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Outreach Education Follow-up Initiative
Pediatric Critical Care

StEP
Stabilization Essentials in Pediatrics

Sedation and Analgesia

Stabilization Essentials in Pediatrics (StEP) is an interdisciplinary two-day course with components of didactic lectures, high fidelity simulations and hands-on workshops, prepared and delivered by PICU faculty. The target audiences are MDs, RNs, and RTs who care for critically ill children over the short term, usually while they await transport. These practitioners may be part of different departments depending on local workflows (ie. ED4, Adult ICU or High Acuity Pediatric Units).

Objectives

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- Become familiar with the tools used for the assessment of sedation and analgesia in pediatric patients
- Recognize the 3 levels of sedation: conscious (moderate) sedation, deep sedation and general anesthesia and when they are indicated
- Understand the principles of co-analgesia
- Develop an approach for the management of sedation and analgesia for:
  - Induction / Intubation
  - Maintenance of mechanical ventilation and non-invasive ventilation
  - Invasive procedures/transfer of critically ill children

Sedation and analgesia goals

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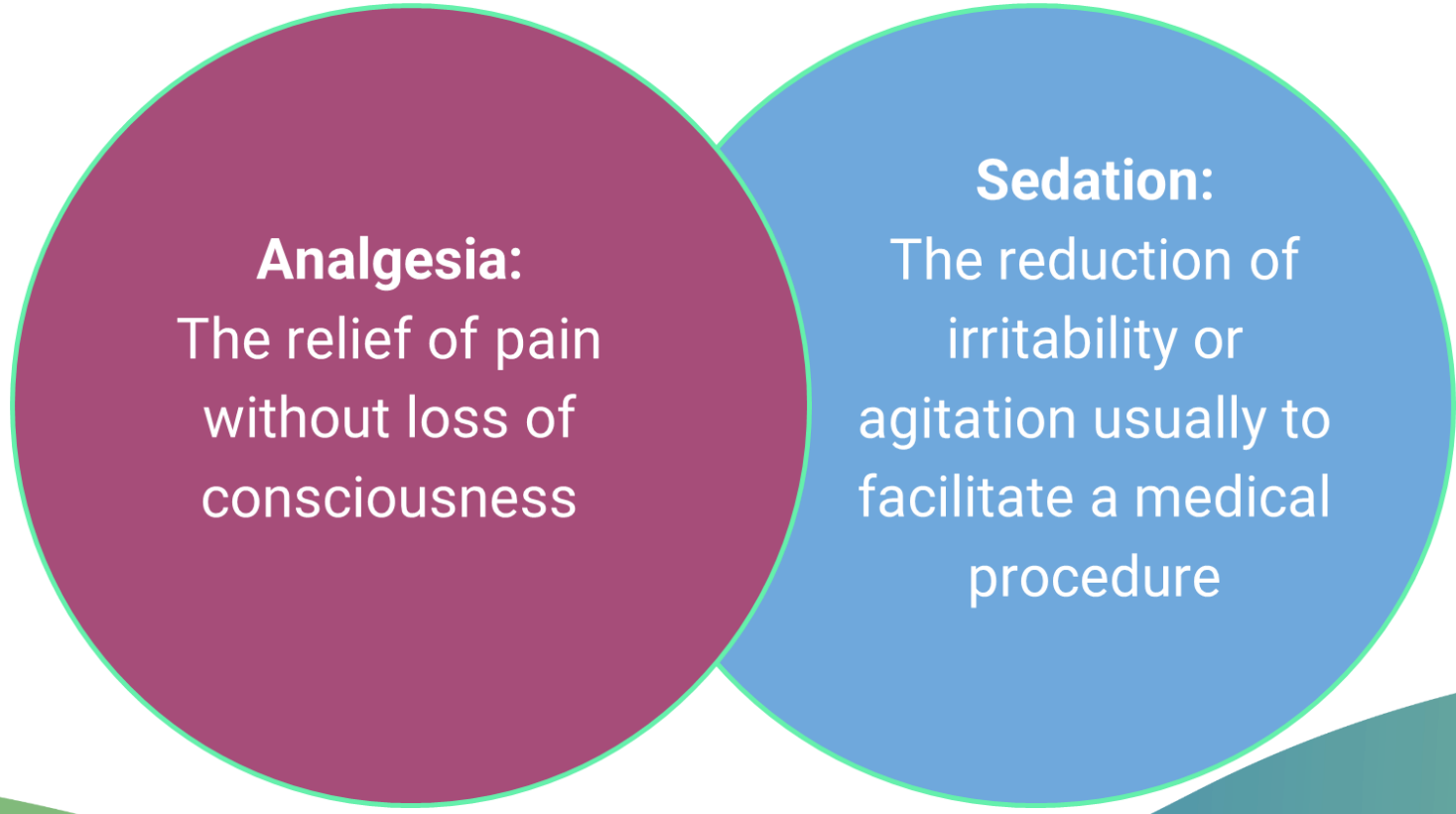
Goals:

