Pediatric Sedation & Analgesia

Timothy Givens, MD

Children's Hospital Colorado
Here, it's different.™

I have no relevant financial relationships with any commercial interests.

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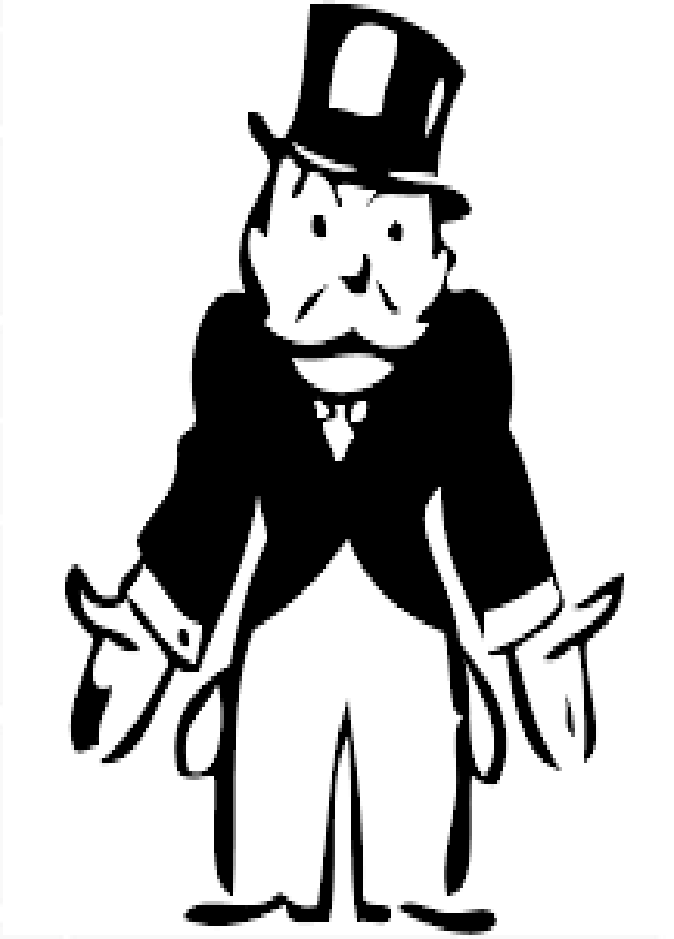

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Goals of a pediatric sedation talk

How many of you are snow skiers?

What's a "Jerry"?

A "Jerry" is a skier who…

- …is blissfully unaware/incompetent at skiing
- …makes careless decisions
- …skis terrain beyond their ability
- …has NO LACK of confidence

- …and is not only annoying but DANGEROUS.

Don't be a sedation "Jerry!"

Sedation and Analgesia in Pediatric Patients

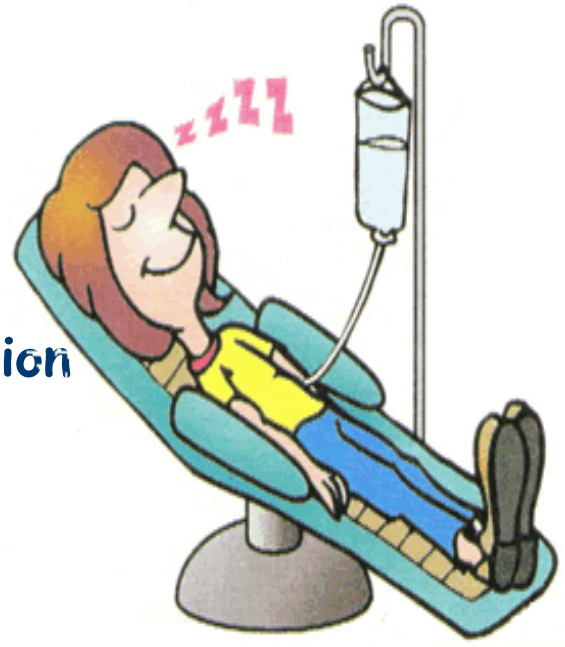
Case: forehead lac

- 2 yo male fell & hit head (eyebrow region) on coffee table 2 hours ago
- 2" linear lac requires sutures
- Appears anxious
- Had stitches last year and had to be "held down"
- Mom worried about scar
- Mom gave him ice cream to calm him after the injury

Objectives

1. Define sedation
2. Discuss depth of sedation
3. Describe the set-up for safe sedation

   --Personnel, equipment, operational procedures



What is sedation?

