity. Intravenous injection of etomidate produces hypnosis characterized by a rapid onset of action, usually within one minute. Duration of hypnosis is dose dependent but relatively brief, usually three to five minutes when an average dose of 0.3 mg/kg is employed. Immediate recovery from anesthesia (as assessed by awakening time, time needed to follow simple commands and time to perform simple tests after anesthesia as well as they were performed before anesthesia), based upon data derived from short operative procedures where intravenous

etomidate was used for both induction and maintenance of anesthesia, is about as rapid as, or slightly faster than, immediate recovery after similar use of thiopental. These same data revealed that the immediate recovery period will usually be shortened in adult patients by the intravenous administration of approximately 0.1 mg of intravenous fentanyl, one or two minutes before induction of anesthesia, probably because less etomidate is generally required under these circumstances.

Reduced plasma cortisol and aldosterone levels have been reported following induction doses of etomidate. These results persist for approximately 6-8 hours and appear to be unresponsive to ACTH stimulation. This probably represents blockage of 11 beta-hydroxylation within the adrenal cortex.

- Adverse Reactions - The most frequent adverse reactions associated with use of intravenous etomidate are transient venous pain on injection and transient skeletal muscle movements, including myoclonus:
  - Transient venous pain was observed immediately following intravenous injection of etomidate in about 20% of the patients, with considerable difference in the reported incidence (1.2% to 42%). This pain is usually described as mild to moderate in severity but it is occasionally judged disturbing. The observation of venous pain is not associated with a more than usual incidence of thrombosis or thrombophlebitis at the injection site. Pain also appears to be less frequently noted when larger, more proximal arm veins are employed and it appears to be more frequently noted when smaller, more distal, hand or wrist veins are employed.
  - Transient skeletal muscle movements were noted following use of intravenous etomidate in about 32% of the patients, with considerable difference in the reported incidence (22.7% to 63%). Most of these observations were judged mild to moderate in severity but some were judged disturbing. The incidence of disturbing movements was less when 0.1 mg of fentanyl was given immediately before induction. These movements have been classified as myoclonic in the majority of cases (74%), but averting movements (7%), tonic movements (10%), and eye movements (9%) have also been reported. No exact classification is available, but these movements may also be placed into three groups by location.
- Over dosage - In the event of suspected or apparent over dosage, the drug should be discontinued, a patent airway established (intubate, if necessary) or maintained and oxygen administered with assisted ventilation, if necessary.

X. Antagonist Drugs

- *Naloxone (Narcan)-Characteristics*
  - Considered among the “purest” of opioid antagonists.
  - One of the several opiate antagonists
  - Very short plasma half life
  - Duration of clinical effect is frequently shorter than that of the opioid which may result in re-narcotization of the patient.
  - Primarily used to reverse respiratory depression. It can also reverse analgesia.
  - Large boluses of naloxone can cause hypertension, ruptured cerebral aneurysm, pulmonary edema, seizures, cardiac arrest and death.
  - Instances of hypotension, hypertension, ventricular tachycardia, and ventricular fibrillation have been reported in patients who have pre-existing cardiovascular disorders.
  - Naloxone also may unmask physical dependence, precipitate acute withdrawal syndrome and elevate catecholamines.
  - The patient must be monitored for one hour following administration of naloxone because of further risk of cardio-respiratory depression.

- ***Flumazenil (Romazicon) -Characteristics***
  - Reverses benzodiazepines making the patient more alert.
  - Sedative antagonist for diazepam and midazolam.
  - Indicated for reversal of benzodiazepine overdose
  - Has shorter duration of action than the benzodiazepine being reversed.
  - In general, flumazenil has few side effects.
  - Adverse effects on patients dependent on benzodiazepines are headache, dizziness, sweating, nausea/vomiting, and flushing, and pain at the injection site.
  - The patient must be monitored for one hour following administration of flumazenil because of further risk of cardio-respiratory depression.
  - May precipitate seizure in patients with seizure disorder.

XI. Potential Complications Associated with Moderate Sedation

- Problems with respiratory system, cardiovascular system, equipment problems, wrong drug dose and convulsions.
- Ineffective ventilation resulting from airway obstruction, respiratory depression causing hypoxia and hypercarbia.
- Aspiration associated with loss of protective airway reflexes.
- Nausea and vomiting.
- Hypotension.
- Anaphylaxis and anaphylactoid reactions.

