Dartmouth Hitchcock Medical Center

Pediatric Sedation Course:

Version 1.0

Required course for all
RN and MD providers of Pediatric Sedation

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Table of Contents:

1. OVERVIEW OF PEDIATRIC SEDATION FACTORS

Sedation for diagnostic and painful procedures is a growing and dynamic area of pediatric practice. This course is intended to bring you the basic information required to provide safe sedation. We have designed the course in three parts: 1) the pre-sedation period including general considerations for sedation, 2) the intra-procedure sedation process including the process, monitors and drugs used for sedation, and 3) the post-sedation time period with an accent on discharge criteria and appropriate conditions for discharge.

Before beginning this course the student should recognize that we do not intend to present algorithms or a "cook book" on how to perform sedation for a child. Each sedation should take into account the type of procedure that will be performed (i.e. painful vs. non-painful) and the age, developmental status, and personality type of the child. Thought should always be given to how a procedure could be accomplished without medication through the use of emotional support and/or distraction techniques.

2. PRE-SEDATION:

a. Levels of Sedation

Professional organizations have defined sedation in different ways. Across the board all these organizations have defined different “levels” of sedation ranging from minimally impaired consciousness to complete unconsciousness or general anesthesia. Any provider who delivers sedation should recognize that different levels of sedation are possible and they are not specific to a given drug. Any drug (given a large enough dose) will produce obtundation, and likewise even the most powerful anesthetic can produce minimal sedation when given in a very small dose.

Sedation providers should recognize that these definitions are arbitrary and there is no clear demarcation between the different levels. The current recommendations from the JCAHO state that a provider of sedation should be able to manage or “rescue” a patient from one level of sedation “deeper” than that which is intended. This is a recognition of the fact that it is impossible to always know the effect that a given dose of a sedation medication will have on an individual patient. It is also a recognition of the fact that different levels of sedation require different levels of expertise in management of the airway and physiological function for a patient.

Table 1. Levels of Sedation and Clinical Response.

Minimal Sedation:
(Also referred to as conscious sedation): a medically controlled state of depressed consciousness that (1) allows protective reflexes to be maintained; (2) retains the patient's ability to maintain a patent airway independently and continuously; and (3) permits appropriate response by the patient to physical stimulation or verbal command, eg, "open your eyes.” Although cognitive function and coordination may be impaired, ventilatory and cardiovascular functions are unaffected;

Moderate sedation/analgesia:
A drug-induced depression of consciousness during which patients 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;

Deep Sedation:
Deep sedation: a medically controlled state of depressed consciousness or unconsciousness from which the patient is not easily aroused. It may be accompanied by a partial or complete loss of protective reflexes, and includes the inability to maintain a patent airway independently and respond purposefully to physical stimulation or verbal command. Patients may require assistance in maintaining a patent airway and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained; and

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 patients are not arousable, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. Patients often require 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.

Editorial Comment: Many older texts and some sedation providers still refer to "conscious sedation" when they discus sedation of children. In fact it is extremely difficult – to impossible – to achieve this level of sedation in children. In fact, most sedation in children is either moderate or (more often) deep sedation. Preparation and qualifications for sedation should be planned with this in mind. The AAP now has issued an official statement discouraging the use of the term "conscious sedation" when referencing sedation in children.

b. Factors Relating to the Procedure

Duration of the procedure:
When choosing a sedation medication or technique, the provider should consider the time that the procedure will require to be accomplished. It would seem ill-advised to give a sedative medication that lasts for several hours to a child who is having a procedure that only takes several minutes. Likewise the drug given should provide sedation for enough time to accomplish a procedure – or directions for further dosing should be included.

Pain as a side effect of a procedure:
Another important aspect of sedation that must be considered is the presence or absence of pain with a given procedure. Many of the sedatives that are commonly used for sedation – such as chloral hydrate and the benzodiazepines - have absolutely no analgesic component. A child may be sedated with one of these medications but as soon as any painful stimulus is felt, he/she will cry out and thrash about wildly. Adequate movement control is only obtained with these medications (during a painful procedure) when the child has consciousness depressed to the deep or general anesthesia levels, which usually indicates a relative overdose of the medication. Other medications such as fentanyl will provide powerful pain control for procedures while not offering the same sedative potency. In general, analgesic medications should be included if the procedure is going to be painful while they may be omitted for non-painful (diagnostic) procedures.

Position required for the procedure:
In planning the depth of sedation, each provider must consider the position that the patient will be in during the procedure. The average child will maintain an open airway in the supine position even when deeply sedated as long as the neck can be slightly extended. If the head must be flexed during a procedure or a scan, obstruction of the airway will be

much more likely and care should be taken to avoid deep sedation unless the provider is ready to place an oral airway or endotracheal tube. In general when children are placed on their side or in a prone position the airway is at least as easy to maintain – or easier than when in the supine position. Finally if the airway is going to be remote from the sedation provider (i.e. MRI scan) the sedation provider must take into account that adjustment of the airway will not be possible and assisting ventilation will require ceasing the procedure itself.

Anxiety/Stress/inability to cooperate as a side effect of the procedure:
Sedation may be required for procedures that are not particularly painful and do not require a great deal of movement control. There are several procedures that are particularly emotionally stressful (such as bladder catheterization required for a voiding cystourethrogram) where a brief period of unconsciousness will allow the patient to avoid an emotionally harmful experience. Often these procedures involve invasion or examination of the genetalia (sexual abuse evaluations) – and the same amount of discomfort involving an extremity would be trivial. These situations should be considered separately from the seriously painful procedures (bone marrow biopsy) or those where movement control is paramount (MRI scan) yet the need for sedation is no less real.

Availability of Rescue Resources:
The geographical location in which the sedation is taking place will impact the sedation. When sedation is given in a particularly remote area of a medical center or hospital the provider must recognize that "back-up" or "rescue" is going to be much less available. Evaluation of critical incidents related to sedation has revealed that the worst outcomes for unexpected apnea events occur when rescue is not readily available. The depth of sedation provided and the type of patient sedated should be reconsidered when the location of the sedation is more than a 5 minute walk/run from personnel who will be able to help in the case of an emergency.

c. Factors Relating to the Patient

Past Experience:
When planning to sedate a child, the previous experiences of the patient to be sedated should be elicited. Both good and bad experiences should be reviewed along with the drugs that were previously administered. Obviously patients who became combative with a given dose of oral Versed would not be well served by repeating that drug and dose for another procedure. Similarly the provider should elicit some indication of the anxiety that the patient and family have regarding the upcoming procedure and sedation. The severely anxious patient will often times need significant sedation where a relaxed patient may only need support or distraction. While these facts may seem self evident, a sedation history is often completely neglected by many providers. The response and satisfaction that a patient and family have with a particular sedation will be heavily influenced by their previous experience.

Allergies:
It is imperative that a good drug allergy and adverse reaction history be elicited prior to providing sedation. If a patient states an "allergy" is present to a given medication, a history of what type of reaction occurred should be obtained. Often patients will interpret nausea after a sedation as an allergy to whatever medication was given when this is clearly not the case. Drugs which were associated with urticaria or shortness of breath should obviously be avoided.

Adverse Reactions:
As mentioned above, many patients will have paradoxical reactions to sedative medications such as chloral hydrate where crying and combative behavior is elicited rather than sedation. It is critically important to elicit this information prior to repeating a failed strategy.

Aspiration Risk:
A history of last oral intake is required before providing sedation. Although the data on aspiration injury associated with pediatric sedation cases is not definitive, most experts advise fasting guidelines (NPO) that mimic those require for anesthesia. The reasoning behind these recommendations follows the thought that is often very difficult to predict the exact depth of sedation that will result from a dose of a sedative in a small child – therefore it should be assumed that airway reflexes may be lost and steps to minimize risk should be taken.

There are no national standard guidelines for fasting prior to sedation. Generally accepted guidelines differentiate between clear liquid intake and heavy meals in a graded fashion as outlined below:

Fasting guidelines for sedation or anesthesia.

Food	***Hours of Fasting Required***
Clear Liquids	2
Breast Milk	2 or 4 depending of mother's diet
Formula or Light Meal (no fat)	6
Full Meal	8

In addition to the history of intake, prior to sedation the provider should elicit a history of gastroesophageal reflux disease. Patients who have a history of severe reflux disease (with associated growth failure or daily vomiting) may not be completed safe under significant sedation unless their airway is protected. At the very least, these patients should have an assured fasting interval, and some experts will insist on securing their airway with an endotracheal tube prior to providing deep sedation.

With the recommendations outlined above in mind, each provider will need to weigh the urgency of the procedure against the relative risk of the "full stomach". Emergency departments routinely do not abide by these fasting guidelines and there is little indication that aspiration is a significant problem in this setting. In spite of this it seems prudent to strive for a reasonable fasting interval when sedating pediatric patients – in particular those having elective procedures.

General Health:

The general health status of each patient undergoing sedation should be considered. The child should undergo a general physical examination with focus on the airway, cardiovascular, and respiratory systems. Most institutions require the physical examination be completed by a licensed practitioner prior to sedation.

