

# **Sedation And Analgesia In Pediatric ICU**

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# Outlines

- Introduction
- Goals
- Definitions
- The challenges of PICU sedation
- Sedation & Analgesia monitoring
- Medications options
- Suggested strategies
- Precautions
- Conclusion & key points

# PICU Experience

- **Physical Pain**

- Primary disease
- Surgical treatment or traumatic event
- Procedure (Central line insertion)
- ET tube presence for MV

# PICU Experience

- Separation from family
- Disturbed sleep cycle
- Noise (machines)
- Fear of death
- Loss of self-control

Anxiety

Emotional  
Distress

sleepless

# 😊 Problem Solved 😊



# Why Do We Need IT?

- **Benefits:**

- Decrease child anxiety and pain
- Facilitate care
- Safety

- **Risks:**

- Prolonged MV with its complications
- Withdrawal syndrome

# ICU Without S&A

- A metabolic, humoral, and hemodynamic response following injury or surgery
- This neuro-endocrine cascade leads to:
  - increased oxygen consumption
  - increased carbon dioxide production
  - a generalized catabolic state with a negative nitrogen balance

# Goals

- Patient comfort
- Control of pain
- Anxiolysis
- Amnesia
- Blunting adverse autonomic and hemodynamic responses
- Facilitate nursing management
- Facilitate mechanical ventilation
- Avoid self-extubation or self injury
- Reduce oxygen consumption

# Definitions

**Sedation:** The act of calming, especially by the administration of a sedative.

**Analgesia:** A condition in which nociceptive stimuli are perceived but are not interpreted as pain.  
Usually accompanied by sedation without loss of consciousness.

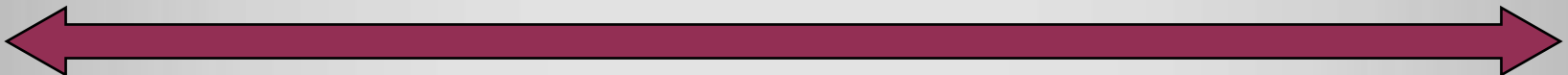
**Sedation ≠ Analgesia**

# Continuum of Consciousness

**Awake,  
baseline**

**Moderate  
sedation**

**General  
anesthesia**



**Minimal  
sedation**

**Deep  
sedation**

# Definitions

## (Level of Sedation)

- **Minimal Sedation (anxiolysis)**

- Responds to verbal commands
- Cognitive function and coordination may be impaired
- Ventilatory and Cardiovascular not affected

- **Moderate**

- Responds to verbal comments alone or accompanied by touch.
- Maintain airway, ventilation and cardiovascular.

# Definitions

## (Level of Sedation)

- **Deep**

- Cannot be easily aroused but responds to noxious stimuli.
- May require assistance to maintain airway and adequate ventilation, cardiovascular maintained

- **General Anesthesia**

- Patient cannot be aroused.
- Often requires assistance to maintain airway and positive pressure ventilation.
- Cardiovascular status may be impaired.

# **The Challenges of PICU Sedation**

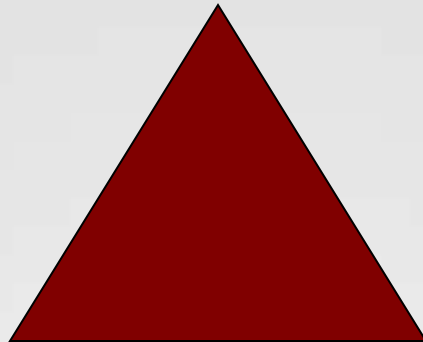
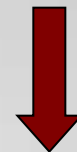
- Assessment of sedation
- Altered pharmacology
- Tolerance
- Delayed emergence
- Withdrawal
- Drug interaction