XII. Factors which may be associated with difficult airway management

- **History:**
  - Previous problems with anesthesia or sedation.
  - Stridor, snoring, or sleep apnea.
  - Dysmorphic facial features (e.g. Pierre-Robin Syndrome, Trisomy 21)
  - Advanced rheumatoid arthritis.

- **Physical Examination:**
  Obesity, short neck, limited neck extension, decreased hyoid-mental distance (<3 cm in adult), neck mass, cervical spine disease or trauma, tracheal deviation.
  Mouth-small opening (<3 cm in an adult); edentulous; protruding incisors; loops or capped teeth; high arched palate; macroglossia; tonsillar hypertrophy; non-visible uvula.
  Jaw-micrognathia, retrognathia, trismus, significant malocclusion.

  Airway obstruction may result from loss of tonicity of submandibular muscles, direct support to the tongue and loss of indirect support to the epiglottis.

- **Treatment of obstructed airway:**
  - Reposition patients head
  - Head tilt
  - Jaw thrust or chin lift
  - Persistent airway obstruction may require the use of airway adjuncts-oropharyngeal and nasopharyngeal airways. This airway may precipitate laryngospasm or vomiting. Nasopharyngeal airway insertion may cause injury to the nasal mucosa resulting in bleeding.

XIII. Respiratory Depression

- **Hypercarbia**

  The body's metabolic rate producing carbon dioxide is balanced with the effectiveness of ventilation. Effective ventilation determines the alveolar carbon dioxide tension which correlates with the $PaCO_2$. Carbon dioxide elimination is regulated by the pontine and medullary respiratory control center of the central nervous system. Stimulation of this location causes ventilation, defined as the mass movement of gases into and out of the pulmonary system. The most useful clinical measurement of ventilation is either the tidal volume, respiratory rate, or the minute ventilation. Carbon dioxide production is relatively constant under most clinical situations. Given this constant carbon dioxide production, ventilation maintains $PaCO_2$ at approximately 40 mmHg. A $PaCO_2$ less than 36 mmHg is defined as hyperventilation. A $PaCO_2$ of more than 44 mmHg is defined as hypoventilation in most patients. If the $PaCO_2$ exceeds 50 mmHg in a patient who was previously normocarbic, respiratory failure is said to have occurred.

  In patients receiving conscious sedation, the usual source of hypercarbia is respiratory center depression. The usual cause of this depression is due to medications administered during the conscious sedation procedure. All narcotics produce some degree of respiratory depression. Benzodiazepines and narcotics have synergistic effects, of which the most noteworthy are airway obstruction and apnea.

  - Maintenance of normal $PaCO_2$ is determined by adequate ventilation.
  - Tidal volume and respiratory rate determine minute ventilation.
  - Hypercarbia is caused by respiratory center depression.
  - All opiates may cause respiratory depression.
  - Benzodiazepines and opioids act synergistically.

- **Hypoxemia**

  Hypoxemia is lower than normal oxygen partial pressure in arterial blood. It does not involve abnormalities or type of hemoglobin. To interpret what is normal, inspired oxygen, barometric pressure, and patient's age must be considered.

  Hypoxia is a reduction of oxygen supply to a tissue below physiologic levels. When PaO_2 is less than 60 mmHg or SpO_2 is less than 90%, hypoxemia is present.

  In normal conscious humans, hypoxemia stimulates the cardiovascular and respiratory systems. Increases in cardiac output, pulse rate, minute ventilation, tidal volume, a right shift of the hemoglobin dissociation curve occur to offset hypoxemia.

  - Initial Treatment of Hypoxemia

  Hypoxemia is present when PaO_2 is less than 60 or SpO_2 by pulse oximeter is less than 90% in adults. Clinically, patients may become agitated before there is noticeable cyanosis of mucous membranes.
    - Determine the underlying source of the respiratory depression.
    - If this is related to patient sedation, suspend further drug administration.
    - Support and maintain patient's airway. Reversal of the patient's sedation should be considered if respirations are not properly resumed.
    - Initially treat with supplemental O_2.
    - Encourage patient to breathe deeply.
    - Provide positive pressure ventilation by mask if necessary.