The AAP guideline recommend that the presedation physical include:

* Age and weight;
* Health history, including (1) allergies and previous allergic or adverse drug reactions; (2) drug use including dosage, time, route, and site of administration for prescription, over-the-counter, or illicit drugs; (3) relevant diseases, physical abnormalities, and pregnancy status; (4) a summary of previous relevant hospitalizations, (5) history of sedation or general anesthesia, and any complications; and (6) relevant family history;
* Review of systems;
* Vital signs, including heart rate, blood pressure, respiratory rate, and temperature;
* Physical examination
* Physical status evaluation
* Name, address, and telephone number of the child's or family's physician.

For hospitalized patients, the current hospital record may suffice for adequate documentation of presedation health; however, a brief note shall be written documenting that the chart was reviewed, positive findings were noted, and a management plan was formulated. If the clinical or emergency condition of the patient precludes acquiring complete information before sedation, this health evaluation should be obtained as soon as feasible.

To aid in assessment of anesthesia risk, the American Society of Anesthesiologists has a classification system for patients which categorizes individuals on a general health basis. As such, it is one of the most important factors used to assess the overall perioperative risk (see table1). Rather than focus on any specific disease entity, the ASA status is intended to group patients together based on health status in order to better asses the risk of anesthesia or sedation of a given patient. Several studies have documented the fact that risk for sedation rises with increasing ASA staus.

Table 1

ASA Class	Description	Examples
1	A normal, healthy patient, without organic, physiologic, or psychiatric disturbance	Healthy with good exercise tolerance
2	A patient with controlled medical conditions without significant systemic effects	Controlled hypertension, controlled diabetes mellitus without system effects, cigarette

		smoking without evidence of COPD, anemia, mild obesity, age less than 1 or greater than 70 years, pregnancy
3	A patient having medical conditions with significant systemic effects intermittently associated with significant functional compromise	Controlled CHF, stable angina, old MI, poorly controlled hypertension, morbid obesity, bronchospastic disease with intermittent symptoms, chronic renal failure
4	A patient with a medical condition that is poorly controlled, associated with significant dysfunction and is a potential threat to life	Unstable angina, symptomatic COPD, symptomatic CHF, hepatorenal failure
5	A patient with a critical medical condition that is associated with little chance of survival with or without the surgical procedure	Multiorgan failure, sepsis syndrome with hemodynamic instability, hypothermia, poorly controlled coagulopathy
6	A patient who is brain dead and undergoing anesthesia care for the purposes of organ donation	
E	This modifier is added to any of the above classes to signify a procedure that is being performed as an emergency and may be associated with a suboptimal opportunity for risk modification	

Prescriptions:

When prescriptions are given to a patient prior to discharge, a copy of the prescription or a note describing the content of the prescription should be in the patient's chart along with a description of the instructions that were given to the responsible person.

This physical evaluation should be reviewed by the sedation provider and particular attention should be paid to:

Airway Issues:

Specific abnormalities of the airway should be noted. A small or malformed mandible or a large tongue are often associated with difficult spontaneous as well as assisted ventilation. Teeth that are protruding or particularly loose should be noted as they may hinder airway visualization or be knocked free during manipulation. Any syndrome that results in an “unusual facies” should be carefully noted as they may also be associated with an airway that is difficult to manage. It may be helpful to give each child a Malampati classification as part of the presedation work up. This examination (which classifies the relative size of the tongue in the mouth) may be used as a trigger for referring a patient for "expert" sedation. In general, a high (III-IV) Malampati classification associated with any other abnormality of the head and neck is indicative of an airway that may well be difficult to manage.

To perform the Malampati examination, the provider has the patient sit facing the examiner and asks the patient to open the mouth as wide as possible. The patient is classified and Malampati I if the examiner can see down to the tonsillar pillars, class II if the examiner can visualize just the full uvula, class III if only the soft palate can be seen, and class IV if the hard palate is all that is visualized. Of course many pediatric patients can not cooperate with this examination but any game that encourages a child to open his/her mouth fully should be employed to generally asses the status of the mouth opening and tongue size.

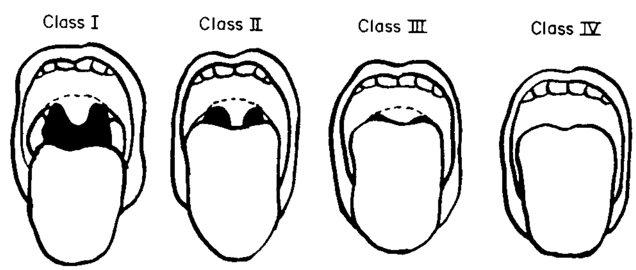


Fig. 5-6 Classification of pharyngeal structures. Note that in Class III the soft palate is visible but in Class IV it is not. (From Samsoon GLT, Young JRB: *Anaesthesia* 42:487, 1987.)

Developmental Issues:

The neurodevelopmental status of the child should be noted. Requirements for sedation will change greatly for any child who is severely delayed. Some of these patients will require more sedation than a similar patient their age while others may actually not require sedation at all. Input from the primary care givers of these patients is critical in determining the amount of intervention that will be required for a given procedure – they can often predict the response a patient will have to a situation – and often it is not what the sedation provider would have guessed after a brief interview and examination. Often these patients have severe scoliosis or limb deformities that require special positioning considerations.

Cardiac and Respiratory Systems:

As mentioned above, the cardiac and pulmonary systems must be assessed prior to beginning the sedation. Patients with a history of significant congenital heart disease deserve to have sedation provided by a true expert. In particular, patients with pulmonary hypertension may have significantly adverse reactions to hypoventilation and increased CO_2 – or hypoxia. The presence of a corrected valve or shunt will require prophylactic antibiotics for minor procedures that otherwise would be the case for a well child. Finally the amount of left to right shunting may be changed by pulmonary or systemic vasodilation which can be the result of medication administration.

Asthma:

Respiratory issues usually involve the presence of asthma or upper respiratory tract infections (see below). Although little data exists concerning the risk of sedation for patients with asthma, experts agree that any time there is the chance of manipulating the airway (as is the case with any significant sedation) an asthmatic should be in his/her best possible condition prior to beginning the procedure. Generally this includes taking all usual inhalers prior to the sedation and assuring that the child is not actively wheezing. There is no firm data to suggest that giving prophylactic oral steroids or antihistamines prior to the procedure will change the outcome of a sedation asthmatic children.

Upper Respiratory Tract Infections:

Children with upper respiratory tract infections should also be considered separately from those who are well when assessing sedation risk. Unfortunately, during the winter months as many as 20% of the pediatric population may have some symptoms of a respiratory infection. If all these cases were cancelled it would be hard to accomplish a large percentage of our sedation work load. There is little clear data to help us categorize the exact increase in risk associated with a current respiratory infection, but several studies have found an increase in airway and respiratory complications after anesthesia is given to patients who have significant cough and mucous production. Prudent practice would dictate that children who have a fever, or those with a significant cough +/- sputum production are best off postponing an elective sedation. Likewise, children with wheezing or croup-like symptoms should not be given routine sedation. Children with mild/moderate nasal discharge or those with minimal cough symptoms should be considered for sedation on a case by case basis.

d. Provider Factors

Dedicated Sedation Monitor

The use of moderate or deep sedation shall include provision of a person, in addition to the practitioner, whose responsibility is to monitor appropriate physiologic parameters and to assist in any supportive or resuscitation measures, as required. It is strongly encouraged that this individual be trained in pediatric basic life support. The support person shall have specific assignments in the event of an emergency and, thus, current knowledge of the emergency cart inventory. [AAP guidelines for sedation]

The practitioner and all ancillary personnel should participate in periodic reviews of the facility's emergency protocol, to ensure proper function of the equipment and staff interaction.

***Skills Related to Depth of Sedation*:**

Prior to sedating a child or to writing sedation protocols, an honest appraisal of the expertise of the sedation provider must be made. The JCAHO has recommended that the provider must have the skills necessary to “rescue” a patient from the consequences of sedation one level “deeper” than that which is intended. Since minimal sedation is almost never adequate for an infant or young child undergoing sedation for a procedure, the provider must be able to rescue a child from “deep” sedation or anesthesia. Specifically, if a sedation provider desires moderate sedation for a pediatric patient, he/she should be readily able to perform bag-mask ventilation and ultimately to perform endotracheal intubation. He/she should understand how to quickly and effectively suction the airway and provide intravenous access in an expeditious manner. If these skills are not clearly present for the sedation provider, then minimal sedation should be the goal and sedation protocols should reflect this.

When planning sedation, one must consider the experience and training of the individual who is providing sedation. Many physicians and nurses have the skills outlined above, but have never had experience with sedation medications and have never been trained in how to asses signs of responsiveness and drug titration to effect. Experience in these areas should be sought through practical experience with experts in sedation.

