



UNIUNEA EUROPEANĂ



GUVERNUL ROMÂNIEI



Fondul Social European
POSDRU 2007-2013



Instrumente Structurale
2007-2013



GUVERNUL ROMÂNIEI
MINISTERUL MUNCII, FAMILIEI,
PROTECȚIEI SOCIALE
ȘI PERSOANELOR VÂRSTNICE
ORPOSDRU REGIUNEA CENTRU



UNIVERSITATEA DE MEDICINĂ ȘI
FARMACIE "CAROL DAVILA"
BUCUREȘTI

AD-COR Program inovativ de formare in domeniul cardiologiei pediatrice POSDRU/179/3.2/S/152012

Data: 05-10-2015

MODUL TEORETIC PAEDIATRIC CARDIAC CRITICAL CARE

Imputernicit: Prof. Dr. Tammam Youssef

Activitate prestata de I.R.C.C.S. POLICLINICO SAN DONATO – MILANO, ITALIA in
baza contractului nr. 18/22144/29.07.2015



UNIUNEA EUROPEANĂ



GUVERNUL ROMÂNIEI



Fondul Social European
POSDRU 2007-2013



Instrumente Structurale
2007-2013



GUVERNUL ROMÂNIEI
MINISTERUL MUNCII, FAMILIEI,
PROTECȚIEI SOCIALE
ȘI PERSOANELOR VÂRSTNICE
CIRPOSDRU REGIUNEA CENTRU



UNIVERSITATEA DE MEDICINĂ ȘI
FARMACIE "CAROL DAVILA"
BUCUREȘTI

Acest material a fost documentat/ validat/ prezentat la sesiunile de formare în cadrul proiectului „AD-COR Program inovativ de formare în domeniul cardiologiei pediatrice” - POSDRU/179/3.2/S/152012, proiect cofinanțat din Fondul Social Operațional Sectorial Dezvoltarea Resurselor Umane 2007-2013.

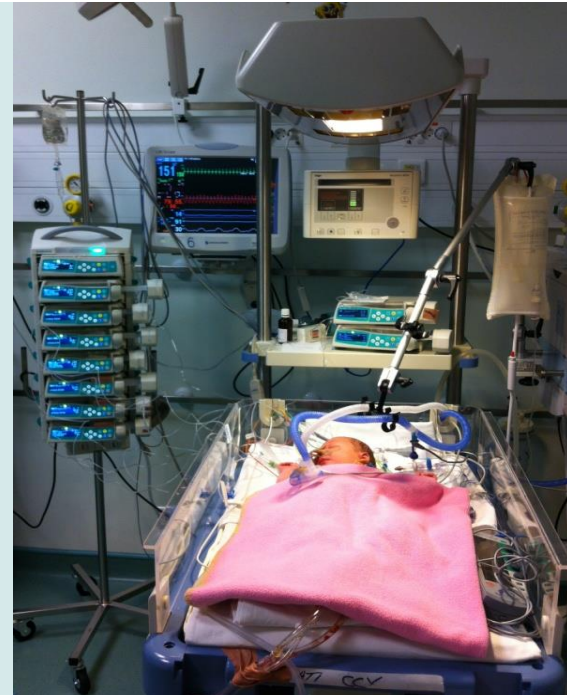
Beneficiar: Universitatea de Medicină și Farmacie „Carol Davila” București



PAEDIATRIC CARDIAC CRITICAL CARE

Bucharest, October 05, 2015

Matthias Angrés, MD, PhD
RobinAid Foundation
Hamburg / Germany





Declaration of Disclosure

I have no actual or potential conflict of interest in relation to this presentation.



Let's continue our walk



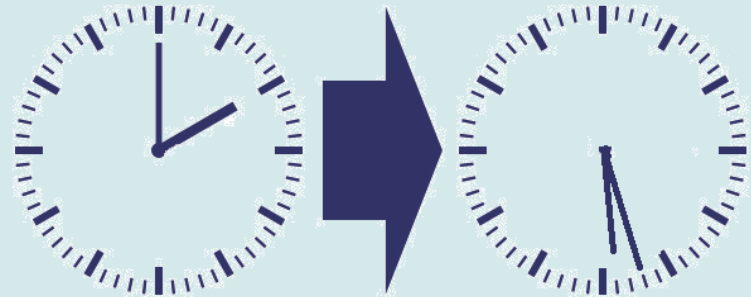
Important topics in Paediatric Cardiac Critical Care