"*Abatement* of physiologic function, especially by administration of a drug"

NOT analgesia (pain relief)

NOT amnesia (loss of memory)

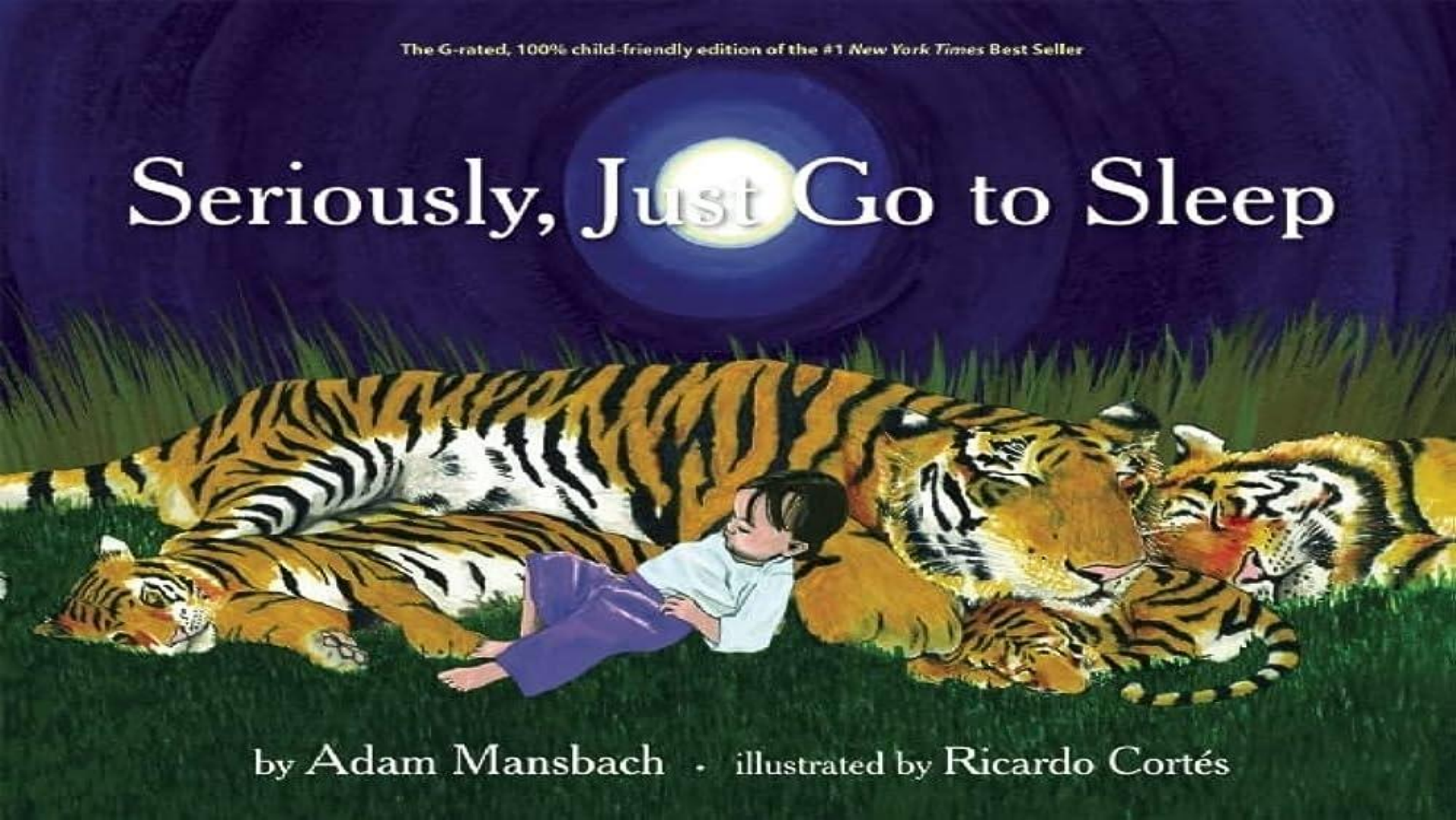
Goals of procedural sedation & analgesia

- Attenuate pain, anxiety, motion,
- Facilitate performance of a necessary diagnostic or therapeutic procedure,
- Provide an appropriate level of amnesia or decreased awareness, *AND*
- *Ensure patient safety!!!*

