Pediatric Anesthesia Outside of the Operating Room

Christina D. Diaz, MD
Disclosures

• No Financial Conflicts

• Contributors: Shobha Malviya, MD
  Samuel H. Wald, MD, MBA
The Outline

• Risks
• Medications
• Locations/ Setting it up
• Recovery
• Closing thoughts
TIME BOMBS for Sedation

- Apnea
- Age < 1 Month (unless inpatient)
- Respiratory Compromise
- Uncontrolled GERD/Emesis - Aspiration
- Craniofacial Abnormality
- Cyanotic or other Cardiac Disease
- High Risk (Resuscitation Likely)
- Painful Procedure (Probable GA)
- Absolute Immobility Required
- Extreme Remote Location
- Inadequate Qualified Personnel

### Adverse Events Out of OR

#### Propofol Sedation

<table>
<thead>
<tr>
<th>Provider type</th>
<th>Total no. of cases</th>
<th>Percent of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesiologist (Pedi-anesthesiologist)</td>
<td>5,117 (4,175)</td>
<td>10.27</td>
</tr>
<tr>
<td>Advanced practice registered nurse/pediatric nurse, Practitioner/physician’s assistant</td>
<td>15</td>
<td>0.03</td>
</tr>
<tr>
<td>Emergency medicine MD (Pedi emergency medicine)</td>
<td>18,034 (17,972)</td>
<td>36.19</td>
</tr>
<tr>
<td>Fellow level trainee</td>
<td>1,215</td>
<td>2.44</td>
</tr>
<tr>
<td>Intensivist (pedi intensivist)</td>
<td>24,296 (23,661)</td>
<td>48.76</td>
</tr>
<tr>
<td>Pediatrician</td>
<td>1,123</td>
<td>2.25</td>
</tr>
<tr>
<td>Radiologist</td>
<td>5</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Numbers in parentheses represent the subtotal of providers who identified as “pediatric” subspecialists.

Most Common Events

- Desaturation <90% for > 30 seconds
- Airway Obstruction
- Inadequate Anesthesia
- Cough (Interrupting Procedure)
- Secretions Requiring Suctioning
- 30% CHANGE in Vital Signs
- Apnea

NO DEATHS, BUT A COUPLE OF “CODES”
Adverse Events Out of OR Propofol Sedation

• Factors related to adverse events
  – Non-anesthesiologist
  – ASA III or Higher
  – Age <6 Months, Age 2-8 Yrs.
  – NPO Solids < 8 Hrs.
    • LIQUID: NO EFFECT FOR NPO TIME
  – Opioids Given

N = 49,836
GA for High-risk Patients in MRI

<table>
<thead>
<tr>
<th></th>
<th>Mortality</th>
<th>No Mortality</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT/MRI/Radiology</td>
<td>3*</td>
<td>570</td>
<td>573</td>
</tr>
<tr>
<td>OR</td>
<td>5</td>
<td>4293</td>
<td>4298</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>4863</td>
<td>4873</td>
</tr>
</tbody>
</table>

Dex: Sole Agent MRI

Key Point: Even high dose Dex may require rebolusing

(1) 2 mcg/kg + 1 mcg/kg/hr
(2) 3 mcg/kg + 1.5 mcg/kg/hr
(3) 3 mcg/kg + 2 mcg/kg/hr
Boxes are NORMAL HR Range
Drugs - Dex and Glycopyrrolate

• High Dose Dexmedetomidine will reduce heart rate, but normal MAP will be maintained
• Case series of pediatric patients given 5 mcg/kg glycopyrrolate for treatment of bradycardia (N=3)
• Bradycardia resolved
• EXAGGERATED INCREASE IN MAP

Dexmedetomidine Cardiac Effects

- N= 12 Ages 5-17 YRS for EP Study for SVT
- 1 mcg/kg bolus followed by 0.7 mcg/kg hr drip
- Depression of Sinus and AV Nodal Function
- Significant Bradycardia 10 min not at 20 min
- No change in Respiratory rate or ETCO2