  - Some Causes of Hypoxemia
    - Hypoventilation

- Low inspired oxygen
- Increased oxygen consumption
- Low cardiac output

XIV. Gastric Emptying

- **Factors that influence gastric emptying are:**
  - Anxiety
  - Pain
  - Abnormal autonomic function (e.g. diabetic patients)
  - Pregnancy
  - Mechanical obstruction.

- **Nausea and Vomiting:**
  - Nausea and vomiting can cause hypertension or hypotension, tachycardia, bradycardia and aspiration.
  - Nausea and vomiting is the leading cause of unexpected hospital admission.

- **Predisposing factors of nausea and vomiting are:**
  - Age (younger patients more susceptible)
  - Female
  - Obesity
  - History of postoperative emesis
  - Presence of hypoglycemia, pain, hypotension, or hypoxia.

- **Treatment of nausea and vomiting:**
  - Evaluate and treat causes such as hypoglycemia, pain hypoxia, or hypotension
  - Drugs used for the prevention and treatment of nausea and vomiting:
    - Metoclopramide (Reglan) – Adult: 10 mg. IV; Pediatric: 0.15 mg/kg/dose IV
    - Ondansetrone (Zofran) – Adult: 4 mg IV
    - Dolasetron (Anzemet)--Adult: 12.5 mg IV
    - Droperidol (Inapsine) – Adult: 0.625-1.25 mg IV. Use with caution as high doses may cause cardiac arrhythmias Pediatric: 0.015 mg/kg/dose IV
    - Trimethobenzamide (Tigan) Adult-- 200 mg IM, not recommended for pediatric use

XV. Hypotension

- Hypotension is often defined relative to the patients baseline blood pressure
- Blood pressure should be monitored during and after moderate sedation. The adult patient is considered hypotensive when systolic BP is less than 80 mmHg and/or mean blood pressure less than 60 mmHg *or* clinical hypotension defined as 20 percent less than the patient's baseline systolic or diastolic blood pressure.

XVI. Aspiration

During sedation where airway protective reflexes may be lost, aspiration is a risk.

Risk factors for aspiration:

- Diabetes
- Pregnancy
- Obesity
- Hiatal hernia or gastric reflux
- Altered consciousness

Diagnosis of Aspiration:

- Suspect aspiration in a patient having respiratory difficulty, tachypnea, tachycardia, cyanosis and oxygen desaturation.
- Blood gases reveal hypoxemia with mixed metabolic and variable respiratory acidosis.
- In severe cases of aspiration systemic hypotension, pulmonary hypertension and pulmonary edema may occur.
- Radiographic findings are variable.

XVII. Anaphylaxis and Anaphylactoid Reactions

Anaphylaxis and anaphylactoid reactions are acute events characterized by wheezing, dyspnea, syncope, hypotension, and upper airway obstruction. Histamine release can be produced by administration of morphine and other agents.

Treatment of anaphylactic or anaphylactoid reactions:

- Prompt recognition of the clinical situation
- Ventilation with 100% oxygen.
- Prompt use of Benadryl, steroids, cimetidine, epinephrine and fluids, as appropriate.

XVIII. Pulse Oximetry

- Pulse oximetry measures percentage of oxygen carried on hemoglobin in the arterial blood.
- Pulse oximetry identifies hypoxemia more quickly than clinical signs, such as cyanosis or disorientation, which occurs much later.
- The accuracy of pulse oximeters declines below 60% saturation. It does not measure the patient's ventilation and does not monitor carbon dioxide accumulation or excretion.
- Oxygen saturation (SpO_2) does not equal (PaO_2). SaO_2 is hemoglobin saturation of arterial blood. PaO_2 is partial pressure of oxygen measured in ABG's.

Hemoglobin (Hg) combines reversibly with oxygen to form oxyhemoglobin. With the binding a change in color absorption occurs, which we see as venous blood (dark red), and arterial blood (bright red). The deoxyhemoglobin absorbs more light in the infrared band. The pulse oximeter probe contains two light emitting diodes in the red and one in the infrared band. When the probe is placed on the appendage, the light emitted from the LED's at 660 and 910 nanometers is transmitted throughout the intervening blood and is sensed by the computer box several hundred times per second. The computer then compares absorption characteristics of unsaturated (deoxyhemoglobin) and saturated (oxyhemoglobin blood).

The percentage of the total amount of blood saturated is determined and averaged over 2-4 seconds, and this is displayed as a percentage in the computer's display panel. 99% of all oxygen is carried by hemoglobin at normal barometric pressure**.** Pulse oximeters measure oxygen saturation of hemoglobin while blood gases measure the amount of dissolved oxygen in plasma. The accuracy of pulse oximeters declines below 60% oxygen saturation.