- Bhatt: Quebec guidelines for sedation. *Ann Emerg Med* 2009

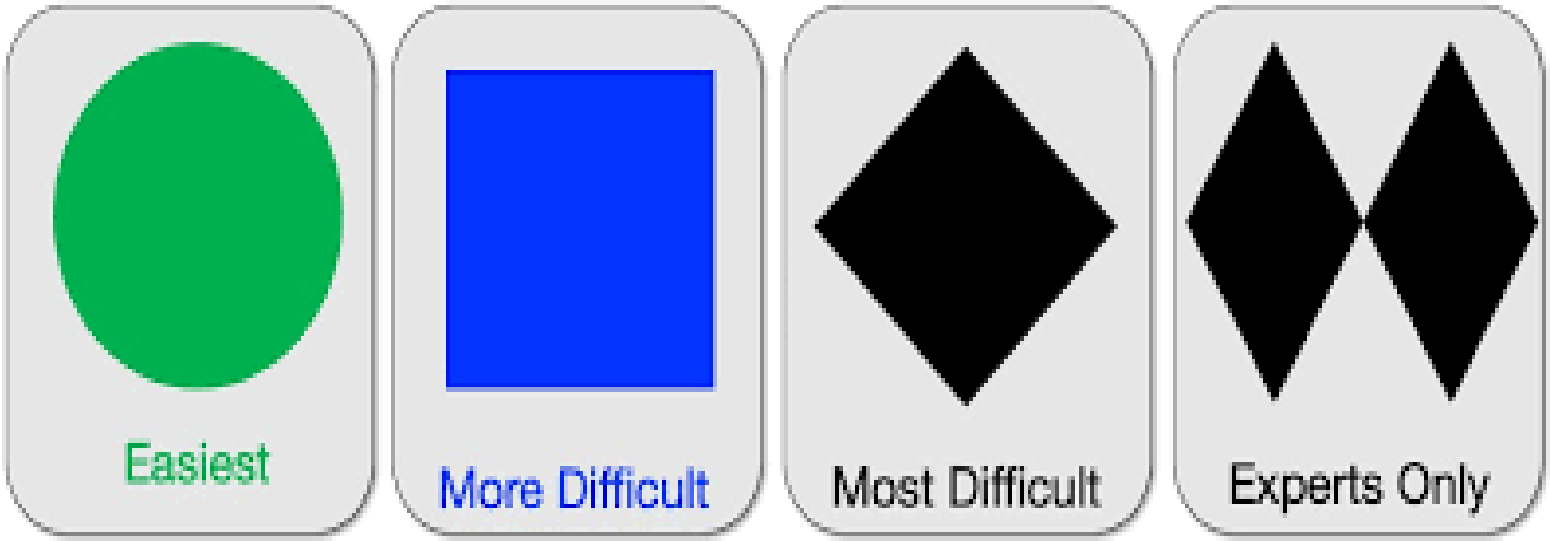
The G-rated, 100% child-friendly edition of the #1 *New York Times* Best Seller

Seriously, Just Go to Sleep



by Adam Mansbach · illustrated by Ricardo Cortés

Back to our skiing analogy…



The trail difficulty continuum

Breck

Breckenridge Ski Resort is made up of Five Peaks, each with its own personality and purpose. Welcome!

Breckenridge Ski Resort is operated under a special-use permit with the White River National Forest.

Peak 10

Accessed by the 6-passenger Falcon SuperChair, Peak 10 is a hub of advanced trails from smooth groomers to moguls, glades and rugged natural terrain. If you've conquered the intermediate terrain of Peaks 7 and 9, this is the next peak to explore. All trails on Peak 10 lead back to the Falcon SuperChair, making it a great area to lap and stack up your vertical feet!

Peak 9

Progress your skills on Peak 9. The lower half of this peak offers mellow learning terrain while the upper half offers long and wide intermediate runs for cruising. As the closest base area to downtown Breck, start your day and end your day right in town.

Peak 8

The heart of the resort! From starting small to going big, Peak 8 has it all, including the highest chairlift on the continent, the Imperial SuperChair. First-timers and beginners should start at the Rip's Ride learning area and progress to 5-Chair, while experienced skiers and riders can head up the Colorado and Rocky Mountain SuperChairs. At the end of the day, ski and ride directly into town via the 4 O'Clock trail.

Peak 7

Hit the mountain fast! Peak 7 is a smaller base area and a great place to start the day on snow if you're ready to get up and go. Featuring intermediate-and-above level terrain, lower Peak 7 is a paradise of rolling groomed trails serviced by the Independence and Freedom SuperChairs. Take it up a notch and above treeline with the T-Bar and Imperial SuperChair and find Peak 7 heaven in the high alpine, with steep and expansive bowl skiing.

Peak 6

The gateway to the high alpine at Breck. This is where experienced skiers and riders can go to get their first taste of the resort's high alpine, above treeline experience on trails like Bliss and Reverie, and where experts can take on heart-pounding, no-fall-zones in the Six Senses.

STAY WITH BRECK

Crystal Peak Lodge
DoubleTree by Hilton Breckenridge
Gravity Haus
Mountain Thunder Lodge
One Ski Hill Place, A RockResort
River Mountain Lodge
Village at Breckenridge

DINE WITH BRECK

Pioneer Crossing
The Maggie
Sevens
Vista Haus
Ski Hill Grill
TenMile Station
The Overlook
TBar
The Living Room

EMERGENCIES ONLY

CALL SKI PATROL 970.496.7911

AVALANCHE TERRAIN CLOSURE AREA INFORMATION

Terrain at Breckenridge is evaluated daily for weather and avalanche concerns and may be open or closed at any time as conditions dictate. Never duck a rope line even if terrain is open on the other side. You must enter through open access gates only. Violators will lose skiing or riding privileges.

If found in closed terrain, you may be subject to legal prosecution AND the loss of skiing and riding privileges. Snowcats, snowmobiles, AND unmarked obstacles, may be encountered at any time. NON-LIFT ACCESS TO SKI AREA FACILITIES SUCH AS UPHILL SNOWSHOEING, HIKING, OR "SKINNING" MAY PRESENT HIGH DANGER OF PERSONAL INJURY TO PARTICIPANTS OR OTHERS AND THEREFORE IS LIMITED TO DESIGNATED ROUTES DURING NON-OPERATING HOURS OR FORBIDDEN BASED ON CONDITIONS, ON-MOUNTAIN ACTIVITY AND/OR MOUNTAIN POLICY. PLEASE CHECK WITH THE RESORT PRIOR TO ACCESS.
Call the trails hotline at 970.547.5627 for updated information.