## Dex/Midaz vs. Propofol for MRI

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dexmedetomidine</th>
<th>Propofol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from mask application to start of infusion (min)</td>
<td>3.9 ± 1.5</td>
<td>4.7 ± 1.1</td>
</tr>
<tr>
<td>Duration of infusion (min)</td>
<td>33.4 ± 9.3</td>
<td>35.6 ± 14.7</td>
</tr>
<tr>
<td>Time in MRI suite (min)</td>
<td>37.4 ± 9.4</td>
<td>40.3 ± 14.7</td>
</tr>
<tr>
<td>Time to eye opening (min)</td>
<td>34.0 ± 18.9</td>
<td>26.9 ± 12.6</td>
</tr>
<tr>
<td>Time to full responsiveness&lt;sup&gt;a&lt;/sup&gt; (min)</td>
<td>44.2 ± 18.0*</td>
<td>29.7 ± 11.1</td>
</tr>
<tr>
<td>Time to PACU discharge (min)</td>
<td>50.3 ± 18.2*</td>
<td>36.5 ± 9.2</td>
</tr>
<tr>
<td>Time from PACU discharge to hospital discharge (min)</td>
<td>45.4 ± 20.6</td>
<td>42.9 ± 22.2</td>
</tr>
<tr>
<td>Time from end of scan until hospital discharge (min)</td>
<td>95.7 ± 26.5*</td>
<td>79.4 ± 24.3</td>
</tr>
</tbody>
</table>

<sup>a</sup> Failure

N=40

1-12 yrs

Heard Anesth Analg 2008;107:1832–9
## Drug Summary

<table>
<thead>
<tr>
<th>drug</th>
<th>minute ventilation</th>
<th>respiratory rate</th>
<th>tidal volume</th>
<th>FRC</th>
<th>CO2</th>
<th>upper airway obstruction</th>
<th>laryngospasm</th>
<th>other side effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>sevo</td>
<td>down</td>
<td>up</td>
<td>down</td>
<td>very down</td>
<td>up</td>
<td>up</td>
<td>very up</td>
<td>BP down</td>
</tr>
<tr>
<td>propofol</td>
<td>down</td>
<td>same</td>
<td>down</td>
<td>up</td>
<td>down</td>
<td>up</td>
<td>little up</td>
<td>BP very down</td>
</tr>
<tr>
<td>barbiturates</td>
<td>down</td>
<td>little up</td>
<td>down</td>
<td>up</td>
<td>little down</td>
<td>little up</td>
<td>up</td>
<td>BP same</td>
</tr>
<tr>
<td>benzos</td>
<td>down</td>
<td>same</td>
<td>down</td>
<td>up</td>
<td>down</td>
<td>up</td>
<td>not really</td>
<td>BP same</td>
</tr>
<tr>
<td>dexmed</td>
<td>little down</td>
<td>same</td>
<td>little down</td>
<td>same</td>
<td>not sure</td>
<td>little up</td>
<td>not really</td>
<td>bradycardia, initial HTN</td>
</tr>
<tr>
<td>ketamine</td>
<td>same</td>
<td>little up</td>
<td>same</td>
<td>same</td>
<td>same</td>
<td>not really</td>
<td>not really</td>
<td>dissociative anesthesia, excessive salivation</td>
</tr>
</tbody>
</table>

Anesth Analg 2007, 105:1578-84  
*Stuth, E. A.E., Stucke A. Compr Physiol 2:1-87, 2012*
Anesthesia Locations

- Radiation Therapy
- MEG Scan
- HEME/ONC
- NUC Medicine
- Procedure Room
- IR
- MRI
- CT

ANESTHESIA/SEDATION/RECOVERY

Society for Pediatric Anesthesia
education • research • patient safety

Intensive Review of Pediatric Anesthesia
2015
How to Set Things Up for Yourself and for Others:

• ASA Task Force: Anesthesiologists should be consulted WHEN:
  – Severely Compromised
  – Extremes of Age
  – Medically Unstable
  – Sedation required to Unresponsiveness

• [The Joint Commission also makes similar recommendations]
Computer Tomography

• Radiation Exposure
• Short Procedure
• May be able to accomplish with parental presence
• Younger patients need sedation vs. GA (short acting drugs)
• Challenging patients (ex. Pierre Robin infants)
CT Scan: Oral Contrast

- Oral contrast Gastrografin - enhances imaging for suspected intraabdominal mass, fluid collection, bowel or pancreatic injury
- Optimal imaging time: 30-60 min after contrast adm
- Full strength 3% gastrografin: hypertonic, pulmonary edema, pneumonitis, osmotic effusion, death if aspirated
- In children, gastrografin is diluted to 1.5-2.5%
- Vol of contrast: 60-90 ml neonate, 240-360 ml 1-5 yr
- Few data to guide acceptable standard of care
- Practice includes RSI, adm contrast via NG tube after securing airway, or GA without a secure airway
Oral Contrast and Gastric Volume