Back-up Systems and Ability to Rescue:
As important as any provider-related issue is the availability of a highly trained and reliable back-up system. Studies of sedation related critical events have shown that sedation accidents are clearly most common in venues where a good back-up or rescue system is not available. The depth of sedation that is sought for any procedure should take this factor into account. A protocol for accessing the back-up help for sedation critical events (most often the "code" team) should be clearly laid out and tested on a regular basis. For a nurse who is providing sedation under the direction of a physician, that physician should be present in the area that the sedation is being given and should be available to help out in the case of an emergency.

e. Summary Table of Procedure, Patient and Provider Factors

Procedural Factors	Patient Factors	Provider Factors
Pain as a side effect	**Indication** for Procedure	**Skills for depth of sedation sought**
Anxiety/Stress/Inability to Cooperate as a side effect	**ASA Status** (Functional Health)	**Opiod titration skills** for pain management
Expected **Duration**	**Meds/Allergies/ Adverse Reactions**	**Sedative hypnotic titration skills** for stress/inability to cooperate management
Required **Position**	Focused ROS- **EDCPA**: Previous **E**xperience, **D**evelopmental Issues, **C**ardiac, **P**ulmonary (asthma, recent URI) **A**spiration Risk	**Monitoring skills** for sedation side effects
Availability of **Rescue Resources**	Vitals- **Room Air SpO2**	**Skills in mobilizing "rescue" resources**
	Airway Exam	

Example Pre-sedation Assessment Tool:

Standard Pre-Procedure Assessment Form

Age:_______

Reason (i.e., dx) for procedure(s): ____

Planned procedures(s): 1)____

2)____

3)____

PMHx: ☐Cardiovascular Dz ☐Pulmonary Dz ☐Renal Dz ☐Neurologic Dz

☐Anxiety Disorder ☐Chronic Pain Disorder ☐Cognitive/behavioural Disorder

PSHx/ProcedureHx: ☐Previous Surgery and anesthesia WITHOUT complications

☐Previous Surgery and anesthesia WITH complications

Medication(s): 1)______________________________ 4)__________________________

2)______________________________ 5)__________________________

3)______________________________ 6)__________________________

Allergy(s) 1)______________________________ 3)__________________________

2)______________________________ 4)__________________________

PE: Wt _____ HR____ BP _________ RR ______ SpO2 ______ Tmp _____

Airway: Mal. I II III IV Oral Aperture: normal decreased

Neck extension: normal decreased Teeth: intact chipped edentulous ⇧ ⇩

Cardiopulmonary: clear rales wheezes rhonchi RRR systolic murmur diastolic murmur

3. GETTING STARTED – INTRA-SEDATION MANAGEMENT

a. Informed Consent:

Any time sedation medications are to be given to a pediatric patient, a clearly worded informed consent should be signed by the guardian of that patient. This consent should include a listing of the possible consequences of adverse drug reactions, allergic reactions and airway difficulties. If the patient is old enough to understand the fact that consent is being signed, he/she should be made aware of the document and should be present when the guardian signs the consent. Several institutions now require “assent” from minors prior to beginning a sedation for any type of procedure.

b. Equipment Needs for Sedation:

Before undertaking sedation of a pediatric patient there are some key pieces of equipment that must be in place – regardless of the desired depth of sedation that is intended. The exact location of the equipment and how “immediately available” each device is for every sedation will vary with the drugs used and intended level of sedation, but in any case this equipment is crucial to the safe care of a sedated pediatric patient.
Many providers have developed mneumonics in order to remember this equipment and remind themselves of what should be in place prior to starting a sedation. The one that might match the categories of equipment in this course is **SOBA MDI** (**S**uction **O**xygen **B**ag-mask **A**irways **M**onitors **D**rugs **I**v-access).

We prefer to have the sedation providers think in terms of categories of equipment that are crucial.

Suction:
Suction apparatus must be available during any pediatric sedation. Emesis with/without aspiration is clearly a rare event in sedation practice, but when it does occur appropriate suctioning of gastric contents from the airway may make the difference between a minor incident and a major injury. More often suctioning comes in handy as a way to clear the airway of secretions that can inhibit spontaneous ventilation and cause coughing and desaturation. The best general purpose option is an appropriately sized Yankhaur suction device that will readily suction food material and sections from the upper airway. Suction catheters of various sizes may also be helpful, but care must be taken with these devices as deep airway suctioning can stimulate powerful vagal responses as well as laryngospasm when done too vigorously. Nasal suctioning should be done with caution as it can result in significant bleeding from the turbinates.

Oxygen:
Anytime sedation is to be induced in a child, a reliable source of oxygen should be present. This source may be the “wall” oxygen that is provided in a given institution. In cases where deep sedation or anesthesia is to be induced (and oxygen delivery is critical), a second “back-up” source of oxygen is helpful in case the institutional supply fails. Most often this would take the form of an “E” sized cylinder of oxygen with an oxygen flow

meter attached. In cases where wall oxygen is not available, the provider should check the oxygen tank supply and assure that there is ample oxygen available for the case – and/or that there are back-up oxygen tanks available.

Bag and Mask:
Airway equipment is also crucial to the safe conduct of pediatric sedation. A bag and mask for positive pressure ventilation must be present for any sedation. This may take the form of an "anesthesia" bag or self inflating bag. If the anesthesia bag is to be used, the provider must understand how to adjust the flow rates and valves to allow good positive pressure ventilation (PPV). Likewise, the provider should be familiar with the self-inflating bags which are often supplied with "pop-off" valves which may need to be closed for positive pressure ventilation. The exact arrangement of the "tail" on this bag that allows for high inspired fraction of oxygen should also be reviewed.

Airways:
A variety of different sized masks should be available. They should be constructed in a way that will allow a good seal to be made with the face of the sedated patient - should PPV be required. These masks may be round or triangular in shape. They may have also an inflatable cuff. Bag-mask ventilation should be practiced (and proficiency should be documented) with the type of bag and mask that is available at the site of the sedation prior to having to use this equipment in an emergency. Since PPV is made much easier in infants and children when an appropriate oral airway is in place, a variety of sizes of oral airways should be present to assist with ventilation.

Monitoring Devices:
Another key to safe pediatric sedation is the use of appropriate monitoring devices. The current AAP guidelines do not specifically require a particular set of monitors. They do state however that "Vital signs, including oxygen saturation and heart rate, must be documented at least every 5 minutes in a time-based record." The most commonly used array of monitors for sedation includes Pulse Oximetry, Electrocardiogram, and noninvasive blood pressure monitoring. We will review oximetry and

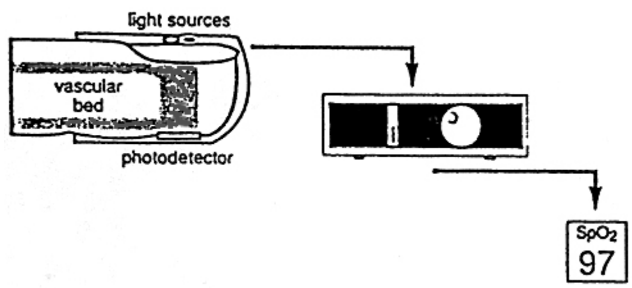
<u>Pulse Oximetry:</u>
Accurate pulse oximetry is mandatory during pediatric sedation. The latest versions of these monitors have software that largely eliminate the motion and light interference that plagued earlier versions. These monitors work by comparing the relative amounts of oxygenated vs. deoxygenated hemoglobin in the pulsing blood of an extremity or digit. This is accomplished by analyzing the amount of light absorbed of different wavelengths that correspond with these different forms of hemoglobin. The read-out of the pulse oximeter includes the percent saturation of hemoglobin with oxygen and the pulse rate. Most units include a plethysmograph that indicates the accuracy with which the pulse is being detected.

It is important for patients to have hemoglobin oxygen saturation above 90%. If they do not, the tissues of their bodies will not be able to function properly. The determination of oxygen saturation in patients undergoing sedation is used to identify problems with oxygenation and to regulate oxygen therapy. The sensor should not be placed on an extremity with an arterial line, blood pressure cuff, or intravenous line.

Anything that obstructs arterial blood flow may disrupt sensing by the pulse oximeter. This technology will also not work when compounds such as dyes or other forms of unusual forms of hemoglobin confuse the calculation mentioned above. In general pulse oximeters are very accurate and give two crucial pieces of information for any child under sedation– oxygen saturation of the blood and pulse rate.

As mentioned above, an Sa02 of 90% or less signifies developing hypoxia and requires confirmation and intervention (i.e. suction, position, O2).

Schematic Representation of the Pulse Oximeter:



<u>Pulse Oximeter Sensor Selection</u>

Chose appropriate size and type of sensor.

- Reusable sensors are for spot checks or short-term use
- Disposable adhesive sensors are for continuous monitoring

Place sensor so that the light beams and photo sensor are opposite each other.
Warm cold extremities to improve circulation.
Avoid extremity with blood pressure cuff, arterial line or tourniquet.
Avoid placing sensor on an area that is moved frequently.
Remove nail polish or dirt, which may not allow light beams to pass through tissue.
Clean dirt off reusable sensor.
Protect sensor from bright external light sources by covering the sensor and the limb it is on.