The oxyhemoglobin dissociation curve compares the relationship between the SaO_2 and PaO_2 values, giving the following approximate values:

SaO_2	PaO_2
95%	80 mmHg
90%	60 mmHg
85%	50 mmHg

Limitations of Pulse Oximetry

- Clinical situations may reduce its accuracy.
- It does not measure the patients' ventilation and does not detect carbon dioxide accumulation or excretion.

Factors that affect the accuracy of pulse oximeter

- Motion at sensor site.
- Ambient light as infrared lights and surgical lamps.
- Methemoglobin and carboxyhemoglobin.
- IV dyes – methylene blue, indocyanine green
- Hypotension.
- Nail polish – green, blue or maroon nail polish
- Vasoconstriction – hypothermia or vasopressors.
- Rapid or erratic heart rates where pulse does not correlate with heart rate.
- Anemia – hematocrit less than 10% may cause underestimation of oxygen saturation.
- Patient movement and tremor

XIV. Suggested Drugs and Doses for Sedation

- The attached Medication Use Guidelines should serve as a guide to an upper safe limit with the use of these medications.
- Certain patients may not tolerate these recommended doses.
- Titrate the dose to desired clinical effects. Some patients may need much less or more than the listed dose.
- Many of these medications have synergistic respiratory depressant effects when administered in combination.

XX. General Cautions

- Dosages should be individualized.
- Do not give by rapid or single bolus IV administration.
- Individual response may vary with age, physical status, and concomitant medications.
- Use small increments to achieve appropriate levels of sedation.
- Wait two or more minutes after each increment to evaluate the sedative effect fully.
- If other central nervous system depressants are used, patients will generally require lower doses than non-premedicated patients. PR=per rectum; IM=intramuscular; IV=intravenous.

References

Benzodiazepines:

1. Stoelting RK: Pharmacology and Physiology in Anesthetic Practice, 2nd Ed., 613, Lippencott, Philadelphia, 1991.
2. Revers SG, Gragen RJ, Vinik R, et al: Midazolam: Pharmacology and Uses. Anesthesiology 62:310, 1985.
3. Bell GD, Spicket GP, Reve PA, et al: Intravenous Midazolam for Upper Gastrointestinal Endoscopy: A study of 8000 consecutive cases relating dose to age and sex of patient. Br. J. of Clin Pharmacology 23:241-243, 1987.
4. Brophy t, Dundee JW, Heazelwood V, et al: Midazolam – A water soluble Benzodiazepine for gastroscopy. Anasth Intensiv Care 10:344-347, 1982.
5. Daily Med: http://dailymed.nlm.nih.gov/dailymed

Pulse Oximetry:

1. Wong DH, Tremperer KK, Davidson J, et al: Pulse oximetry is accurated in patient with dysrrhythmias and pulse deficit. Anesthesiology 70:1024, 1989.
2. Scheller MS, Zinger RJ, Kelner MS: Effects of intravenously administered dyes on pulse oximetry readings. Anesthesiology 65:550, 1986.
3. Ralston AC, Webb RK, Runciman WB: Potential errors in pulse oximetry I. Anesthesia 46:202, 1991.
4. Ralston AC, Webb RK, Runciman WB: Potential errors in pulse oximetry III. Anesthesia 46:291, 1991.
5. Severinghaus JW, Kelleher SF: Recent developments in pulse oximetry. Anesthesiology 76:1018, 1992.

Respiratory Physiology:

1. Nunn JF: Applied Respiratory Physiology, 3rd Ed. London, Butterworths, 1987.
2. Guyton AC: Textbook of Medical Physiology, Seventh Edition, Saunders, 1991.
3. Marshall BE, Wychel MQ: Hypoxemia during and after anesthesia. Anesthesiology 37:178, 1972.

Nausea and Vomiting:

1. Watcha MF, White PF: Postoperative Nausea and Vomiting: Its etiology, treatment, and prevention. Anesthesiology 77:162, 1992.
2. Moyers JR: Preoperative Medication, p. 615. In Barash PG, Cullern BF, Stoelting RK, Eds: Clinical Anesthesia, 2nd Ed. JB Lippincott, Philadelphia, 1992.
3. Van Erdewyk JM: Postoperative Nausea and Vomiting in Anesthesiology: Review, p. 568, Churchill Livingstone, 1994.