N = 365 Oral Contrast
90% < 5 years
GFV by CT

Mahmoud M A & A
Nov 2010 Vol 111 (5)
1252-1258

49% had >0.4 ml/kg
MRI: Technology

- Magnetic field orients hydrogen protons in patient’s body along long axis of body
- Oscillating magnetic pulses hit these spinning protons essentially transforming each into tiny radio emitters
- When the pulse ends, the protons return to alignment, releasing an electrical signal that is detected by a receiver coil and transformed into an image
- These are weak signals and the MRI picture is based on averaging data from multiple signals
Sources of Artifact

• Any movement of the patient - since the emitted signal comes from a different point in space

• External radiofrequency interference - monitors, radio, TV distort the weak signals from the patient

• Magnetic field effects - distortion of magnetic field by ferromagnetic equipment
MRI Terminology

• Tesla
  – strength of magnetic field is reported in Tesla units.
  – One T = 10,000 - 20,000 times stronger than the earth’s magnetic field at the surface.
  – One T = 10,000 Gauss (G)
  – Earth’s magnetic field = 0.5 – 2 G
• Faraday cage
  – The inside wall of the scanning room is sheathed with copper sheeting to protect the magnet from radiofrequency in the environment.
MRI Terminology

- **MRI SAFE**: an item (device or equipment) that poses no known hazard in all MRI environments

- **MRI CONDITIONAL**: an item that has been demonstrated to pose no known hazards in a specified MRI environment with specified conditions of use

- **MRI UNSAFE**: any item, device, or equipment labeled as MR unsafe CANNOT go into the MR magnetic field
MRI Terminology

- **Zone 1**: A public access area with no restrictions

- **Zone 2**: A semi restricted area where patients and hospital staff can interact - reception area, dressing room

- **Zone 3**: Completely physically restricted from non MR personnel especially the general public - control room, computer room

- **Zone 4**: The magnet room
MRI Safety: Implanted Medical Devices

- Cerebral aneurysm clips
  - Clips inserted prior to 1995 with ferromagnetic content may be displaced by magnetic forces causing injury and death
  - Review documentation of type of clip before scanning
  - Clips made of titanium or with manufacturer's labeling as MRI-compatible are safe to scan
- Intraorbital metal FB, prosthetic limbs may move and dislodge

- Cochlear Implants - magnet associated with implant may have to be surgically removed prior to MRI.
- Spinal cord stimulators and programmable VP shunts may malfunction in the powerful magnet
- Bivona tracheostomy tubes should be replaced before MRI
- Eye make up and tattoos may contain metallic dyes and may cause skin or ocular irritation
MRI safety: Pacemakers and AICDs

• Heating of pacemaker lead due to radiofrequency energy is the major concern
• Other risks include:
  - shifting of device
  - damage to pacemaker circuits
  - activation of reed relay switch converts pacer to asynchronous mode
  - inhibition of pacer output
  - rapid atrial pacing
  - inappropriate AICD activation
  - ventricular fibrillation
MRI Safety: Pacemakers and AICDs

- Changes in pacemaker electronics since mid 1990s, some devices are deemed “MRI-conditional” but not “MRI-safe”
- MRI in a patient with a pacer/AICD remains a high risk procedure
- Patients with such devices may undergo MRI scanning if:
  - it is the only test that can make the diagnosis and diagnostic benefit outweighs the risk
  - 1.5 T magnet, minimize procedure duration
  - in the pacer dependent, pre program pacer to AOO, VOO or BOO
  - continuous pulse ox and EKG
  - EP expert, equipment, F/U device interrogation
- AICDs pose > risk than pacers and should be interrupted before scan
CPR in the MRI Scanner

- Rapid resuscitative efforts hampered by strong magnetic fields
- Defibrillator failure if batteries are ferromagnetic
- Screening of members of code team
- Turning off the magnet is not a good option – several minutes to completely eliminate its magnetic field and several hours to re-establish it
- Patient should be brought out of scanner and rapidly moved to pre-identified area where resuscitation will occur
Cardiac MRI: Anesthetic Techniques

- GA with ETT and controlled ventilation due to need for breath holding in infants and small children
  - muscle relaxant may be needed
  - breath holds as tolerated
- Older children who can cooperate with breath holds and remain motionless may undergo scan awake or lightly sedated

Cardiac MRI - sagittal view showing discrete, tight coarctation of aorta

Cardiac MRI and MRA

• Provide high-resolution 3-D anatomical reconstruction of:
  - heart
  - systemic and pulmonary veins and arteries
  - tracheobronchial tree