# Sedation Balance

**Causes  
for Agitation**

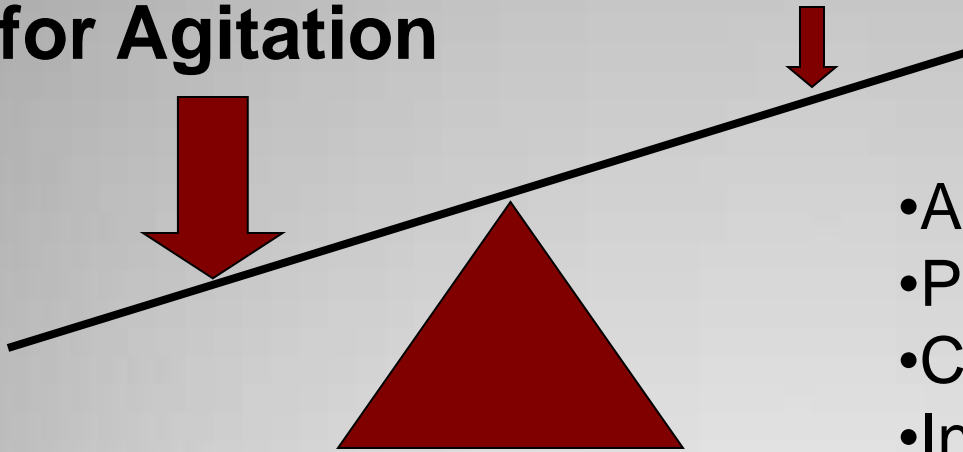


**Sedatives**



**Causes  
for Agitation**

**Sedatives**



- Agitation & anxiety
- Pain and discomfort
- Catheter displacement
- Inadequate ventilation
- Hypertension
- Tachycardia
- Arrhythmias
- Wound disruption
- Patient injury

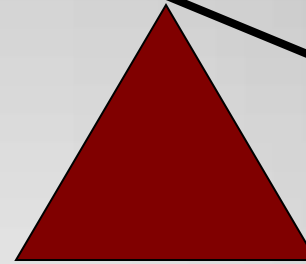
Causes for Agitation



**Sedatives**



- Prolonged sedation
- Delayed emergence
- Respiratory depression
- Hypotension
- Bradycardia
- Increased protein breakdown
- Muscle atrophy
- Venous stasis
- Pressure injury
- Loss of patient-staff interaction
- Increased cost



# Correctable Causes of Agitation

- Full bladder
- Uncomfortable bed position
- Inadequate ventilator flow rates
- Mental illness
- Uremia
- Drug side effects
- Disorientation
- Sleep deprivation
- Noise
- Inability to communicate

# **Causes of Agitation Not to be Overlooked**



- Hypoxia
- Hypercarbia
- Hypoglycemia
- Endotracheal tube malposition
- Pneumothorax
- Abdominal pain
- Drug withdrawal

# Sedation Scoring Scales

- Ramsay Sedation Scale (RSS)
- Sedation-agitation Scale (SAS)
- Observers Assessment of Alertness/Sedation Scale (OAASS)
- Motor Activity Assessment Scale (MAAS)