<u>Trouble Shooting when Pulse Oximeter Readings are Low</u>

Assess patient's respiratory effort.
Check connections

Plug machine in when not in use to charge battery.
Plug machine in when

Check the patient's circulation

? cold vs. warm
? pale vs. pink
? history of poor circulation

? tape to tight on extremity
? BP cuff or Arterial line present
Check external light that might be interfering.
Stop movement or select another area to monitor that is not moving.
Try the machine on yourself to see if it is working!

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Ventilation Monitors:

A monitor of ventilation is also very helpful during sedation – especially at deeper levels. While the pulse oximeter yields information on oxygen saturation, it does not give the status the patient's ventilation – or exchange of CO2. While these two physiologic variables often go together (if your oxygen saturation is low you are probably not ventilating well) – this is not always the case. More importantly, the pulse oximeter has a significant "lag time" between the cessation of respirations (apnea) and the change in the pulse oximeter reading. In fact a child may be apneic for 30-90 seconds (depending on size) before the oxygen saturation changes. The AAP guidelines on sedation are clear on this point. "The use of a precordial stethoscope or capnograph to aid in monitoring adequacy of ventilation is encouraged."
Precordial stethoscopes are placed over the chest or trachea to that the provider can listen to air movement and detect partial obstruction or complete apnea. They are accurate and inexpensive although (depending on the procedure to be performed) they may not be particularly convenient to use.

Capnography refers to measuring the CO2 level expired by a patient and processing that data graphically. Historically these monitors have used infrared wavelength absorption, Raman spectroscopy, or mass spectroscopy to measure CO2. Their use has been standard in the operating room environment for years. These monitors are now widely available in very portable (handheld) form using infrared technology. These units are available from a variety of manufacturers and most use a "side stream" detection technique in which a small amount of gas is continuously sampled from the nasal cannula or inside of the mask which the patient is breathing. The monitor then measures the level of CO2 in the gas and graphically displays the CO2 content.

The capnograph can be used to confirm air exchange with each breath. Apnea can be detected as soon as it occurs. Likewise rebreathing of CO2 inside of a mask can be detected by the presence of CO2 during the inspiratory phase of respiration. The absolute accuracy of the CO2 level detected will vary with the monitor used, the type of oxygen delivery device, and the oxygen flow rates used therefore it can not be considered completely reliable.

Troubleshooting:

If the capnograph is not recording any expired CO2 first check to be sure that the child's airway is open and that there are respiratory efforts.
If no respiratory effort is being made, initiate positive pressure ventilation immediately.
If there appears to be respiratory effort but the end-tidal monitor is not working, check to be sure that the sampling line has not become disconnected or is not kinked.
The sampling filter in the Capnograph can be obstructed with water – it may need to be changed.
Very high flows of oxygen in the mask or in the nasal cannula may "dilute" the CO2 sample and give a very low or ?absent CO2 reading.
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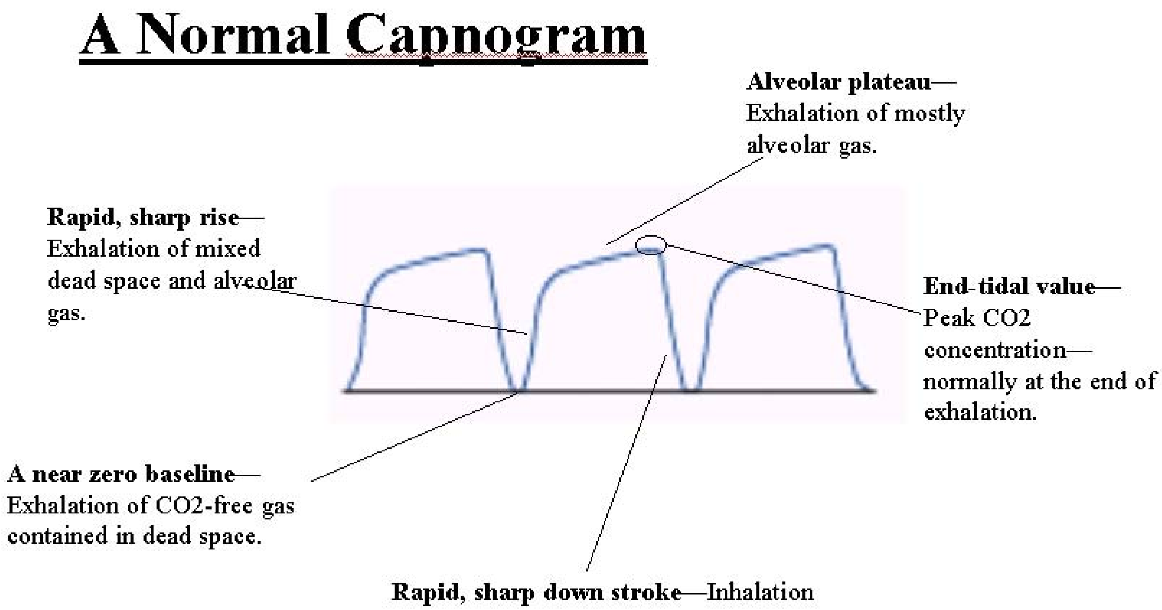

Plethesmography or measures of chest wall movement have also been used as respiratory monitors. Unfortunately this monitor will not detect the situation where the airway is obstructed and no air exchange is taking place but the chest wall is moving. Since airway obstruction is a major risk during sedation, this monitor is considered somewhat insensitive during sedation.

<u>ECG and Blood Pressure:</u>
The standard monitors for sedation include an ECG, pulse oximeter, and non-invasive blood pressure. The ECG gives information on the heart rhythm and rate – and can be used to confirm the accuracy of the pulse oximeter in that it can confirm the accuracy of the pulse rate. Blood pressure monitoring is most helpful for deep sedation. During minimal or moderate levels of sedation the cycling of the cuff may be disturbing to the patient and may inhibit the effectiveness sedation – many sedation providers omit blood pressure monitoring during sedation other than deep sedation or anesthesia.

Drugs for Emergency Resuscitation:
Drugs for resucitation that should be available. Succinyl Choline, Atropine, Epinephrine, Lidocaine, Calcium cholide, Naloxone, Flumazenil.

Intra-Vascular Access:
Children undergoing deep sedation or anesthesia should have an intravenous catheter in place. The availability of intravenous access allows the practitioner to administer medications that can immediately airway obstruction, reverse bradycardia, and administer specific reversal drugs for patients who become inadvertently oversedated with benzodiazepines or opioids.

c. Available Resuscitative Equipment (i.e., on "Code Carts")

Laryngoscopes and Endotracheal Tubes:
Even with the most careful titration of sedation medication, the sedation provider must be prepared for the rare instance where a child will become apneic and require prolonged positive pressure ventilation. In these cases definitive airway control with an endotracheal tube may be preferred. Because of this, laryngoscope blades of appropriate size for each patient undergoing sedation must be available in the immediate area of the child undergoing sedation. In general it is easiest to keep a supply of #0-3 Miller blades and 1-3 MacIntosh blades cleaned and ready for use. The batteries for the laryngoscope handles should also be tested at regular intervals. Endotracheal tubes sized to fit each patient should also be handy. Once again it is often easiest to stock a supply of uncuffed endotracheal tubes from size 3-6mm along with cuffed tubes from 4.5-6.5 and replace each tube as it is used.

Laryngeal Mask Airways (LMA's):
The LMA has become increasingly popular for airway management during anesthesia and in emergency situations. It is quite easy to place after sufficient training. While most sedation providers (non-anesthesiologists) will not be very familiar with their use, having various sizes available (size 1.5 – 4) in case of emergency will aid anyone who is familiar with their use – particularly in the case of individuals with airways that are difficult to intubate.

d. Overview Drugs Used for Sedation

When choosing drugs for pediatric sedation there are several key points that must be kept in mind:

1) Pharmacodynamics-The action of a drug:
The sedation provider must recognize that drugs used for sedation may be divided into two general groups: 1) those which provide sedation and 2) those which provide primarily analgesia. Procedures which are associated with significant discomfort do not lend themselves to sedation with drugs that do not afford any pain control. Likewise, procedures

that are not painful (MRI scans) do not necessarily require the addition of strong analgesics.

2) Pharmacokinetics-onset, duration and route of administration:
The sedation provider must understand the pharmacokinetics of the drugs that are available - including their onset of action and the duration of action.

Sedation drugs can be given orally, intravenously, intramuscularly, intra-nasally, or rectally. Sedation providers should be familiar with one or two medications that can be given by each route and should understand the above mentioned properties of these medications.
A major concern of any medication administered rectally is unreliable absorption, depending on the depth of insertion of the administration device. In addition, bowel movements may be stimulated with concomitant loss of medication and uncertainty as to how much the child has received. Oversedation or undersedation may occur. Titration to desired effect is impossible. Rectal administration of medications is generally not advised for patients over the age of 4 years as these children may attach a variety of complex meanings to rectal administration of medications, depending on a number of factors, including age, culture, and past experiences.[60]

Intravenous administration is usually the preferred route of administration of sedative/analgesic medications. One advantage this method of administration has over all others is the ability to titrate medications to the desired effect. In addition, combinations of medications may be employed with caution, as these combinations are always more potent than an individual medication. Intravenous administration of combinations of medications is the most common cause of respiratory depression in children undergoing moderate or "conscious" sedation.