• MRA and phase velocity mapping:
  - analyze pressure gradients
  - calculate flow volumes
  - calculate Qp/Qs, C.O., SV, EF

• Reliable monitoring essential during cardiac MRI because:
  - image sequencing synchronized with ECG
  - limited cardiovascular reserves in infants and children with CHD

• Breath holds reduce artefacts caused by lung excursion, faster image acquisition and shorter scan duration

• High risk but eliminates need for cardiac cath in many cases
MRI: Acoustic Injury

- Noise level in 1.5T magnet is 65-95 dB
- Louder in 3T magnet – 99dB
- Comparable to noise levels of very heavy traffic or light roadwork
- Exposure should be limited to < 2h/day
- Temporary and permanent hearing loss reported

- Use of earplugs and/or MRI compatible headphones effective in noise reduction
- Required for 3T magnets
MRI: Monitoring

- Conventional ECG monitors incompatible - degrade image, leads heat causing burns
- Fiberoptic ECG - low risk of burns
- Avoid exposed wires, frays, knots in cables, conductive loop
- Wires or leads should not be in contact with skin
- Imaging coil must not be left unconnected during the scan
- Temperature monitoring using liquid crystal display or fiberoptic skin, rectal or esoph probes

- Divided nasal cannula for supplemental O₂ and ETCO₂ monitoring
- Conventional pulse oximetry incompatible - Fiberoptic pulse oximetry needed
- Risk of burns from conventional pulse oximeter probes left on patient during scan
- Wireless fiberoptic communication available for ECG and pulse oximetry in 1.5T and 3T magnets
- Compatible Infusion pump
MRI: Contrast

- Gadolinium (gadopentate dimeglumine) - IV contrast for enhancement of MRI images
- Forms a complex with chelating agents
- Excreted via kidneys
- $\frac{1}{2}$ life = 1.3 - 1.6 hr
- Does not cause an osmotic load
- Considered safer and less allergenic than iodinated contrast agents

- Risk of nephrogenic systemic fibrosis (NSF) in pts with advanced kidney disease who received gadolinium
- Systemic sclerosis, muscle weakness, loss of ambulation, pain, burning and itching
- Debilitating, sometimes fatal
- Should be avoided in advanced kidney disease, consider dialysis after completion of scan
MRI: Quenching the magnet

- Magnet coils are supercooled with liquid cryogens such as helium.
- System Quench is done in an extreme emergency to remove a projectile/patient from the scanner.
- Cryogens evaporate and escape the cryogenic chamber - loss of superconductivity of the magnet.
- May occur unintentionally due to system malfunction.
- If a quench occurs, patient and staff must be removed from the room immediately.

**Risks of a quench:**
In case of failure of quench pipe that vents cryogenic gases outside, rapidly expanding helium may enter the scanning room displacing the O₂ - risk of asphyxiation and frostbite to patient/staff.
Interventional Radiology (IR)

- Spectrum: PICC lines to embolization
- Usually require GA/Sedation
  - control of movement is critical
  - breath holding for clear images
  - hypercarbia - enhances images by vasodilating arteries
- Abdominal angiography
  - N₂O distends bowel, may distort vasculature of interest
  - IV glucagon 0.25 mg/dose reduces peristalsis and motion artifact
  - glucagon causes hyperglycemia, vomiting, electrolyte imbalance, clotting disturbance - close monitoring, prophylactic anti-emetics
IR: Cerebral Angiograms and Interventions

• High risk procedures for w/u or f/u of vascular malformations, tumor resection, stroke, hemorrhagic events, mental status changes

• GA to ensure no movement, allow breath holding and induce hypercarbia
  - ETCO$_2$ $\geq$ 50 mmHg causes cerebral vasodilation, allows radiologist to visualize and insert catheter into smaller vessels

Moyamoya disease - progressive occlusion of internal carotid artery

• Goals of GA - avoid TIA / stroke
• Avoid hypotension, liberal IV fluids, bolus prior to induction
• Hyperventilation and crying may precipitate stroke
• Maintain normocapnia/mild hypercapnia
• Radiologist may inject NTG into catheter for vasospasm
• Smooth emergence, avoid HTN and crying
IR: Embolization and Sclerotherapy

• Vascular malformations are present at birth but are discrete, may expand rapidly
• High flow lesions - AV fistulas, AVMs, hemangiomas, may be assoc with high output failure and pulm edema
• Low flow lesions - venous and lymphatic malformations
• If surgical resection is incomplete, may come back and enlarge rapidly