- Analgesia (no or mild pain)
- Sedation and anxiolysis
- Amnesia



Pain/sedation Assessment

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- Important to perform a baseline assessment (including VS) and to involve the child's caregiver to help identify patient's cues
- Requires continuous monitoring using validated scales
- Can be difficult to differentiate between pain, anxiety, delirium and withdrawal
  - ? Needs more (or less) sedation
  - ? Needs more (or less) analgesia

Pain Assessment

- Assessing pain and sedation in children is challenging
- Pain is not directly correlated to severity of injury
- Wide assessor variability for pain
- Wide patient variability (both between patients and with the same patient) in pain/discomfort cues
- Developmental and communication differences

Pain = subjective experience

FLACC Pain Assessment

Figure 2. FLACC and r-FLACC scales

Category	0	1	2
F Face	**No particular expression or smile**	**Occasional grimace/frown; Withdrawn or disinterested;** *appears sad or worried*	**Consistent grimace or frown; frequent/constant quivering chin, clenched jaw;** *distressed-looking face; expression of fright or panic*
L Legs	**Normal position or relaxed;** *usual tone and motion to limbs*	**Uneasy, restless, tense;** *occasional tremors*	**Kicking, or legs drawn up;** *marked increase in spasticity, constant tremors or jerking*
A Activity	**Lying quietly, normal position, moves easily;** *regular, rhythmic respirations*	**Squirming, shifting back and forth,** *tense or guarded movements; mildly agitated (e.g. head back and forth, aggression); shallow, splinting respirations, intermittent sighs*	**Arched, rigid or jerking;** *severe agitation; head-banging; shivering (not rigors); breath-holding, gasping or sharp intake of breaths, severe splinting*
C Cry	**No cry/verbalization**	**Moans or whimpers; occasional complaint;** *occasional verbal outburst or grunt*	**Crying steadily, screams or sobs, frequent complaints;** *repeated outbursts, constant grunting*
C Consolability	**Content and relaxed**	**Reassured by occasional touching, hugging, or being talked to, distractible**	**Difficult to console or comfort,** *pushing away caregiver, resisting care or comfort measures*

0 =	Relaxed and comfortable
1–3 =	Mild discomfort
4–6 =	Moderate pain
7–10 =	Severe pain or discomfort or both

Adapted from Malviya 2006 [30] combining the original FLACC **(text in bold)** and the addition of the r-FLACC *(text in italic)*

Pain assessment

- Scales
  - NRS-11: verbal numeric rating scale
  - Faces-pain scale revised
  - Color Analogue Scale: slider
- Observational
  - R-FLACC
  - Comfort (CBS)
  - And multiple others