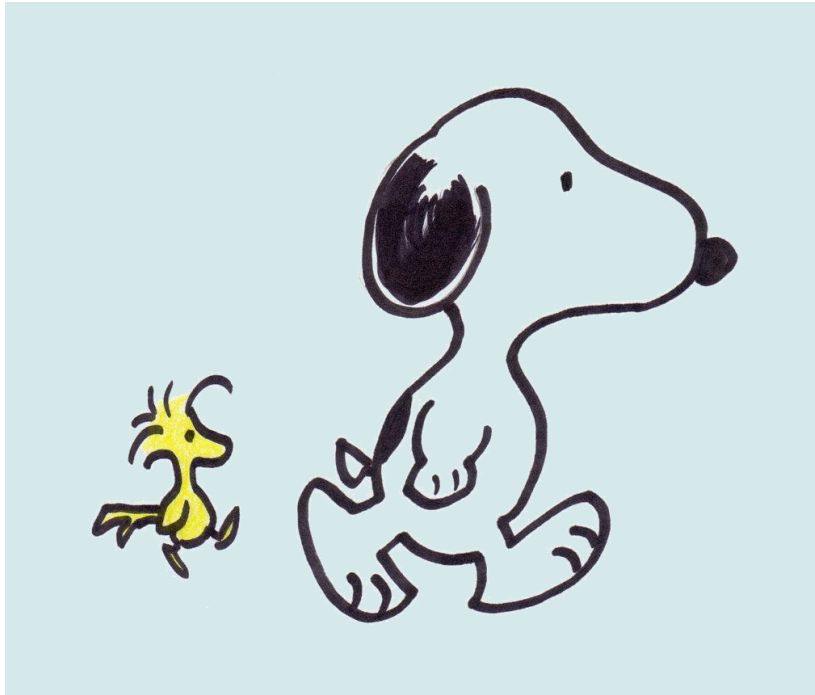
Today's agenda



- Welcome and short flashback
- Three parts à 60 min
- 15 minutes break after each part



14 important topics



1. *Inotropic agents in paediatric cardiac critical care* ✓
2. Human factors in paediatric cardiac critical care
3. Challenges in setting up a new Paediatric Cardiac Critical Care Unit
4. *The effects of cardiopulmonary bypass during paediatric cardiac surgery*
5. *Importance of pain management in paediatric cardiac critical care*
6. Respiratory assessment and management / respiratory complications
7. Cardiac arrhythmias: assessment and management / temporary pacemaker

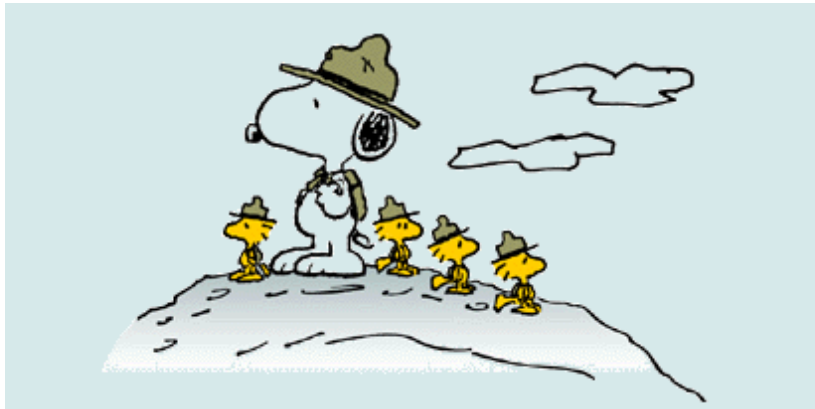
14 important topics

8. Medistinal bleeding and cardiac tamponade / blood transfusion, coagulation disorders, and postoperative anticoagulation
9. Post-cardiac surgery pulmonary hypertension: identification and management
10. Infections in the cardiac intensive care unit
11. Fast-track extubation in pediatric cardiac surgery
12. Basics of echocardiography in monitoring the postoperative pediatric cardiac surgery patient.
13. Mechanical circulatory support in paediatric cardiac surgery
14. One hundred useful references in paediatric cardiac intensive care



First important message

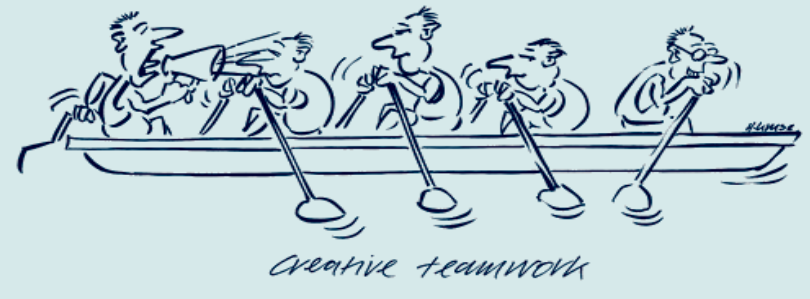
The highly complex paediatric patients with congenital or acquired heart disease require **interprofessional teamwork and collaboration** to ensure high quality outcomes with low mortality and morbidity.