3) Titration of drugs and hazards (dose stacking and synergy):
Dose response

Dose Stacking
It is imperative to avoid the repeated administration of medications before the peak effect of a previous dose has been reached, thus resulting in an excessive total drug effect over time (dose stacking).

Synergism
The sedation provider must also recognize the risks associated with the use of combinations of medications. A common example of this is the fact that when opiates are added to benzodiazepines respiratory depression is much more likely that when either of these drug classes are used by themselves.

4) Time Based Record:
Any sedation activity should be accompanied by a time-based record that includes the name, route, site, time, dosage, and patient effect of administered sedation drugs. During administration, the inspired concentrations of oxygen and the duration of their administration shall be documented. Adverse events shall be documented. Special attention must be paid to calculation of dosage, ie, mg/kg or mg/lb.

CHaD Children's Hospital
Dartmouth-Hitchcock Medical Center

Patient Addressograph

Example of Time Based Record:

Wt in Kg_______________

Medications

Chloral Hydrate mg (oral)									
Midazolam mg (oral, IM, IV)									
Morphine mg (IM, IV)									
Meperidine mg (IM, IV)									
Fentanyl mcg (IV)									
Ketamine/Glycopyrolate mg/mg (IM, IV)									
Propofol bolus mg (IV)									
Propofol gtt mcg/kg/min (IV)									
Remifentanyl gtt mcg/kg/min (IV)									

Time

Monitoring

BP
Systolic V
Diastolic Λ

HR ●

SpO2 x

Respiratory Rate (R)
EtCO2 ☐
Auscultation ☐
Observation ☐

DOCS: 0 to 5
(Dartmouth Operative Conditions Scale)

200
150
100
50
10
5
0

e. Specific Drugs that provide sedation (decreased anxiety and improved cooperation)

Sucrose Pacifier:

Before the advent of modern pediatric anesthesia, sugar-dipped pacifiers or "whiskey nipples" were used in conjunction with restraints for surgical operation such as pyloromyotomy in neonates. A recent study evaluated sterile water and 3 different concentrations of sucrose in infants 1-6 days of age prior to undergoing heel prick sampling.[44] There was a significant reduction in crying time with the use of this maneuver, with a greater reduction in those infants who received the highest concentration of sucrose. Perhaps this simple maneuver should be employed more frequently in infants undergoing brief painful procedures.[45]

Oral Chloral Hydrate:

Chloral hydrate is a halogenated hydrocarbon that has been used for sedation of pediatric patients during painless procedures for many years. The usual dose is 20-75 mg/kg orally. The drug has a bitter taste that may not be tolerated by all children (rectal administration is also effective). Most practitioners limit the dose to 100mg/kg or a total dose of 2gms.[31] The peak effect may take as long as 60 minutes and the plasma half-life is 4-9 hours. The drug can result in prolonged sedation, particularly in infants, with peak effect occurring well after the intended time of desired sedation.[28] One of the main advantages of chloral hydrate is its lack of associated respiratory depression.[32] Although rare, the potential for respiratory depression does exist however, and is most marked when the drug is combined with opioids or other sedatives. Deaths have been reported with doses of chloral hydrate in the recommended range; thus adherence to the sedation guidelines mentioned above, as well as monitoring during procedure and recovery period is imperative.[28]

Choral hydrate in high doses will arrest cell mitosis and alter the number of chromosomes in a cell. A metabolite of chloral hydrate has been shown to cause liver tumors in rodents. There is no data supporting toxic or carcinogenic effects in humans under currently accepted practice and there appears to be no reason to withdraw the drug on the basis of the currently available data.[33]

The use of chloral hydrate for procedural pain is limited by the fact that it lacks analgesic properties and the behavioral effects with stimulation can be highly variable at moderate doses (hyperactivity and agitation is not unusual).[34]

<u>Recommended use:</u> Chloral hydrate is well established as an agent for sedation in painless procedures such as diagnostic radiology-usefulness in painful procedures is limited by patient movement and agitation even when sedated especially in the young (less than one year old) child. The long half-life indicates a need for prolonged supervision prior to discharge.

Rectal Chloral Hydrate:
Because of its somewhat bitter taste, oral chloral hydrate is not tolerated by all patients. In these cases, the drug may be administered by the rectal route. Although data on this route of administration is not abundant, the recommended dosage and effectiveness of the drug is apparently not changed(50-100mg/kg).[64] Respiratory depression is rare, but monitoring is recomended, especially when the drug is employed in bombination with other sedatives or analgesics.
Recommended use: Sedation for minimally painful procedures in toddlers who will not tolerate the oral medication.

Oral Midazolam:
Midazolam is a short acting, water soluble benzodiazepine devoid of analgesic properties. The drug has become particularly popular because of its short duration, predictable onset, and lack of active metabolites. It is effective in eliminating the stress response largely by binding with gammaaminobutyric acid (GABA) receptors to inhibit spinal afferent pathways. This results in skeletal muscle relaxation, amnesia, and anxiolysis. Although originally formulated for intravenous use, the same medication used orally has proven very successful in producing light sedation and amnesia.[28-30] The recommended oral dose is 0.5-0.75 mg/kg, with onset of sedation in approximately 15 minutes, with a rapid offset approximately 30 minutes after the peak effect is noted. Midazolam is highly lipid soluble and redistributes rapidly. It is highly metabolized in the liver- undergoing a large first pass effect and has a beta elimination half life of 106 +/- 29 minutes. Unfortunately, the drug has a very bitter taste that is difficult to disguise. Several strategies including dilution in cola syrup, apple juice with sweeteners, Ibuprofen syrup, or liquid acetaminophen have been described. Allowing self administration through a prefilled syringe in a comforting environment (parent's arms) has met with the most success in these authors' experience.

Respiratory depression is rare with oral administration of midazolam.[29] As a general rule, this medication and mode of administration comes the closest of any of the current sedatives available to providing true conscious sedation - providing a sedated yet arousable and cooperative patient at the indicated doses. One of the most desirable side effects is the anterograde and (less frequent) retrograde amnesia that is produced although the extent of this effect will vary with the age of the patient and the dose employed.[28]

Recommended use: Oral midazolam is most useful as a sole agent for children who will drink liquid medication. Anxiolysis and cooperation are excellent for minor invasive procedures such as intravenous catheter placement. Administration of local anesthetic often provides the analgesia necessary to allow a painful procedure to be performed.

Rectal Midazolam:
Midazolam may be administered rectally at doses of 0.3-0.7mg/kg. A dose of 0.3mg/kg has been shown to give reliable levels of sedation with a mean time of 16 minutes to maximal blood level.[63] After thirty minutes, blood levels were generally low but sedation and anxiolysis effects remained. Cautions and monitoring advised for other modes of midazolam delivery apply to this route of administration as well.

Nasal Midazolam:
Midazolam may be given by the intranasal route at doses of 0.2-0.4mg/kg. Onset time is intermediate between the oral and IV routes of administration (10-15 minutes). The effectiveness of this route of administration is well established as a premedicant for anesthesia but its use is limited by burning on application to the nasal mucosa which most children find very objectionable, as well as the bitter taste of midazolam reaching the oropharynx.[58] Adverse effects including respiratory depression and synergy with opioids are similar to those mentioned above.[30]

Recommended use: For sedation and anxiolysis in young children who either refuse or cannot take an oral dose of midazolam. Onset is reliable but most children will only accept this route of administration once.

Intra-Muscular Midazolam:
Midazolam may be given as an intramuscular bolus of 0.08mg/kg. Good sedation and cooperation scores were recorded at 15 minutes after this dose in one study.[65] Persistent sedation was minimal 60 minutes after the dose.

Recommended use: Midazolam gives reliable sedation after intramuscular dosing - a useful alternative for children who will not accept oral medications, particularly where residual sedation is a concern.

Intra-Venous Midazolam:
Intravenous midazolam is titrated to effect with fractionated doses of 0.05-0.10mg/kg that may be repeated at intervals of 3 to 4 minutes to a total dose of 0.7mg/kg. As opposed to the oral route of administration, intravenous midazolam reaches peak effect in 2 to 3 minutes and is redistributed more rapidly.[49] Slow IV administration is recommended with close observation for respiratory depression. When combined with intravenous opioids for painful procedures, midazolam has potent sedative effects and the use of cardiorespiratory monitoring is imperative. A maximum IV dose of 0.05 mg/kg has been recommended when combining the drug with narcotics. A constant infusion of the drug (0.05-0.20mg/kg/hour) may be used particularly for ICU patients requiring prolonged sedation or anxiolysis.[5]

Anterograde amnesia and (at times) retrograde amnesia effects are even more prominent than when the drug is used orally. Slurred speech has been shown to coincide with the onset of anterograde amnesia. As mentioned in the introduction, the value of amnesia and anxiolysis can not be underestimated in the performance of painful procedures in children.[8]

Certain underlying conditions or medications may prolong the effects of midazolam. Heparin decreases protein binding and increases the free fraction. Hepatic metabolism is inhibited by cimetidine which prolongs the elimination half-life. Patients in renal failure may have three times the free fraction of the drug secondary to decreased protein binding.[51]

Recommended use: IV midazolam is an excellent agent for sedation and anxiolysis in patients for minor procedures when an intravenous line is in place. It provides complementary sedation for patients receiving opioids for very painful procedures but extreme caution is warranted when combining the drugs.