Be aware of where you are skiing/riding and know your abilities as they relate to high alpine terrain. At any point you may encounter steep pitches, unmarked obstacles, man-made moguls, or other terrain beyond your abilities. Rescue for these areas can take time.

TERRAIN PARKS

Eldorado	Small
Highway 9	Medium
Park Lane	Large

TOYOTA
TOYOTA BANKED SLALOM COURSE
Located on Freeway

epic LIFT UPGRADE

Rip's Ride: New High-Speed Quad Now Open

- Newer, faster lift. More time to learn on snow!
- Easier access to Peak 9

Peak 8 Base Area Upgrades Coming Winter 2023-24

- NEW High-speed Quad to replace 5-Chair
- Enhanced base area experience and circulation

LIFT STATS

LIFT NAME	CAPACITY	TYPE	TERRAIN	VERT. RISE
BreckConnect Gondola	8			396ft / 121m
Colorado SuperChair	6		■ ◆ ◆◆	1,325ft / 404m
Quicksilver SuperChair	6		●	632ft / 193m
Falcon SuperChair	6		■ ◆◆	1,404ft / 428m
Independence SuperChair	6		■ ◆	1,320ft / 402m
Kensho SuperChair	6		■ ◆ ◆◆ ◇◇	1,536ft / 468m
Freedom SuperChair	4		■ ◆	1037ft / 316m
Zendo Chair	4		■	317ft / 97m
Peak 8 SuperConnect	4		■ ◆ ◆◆	1,424ft / 434m
Beaver Run SuperChair	4		■ ◆ ◆◆	1,591ft / 485m
Mercury SuperChair	4		■ ◆ ◆◆	1,466ft / 447m
Rocky Mountain SuperChair	4		■ ◆ ◆◆	1,248ft / 380m
Imperial SuperChair	4		◆ ◆◆ ◇◇	1393ft / 424m
Rip's Ride	4		● ■	306ft / 93m
A-Chair	3		●	620ft / 189m
C-Chair	2		■ ◆	1,253ft / 382m
E-Chair	2		■ ◆ ◆◆	967ft / 296m
5-Chair	2		● ■	711ft / 217m
6-Chair	2		◆ ◆◆	990ft / 302m
Snowflake	2		● ■	631ft /192m
Horseshoe Bowl T-Bar	2		◆ ◆◆	1,234ft / 376m
Beginner Learning Areas	Surface/ Carpet Lifts		●	

MOUNTAIN STATS

Base Elevation	9,600ft / 2,926m
Summit Elevation	12,998ft / 3,962m
Vertical Rise	3,398ft / 1,036m
Avg. Annual Snowfall	356in / 899cm
Total Terrain	2,908 acres / 1,777 hectares
High Alpine Terrain	1,061 acres / 429 hectares
Snowmaking	708 acres / 287 hectares
Number Of Trails	187
Longest Run	4 O'Clock – 3.5m / 5.6kmh

TRAIL CLASSIFICATION

● Easiest 11% ■ More Difficult 31% ◆ Difficult 24% ◆◆ Most Difficult 34%

Breckenridge.com

epic MIX

Official Partners of Breckenridge Ski Resort

TOYOTA – OFFICIAL MOBILITY PARTNER
OFFICIAL SOFT DRINK
OFFICIAL UNIFORM
OFFICIAL BEER PARTNER
GOOD COMPANY HARD SELTZER – OFFICIAL HARD SELTZER PARTNER
T-Mobile – OFFICIAL WIRELESS PARTNER
AMERICAN EXPRESS – OFFICIAL PAYMENT PARTNER
NATURE VALLEY – OFFICIAL GRANOLA BAR
OAKLEY – OFFICIAL EYEWEAR, GOGGLE AND HELMET
OFFICIAL ENERGY DRINK PARTNER
GoPro – OFFICIAL CAMERA
LUGGAGE FORWARD – OFFICIAL LUGGAGE SHIPPING SERVICE
ECO PRODUCTS – OFFICIAL ZERO WASTE PARTNER

Facts about a ski trail map

- Trail ratings vary
  - Trail designations only compare trails within a particular ski area with one another—no firm standards across resorts
- Steepness can be expressed as degrees or %age
  - Not all measures are "apples to apples"
- There are other elements that determine difficulty
  - Length, width, grooming, weather conditions, bailout points
  - Stratton's Sunriser Supertrail (blue) only bailout points are through black diamond terrain

- Hirschfeld C. *New York Times*. Dec 10 2015


Green slope


ELK HORN
POWDER RIVER
MOONLIGHT LODGE
LAZY JACK
EASIEST WAY
CINNABAR
SIX-SHOOTER & DERRINGER LIFTS
MADISON VILLAGE

Sedation is a continuum

- Sedation is *individual patient-specific*
- *Targeted* vs. *Achieved* depth of sedation

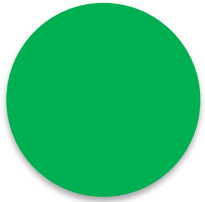
Why is depth of sedation important?