Anaphylaxis and Anaphylactoid Reactions:

1. Moss J: Anaphylactoid and Anaphylactic Reactions in the Operating Room: p. 145 ASA Refresher Course Lectures, 1994.
2. Levy JH: Anaphylactic Reactions in Anesthesia and Intensive Care. 2nd Ed. Butterworths, Boston, 1992.
3. Watkins J: Anaphylaxis: International Anesth. Clin. 23:17-40, 1985.
4. Beamish D, Brown DT: Adverse Response to IV Anesthetics. Br J Anasth 53:55, 1981.
5. Christopherson TJ: Anaphylactic and Anaphylactoid Reactions, p. 191. Anasthesiology Rev, 2nd Ed., 1994.

6. JCAHO
7. Medical Staff Policy
8. SACH Hospital Policy - Moderate Sedation
9. SACH Hospital Policy – Deep Sedation

Drug	Dosage	Approximate Clinical Effect Onset Peak Duration	Special Considerations	Antidote
DEMEROL (Meperidine)	***Adult:*** ***IM:*** *50-150mg 60 min prior* ***IV:*** *12.5-25mg q 2 -15 min* ***Pediatrics:*** ***IM:*** *1-2 mg/kg up to adult dosage 60 minutes prior* ***IV:****0.5mg/kg q 5min up to a maximum of 2mg/kg*	*within 10min within 45 min 2-4hrs* *within 5 min 10-20 min 1-2hrs* *within 10min within 45 min 2-4hrs* *within 5 min 10-20 min 1-2hrs*	*More rapid onset but shorter acting than morphine* *Contraindicated in pts. on MAO inhibitors* *Lower dose by 25-50% if other sedatives or CNS depressants used* *Give by slow IV over 2 min* *May cause hypotension, patient should be lying down* *Dilute to 10mg/ml for IV push*	***NARCAN*** *(naloxone)* ***Adult:*** *0.1-0.2 mg q2-3 min until desired effect.* *For complete reversal, use 2mg doses* ***Pediatric:*** *≤ 5 yrs or ≤ 20 kg: 0.1 mg/kg; repeat q2-3 min prn* *>5 yrs or > 20 kg: 2mg/dose q 2-3 min prn.* ***Neonatal:*** *0.1mg/kg/dose q3-5min prn.* ***Should only be used for significant adverse effects and not as a regular part of moderate sedation procedure*** ***Patient must be monitored for at least 1 hour to protect from resedation***
MORPHINE	***Adult:*** ***IM:*** *0.1mg-0.3mg/kg 60 minutes prior* ***IV:*** *1-4mg q 2-15min* ***Pediatrics:*** ***IM:*** *0.1-0.2mg/kg up to 15mg 60 min prior* ***IV:*** *0.05mg/kg q 5-15 min*	*within 15 min within 60min 3-7hrs* *within 1-3 min 10-20 min 1-2hrs* *within 15 min within 60min 3-7hrs* *within 1-3 min 10-20 min 1-2hrs*		As Above
FENTANYL	***Adult:*** ***IM:*** *0.05-0.1mg 30-60 minutes prior* ***IV:*** *Loading dose up to 1mcg/kg then 12.5mcg-50mcg q 5-10min* ***Pediatrics:*** ***IM:****2-3 mcg/kg 30-60 minutes prior.(2-12 years)* ***IV:*** *0.5-1mcg/kg q5-10 minute*	*within 7-8 min 15min 1-2hours* *1-1.5 minutes 5-15min 0 .5-1 hour* *within 7-8 min 15min 1-2 hours* *1-1.5 minutes 5-15min 0 .5-1 hour*	*Inject slowly over 1-2 minutes* *Respiratory effect lasts longer than analgesic effect. Start any follow-up narcotics at 25% to 30% of normal dosing initially.* *Lower dose if other sedatives or CNS depressants are used.* *For IV, dilute with NS to a volume to allow control of injection rate*	As Above