Intra-Venous Propofol:
Propofol is a 2,6-diisopropylphenol compound that has potent sedative and hypnotic properties. Because it is only slightly soluble in water, the drug is dissolved in a solution of soybean oil. The nature of this solution requires the drug be handled in a sterile manner and use quickly once it is opened. Onset of action is extremely rapid and induction of anesthesia may be achieved with 2-3mg/kg in 95% of patients within 60-90 seconds. Sleep may be induced by as little as 1.5mg/kg and maintenance of sedation is usually accomplished through the use of an intravenous infusion at 50-150μg/kg/minute. Recovery from the drug is faster than with any other intravenous sedative (2-3 minute redistribution time) and the incidence of prolonged sedation or vomiting is extremely low.[52] A dose related decrease in blood pressure is noted that is similar to that found with other anesthetics. Propofol causes pain on injection - this may be prevented by administering a small dose of lidocaine (1mg/kg) through the IV catheter prior to administration of the drug or administering the drug through a fast-flowing intravenous line into a large vein such as an antecubital vein.

Because anesthesia, with its complete loss of airway reflexes, respiratory depression, and cardiovascular depression can be induced so rapidly with propofol, many hospitals limit its use to anesthesia personnel. The role of this drug in the ICU and emergency department remains to be defined - clearly only individuals skilled in airway management should be administering the drug. Unexplained metabolic acidosis and cardiac failure have occurred in some patients on long term propofol infusions in the ICU.[53]

<u>Recommended use:</u> Propofol is an ideal agent for brief periods of deep sedation. Minimal adverse effects and rapid awakening are unique among currently available agents. Extreme caution is advised in using this drug as general anesthesia is induced rapidly - may be limited to use by anesthesia personnel and in the intensive care environment.

f. Specific drugs that provide analgesia (relief of pain)

Oral Tansmucosal Fentanyl Citrate (OTFC):
Fentanyl is a powerful synthetic opioid which is 100 times more potent than morphine. It has a very high degree of fat solubility that allows for very rapid penetration of the blood brain barrier.[28] The sedation effects are relatively brief as the offset of the drug is dependent on redistribution rather than elimination. Oral transmucosal fentanyl (OTFC) is available as a sweetened lozenge on a plastic stick of various strengths (200μg, 300μg and 400μg). The recommended dosage is 15-20μg/kg orally. Generally there is excellent and rapid uptake of the drug from the oral mucosa although the effectiveness of a given dose varies with how much of the drug is swallowed by the patient rather than allowed to absorb transmucosally. Drug that reaches the stomach for absorption may be responsible for prolonged serum concentrations. Sedation reliably occurs within 15-30 minutes.[40] Note: Awareness may be maintained even when the patient appears asleep.

Adverse effects of this form of the drug are those commonly associated with mu receptor agonists. Pruritis occurs in 44%. Nausea and vomiting occurs in approximately 15-20% of patients and is not prevented by the administration of antiemetics.[41] Respiratory depression with oxygen desaturation to less than 90% has been reported in 5% of children but usually resolves with verbal prompting.[42] Other adverse effects including chest wall and glottic rigidity are possible but much more common with the IV form of the drug.[43]

Recommended use: OTFC offers a painless method of delivering opioid which may be of particular use in patients without an intravenous line undergoing painful procedures. Associated nausea and vomiting, and the need for more intensive monitoring and observation than other oral sedatives have limited its popularity to date. The use of pulse oximetry is mandatory in these patients even when they appear awake and alert. A medical observer must be present.

Intra-Venous Fentanyl:
As mentioned above, fentanyl is a very potent synthetic opioid. The IV dose recommendation is 0.5-1µg/kg/dose, titrated to a total dose of 4-5µg/kg. Fentanyl as a sole agent offers excellent pain relief with mild sedation at these doses. Maximal effect occurs within 5 minutes when administered intravenously. Opioid effects last for 30-40 minutes.

Respiratory depression is a significant risk and may outlast opioid effects by as much as 60-90 minutes.[46] Strict adherence to monitoring standards is mandatory. Chest wall rigidity may occur with intravenous fentanyl dosing and is particularly problematic when the drug is rapidly administered.[47] Respiratory depression is *markedly* increased when the drug is combined with midazolam or other sedative and increased vigilance for possible airway management requirements should be made when the drugs are administered together.

Bradycardia may occur from stimulation of the central vagal nucleus and prolongs both the atrioventricular node conduction and refractory period. In spite of this, fentanyl has the least hemodynamic effects of any opioid. The adverse effects of the drug are reversed by naloxone which should be readily available when this drug is administered. Metabolism may be prolonged in neonates and patients with hepatic disfunction, but children older than 3 months are actually less likely than adults to suffer respiratory depression at equivalent doses.[48]

Recommended use: Intravenous fentanyl offers excellent analgesia and mild sedation with a short duration of action - ideal for very painful procedures in children with an IV in place. Careful respiratory and cardiac monitoring is mandatory especially when the drug is combined with other sedatives.

Oral Ketamine:
Ketamine is a unique medication of the phencyclidine class that binds to opioid receptors and possesses intense analgesic, sedative, and amnestic qualities. It has a long track record

of safety as a sedative for painful procedures in children, particularly those undergoing burn debridement or tubbing.[35,36] The oral dose recommendation is 5-6 mg/kg.[36,37] Onset of sedation occurs in 15-30 minutes and effects may be prolonged with this route - lasting 3 to 4 hours. A functional dissociation is created between the cortical and limbic systems of the brain.[38] Spontaneous respirations and airway reflexes are maintained. The eyes remain open with a slow nystagmic gaze with intact corneal and light reflexes. Patients may exhibit random tonic movements of the extremities that make this drug inappropriate for procedures where the patient must lie perfectly still (i.e. CT and MRI scans). Ketamine generally causes an increase in heart rate, blood pressure, cardiac output and intracranial pressure.[35] The drug should be used with caution (or not at all) in patients with suspected increased intracranial pressure or open globe injuries. Oral secretions are mildly increased with oral ketamine although administration of an antisialogogue is rarely required. This drug also has bronchodilator qualities. Ketamine causes hyperactive airway reflexes, with a risk of laryngospasm. it has been documented to cause an incompetent gag reflex and should be administered with caution to patients with a full stomach or with gastroesophageal reflux. Prolonged emergence may occur, but postsedation emesis and dysphoria are rare with oral ketamine.[39]

Recommended use: Oral ketamine provides excellent analgesia, amnesia, and sedation for painful procedures. Oral dosing is much less reliable and has less favorable kinetics when compared to other routes of administration. A delayed recovery may be anticipated with higher doses.

Intra-Muscular Ketamine:

Intramuscular ketamine reaches peak blood levels and clinical effect in five minutes after a 3 to 10mg/kg IM injection. Recovery from dissociation occurs within 15 to 30 minutes with coherence and purposeful neuromuscular activity returning in 30-120 minutes. The elimination half life is one to two hours in children.[66] A smaller dose of 3 mg/kg has been employed to facilitate intravenous catheter placement or acceptance of a mask for anesthesia induction, with no delay in discharge compared to control patients after 60 minutes.[67] Elimination may be prolonged when the drug is administered with other medications that undergo hepatic metabolism. Concurrent administration of barbiturates or benzodiazepines has been shown to prolong the clinical recovery time by 30%.[66] The 100mg/ml formulation of ketamine is preferred for IM administration in older children to minimize volume related injection site discomfort. Because of associated salivary and tracheobronchial secretions, most authors recommend administering a concurrent anticholinergic if the larger doses of ketamine are administered. The anticholinergic may best be added directly to the syringe with ketamine. Antisialogogues are not necessary if ketamine 3 mg/kg is employed intramuscularly.

Experience with intramuscular ketamine is extensive. Sedation is accompanied by the same excellent analgesia as mentioned above for IV and oral administration. Cautions concerning increased intracranial pressure, airway protection, dysphoria, and vomiting apply with IM administration as mentioned above.

Recommended use: IM administration of ketamine is an excellent means of sedating the "out of control" patient for IV placement or moderately painful procedure. A dose of 3 mg/kg is usually all that is required if the procedure is brief. Contrary to previous practice in some institutions, full monitoring standards should apply.

Intra-Venous Ketamine:
Ketamine may be given in small IV doses of 0.05 to 1mg/kg. Peak concentrations occur within 1 minute and rapid absorption by the highly perfused cerebral tissue allows almost immediate induction of clinical effects. Ketamine then slowly redistributes into the peripheral tissues; this decrease in CNS levels correlates with return of coherence, generally averaging 15 minutes if no additional doses are given.[35,54] Deep levels of sedation are achieved and maintained - "conscious sedation" is not possible with ketamine. Remarkably painful procedures are tolerated well following administration of ketamine because of its profound analgesic properties as well as the sedation it affords.