Levels of Sedation

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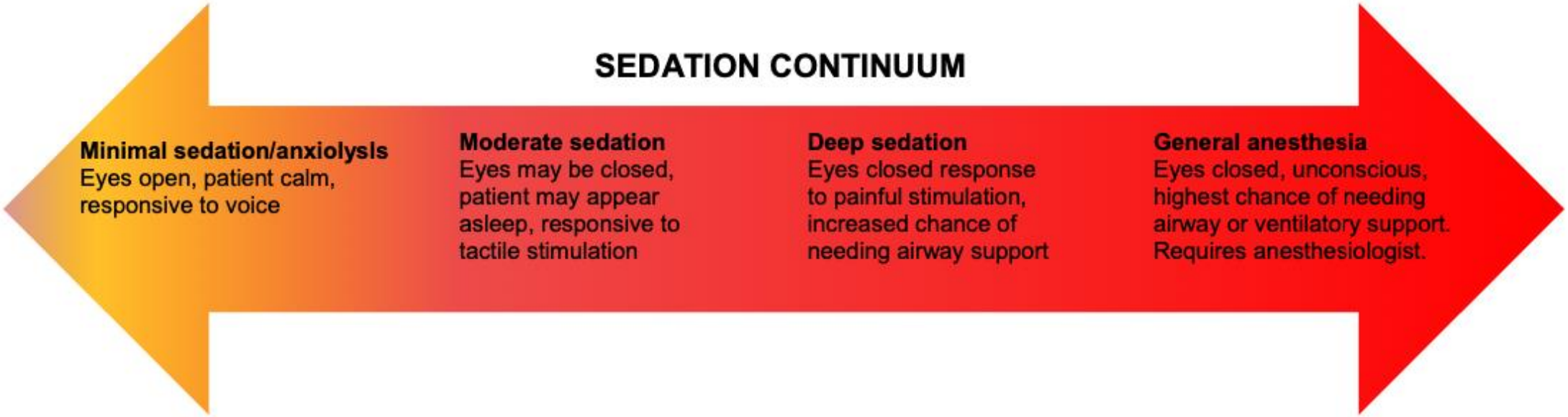

SBS: State Beha

Dimensions
Respiratory Drive
Response to Ventilation
Coughing
Best Response to Stimulation
Attentiveness to Care Provider
Tolerance to Care
Consolability
Movement after Consoled

SEDATION

State Behavioral Score (Assessing Sedation for all patients)

Score	Description	Definition
+2	Agitated	May have difficulty breathing with ventilator Coughing spontaneously No external stimulus required to elicit response Unsafe (biting ETT, pulling at lines, cannot be left alone) Unable to console Increased movement (restless, squirming, thrashing or kicking)
+1	Restless and difficult to calm	Spontaneous effective breathing/having difficulty breathing with ventilator Occasional spontaneous cough Responds to voice/no external stimulus required to elicit response Intermittently unsafe Does not consistently calm despite 5 minute attempt/unable to console Increased movement (restless, squirming)
0	Awake and able to calm	Spontaneous and effective breathing Coughs when repositioned Responds to voice/no external stimulus is required to elicit response Distress with procedures Able to calm with comforting touch or voice when stimulus removed Occasional movement of extremities or shifting of position/increased movements
-1	Responsive to gentle touch or voice	Spontaneous but ineffective non-supported breaths Coughs with suctioning/repositioning Responds to voice/touch Able to pay attention but drifts after stimulation Distress with procedures Able to calm with comforting touch or voice when stimulus removed Occasional movement of extremities or shifting of position
-2	Responsive to noxious stimuli	Spontaneous yet supported breathing Coughs with suctioning/repositioning Responds to noxious stimuli Distress with a noxious procedure Does not move/occasional movement of extremities or shifting of position
-3	Unresponsive	No spontaneous respiratory effort No cough or coughs only with suctioning No response to noxious stimuli Does not distress with any procedure (including noxious) Does not move

GOALS for Sedation:
For most PICU patients the **Goal is 0 to -1.** Exceptions may be made in some clinical conditions. If muscle relaxed score P for paralyzed.

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Stabilization Essentials in Pediatrics

PCCM 2006

Case Study 1

Billy is a 3yo male with known asthma who presents with hypoxia and a serious asthma exacerbation

- Initial treatment is complete (Ventolin/Atrovent back to back, Methylpred, MGSO4) and he continues to have severe WOB:
  - RR 45
  - HR 165
  - stable BP
- He appears unwell and fatigued. Ventolin is being used q30min.

Case Study 1

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- How would you like to support his breathing? What challenges can be anticipated?
- What are our sedation goals and options?
- Is sedation even required?
- What strategies can be used for initiating sedation?