Drug	Dosage	Approximate Clinical Effect Onset Peak Duration	Special Considerations	Antidote
VERSED (Midazolam)	***Adult:*** ***IV:****0.25mg-1mg q 2-5 min* ***Pediatric:*** ***IV:****0.05mg-0.1mg/kg q 3-5 min* ***Syrup:*** *0.25mg/kg to 1mg/kg 30-45 min. prior to procedure Maximum dose = 15-20mg* ***IV for Oral use:*** *may use IV form of med and dilute with syrup (1ml injection/1ml syrup) and dose as stated above for syrup.* *25% -50% of dose when patient is pre-medicated with other sedatives*	*-5 minutes 10-15min 1-.5hrs.**** *5-15min 20-60min 2 hrs.** *10-30 min 20min-2 hours 2-7hrs.* *** May be as high as 6 hours in some pts.*	*Do not give as bolus for conscious sedation.* *May cause tachycardia, PVCs, or vaso-vagal effect.* *May cause respiratory depression* *Give dose over 2 minutes and wait 2 minutes before giving another. Titrate to desired effect (slurred speech).* *Maintenance doses should be about 25% of the dose it first took to get to sedative endpoint.* *Give slowly over 2 minute. Give only if need is clearly indicated.* *Where you start on dosing range is dependent on age and health of patient. Start at low end for elderly (>60y/o), debilitated or chronically ill patients.* *In pediatrics, it may be associated with disinhibition.* *Dilute to 0.5mg/ml for IV push*	***ROMAZICON*** *(flumazenil):* ***Adult:*** *.2 mg q 1 min as needed, up to 1 mg.* ***Pediatric:*** *0.01mg/kg (max of 0.2mg) q 1min up to max of 1mg.* ***Neonatal:*** *0.002-0.01mg/kg/dose q 1min x 3 doses. May repeat in 20 min as needed* ***Should only be used for significant adverse effects and not as a regular part of moderate sedation procedure*** ***Patient must be monitored for at least 1 hour to protect from resedation.*** ***Contraindicated in pt.'s receiving benzodiazepines for control of serious seizures or pts. that are tricyclic overdoses***
ATIVAN (Lorazepam)	***Adult:*** ***IM:*** *0.05mg/kg up to a maximum of 4 mg given 2 hours before procedure.* ***IV:*** *0.044mg/kg (up to 2mg total) administered 15-20 prior.* ***Pediatrics:*** ***IM:*** *0.6-1mg/kg/dose* ***IV:*** *0.05-0.1mg/kg/dose*	*15-30min 60 min 12-24hrs* *1-5min 15-20min 12-24hrs*	*May cause respiratory depression* *For IM, inject deep in large muscle undiluted* *For IV:,dilute 1ml Ativan to 1ml NS* *Give over 1 min* *Increased respiratory depression in children < 2 years old.*	As above

Drug	Dosage	Approximate Clinical Effect Onset Peak Duration	Special Considerations	Antidote
VALIUM (Diazepam)	***Adult:*** ***IV:*** *1-2mg q3-10 min* ***IM:****2-10mg* ***Pediatrics:*** ***IV:*** *0.05-0.1mg/kg q 3-10min (max of < 0.25mg/kg)*	*1-5min 10-30min 2-6hrs* *15-30min 1-2 hrs 2-6 hrs* *1-5min 10-30min 2-6hrs*	*May cause respiratory depression* *IM injection should be given deep and is painful* *Injection thru tubing should be as close to vein insertion as possible due to compatibility problems* *Potentiated by other CNS depressants.* *Give IV slowly over 1 minute for each 5 mg.* *Administer into large vein* *Do not dilute. Not compatible with other drugs.*	***ROMAZICON*** *(flumazenil)* *Follow dosing and use as previously stated.*
NEMBUTAL (Pentobarbital)	***Pediatric:*** ***IV:****1-2mg/kg q 5min (max total dose of 6mg/kg or 200mg total)* ***IM:*** *2-6mg/kg/dose(not to exceed 100mg)* ***RECTAL:****<4y/o= 3-6mg/kg/dose* *> 4y/o= 1.5-3mg/kg/dose*	*30-60 sec 1min 15+ min* *10-25 min 40min 1-4 hours* *10-30min 60min 1-4 hours*	*Mild respiratory depressant* *50mg/min IV rate* *Incompatible with many medications. Do not mix.* *Do not dilute*	***No reversal agent***
KETAMINE	***Pediatric:*** ***IV:*** *0.2-1mg/kg (sedation/analgesia) 1-1.5mg/kg (intubation)* ***IM:*** *2-10mg/kg* *4-5mg/kg is common for ED procedures* ***PO:*** *3-6mg/kg*	*30-40 sec 1 min 5-10 min* *1min 5 min 12-25min* *5-10 min*	***For procedural sedation in ED/OR only*** ***IV:*** *Administer at 0.5mg/kg/min* *-Do not administer faster than 1 min* *-Dilute to a final concentration of 2mg/ml* *-adjuvant use of other sedative will effect dosing and response* *-Recovery from IV is about 1-2 hrs.* ***IM:*** *Recovery from IM is about 3-4 hrs.* ***PO:*** *Use ketamine IV to prepare oral solution. Dilute dose in cola or other flavored beverage.* *-In all the above routes, the Anal onnset is slower and lasts longer than the sedative effect.* *-Use with caution in pts. with GI reflux, increased CSF pressure, and with hepatic dysfunction*	***No reversal agent***