Intravenous ketamine is well established as a safe and efficacious agent with over 90 separate series investigating its use in over 11,000 pediatric patients.[35] The relatively short action of the IV form of the drug allows this drug to be used in small doses(0.05-0.1mg/kg) in the ambulatory pediatric patient without delaying discharge.[55] Because of higher blood levels with intravenous use, ketamine administered by this route may have more problems than oral or intramuscular administration. Oral secretions may be avoided by the adminstration of an antisialogogue (atropine 0.01mg/kg or glycopyrrolate 0.005 mg/kg IV). Increases in intracranial pressure, heart rate, and blood pressure may be concerning. Although patients will continue to breath and maintain airway tone, silent pulmonary aspiration of oral contents has been reported with deep levels of sedation. Patients may continue to move during sedation and eyes remain open. Emergence delirium is much less common in children than adults and can often be prevented or treated the administration of a small dose of benzodiazepine.[35]

Recommended use: Ideal for painful procedures such as burn debridement, foreign body removal, abscess incision and orthopedic procedures. More often administered intravenously to hospitalized patients rather than ambulatory patients.

Nitrous Oxide:
Nitrous Oxide (N_2 O) is a colorless, odorless gas that has both analgesic and anxiolytic effects. The drug must be delivered with oxygen to avoid a hypoxic gas mixture. This may be accomplished though the use of flow meters from separate sources or through the delivery of a fixed 50% mixture of N_2O/oxygen (Entonox). The drug may be delivered alone at concentrations of 30-50% for moderately painful procedures or in combination with a mild sedative at lower concentrations for similar effect.[71] Onset of sedation and analgesia occurs in minutes and is terminated rapidly when the gas is discontinued. Nitrous Oxide has minimal cardiovascular and respiratory effects when not combined with a potent sedative or opioid. Studies in large groups of patients (some with mild IV sedation) have failed to show any significant risk of cardiopulmonary depression when nitrous oxide is used at the concentrations cited here.[72,73]

Cautions when using the drug include the possibility of providing a hypoxic mixture of gas to the patient if equipment fails. Deep sedation is possible with high concentrations or when combined with opioids - this may be avoided by insisting on self administration of higher than 30% concentration of N_2O. There is a slight increase in nausea and vomiting associated with use of nitrous oxide but airway reflexes are reliable maintained with the lower concentrations plus light sedation or with the higher concentration alone. If any inhalational agent is to be used, Occupational Safety and Health Administration (OSHA) guidelines for scavenging and room air turnovers must be met. This requirement may make the use of N_2O impractical except in dedicated rooms where such equipment is present.[74]

Recommended use: Nitrous oxide is useful for brief painful procedures and may be combined with a mild sedative. Expensive equipment and ventilation apparatus required for delivery will limit its widespread use.

g. Reversal Agents:

Specific reversal agents exist for benzodiazepines and opioids. Sedation providers must understand their use in order to responsibly utilize either of these classes of agents.

Flumazanil:

Flumazanil can be used to reverse the effects of benzodiazepines and should be immediately available when using benzodiazepines for sedation. A dose of 0.01mg/kg may be repeated 4 times as needed. Although rare, resedation may occur and additional doses of flumazenil may be required. Careful observation for this resedation should be maintained for at least an hour following the administration of flumazenil.

Naloxone:

Naloxone (Narcan) is an opioid antagonist and can be given intravenously, intramuscularly, or subcutaneously but the preferred route of administration is intravenous. The drug should be given in a slowly titrated manner when possible. The standard preparation contains 0.4mg/cc of naloxone. The neonatal preparation which contains 0.02 mg/kg is not recommended. The dose for children is 0.1 mg/kg for children under 20 kg. The dose for children over 20 kg is 2 mg.

The drug is incredibly effective in reversing the depressive effects of the Opioids. The effect can be very abrupt. Children will often be quite disturbed when they are awakened from sedation by administering naloxone. The most common side effect is nausea. Unusual catastrophic events (such as sudden death) that have been described in adults – are not reported in children.

h. Summary Table of Drugs that Provide Sedation and Analgesia

Indication	Route	Drug	Dose	Onset	Potency
Sedation	Oral	Sucrose Pacifier	?	1 min	+
	Oral/Rectal	Chloral Hydrate	75mg/kg (2gm max)	20 min	++
	Oral/Rectal	Midazolam	0.25-0.5mg/kg	20 min	++
	Nasal	Midazolam	0.3mg/kg	15	++
	IM	Midazolam	0.08mg/kg	15	++
	IV	Midazolam	0.05-0.1mg/kg	3min	+++
	IV	Propofol	100mcg/kg/min	1min	++++
Analgesia	Oral	Fentanyl	15mcg/kg	20	+
	IM	Fentanyl			
	IV	Fentanyl	0.5-1.0mcg/kg	5	+++
	Oral	Ketamine	4-6mg/kg	20	++
	IM	Ketamine	2-4mg/kg	5	+++
	IV	Ketamine	0.05-0.1??	3	+++

Oxygen delivery:

Supplemental oxygen should be a administered to any patient respiratory distress with a patent airway.

Methods of oxygen administration include:
Nasal Cannula: provides up to 44% oxygen. It is a low flow system where tidal volume (from the patient) mixes with room air. The inspired percent O2 will depend on flow rate and patients tidal volume. The addition of each liter of O2 flow increases the inspired 02 percent by about 4%. 1L/min 24% - 6L/min 44%.

Secure the cannula if necessary with transparent occlusive dressing on each cheek. Chart the flow of 02 after the cannula is in place.

Simple face mask: Provides up to 60% 02. Flow rate is usually set between 6-10 L/min.

- The mask should extend from the bridge of the nose to the cleft of the chin. The correctly sized mask fits tightly without placing excessive pressure on the eyes. Place the mask on the face, starting from the nose downward, and adjust the nose clip and head strap.
- Liter flow must be 6 lpm or greater to prevent accumulation of carbon dioxide under the mask.

- Nonrebreather mask at 10 to 12 liters/minute (or at a flow rate to keep the reservoir bag inflated). Indicated in patients who require high oxygen concentrations (can achieve oxygen concentrations of 60% to 90%).

- The mask should extend from the bridge of the nose to the cleft of the chin. The correctly sized mask fits tightly without placing excessive pressure on the eyes. Place the mask on the fact, starting from the nose downward, and adjust the nose clip and head strap.

- Liter flow must be high enough to keep the reservoir bag inflated, generally 10-12 lpm.

Open the airway: Ensuring a patent airway is the first priority of airway management in the patient with signs of respiratory distress or failure.

The most common cause of obstruction is due to loss of tone in the throat muscles causing the tongue to drop back obstructing the trachea. (Fig 1)

Fig 1. Obstructed Airway

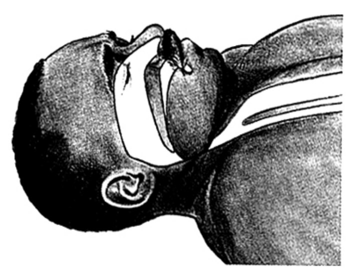

FIGURE 1. Obstruction by the tongue and epiglottis.

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Techniques to open the airway:

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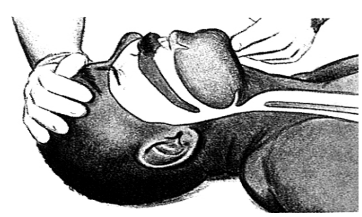
o Head tilt – chin lift. (Fig 2)

Place the palm of one hand on the forehead and apply firm backward pressure back. Gently lift the chin with the other hand.



Jaw thrust (Fig 3)

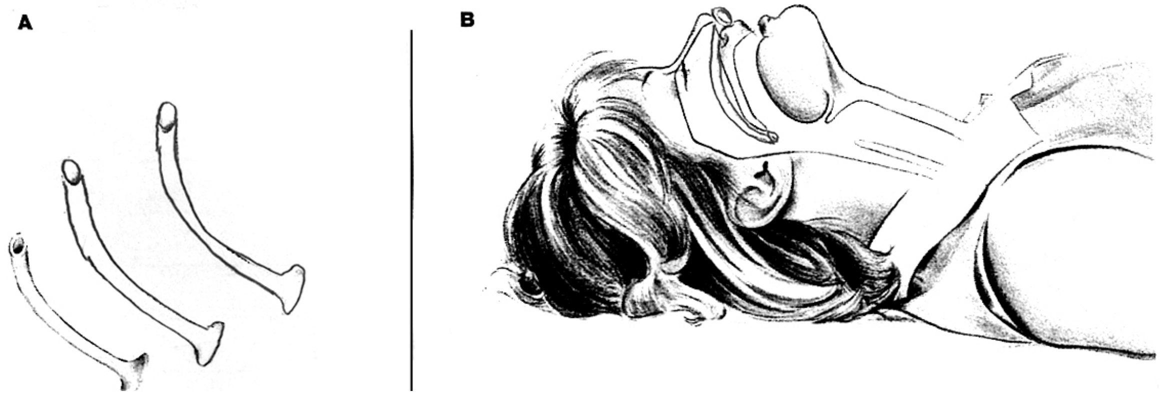
Place fingers under the angles of the patient's jaw. Lift without moving the head/neck.