- Deeper levels → greater risk for adverse events
  - Similarly, steeper trails = greater risk of injury
- Hospitals may grant sedation privileges based on depth
  - Often drug administration specific
- Key: be able to RESCUE from next level of sedation

Levels of sedation

- Minimal (anxiolysis)
- Moderate
- Deep
- General anesthesia

Minimal (anxiolysis)

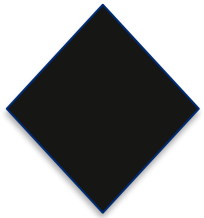


- Patients respond normally to verbal commands
- Ventilatory and cardiovascular functions unaffected
- Many hospitals don't require specific sedation credentials

Moderate

- Patients respond purposefully to verbal commands or light tactile stimulation
- No interventions required to maintain patent airway
- Spontaneous ventilation adequate

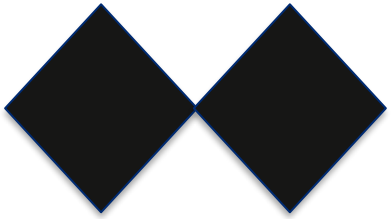
Deep



- Patients can't be easily aroused, but respond purposefully following repeated or painful stimulation

- Independent maintenance of ventilation may be impaired
  - Patients may require assistance in maintaining patent airway
  - Spontaneous ventilation may be inadequate
  - Cardiovascular function usually maintained

General anesthesia



- "A drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to independently maintain ventilatory support is often impaired…"

- **Centers for Medicare & Medicaid Services.** CMS Manual System. Pub 100-07 State Operations Provider Certification. Appendix A. 42 CFR. Section 482.52. Revised hospital anesthesia services interpretive guidelines. January 14, 2011.

Back to the continuum…

- Difficult to identify subtle changes in level of sedation
- Individual patients will respond differently
  - Like ski trails/resorts, no two are exactly alike
- ALL sedation drugs & routes of administration may result in significant adverse events
- Sedation providers: must be prepared to RESCUE
- Cote CJ et al, *Pediatrics* 2000

Safety—how to ensure it???

- Pre-sedation assessment of the patient
- Physiologic monitoring
- Pediatric equipment—prepped & ready
- Trained & credentialed personnel
- Standardized recovery & discharge criteria
- Same precautions EACH & EVERY time
  - Always fully prepared to perform RESCUE

Assessment

- Is this sedation *necessary* and *appropriate*?
  - Elective vs. emergent
  - The right setting?
  - Patient factors
    - Age (and therefore, airway)
    - At-risk conditions: obesity, OSA, URI
    - ASA physical status classification
    - Duration of procedure
    - Fasting state (NPO)
  - Specific goals for this sedation
    - Sedation (targeted depth), analgesia, amnesia

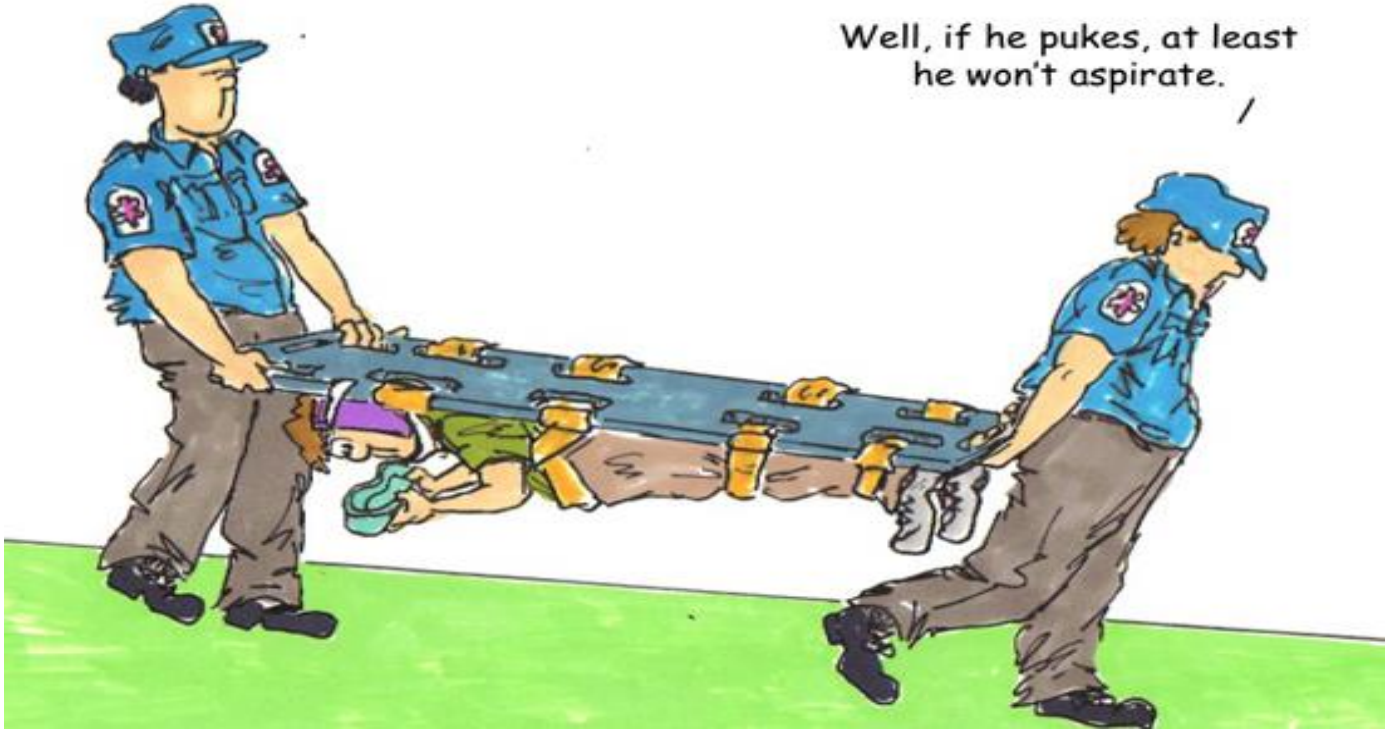
How urgent is this intervention/procedure?