Drug	Dosage	Approximate Clinical Effect Onset Peak Duration	Special Considerations	Antidote
ETOMIDATE	***Adult:*** ***IV:*** *0.1 mg/kg (sedation dose)* ***Pediatric:*** *IV: 0.2mg/kg (sedation dose)*	*10-20 sec* *1 min* *2-6 min*	***For procedural sedation in ED/OR only*** ***Dosing given is for moderate sedation and not rapid sequence intubation*** *Adjuvant use of other sedative effect dosing and response* *-Administer over 1-2 min* *-Recovery time is approximately 15 min.* *-In some patients more than 1 dose may be needed to obtain desired sedation* *-Involuntary muscle movement (myoclonus) is common and dose related.* *-GI effects are common*	***No reversal agent***

SAN ANTONIO REGIONAL HOSPITAL

MODERATE SEDATION EXAMINATION

Number	True	False	Question
#1			A patient whose only response is reflex withdrawal from a painful stimulus represents an example of proper moderate sedation.
#2			Moderate sedation means the patient has a depressed level of awareness, can maintain his/her airway independently and can handle secretions without aspiration.
#3			Pulse Oximetry is a completely reliable monitor of ventilatory function.
#4			Naloxone (Narcan) is virtually free of side effects.
#5			5 mg of I.V. Morphine is equal to roughly 50 mg of I.V. Meperdine.
#6			In addition to suspending further drug administration, respiratory depression should be initially treated with supplementary oxygen, encouragement to the patient to breathe deeply and if necessary, positive pressure ventilation by mask.
#7			Once a patient has received flumazenil there is no further risk of cardio-respiratory depression.
#8			A patient with a history of sleep apnea may present with a difficult airway.
#9			Obese patients and patients with anomalous features of the face and jaw may be associated with a difficult airway.
#10			Intravenous diazepam can cause phlebitis.
#11			Patients with COPD are more susceptible to midazolam induced ventilatory depression than patients without lung disease.
#12			Benzodiazepines, including midazolam, do not have analgesic effects.
#13			Transient skeletal muscle movements have been reported in up to 32% of patients following etomidate injections.
#14			Duration of action of IV morphine is approximately 1-2 hours.
#15			The peak analgesic effect of IV morphine occurs about 10-20 minutes after injection.
#16			Fentanyl IV has an onset of 2 to 3 minutes.
#17			Large doses of IV Fentanyl given rapidly can cause thoracic muscle rigidity that may impair ventilation (stiff chest syndrome).
#18			Acute reversal of opioid-induced analgesic with Narcan can result in hypertension and even pulmonary edema.
#19			Titration of 0.25mg to 1mg is the initial recommended dose for Versed. The age and health of the patient should be taken into consideration.
#20			Valium may have a half-life up to 96 hours in the geriatric patient.
#21			Benzodiazepines and narcotics have synergistic effects of which the most noteworthy are airway obstruction and apnea.
#22			Normeperidine, an active metabolite of meperidine, can cause seizures.
#23			Because of its shorter half-life and lack of active metabolites, Versed is preferable to Valium for moderate sedation.
#24			The initial recommended adult dose of flumazenil (Romazicon) is 0.2mg q 1 minute, up to 1mg.

Physician Printed Name _____ **Physician Signature** _____ **Date** _____

(For Medical Staff Office Use Only) _____ # OF MISSED QUESTIONS □ Pass □ Fail

(May only miss three (3) for a passing score)

PLEASE COMPLETE AND RETURN THIS PAGE