Case Study 1

- Non-Pharmacologic
  - Environment
  - NG Tube
  - Bundling of care
  - NPO Status
- Pharmacologic
  - Dexmedetomidine vs Ketamine
  - Midazolam?

Non-pharmacological Management

- Parental presence
- Talk and explanations
- Touch: calming touch, holding/cuddling
- Environmental measures
- Reduction of physical discomfort
- Distraction – tv, music, toys
- Hypnosis (Magic Glove technique)

Non Invasive Ventilation

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- Initiation: try non-pharmacological strategies first
  - Kids in significant respiratory distress often don't need any drugs to initiate.
  - Can consider using 0.5mg/kg dose of ketamine (IV)
  - Can consider using Precedex (IN) if no IV – will take 20 min for effect
  - Can consider starting Precedex at higher rate (1mc/gk/h) for more rapid onset

- Maintenance: try non-pharmacological strategies first
  - **Dexmedetomidine = 1st choice if pharmacological management required**
  - Midazolam infusion vs lorazepam PRN (use low dose, beware of respiratory depression)
  - Ketamine infusion = avoid if possible (bronchorrhea) useful for asthmatics

Topical Agents

Drug	Timing Application limits	Ongoing Effect after removal	Contraindications
Ametop (Amethocaine-Tetracaine)	Onset - 30 minutes Max 1 hr application	4 hours	Not used in premature infants Mucosae Open Wounds Eyes
EMLA (Lidocaine-Prilocaine)	Onset 60 minutes Maximum 4 hrs application **except only 1 hour in < 3mo**	1-2 hours Increased effects 15-60 min after removal	Methemoglobinemia/G6PD Mucosae Open wounds Eyes
Maxeline Liposomal Lidocaine	Onset 30 minutes Max 2 hr application	More than 1-2 hours Increased effects 30 min after removal	Mucosae Open Wounds Eyes

Reference - Managing pain and distress in children undergoing brief diagnostic and therapeutic procedures, CPS Position Statement

Case Study 2

Lucy is a 16 month old, 15 kg pt. She was brought in by EHS for first episode status epilepticus. Midaz IN x2, PHY 20mg/kg, Keppra 60mg/kg given. Seizures aborted after 50min.

- On examination:
  - Altered LOC
  - Upper airway secretions
  - Poor cough with RR 6
  - Occasional desaturation event
  - Hemodynamically stable

Case Study 2

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You are preparing for intubation:

- What drug options are there for induction?
- What are our sedation goals?
- How does hemodynamic instability change your choice of management?
- How might induction impact your ability to clinically assess the patient?

Intubation-Induction

Drug	Dose	Onset	Duration	Comments
Ketamine	1 mg/kg/dose Low dose (0.5mg/kg) if patient HD unstable	1 minute	10-15 min	Primary drug used for most intubation.
Rocuronium	1 mg/kg/dose	Approx. 1 minute	25-40 min	Give 1 minute after ketamine dose. Protect airway.
Fentanyl	1-2 mcg/kg Low dose (0.5 mcg/kg) if patient HD unstable	<1 min	30-45 min	For unstable patients – most likely to maintain HD status

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WEIGHT in kg	3
Average AGE for weight (MONTHS)	newborn