*BMJ* 1974;2:656-659

*Crit Care Med* 1999;27:1325-1329

*J Clin Psychopharmacol* 1990;10:244-251

*Crit Care Med* 1999;27:1271-1275

# Challenges in PICU

Behavioral clues to pain or anxiety  
are often difficult to differentiate



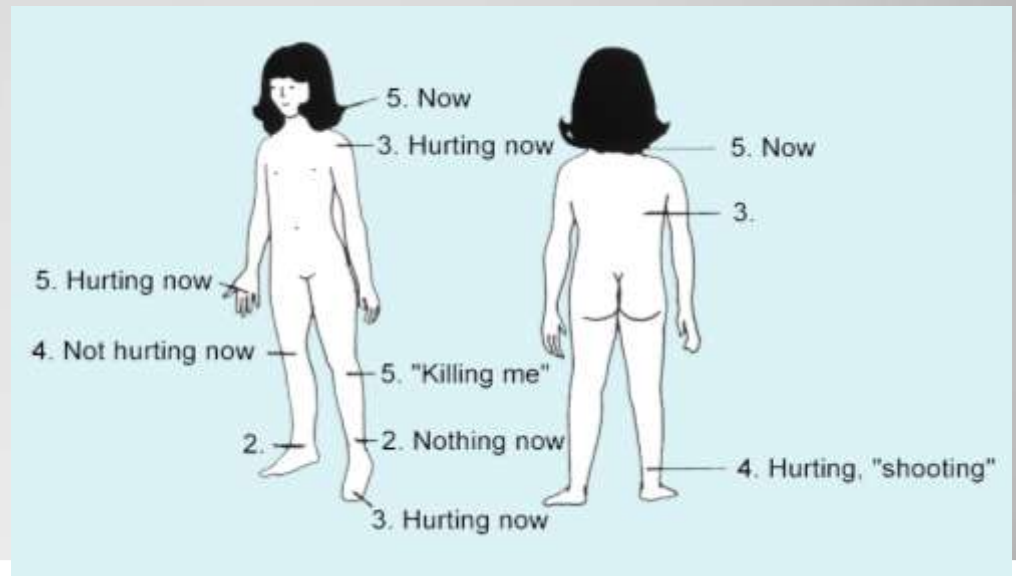
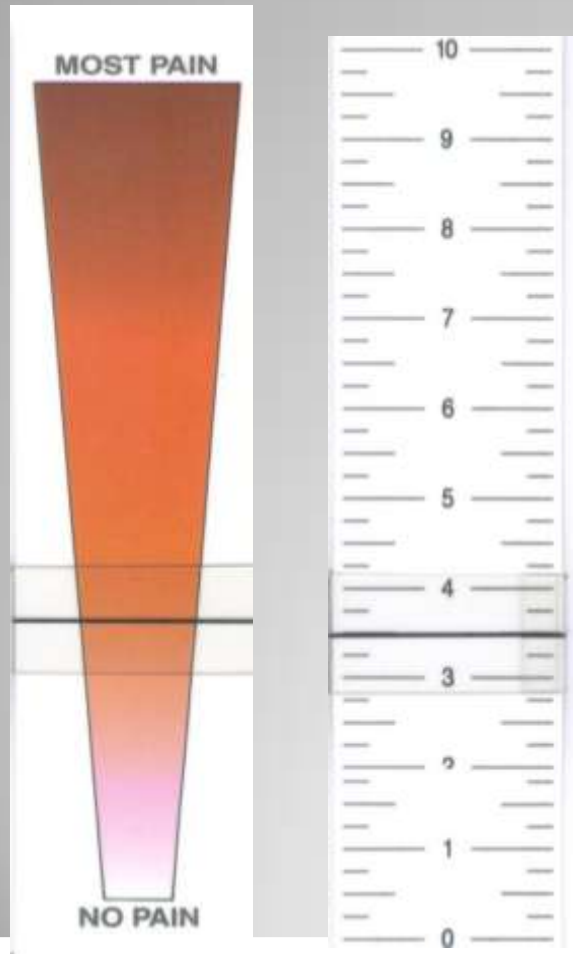
# Facts about Pain in Infants and Children



## **Children Do Not Tolerate Pain Better Than Adults**

- Children's tolerance to pain actually increases with age.
- Children beyond infancy can accurately point to the body area or mark the painful site on a drawing

# Children as young as 3 years can use pain scales.



# Photographic/ Numeric Pain Scale (Oucher scale) ---->



# Wong Baker Faces

## 3 Years and above



Ask the child to pick the face that best describes how much hurt or pain he/she has. Explain the faces and point to each one as you say the words shown beneath the face.