Figure 3. Jaw thrust without head tilt.

Airway adjuncts may be needed to maintain a patent airway.

Oropharyngeal Airways	**Technique**	**Hazards**
• Oropharyngeal airways (Fig 4) are S-shaped devices that hold the tongue away from the posterior wall of the pharynx. They are most helpful in the spontaneously breathing patient who is semiconscious and at risk of occluding the airway via tongue and pharyngeal relaxation. • Oropharyngeal airways keep the airway open during bag-mask ventilation when rescuers tend to unknowingly push down on the chin, blocking the airway. These devices help suction the mouth and throat and prevent the patient from biting and occluding a tracheal tube.	• Clear the mouth and pharynx of secretions, blood, or vomitus using a rigid pharyngeal catheter with suction tip. • Place the airway so that it is turned backward as it enters the mouth. • As the airway passes through the oral cavity and approaches the posterior wall of the pharynx, rotate the airway 180 degrees into the proper position. • Another method is to move the tongue out of the way with a tongue blade depressor before inserting the airway. • The airway is properly sized and placed when there are clear breath sounds on auscultation of the lungs during ventilation. • Once the airway is in place, continue to maintain proper head position.	• A long oropharyngeal airway may press the epiglottis against the entrance of the larynx, producing complete airway obstruction. • If the airway is not inserted properly, it may push the tongue posteriorly, aggravating upper airway obstruction. • To prevent trauma, the operator should make sure that the lips and tongue are not between the teeth and airway. • The airway should be used only in the unconscious patient because it may stimulate vomiting and laryngospasm in the conscious or semiconscious patient.

FIGURE 5. Nasopharyngeal airways. A, Four airways, B, One airway inserted.



Nasopharyngeal Airways

- Nasopharyngeal airways (Fig 5) are uncuffed tubes made of soft rubber or plastic.
- They are used most frequently for the intoxicated or semiconscious patient who cannot tolerate an oropharyngeal airway.
- A nasopharyngeal airway is indicated when insertion of an oropharyngeal airway is technically difficult or impossible (because of strong gag reflex, trismus, massive trauma around the mouth, or wiring of the upper and lower jaws.

Technique

- The proper-sized airway is lubricated with a water-soluble lubricant or anesthetic jelly and gently inserted close to the midline along the floor of the nostril.
- Continue inserting the airway into the posterior pharynx, behind the tongue.
- If resistance is encountered, slight rotation of the tube may facilitate insertion at the angle of the nasal passage and the nasopharynx.

Hazards

- A long nasopharyngeal airway may enter the esophagus. With active ventilation, such as bag mask, the nasopharyngeal airway will cause gastric inflation and possible hypoventilation.
- Although a nasopharyngeal airway is better tolerated by semiconscious patients, its use may also precipitate laryngospasm and vomiting.
- Insertion of the airway may injure the nasal mucosa and cause bleeding, with possible aspiration of clots into the trachea. Suction may be necessary to remove blood or secretions.
- Insertion of the airway may injure the nasal mucosa can cause bleeding, with possible aspiration of clots into the trachea. Suction may be necessary to remove blood or secretions.
- Maintain head tilt with anterior displacement of the mandible by chin lift and if necessary by jaw thrust when using this airway.

Precautions

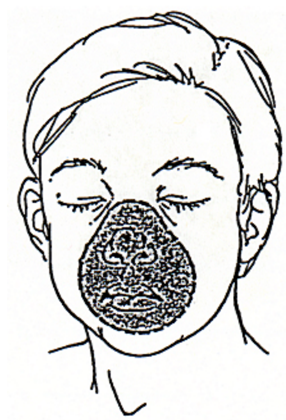
- Always check spontaneous respirations immediately after insertion of an oropharyngeal or nasapharyngeal airway.
- If respirations are absent or inadequate, start artificial positive-pressure ventilation at once with an appropriate device.
- If adjuncts are unavailable, use mouth-

	to-mouth ventilation.

- Bag valve mask ventilation: Continued signs of respiratory distress or decreased perfusion may necessitate ventilator assistance using a properly sized bag valve mask device with reservoir with 100% oxygen.

- Adequate ventilation can be assessed by observing for bilateral chest expansion and bilateral breath sounds during ventilation.

- Choose the correct size mask. The mask should extend from the bridge of the nose to the cleft of the chin. Avoid applying pressure to the eyes.



- Place the head in a neutral sniffing position.

- The mask is held in place with a one-handed head tilt-chin left maneuver or with a two-person procedure. The two-person procedure uses one person holding the mask to the face and the second person ventilating.

- Insert an oropharyngeal airway if the patient will require assisted ventilation for an extended length of time.

- Manual ventilation bags are more difficult to use and, therefore, should be used by individuals with proper training and experience.

Emergency States During Sedation:

Apnea:

Apnea is characterized by the lack of any air movement through the airway**.** Apnea can be classified as obstructive – when respiratory efforts are still being made but air flow is blocked by anatomical structures or a foreign body. Central apnea is notable for the lack of any breathing effort – it is usually induced by an excess of a sedative medication or a combination of medications that results in severe respiratory depression.

The response to apnea should be immediate:
1)Efforts should be made to open the airway using head tilt and jaw thrust maneuvers.
2)Oral and/or nasal airways may be required to assist in opening the airway.
3)If respiratory efforts are not evident, bag mask ventilation should be instituted immediately.
4)A call for help should be made if definitive airway management capability is not present at the scene of the sedation.
5)Consider reversal medications if sedation has consisted of benzodiazepines and/or opiates.
6)If prolonged airway management is require endotracheal intubation may be required.

Respiratory Distress:
Respiratory distress is a clinical state characterized by increased work of breathing. The signs an symptoms include:

- Color – pale – dusky – blue
- Tachypnea (high resp rate)
- Use of accessory muscles (chest muscles)
- Retractions
- Nasal flaring
- Tachycardia (high heart rate)
- Dysphagia (difficulty swallowing)
- Abnormal breath sounds
- Snoring (indicates a partial airway obstruction by the tongue or secretions)
- Altered level of consciousness
- Stridor (high pitched noisy breath sounds)

Response:
The response to respiratory distress must be immediate:
1)Call for help
2) Attempt open the airway with head tilt and jaw thrust maneuvers
3) suction the airway.
4) Assist ventilations if the patient will allow
5) If excessive sedation is suspected, consider reversal medications for opioid or benzodiazepine overdose.
6)If movement of air is minimal – must consider definitive airway control with an endotracheal tube.

4. TIME TO GO – RECOVERY AND DISCHARGE

Appropriate discharge guidelines are a key element of safe sedation practice.

a. Recovery Area and Equipment:

Recovery should take place in a well lit area that is not too removed from the sedation site itself. The recovery area should be equipped with suction, oxygen, and equipment for positive pressure ventilation. Monitoring equipment including pulse oximetry, ECG, blood pressure, and ventilation monitoring should be available as well. A record of vital signs should be kept at regular intervals until the child is awake and interactive.

b. Discharge Criteria:

Patients should be discharged only when they have met specific criteria – this should be consistent regardless of the procedure that was performed or the drugs that were used for sedation. The criteria for discharge should include: 1) stable vital signs 2) pain under control 3) a return to the level of consciousness that is similar to the baseline for that patient 4) adequate head control and muscle strength to maintain a patent airway 5) Nausea and/or vomiting should be controlled and the patient should be adequately hydrated.

Of particular note are those children who have received large doses of long acting sedative medications. When significant effort must be made to wake these children up post sedation (shouting or shaking) it should be noted that they will often become resedated if left alone for a period of time (riding in the car). These children are not safe for discharge. Obstruction of the airway while in a car seat has been described in children who have experienced exactly this scenario.

Similarly children who have had their sedation reversed with flumazanil or naloxone should be observed for an extended period of time due to the fact that resedation can occur as the reversal agent wears off and the sedative agent still have a therapeutic blood level.

c. Discharge Documentation:

At the time of discharge the status of the child should be documented and the time of discharge should be recoded. Specific instructions given to the family of the child instructing them what to do if the child should appear sedated or have any other medical problems in the time immediately following discharge.

5. FINAL COMMENTS:

Painful procedures cause not only pain, but fear in pediatric patients. This occurs prior to the anticipated procedure as well as during the procedure. It is always important to maximize the intervention for the first procedure so that anticipatory anxiety does not increase with each procedure. Whether to add pharmacologic intervention to the psychologic and behavioral tools employed for every patient should be determined by the level of anxiety and context of the procedure. Parental education is always valuable, and parental presence is frequently an aide to the child's coping and ability to cooperate.

Psychologic intervention and local anesthesia may be sufficient for pain control and enhancing the child's mastery and feelings of self-esteem. However, if the procedure is expected to be very painful, prolonged, or repeated, pharmacologic adjuncts should be considered. The goals of procedure-related pain management are to make the procedure as nonthreatening and comfortable as safely possible.

This will limit the child's fear of future procedures, enhance cooperation, encourage mastery and a feeling of control, and involve the parents in an intervention that is supposed to, after all, help the child to get well.

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