PEDIATRIC MEDICATIONS DOSE CALCULATOR

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Resuscitation						
DRUG	**dose/kg**	**dose**	**concentration**	**GIVE**	**route**	**additional info**
ADENOSINE	0.1 mg/kg	0.3 mg	3 mg/mL	0.1 mL	IV	Max 6 mg. If less than 0.2 mL dilute with NaCl. Rapid push
CALCIUM CHLORIDE 10%	20 mg/kg	60 mg	100 mg/mL	0.6 mL	IV	Max 1000 mg
CALCIUM GLUCONATE 10%	100 mg/kg	300 mg	100 mg/mL	3 mL	IV	60-100 mg/kg/dose. Max 3000 mg
DEXTROSE (50% glucose)	0.5 g/kg	1.5 g	0.5 g/mL	3 mL	IV	Dilute 1:1 with sterile water. Max 50 mL Max 200 mg/kg/min
DEXTROSE (10% glucose)	0.5 g/kg	1.5 g	0.1 g/mL	15 mL	IV	Max 250 mL. Max 200 mg/kg/min
EPINEPHRINE (Resusc)	10 mcg/kg	30 mcg	0.1 mg/mL	0.3 mL	IV	0.1 mg/mL = 100 mcg/mL; Check strength
EPINEPHRINE (low dose push)	1 mcg/kg	3 mcg	0.01 mg/mL	0.3 mL	IV	0.01 mg/mL = 10 mcg/mL; Not a standard concentration, needs to be mixed
3% SODIUM CHLORIDE	5 mL/kg	15 mL	0.514 mmol/mL	15 mL	IV	Max 300 mL. Give over 10 min
MANNITOL (20%)	1 g/kg	3 g	0.2 g/mL	15 mL	IV	Max 50 g. Filter required. Push over 3-5 min
NALOXONE	0.1 mg/kg	0.3 mg	0.4 mg/mL	0.75 mL	IV/IM	Max 2 mg/dose. Push over 30 sec. Repeat q 2 min PRN
Intubation Medications						
DRUG	**dose/kg**	**dose**	**concentration**	**GIVE**	**route**	**additional info**
KETAMINE	1 mg/kg	3 mg	10 mg/mL	0.3 mL	IV	Push over 1 min
ROCURONIUM	1 mg/kg	3 mg	10 mg/mL	0.3 mL	IV	Push over 5 sec
FENTANYL	1 mcg/kg	3 mcg	50 mcg/mL	0.06 mL	IV	1-2 mcg/kg/dose range. Max 50 mcg. Push over 3-5 min
Analgesia & Sedation						
DRUG	**dose/kg**	**dose**	**concentration**	**GIVE**	**route**	**additional info**
KETAMINE	1 mg/kg	3 mg	10 mg/mL	0.3 mL	IV	Can repeat dose. Push over 1 min
MORPHINE	0.05 mg/kg	0.15 mg	10 mg/mL	0.015 mL	IV	Max 5 mg. Push over 5 min
MIDAZOLAM	0.05 mg/kg	0.15 mg	5 mg/mL	0.03 mL	IV	Max 8 mg. Push over 2 min
Anaphylaxis						
DRUG	**dose/kg**	**dose**	**concentration**	**GIVE**	**route**	**additional info**
EPINEPHRINE	0.01 mg/kg	0.03 mg	1 mg/mL	0.03 mL	IM	Max 0.5 mg/dose 0.01 mg/kg = 10 mcg/kg
Seizures						
DRUG	**dose/kg**	**dose**	**concentration**	**GIVE**	**route**	**additional info**
LevETIRAcetam	60 mg/kg	180 mg	100 mg/mL	1.8 mL	IV	Max 4500 mg. Refer to parenteral manual for administration instructions
PHENYTOIN	20 mg/kg	60 mg	50 mg/mL	1.2 mL	IV	Max 1500 mg. Refer to parenteral manual for administration instructions
PHENOBARBITAL	20 mg/kg	60 mg	120 mg/mL	0.5 mL	IV	Max 1000 mg. Refer to parenteral manual for administration instructions
LORAZEPAM	0.1 mg/kg	0.3 mg	4 mg/mL	0.075 mL	IV	Max 4 mg. Refer to parenteral manual for administration instructions

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Drugs…

Case Study 2 continued…

Lucy has been successfully intubated and ETT confirmed. She is ventilating appropriately. 2x PIV. Investigations non-specific. CT head normal.

- What might be initial sedative choices?
- What are our goals of sedation?
- What ranges of sedative infusion can be considered?
- What side effects must be considered?
- What ‘rescue’ medications could be utilized (while awaiting ITT arrival) as needed?