إسأل الطفل أن يختار أكثر وجه معبر عن الألم الذي يحس به  
إقرأ الكلمات أسفل كل شكل أثناء الإشارة لكل وجه

# CRIES Pain Scale

## 0-6 months

	0	1	2
<i>Crying</i>	No cry or cry that is not high-pitched	Cry high pitched but baby is easily consolable	Cry high pitched but baby is inconsolable
<i>Requires O2 for SaO2 &lt; 95%</i>	No oxygen required	<30% oxygen required	>30% oxygen required
<i>Increased vital signs (BP* and HR*)</i>	Both HR and BP unchanged or less than baseline	HR or BP increased but increase in <20% of baseline	HR or BP is increased >20% over baseline
<i>Expression</i>	No grimace present	Grimace alone is present	Grimace and non-cry vocalization grunt is present
<i>Sleepless</i>	Child has been continuously asleep	Child has awakened at frequent intervals	Child has been awake constantly

# Physiological Indications of Acute Pain

- Dilated pupils
- Increased perspiration
- Increased rate/ force of heart rate
- Increased rate/depth of respirations
- Increased blood pressure
- Decreased urine output
- Decreased peristalsis of GI tract
- Increased basal metabolic rate

# Multidimensional Model of Pain Assessment



# The Golden Rule

What is painful to an adult  
is painful to an infant and child



# Observe for Improvement in Behavior Following an Analgesic



# FLACC (0-8 Years)

	0	1	2
<b>Face</b>	No particular expression or smile. Relaxed face, makes eye contact, Shows interest in surroundings	Occasional grimace or frown, withdrawn, disinterested Worried facial expression, eyebrows lowered, eyes partially closed, cheeks raised, mouth pursed	Frequent to constant frown, quivering chin, clenched jaw Deep furrows in forehead, closed eyes, open mouth, deep lines around nose and lips
<b>Legs</b>	Normal position or relaxed Normal muscle tone and motion in limbs	Uneasy, restless, tense Increased tone, rigidity, or tension Intermittent flexion or extension of limbs	Kicking, or legs drawn up Hypertonic; legs pulled tight, exaggerated flexion or extension of limbs, tremors
<b>Activity</b>	Lying quietly, normal position, moves easily Normal activity/restrictions	Squirming, shifting back and forth, tense torso Hesitant to move, guarding, demonstrates pressure on a body part	Arched, rigid or jerking In a fixed position, rocking, side-to-side head movement, rubbing a body part
<b>Cry</b>	No cry or moan (awake or asleep)	Occasional moans, cries, whimpers, sighs	Crying steadily, screams or sobs, Frequent or continuous moans, cries, grunts
<b>Consolability</b>	Content, relaxed Calm, does not require consoling	Reassured by occasional touching, hugging or being talked to, distractible Responds to comfort by touching or talking in 30 sec. to 1 min.	Difficult to console or comfort, requires constant comforting, inconsolable

# COMFORT SCALE SCORE

## Intubated, Non-paralyzed patients (Target Range 17-26)

	1	2	3	4	5
<b>ALERT</b>	Deeply Asleep	Lightly Asleep	Drowsy	Alert & Awake	Hyper Alert
<b>CALMNESS</b>	calm	Slightly Anxious	Anxious	Very anxious	Panicky
<b>RESPIRATORY RESPONSE</b>	No cough or spontaneous respirations	spontaneous respirations	Occasional cough or breaths out of synchrony with vent	Actively breaths against the vent or cough regularly	Fights ventilator; cough or choking
<b>PHYSICAL MOVEMENT</b>	none	Occasional slight movement	Frequent slight movement	Vigorous movement	Vigorous movement of head & torso
<b>BLOOD PRESSURE</b>	Below baseline	Consistently at baseline	Infrequent (1-3) elevation of 15% / more	frequent (>3) elevation of 15% / more	Sustained elevation > or =15% above the baseline
<b>HEART RATE</b>	Below baseline	Heart rate at baseline	Infrequent (1-3) elevation of 15% / more	frequent (>3) elevation of 15% / more	Sustained elevation > or =15% above the baseline
<b>MUSCLE TONE</b>	Relaxed/ no muscle tone	Reduced Muscle tone	Normal muscle tone	Increased muscle tone	Extreme muscle rigidity
<b>FACIAL MUSCLE</b>	Relaxed / no facial muscle tone	Normal facial tone	Some tension in brow, forehead or mouth	Full facial tension	Facial muscles contorted

## **State Behavioral Scale score**

Patient's response to voice, then gentle touch, then noxious stimuli  
"planned endotracheal suctioning or < 5 seconds of nail-bed pressure"