• Angiography and embolization is a popular alternative
• Goal: Attempt to cut off feeding vessels using polyvinyl alcohol foam, ethanol, coils, glues and gelatin pledgets
• Absolute ethanol (99.9% alcohol) - thrombososes vessels at the level of the capillary bed by injuring the vascular endothelium
IR: Risks of Embolization and Sclerotherapy

- Ethanol sclerotherapy can cause:
  - post procedure coagulopathy with +ve d-dimers, increased PT and decreased platelets
  - neuropathy and tissue necrosis if not injected selectively
  - serum alcohol levels above the intoxication level causing agitation or excessive sedation on emergence

- Pulmonary emboli - inadvertent migration of embolization material to lungs

- Local hemolysis when sclerosing agent injected into vascular bed - hemoglobinuria, risk for renal injury
  - adequate hydration
  - diuresis - furosemide, foley cath
  - if persistent - alkalinize urine by NaHCO₃ administration

- Risks incl intracranial hemorrhage, cerebral ischemia, and stroke
### Nuclear Medicine

#### Indications
- Evaluate extent of disease for neoplasms
- Detect epileptic foci in refractory epilepsy
- Evaluate cerebrovascular disease
- Evaluate cognitive and behavior disorders
- Detect renal function and disease

#### Procedure
- Scans last 20-60 min, pain free
- Child must remain motionless
- No ionizing radiation emitted
- IV access for administration of tracer well ahead of scan
- Bladder must be emptied to avoid interference from concentrated tracer in bladder
- Dispose urine in radioactive-safe manner
Nuclear Medicine: SPECT scans

• Single-Photon Emission Computed Tomography (SPECT) uses radioisotopes and rotating gamma cameras to produce 3-D brain images
• Used for localizing seizure foci
• Radiolabeled technetium-99m injected during a seizure will tag areas of increased CBF and localize the seizure foci
• ½ life of the radionuclide is 6 hr, therefore child must be scanned between 1-6 hr after seizure and injection of tracer
• Flexibility in anesthesiology scheduling
Nuclear Medicine: PET scans

- Positron emission tomography (PET) scans use radionuclide tracers of glucose metabolism to seek seizure foci or tumor recurrence.
- Short $\frac{1}{2}$-life of the glucose tracer (110 minutes) requires the scan to be completed during the seizure or within 1 hr thereafter.
- Anesthesia team on very short notice.
- IV hydration to avoid hypovolemia while child is NPO, waiting for seizure.

PET CT scanner with ceiling mounted pump for injection of contrast agent.
Radiation Oncology

- Ionizing photons used to destroy lymphomas, acute leukemias, Wilms tumor, retinoblastomas, CNS tumors
- Fractionated treatments adm once or twice daily
- Typically 5 days/wk for 6 wk
- Allows normal tissue repair between sessions as tumor burden is lessened
- Initial planning session in a simulator or CT scanner

- Planning session
  - Maps the fields that require RT
  - Fiberglass cast of the head made while the child is anesthetized with a natural airway
  - Body mold is used for secure positioning to ensure no movement during treatments
  - Mask must be configured for optimal airway patency
Rad Onc: Anesthetic Considerations

- NPO times challenging especially for twice daily treatments
- High radiation exposure, only child stays in the room during treatments, video observation
- CVL avoids need for repeated IV
- Propofol infusion + midazolam
- Blow by O₂, ETCO₂ monitoring
- Neuraxial treatment for spinal metastases requires 4 treatments in supine and prone positions
- For retinoblastoma, eye must be completely immobile during treatment.
- Very deep propofol sedation or GA is necessary
- Ketamine should be avoided due to nystagmus
Stereotactic Radiosurgery

- Indicated for tumors deep in the brain or in an area that could place the child at risk (e.g. motor, speech, cerebellum or brainstem)
  - ependymoma
  - glioblastoma
  - vascular malformations
  - acoustic neuroma
  - pituitary adenoma

- Radiosurgery or gamma knife:
  A single large fraction of radiation directed at a specific target with minimal radiation exposure to the surrounding normal tissues

- Optimal results achieved with small tumor volumes $\leq 14 \text{ cm}^3$

- Sedation/GA duration is 9-15 hr

- Coordination between radiation oncologist, radiologist, and anesthesiologist
Stereotactic Radiosurgery: Procedure

- Procedure begins in CT scanner
  - Induction of GA, ETT
  - Stereotactic head frame applied (key taped to head frame)
  - Imaging
- Child transported to PACU, intubated, sedated, monitored for 3-5 hr