What setting are we in?

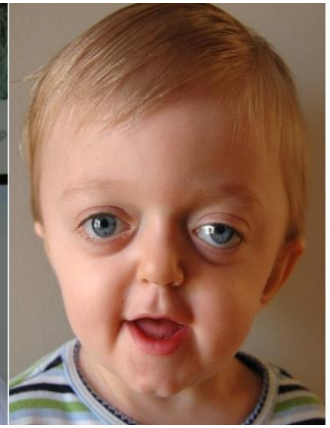
Operating Room

Emergency Department

In the field



What are the characteristics of our patient?



Class I

Class II

Class III

Class IV

NPO Recommendations

American Society of Anesthesiologists (ASA)

- Re: *healthy* patients
- NPO before sedation *elective* procedures
- Clear liquids: 2 hours
- Breast milk: 4 hours
- Infant formula, light meal: 6 hours

- Practice guidelines for sedation & analgesia by non-anesthesiologists. *Anesth* 2002;96:1004-17.

NPO status in our world

- Irrelevant for emergent procedures
- Relative consideration for urgent procedures
- International Committee for Advancement of Procedural Sedation (ICAPS)
  - Fasting does NOT guarantee an empty stomach
  - Probability of "clinically important aspiration" negligible
  - Fasting duration often >>> recommended time thresholds

NPO and aspiration risk factors

- NPO status not independent risk factor
- Aspiration risk in procedural sedation less than in general anesthesia, is rare in children (0.8/10,000)
- Patient factors → most significant impact on risk
  - Severe systemic disease
  - Age less than 1 year
  - Obesity and OSA
  - Airway abnormalities
- Other factors: procedure type, sedation technique
- Bhatt, et al *JAMA Pediatrics* 2017;171(10):957-964.

ASA Physical Status Classification

- Class I: Normal healthy patient
- Class II: Mild systemic disease (controlled asthma)
- Class III: Severe systemic disease (active wheezing)
- Class IV: Disease is constant threat to life (status asthmaticus)
- Class V: Moribund patient not expected to live without procedure/operation

What factors lead to poor outcomes?

- Sedation performed outside of a hospital setting
- Inadequate…
  - Evaluation
  - Monitoring
  - Observation
- Medication errors

- Ability to RESCUE patient mitigates poor outcomes

- Cote, 2000

- Is my unit adequately staffed to do this procedure safely?
- Can this procedure be completed in a reasonable period of time (30 minutes)?
- Is an acceptable result feasible within those constraints?

Set yourself up for success

- Get in the correct position

Set yourself up for success

- SOAPME

- Suction
- Oxygen
- Airway
- Pharmacy
- Monitors
- Equipment (IV & RESCUE)

SOAPME

- **S**: size-appropriate catheters; functioning system
- **O**: oxygen supply; adequate delivery
- **A**: NP/oral airways; bag-mask; ET tubes, laryngoscopes
- **P**: oxygen, epi, paralytic; antagonists (naloxone, flumazenil)
- **M**: ECG/BP monitors; pulse oximeter; end-tidal CO2
- **E**: IV (functioning); RESCUE airway equipment

Proper type, size of equipment matters!

Proper training, supervision is critical to safety & success.

Monitoring Personnel

All sedations should ideally have a designated, trained provider observing the patient *who is NOT performing the procedure*

Discharge Criteria

- Vital signs & pulse oximeter normal/baseline
- Baseline mental status & verbal ability
- Able to sit unassisted (age-appropriate)
- Demonstrate ability to protect airway
- If reversal drugs given, minimum 2 hours observation post-administration

Sedation set-up summary

- Pre-sedation assessment
  - Right procedure, length, setting—be selective
  - Minimize pre-procedure agitation
- Proper monitoring
  - CR monitor/BP, pulse oximeter, capnography
- Assemble all equipment & personnel
  - Oxygen, suction, bag-mask, airway adjuncts
- Be prepared to perform RESCUE

OK, ready to go…

What does success look like?