**-3 → 0 → +3**

# BIS Monitoring



**For objective sedation measurement.**



**BIS** 100

## Awake

- Responds to normal voice

80

- Responds to loud commands or mild prodding/shaking

60

- Low probability of explicit recall
- Unresponsive to verbal stimulus

40

20

- Burst suppression

0

## Flat Line EEG

Anxiolysis

Moderate Sedation

Deep Sedation

# **Altered Pharmacology in PICU Setting**

# Physiologic Changes That Affect Pharmacokinetics in PICU Patient

- Unstable patients often present with significant hemodynamic alterations and organ dysfunction, which may significantly alter drug:
  - Absorption
  - Transport
  - Metabolism
  - Excretion

# Absorption

- Altered GI motility and peristalsis (ileus, recent GI surgery)
- Reduced gut function and absorptive surface area (pancreatitis, recent GI surgery)
- Reduced GI blood flow (shock)
- Physical removal of drug by nasogastric suctioning.

# Other Routes

- Parenteral (IV, IM, SQ) drug administration is most common in the critically ill.
- Drug absorption may be decreased due to decreased tissue perfusion and decreased movement of drug through edematous tissue.
- Transdermal route may become useful (e.g., using fentanyl, clonidine)

# Distribution

- Poor perfusion is often a factor that limits distribution of a drug to its target tissue.
- Many analgesic drugs are transported attached to the serum proteins.
- The extent of protein binding may decrease in critical illness, causing elevated free levels of drug and possible toxicity.
- Third-spacing of fluid may result in additional volume into which the drug can distribute.

# Metabolism and Elimination

- It is common for ICU patients to have some degree of either renal or hepatic functional impairment.
- Intra-abdominal pressure if significantly increased, it will impair both portal and renal blood flow.

# Kidney & Excretion Problem

- The parent drug and metabolites may accumulate in RF.
- Morphine is metabolized to morphine-3-glucuronide and morphine-6-glucuronide. Morphine-6-glucuronide is an active metabolite eliminated by the kidneys.
- In renal failure, morphine-6-glucuronide may accumulate, and it has been associated with toxicity.
- Normeperidine may accumulate and cause central nervous system (CNS) excitability and possible seizures.

# Principles of Sedation

- Safety
- Minimal physical discomfort and pain
- Minimal psychological trauma
- Amnesia
- Behavior control/ immobility
- Rapid return to a state of alertness

# **Ideal PICU Sedative/Analgesic**

- Rapid onset and Rapid recovery
- Predictable duration
- No active metabolites
- Multiple routes of delivery
- Easy to titrate
- Minimal cardiopulmonary effects
- Not altered by renal or hepatic disease
- No drug interactions
- Wide therapeutic index

# COMMON DRUGS UTILIZED

- Opiates (Narcotics)
- Benzodiazepines
- Chloral hydrate
- Barbiturates
- Ketamine
- Propofol
- Neuroleptics
- Paralytics?!