- Radiologists and neurosurgeon review images and plan radiosurgery

- Child transported to the stereotactic radiosurgery linear accelerator for treatment
  - GA and full monitoring
  - High radiation exposure, only child remains in room, remote video monitoring
  - Procedure lasts approx 1 hr

- After radiosurgery, child transported to PACU, extubated

- Risk of multiple transports and prolonged anesthesia/sedation
Magnetoencephalogram (MEG)

- Used for presurgical seizure foci evaluation
- May require sedation
- No danger of magnetic field
- Doesn’t make noise
- Special Requirements:
  - In a shielded from to protect from magnetic fields (electronics, earth)
  - No metal in the room
  - Opening room requires reequilibration
  - Patient immobile
GI Endoscopy

- Upper EGD - significant stimulation, requires deep sedation/GA in infants and children
- ETT placement should be considered for infants<6 mo. of age or <10kg
- Avoids airway compression by endoscope and high risk of respiratory complications
- ETCO2 monitoring via N/C for those who are not intubated
- Transoral and transpyloric passage of the endoscope are most stimulating
- ERCP in children requires GA in most cases
- Increased stimulation when traversing the colon to the splenic flexure and ileocecal valve
- Large study, n = > 10,000, overall complication rate of 1.2% in GA group vs. 3.7% in sedation group
- Young age and high ASA score assoc. with complications
Contrast Agents

- IV contrast is used frequently in radiology and cardiac catheterization
- Incidence of serious contrast reactions:
  - High osmolality ionic agents (Hypaque, Conray) 1-2/1000 studies
  - Low osmolality nonionic agents (Omnipaque) 1-2/10,000 studies
- Doses should be limited to
  - 4 ml/kg in healthy children < 1yr
  - 6 ml/kg in older children
Contrast Agents: Adverse Reactions

• Incidence of reactions ranges from 0.2-0.4% (mild) to 0.01 to 0.02% (life-threatening) with the use of low osmolality contrast

• FDA and drug company data from 1990s found 2.1 deaths/1 million studies using contrast

• **Mild reactions** - nausea, vomiting, sensation of warmth, flushing, urticaria, pain on injection
  
  Vital signs, observe for 20-30 min, antihistamines prn

• **Moderate reactions** - Urticaria/erythema, bronchospasm, tongue or facial swelling, transient hypotension, vasovagal reaction
  
  - close monitoring until symptoms resolve completely
  
  - secure IV access, suppl O₂, antihistamines, bronchodilators
Contrast Agents: Adverse Reactions

• Severe reactions:
  - rare but unpredictable, require prompt recognition and treatment
  - altered mental status, respiratory distress, severe bronchospasm, laryngeal edema, diffuse erythema, severe hypotension, pulmonary edema, seizures, cardiac arrest and renal failure
  - aggressive fluid resuscitation, epinephrine, secure airway, steroids, treat specific symptoms
Contrast Reactions

• Risk factors for severe reactions:
  - h/o allergies, atopic disease, asthma, significant cardiac disease, paraproteinemias, previous contrast reaction
  - pre-treat with prednisone and benadryl

• Risk factors for adverse renal effects:
  - pre-existing renal insufficiency (S. Creatinine ≥ 1.5 mg/dl)
  - diabetes, CV disease, HTN, dehydration, hyperuricemia
  - avoid contrast/minimize volume of contrast used
  - prehydration
  - osmotic and loop diuretics
  - allow at least 48 hr between 2 contrast examinations
Recovery Recommendations

• Baseline mental status and vital signs
• Use of scoring systems may assist in documentation of fitness for discharge.
• Sufficient time since administration of a reversal agent (naloxone or flumazenil) [2 HOURS]
Increased demand for procedural sedation and analgesia outside the operating room

• The Joint Commission on Accreditation of Healthcare Organizations mandate anesthesiologists responsible for institutional guidelines for pediatric sedation.
• The medication used, level of sedation provided, monitoring and degree of training of sedation providers varies across the institutions.
• Majority of adverse events are related to airway or respiratory events, which can be managed with simple maneuvers.
Be Safe

• Preprocedural health evaluation before sedation should be performed by an appropriately licensed practitioner.

• Continuous monitoring of oxygen saturation and heart rate, capnography and intermittent measurement of blood pressure should be documented.

• Adequate preparation, equipment, medication and monitors is critical.

• After the child has received sedation and analgesia he/she must be observed in a suitably equipped recovery location.