Sedation/analgesia - infusions

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Drug	Dose	Comments
Morphine	10 – 40 mcg/kg/hr	Analgesic Active metabolites = pruritus, N/V, constipation, urinary retention
Midazolam	30 – 200 mcg/kg/hr	Sedative, anxiolytic and amnesic Respiratory depression, hypotension, paradoxical reaction
Dexmedetomidine (Precedex)	0.1 – 1.2 mcg/kg/hr	Alpha agonist. Sedative, anxiolytic and analgesic Minimal respiratory depression May cause bradycardia and hypotension (esp. loading dose)
Ketamine	5 – 20 mcg/kg/min	Dissociative, amnesic and analgesic (anti-epileptic) Mobilizes endogenous catecholamines = increased HR/BP (transient) bronchodilation, bronchorrhea, tachyphylaxis
Propofol	20-160 mcg/kg/min (GA dosing)	Sedative, anxiolytic and amnesic (anti-epileptic) Short term sedation ONLY in hemodynamically stable older patients Propofol-related infusion syndrome risk ****

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IV INFUSIONS

Infusions: BP/Cardiac

DRUG	dose range	weight	standard concentration	starting rate	additional info
EPINEPHRINE	0.01-0.4 mcg/kg/min	2 to 6 kg	25 mcg/mL	0.05 mcg/kg/min	Central line not required for low dose infusions
		6 to 30 kg	50 mcg/mL		
		> 30 kg	100 mcg/mL		
NORepinephrine	0.01-0.4 mcg/kg/min	2 to 6 kg	25 mcg/mL	0.05 mcg/kg/min	Central line not required for low dose infusions
		> 6 kg	50 mcg/mL		
ALPROSTADIL (PROSTAGLANDIN)	0.005-0.1 mcg/kg/min	< 2 kg	1 mcg/mL	0.01 mcg/kg/min	
		2 to 8 kg	5 mcg/mL		

Infusions: Analgesia & Sedation

DRUG	dose range	weight	standard concentration	starting rate	additional info
MORPHINE	5 to 20 mcg/kg/h	< 6 kg	200 mcg/mL	10 mcg/kg/h	1000 mcg/mL = 1 mg/mL
		6 to 30 kg	400 mcg/mL		
		> 30 kg	1000 mcg/mL		
MIDAZOLAM	30 to 300 mcg/kg/h	< 6 kg	1 mg/mL	60 mcg/kg/h	
		>/= 6 kg	5 mg/mL		
DexmedeTOMidine	0.2 to 1.2 mcg/kg/h	all	4 mcg/mL	0.4 mcg/kg/h	
KETAMINE	5 to 20 mcg/kg/min	all	10 mg/mL	5 mcg/kg/min	Note rate is per minute

INTRANASAL MEDICATIONS

DRUG	dose/kg	dose	max per nostril	onset	additional info
DexmedeTOMidine	3 mcg/kg	9 mcg	100 mcg	20-45 min	Dose range 1-3 mcg/kg; give half the dose in each nostril. Use dexmedetomidine 200 mcg/2 mL vial. Max 200 mcg/dose
MIDAZOLAM	0.3 mg/kg	0.9 mg	5 mg	5 min	Dose range 0.2-0.3 mg/kg, May repeat in 5 min. Max 10 mg/dose. Dose appropriate for seizure rescue or sedation
FENTANYL	1.5 mcg/kg	4.5 mcg	50 mcg	5-10 min	Max 100 mcg/dose

Sedation Maintenance

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- Always use the lowest amount of drugs possible.
- If patient overall well sedated but has periods of agitation = consider using boluses instead of increasing the infusions (midazolam, ketamine, morphine for pain)
- Ensure patient is well sedated under neuro-muscular blockade (look at HR/BP)
- In overweight patient, use ideal body weight for sedation/analgesia dosing

Sedation/analgesia boluses in critically ill patients

- Indications
  - Agitation
  - Pain
  - Painful procedure
  - Investigations/transfer of intubated patients
- General principles
  - Targeted to the indication*
  - In hemodynamically unstable patient start low and titrate to effect
  - If acute safety concern in an intubated patient – give sedation/analgesia + neuromuscular blockade (ensure ventilator settings appropriate!)
  - If multiple boluses required = maintenance sedation/analgesia must be optimized

Sedation/analgesia intermittent dosing

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Drug	Dose	Comments
Morphine	0.025-0.05 mg/kg/dose IV	Analgesia Painful procedure
Midazolam	0.025-0.05 mg/kg/dose IV	Agitation
Ketamine	0.5-1 mg/kg/dose IV	In non-intubated patient- laryngospasms Agitation, pain, procedure, transfer
Propofol	0.5-1 mg/kg/dose IV	High risk of respiratory depression and hypotension. Use with caution
Clonidine	1-2 mcg/kg/dose po	A-agonist. Sedative and analgesic. Hypotension/bradycardia
Fentanyl	1 mcg/kg/dose IV	Apnea/chest wall rigidity may occur

Case Study 4

Liam, 7-year-old male, 25 Kgs who arrives at the ED after falling off a monkey bars at school.