- Procedure performed successfully
  - Bare minimum—lowest bar!!
- Child has no unpleasant recall
  - (Sedation team has no unpleasant recall)
- Child did not actively resist or require physical restraint
- No sedation-related adverse events
  - Threatened or actual patient injury or discomfort
  - Abandoned procedure
  - Unplanned hospital admission or prolonged ED stay

Case: options

- No sedative meds
  - Controlled setting: dim lights, music, family assistance
  - Distraction, guided imagery
- Minimal sedation
  - Midazolam
    - IN 0.4.mg/kg (max 5 mg)
  - Dexmedetomidine
    - IN 2 – 3 mcg/kg
  - Nitrous oxide

Choice:
Midazolam 0.3-0.5 mL per nostril (larger volumes become po)

Non-pharmacologic methods

- Distraction
  - Music, books, videos, virtual reality
  - Hypnosis, guided imagery
  - Child Life Specialists
  - Position of comfort
  - Minimize pre-sedation agitation

Let's talk drugs--sedatives

- Benzodiazepines
  - Midazolam (Versed)
  - Diazepam (Valium)
  - Lorazepam (Ativan)
  - Reversal agent--Flumazenil
- Barbiturates
- Etomidate
- Propofol

- Sedation/anxiolysis *yes*, but NO ANALGESIA

Midazolam (Versed)

- Multiple routes for administration
  - IV, intranasal, IM, PO, sublingual, rectal
- Rapid, predictable onset of action
- Short duration
- Amnesia for the event
- Reversal with Flumazenil (Romazicon)

Midazolam (Versed)

- Disadvantages
  - Respiratory depression
  - Laryngospasm
  - Hallucinations
  - Spatial relations difficulty
  - Mild hypotension (minimal)
  - Paradoxical agitation possible

Midazolam (Versed)

- Intranasal
  - Use of atomizer
  - Excellent absorption
  - 0.2 – 0.4 mg/kg dose
  - Max dose 8 mg
- Intravenous
  - 0.05 – 0.1 mg/kg dose

Fentanyl

- NOT a "sedation" drug per se
  - Opiate = analgesia
  - Sedation is minimal
- Dose:
  - Intranasal: 1 mcg/kg with atomizer
  - IV: 1-3 mcg/kg
- Adverse effects
  - Respiratory suppression, apnea
  - Hypotension
  - Chest wall rigidity with rapid infusion
- Reversal agent: naloxone

Ketamine

- PCP derivative
- Dissociative sedative (trancelike state)
- Sedation, analgesia, amnesia—triple threat
- IV: 1 - 2 mg/kg
- IN: 1 - 2 mg/kg
- IM: 2 - 4 mg/kg

Ketamine: effects

- Increased heart rate & blood pressure
- Increased intracranial & intraocular pressure
- Increased intragastric pressure (vomiting risk)
- Increased incidence apnea
  - Age < 3 months
  - Rapid infusion
- Muscle rigidity, myoclonic jerks possible
- Maintains airway protective reflexes

Ketamine: adverse events

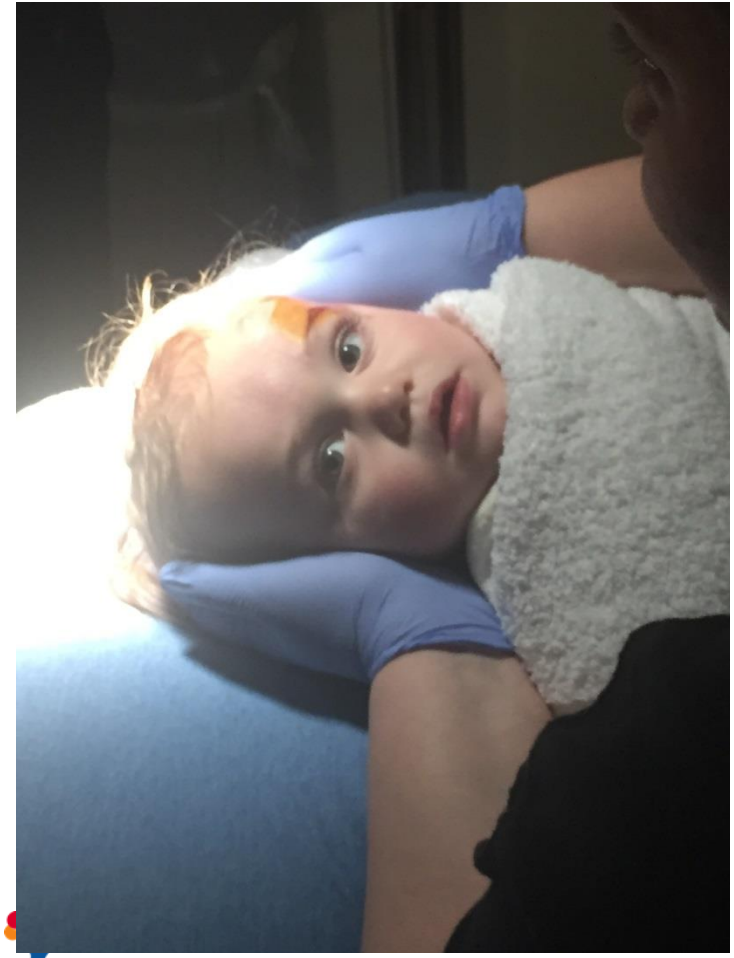
- Apnea
- Sialogogue
- Laryngospasm
- Oxygen desaturation
- Vomiting*
- Emergence reactions
- Risk factors for airway/respiratory events:
  - High IV dose
  - Children < 2 yo or > 12 yo
  - Co-administered benzos, anticholinergics