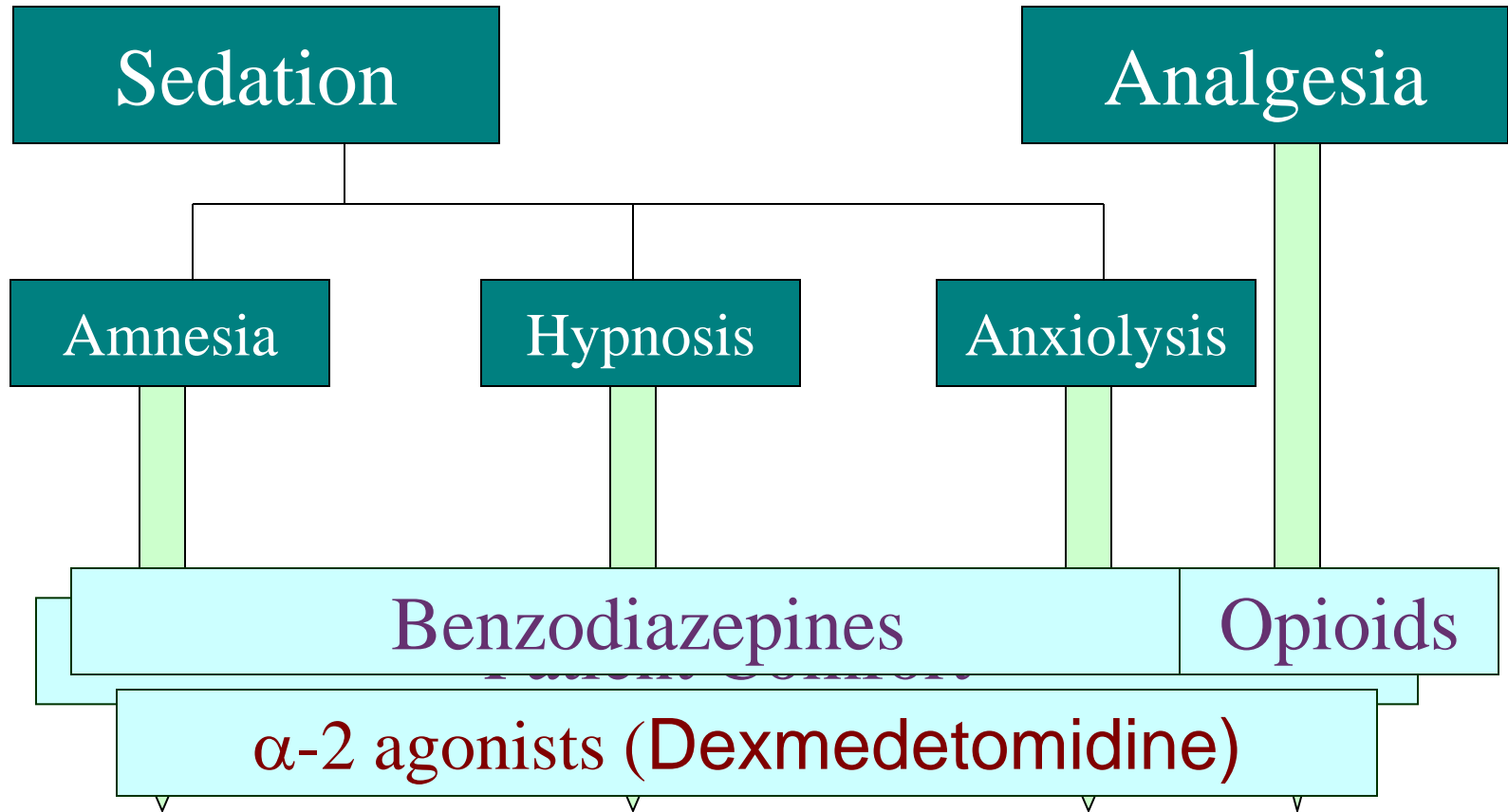
## Define The Goals

- Is the patient in pain?
- Is the child anxious?
- Does the case require immobility?
- Does the child need to be interactive?
- Will the effects of administered drugs interfere with the patient exam?

# Common Conditions in PICU

- MECHANICAL VENTILATION
  - Respiratory failure
  - Airway
  - Neurological
- POST-OPERATIVE
- HEAD INJURY
- PULMONARY HYPERTENSION
- PROCEDURES

# Choosing the Right Drug



## **Analgesics inappropriate for use in the ICU**

<b>Drug</b>	<b>Comments</b>
Meperidine	Analgesia not superior to morphine; normeperidine metabolite is renally eliminated and has neurotoxic effects, including seizures and delirium.
Codeine	Low analgesic potency when administered parenterally; most of its analgesic effect is due to hepatic metabolism to morphine.
Methadone	Extended duration of activity increases risk of accumulation and adverse effects with repeated dosing.
Nonsteroidal antiinflammatory drugs (NSAIDs)	Analgesia not superior to opiates; platelet inhibition, antiprostaglandin effects increase risk of stress ulcers and renal injury.