- Confirmed displaced mid-shaft fracture of the radius and ulna
  - Neurovascular status: Intact (cap refill <2s, good radial pulse, moves fingers with minimal discomfort)
  - No open wounds or signs of compartment syndrome
  - VSS, previously healthy

- The Plan: Closed reduction and splinting under procedural sedation

Case Study 4

- What are my goals for procedural sedation? Depth of sedation?
- How do we determine our plan when performing procedural sedation? Roles?
- How should I monitor the patient?
- What sedative agents should we use? Why?
- What contingency plans should we have in place?

Procedural sedation analgesia

Appendix C: Procedural Sedation Checklist

Procedural Sedation Checklist

Pre-Sedation Assessment & Huddle

- Indications for sedation
- Contraindications & ASA Classification
- Fasting/NPO Status
- Informed Consent
- Intended Level of Sedation
- Additional Comfort Measures:
- Psychologic
- Local/Topical Anesthetics (Ametop/EMLA)

Pre-Procedure Huddle

For areas of sequential (multi patient) procedural sedations

- Name/Role of team members
- Review patients, procedures and sedation plans
- Highlight any medical/mental health concerns
- Review plan for patient disposition post procedure

Sign In

- Verify patient ID and ID band
- State sedation plan
- Medication review
- Local agents
- Emergency medications
- Plan for consequences
- State procedure
- Confirm consent complete
- State patient weight and drug allergies
- Verify fasting guidelines

Verify necessary equipment checked and ready

- Crash Cart Available
- Emergency Call Button
- Patient Monitoring/Rescue
  - ECG leads
  - Pulse oximeter
  - Blood pressure
  - End tidal CO2
  - Stethoscope
  - Yankauer suction &tubing, immediate access to suction
  - Oxygen and face mask
  - ABC Box – OPA/NPA
  - Self-inflating bag attached to O2
  - Functioning/patent IV

Pre-Procedure Time Out

Verbally with the team and documented in health record

- State Procedure
- Identify patient and verify patient ID band in place
- Verify patient weight & medication doses
- Confirm allergy status
- Confirm informed consent completed
- Verify procedure site is marked (as applicable)
- Identify roles present

Do any Team members have concerns?

STOP THE LINE

During Procedure

Documented in health record

- Level of sedation
- Monitoring/vital signs

Post Procedure

Recovery

- Post sedation monitoring using UMSS and modified Aldrete

Documentation

- Review and verify documentation including unexpected outcomes

Sign-Out (debrief)

- Review procedure
- Review effectiveness of sedation
- Ensure specimens properly labelled (as applicable)
- Identify areas of concern or for improvement

Procedural Sedation / Analgesia

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PROCEDURAL SEDATION GUIDELINE: PEDIATRICS

DOCUMENT TYPE: GUIDELINE

Appendix F: Continuum of Depth of Sedation

	Minimal Sedation (Anxiolysis)	Moderate Sedation/Analgesia ('conscious sedation')	Deep Sedation/Analgesia	General Anesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful* response to verbal or tactile stimulation	Purposeful* response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous Ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular Function	Unaffected	Usually maintained	Usually maintained	May be impaired
*Note: reflex withdrawal from a painful stimulus is **not** considered a purposeful response				

Source: American Society of Anesthesiologists. 2019. Continuum of Depth of Sedation: Definition of General Anesthesia and Levels of Sedation/Analgesia. Accessed June 3, 2021 from https://www.asahq.org/standards-and-guidelines/continuum-of-depth-of-sedation-definition-of-general-anesthesia-and-levels-of-sedationanalgesia