Ketamine emergence reactions

- Euphoria/dysphoria
- Agitation
- Hallucinations
- Active dreams/nightmares
- Any of these: 5-27%

Pain management (analgesia)

- PICHFORK (Pain in Children Fentanyl or Ketamine)
  - Double-blind, randomized controlled trial
  - Age 3 – 13 yo, isolated extremity injury
  - Moderate to severe pain
  - 1.5 mcg/kg IN fentanyl vs. 1 mg/kg IN ketamine
    - Similar (effective) pain reduction in both groups
    - Ketamine—more minor adverse events, mainly due to dizziness/drowsiness (sedation)
  - Graudins A, et al, *Ann Emerg Med* 2015; 65(3):248-254.

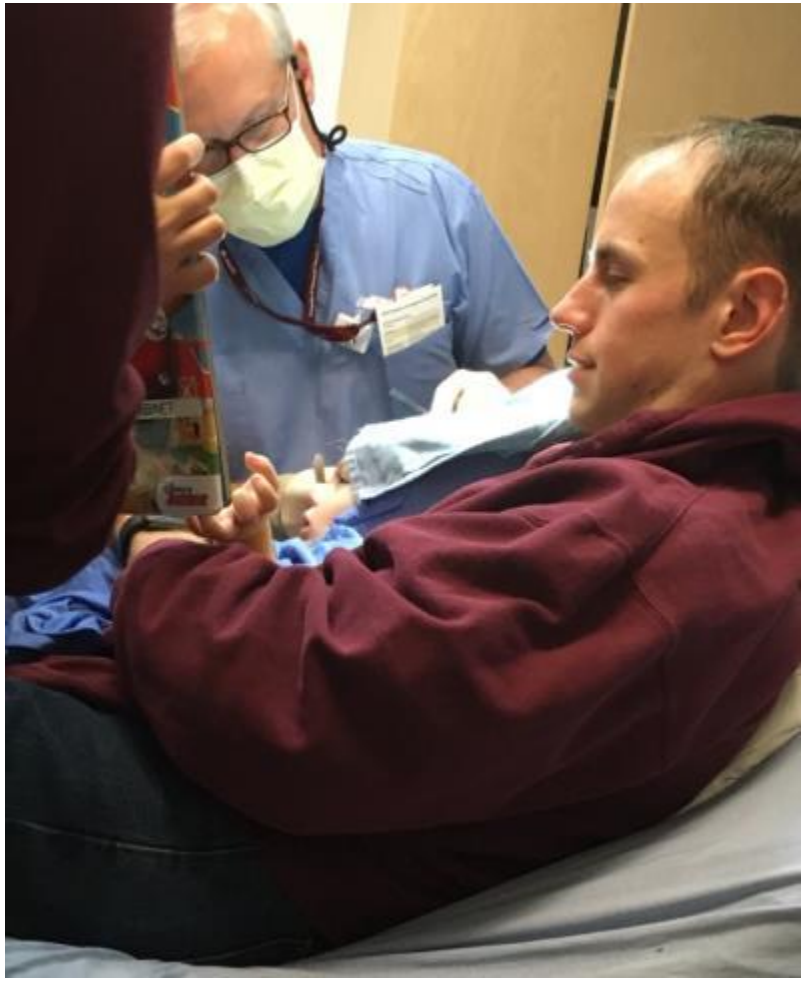


Adjunct maneuvers

- Painless local anesthesia: LET
- Position of comfort
- Distraction
- Papoose? Dad?

Case: procedure

- Child did not actively resist or require physical restraint



Case: resolution

- No unpleasant recall
- Procedure completed successfully
- Parents happy
- Laceration healed well

Thank you

Children's Hospital Colorado
Here, it's different.™

Dexmedetomidine

- Alpha-2 adrenergic agonist
- Minimal depression of respirations
- Maintains patent airway
- Depresses cardiovascular system
  - Bradycardia, hypo- and hyper-tension all possible
- Has analgesic properties
- 2-hour elimination half-life—protracted recovery
  - Used for sedation for prolonged procedures, MRI

Nitrous oxide

- Odorless, tasteless gas
- Produces dissociative euphoria
- Used for years in pediatric dentistry
- Largely considered effective & safe
- When used at levels < 50%, maintains protective airway reflexes
  - No fasting, minimal post-procedure monitoring
- Amnesia, mild analgesia (but not sufficient alone for most procedures)

Nitrous oxide

- 30% nitrous/70% oxygen mix typically titrated to 50%/50% until effective
- Peak effect within 5 minutes
- Offset within 5 minutes of removal
- No IV required
- Doesn't cause respiratory depression
- Adverse events in up to 10%: nausea +/- vomiting
- Post-sedation HA can occur
- Little to no effect on hemodynamics

Nitrous oxide

- Ventilation intact, so pCO_2 does not increase
- Can have hypoxia if oxygen:NO ratio too low
  - Requires monitoring
  - Must have available equipment for gas (O_2) administration & elimination


PLANK