## Alternative sedative agents in the PICU

Drug	Dose (mg/kg)	Route	Interval (hrs)	Comments
Diphenhydramine	0.5–1	PO, IV, IM	4–6	Antihistamine; provides sedation and is antipruritic and antiemetic Adverse effects include dry mouth, tachycardia, and respiratory depression
Promethazine	0.5–1	IV, PO, PR, IM	6–8	Phenothiazine commonly used as an antiemetic Risk of causing extrapyramidal reactions and neuroleptic malignant syndrome
Haloperidol	0.01–0.02	IV, IM	8–12	Antipsychotic; can have dystonic reactions and neuroleptic malignant syndrome
	0.1–0.2	PO	Not for p.r.n. use	
Chloral hydrate	50–100	PO, PR	24	Aliphatic alcohol, unknown mechanism of action Not to be used repetitively or in prolonged fashion Unpredictable onset and duration of sedative effects GI irritant No analgesic effects
Clonidine	0.002–0.005	PO	4–6	$\alpha_2$ adrenergic agonist Possible hypotension Potentiates sedative/analgesic effects of other agents Available in transcutaneous patches of 0.1, 0.2, 0.3 mg, which are changed every 7 days

## The Problem Patient

# **Consensus guidelines on sedation and analgesia in critically ill children**

**Paediatric Intensive Care Society Sedation,  
Analgesia and Neuromuscular Blockade  
Working Group**

Intensive Care Med (2006) 32:1125–1136

Stephen Playfor  
Carolyne Boyles  
Gerald Davies  
Gillian Hinson  
Neil Morton  
Andrew Wolf

Ian Jenkins  
ImtiChoonara  
Tim Haywood  
Anton Mayer  
Tanya Ralph

# Recommendations

1. Non-pharmacological interventions
2. Pain assessment and analgesic management
3. Sedation assessment and sedative agents commonly used in the PICU
4. Withdrawal syndrome assessment, prevention and management

# Non-pharmacological interventions: environmental factors, relaxation, distraction, promotion of sleep and day–night orientation

## **Recommendations:**

- *Any correctable environmental and physical factors causing discomfort should be addressed alongside the introduction of pharmacological agents.*
- *A normal pattern of sleep should be encouraged.*
- *Attention should be paid to lighting, environmental noise and temporal orientation of patients.*



# Pain assessment and analgesic management

## **Recommendations:**

- *All critically ill children have the right to adequate relief of their pain.*
- *Local and regional anaesthetic techniques should be considered.*
- *A patient controlled analgesia (PCA) device may be useful in older children.*



# Pain assessment

## Recommendations

- Pain assessment should be performed regularly by using a scale appropriate to the age of the patient and routinely documented.
- The level of pain reported by the patient must be considered the current standard of analgesia.



- Patients who cannot communicate should be assessed for the presence of pain-related behaviours and physiological indicators of pain.
- A therapeutic plan for analgesia should be established for each patient and regularly reviewed.

# Recommended analgesic agents

## **Recommendations**

- *Continuous intravenous infusions of morphine or fentanyl are recommended for the relief of severe pain.*
- *Non-steroidal anti-inflammatory drugs?! or paracetamol may be used as adjuncts to opioids in certain patients.*

# Sedation assessment and sedative agents commonly used in the PICU

## Recommendations

- *Adequate analgesia should be provided to all critically ill children regardless of the need for sedation.*
- *The level of sedation should be regularly assessed and documented using a sedation assessment scale, wherever possible using a validated scoring system such as the COMFORT scale.*
- *The desired level of sedation should be identified for each patient and should be regularly reassessed.*
- *Doses of sedative agents should be titrated to produce the desired level of sedation.*

# Recommended and commonly used sedative agents in PICU

## Recommendation

- *Midazolam* is the recommended agent for the majority of critically ill children requiring intravenous sedation.  
It should be given by *continuous infusion*.
- *Early use of enteral sedative agents is recommended.*
- *Propofol should not be used to provide continuous sedation in critically ill children.*

# Withdrawal syndrome assessment, prevention and management

## **Recommendation**

- *The potential for opioid and benzodiazepine withdrawal syndrome should be considered after 7 days of continuous therapy.*
- *When subsequently discontinued, the doses of these agents may need to be routinely tapered.*

# Conclusions

- The quality of evidence available in the literature to support these recommendations is poor.
- There is little evidence to guide PICU staff with the common clinical problems of tolerance, withdrawal, and the patient who requires long-term sedation, or who is difficult to sedate appropriately with standard agents.