Intranasal Medications

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Infusions: Analgesia & Sedation					
DRUG	**dose range**	**weight**	**standard concentration**	**starting rate**	**additional info**
MORPHINE	5 to 20 mcg/kg/h	< 6 kg	200 mcg/mL	10 mcg/kg/h	1000 mcg/mL = 1 mg/mL
		6 to 30 kg	400 mcg/mL		
		> 30 kg	1000 mcg/mL		
MIDAZOLAM	30 to 300 mcg/kg/h	< 6 kg	1 mg/mL	60 mcg/kg/h	
		>/= 6 kg	5 mg/mL		
DexmedeTOMidine	0.2 to 1.2 mcg/kg/h	all	4 mcg/mL	0.4 mcg/kg/h	
KETAMINE	5 to 20 mcg/kg/min	all	10 mg/mL	5 mcg/kg/min	Note rate is per minute

INTRANASAL MEDICATIONS					
DRUG	**dose/kg**	**dose**	**max per nostril**	**onset**	**additional info**
DexmedeTOMidine	3 mcg/kg	75 mcg	100 mcg	20-45 min	Dose range 1-3 mcg/kg; give half the dose in each nostril. Use dexmedetomidine 200 mcg/2 mL vial. Max 200 mcg/dose
MIDAZOLAM	0.3 mg/kg	7.5 mg	5 mg	5 min	Dose range 0.2-0.3 mg/kg, May repeat in 5 min. Max 10 mg/dose. Dose appropriate for seizure rescue or sedation
FENTANYL	1.5 mcg/kg	37.5 mcg	50 mcg	5-10 min	Max 100 mcg/dose

Procedural Sedation / Analgesia

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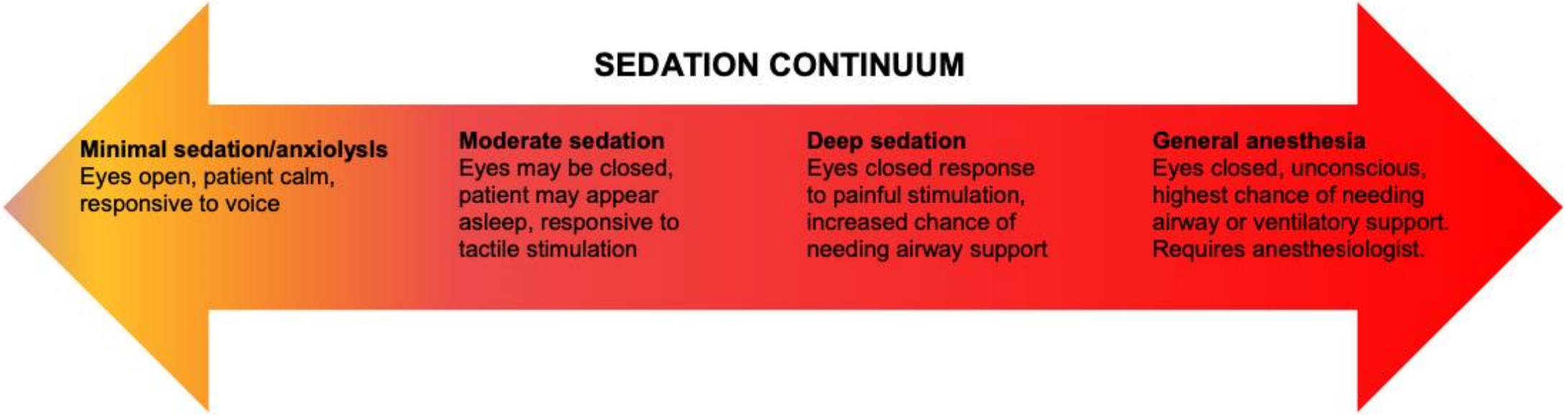
- Goals of Procedural Sedation/Analgesia (PSA)

Maintain spontaneous breathing + stable hemodynamics AND:

- Patient Safety: know the drugs + be able to rescue patient
- Minimize physical discomfort and pain
- Anxiolysis and amnesia
- Safe discharge



Conclusion

- Patient safety is fundamental
- Good pain/sedation control
- Choosing the right drugs/dosing for the right patient
- Family centred care
- Call for help

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