## Key Points

# **Definitions confused with addiction**

- **Drug tolerance:**  
need for larger dose of opioid to maintain original effect.
- **Physical dependence:**  
withdrawal symptoms when chronic use of opioid is discontinued or opioid antagonist (Narcan) is given.

# Narcotic Addiction

## **Behavioral and voluntary pattern**

- **characterized by compulsive drug-seeking behavior**
- **leading to overwhelming involvement with procurement, and**
- **use of opioid **NOT** for medical reasons, such as pain relief.**

# Key Points

- The treatment and alleviation of pain is a basic human right for everyone, regardless of age.
- Pain is a subjective experience
- Pain and sedation assessment and management are interdependent, and one is essentially useless without the other.

# pharmacokinetic & pharmacodynamic

- Sedatives and analgesics are given by titration to effect.
- Many PICU patients require enormous doses of analgesics and sedatives, doses so high, that to an outsider they seem preposterous if not dangerous.

# Mild Analgesia

- The most commonly used nonopioid analgesic in pediatric practice remains acetaminophen (**paracetamol**).
- Avoid NSAID if possible: platelet inhibition, risk of stress ulcers and renal injury.

# Strong Analgesia

- The opioids most commonly used in the management of pain are  $\mu$  agonists.
- These include morphine, meperidine, methadone, codeine, and the fentanyls.
- At equianalgesic doses, the pharmacodynamic effects of all of the  $\mu$ -opioid agonists are similar and include:
  - Analgesia & Sedation
  - Respiratory depression
  - Nausea and vomiting & Constipation
  - Pruritus. Miosis
  - Tolerance, and physical dependence.

# Opioids in PICU

- **Fentanyl** is 50 to 100 times more potent than morphine. and
- Fentanyl has become the most commonly used analgesic for procedures and pain control in the PICU.
- It is short-acting following single doses (redistribution) but long-acting following infusions.
- Methadone can be used to wean patients following prolonged analgesic therapy.

## Multifactorial Effects

Anxiety, fear, a sense of helplessness, and lack of sleep will potentiate pain and, if left untreated, can lead to psychosis in critically ill patients.

# Sedation ≠ Analgesia

- Most sedatives, such as:
  - The benzodiazepines
  - Chloral hydrate
  - The barbiturates, and
  - All neuromuscular blocking agents

have no analgesic properties and may actually exacerbate pain.

# Benzodiazepines

- The benzodiazepines are extremely potent:
  - amnestics,
  - anticonvulsants,
  - sedatives,
  - hypnotics,
  - skeletal muscle relaxants,
  
  - effective whether given parenterally or enterally, and produce dose-dependent depression of breathing.
- Benzodiazepine-withdrawal symptoms are well described (Like opiates)

# Anesthesia in PICU

- Unexpected fatal lactic acidosis in critically ill children who are sedated for prolonged periods with propofol (propofol infusion syndrome) precludes prolonged (>6 hrs) use in the PICU.
- The use of inhalational anesthetic agents (N<sub>2</sub>O, isoflurane) in the PICU is limited by institutional and nursing credentialing, availability of specialized delivery and monitoring equipment, and the ability to scavenge exhaled gas.

# Dexmedetomidine

$\alpha_2$  Agonists,  
particularly dexmedetomidine,  
are a new tool in the sedation of  
ventilated and nonventilated  
patients in the PICU

# Withdrawal Risk

- When physical dependence has been established, sudden discontinuation of an opioid or benzodiazepine agonist produces a withdrawal syndrome within 24 to 72 hrs of drug cessation.
- A simplified, weaning protocol with close observation is recommended to assess withdrawal symptoms and guide therapy.



**Thank You**