Paediatric Cardiac TEAM



- Intensivist
- Cardiologist
- Neonatologist
- Anaesthetist
- Surgeon
- Nurses
- Physiotherapist
- Technicians
- Perfusionist
- Radiologist



Second important message

The care of critically ill children after cardiac surgery is challenging and best performed with the emphasis on an **anticipatory** (rather than reactive) **approach**.



In other words



Anticipation and prevention are the most important **keys for recognition, diagnosis, and successful management** of all potential risks and complications in the postoperative critical care of paediatric cardiac patients.

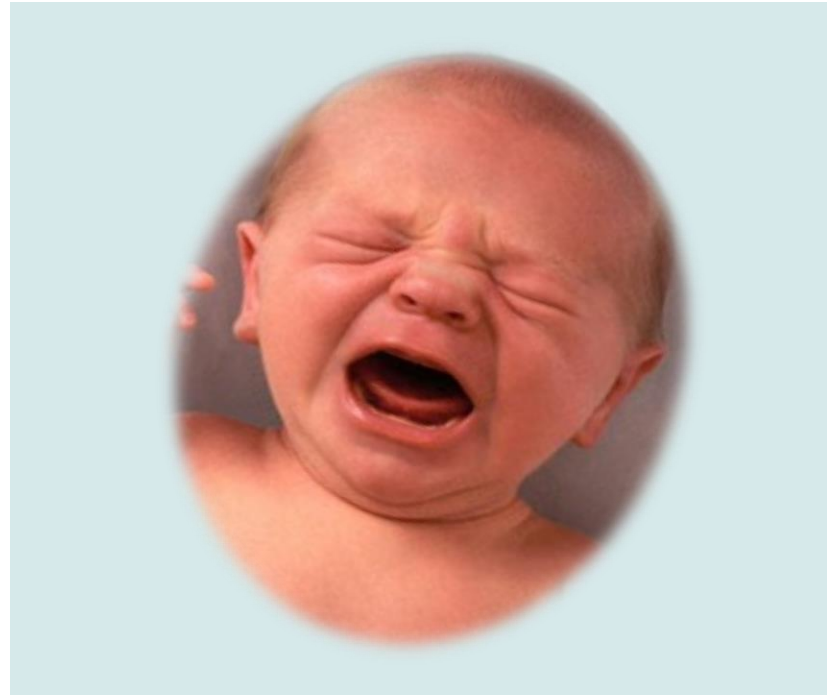
Now let's start with the
today's topics

Importance of pain management in paediatric cardiac critical care



Pain management myths

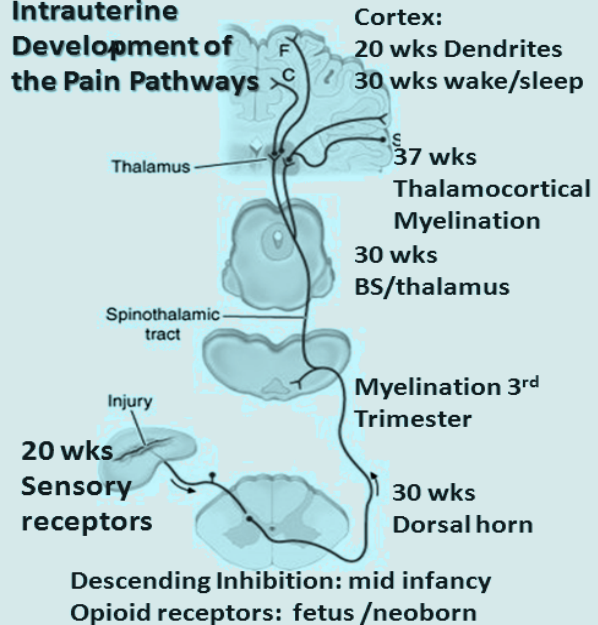
- Neonates do not feel pain
- Infants are less sensitive to pain than adults
- Neonates have no memory of pain
- Children will tell you when they are having pain
- If a child can be distracted, he is not in pain
- Neonates are not able to tolerate the effects of analgesics
- Narcotics can lead to addiction in children
- Infants become accustomed to pain



What are the facts?

- Newborn infants have functional nervous systems which are capable of perceiving pain
- Physiologic means of assessing pain (VS) can be an unreliable predictor of pain
- Infants often develop an increase in signs of discomfort with repeated painful procedures
- Premature infants can have unpredictable responses to painful stimuli
- Unmanaged pain in the neonatal period can cause long term developmental complications

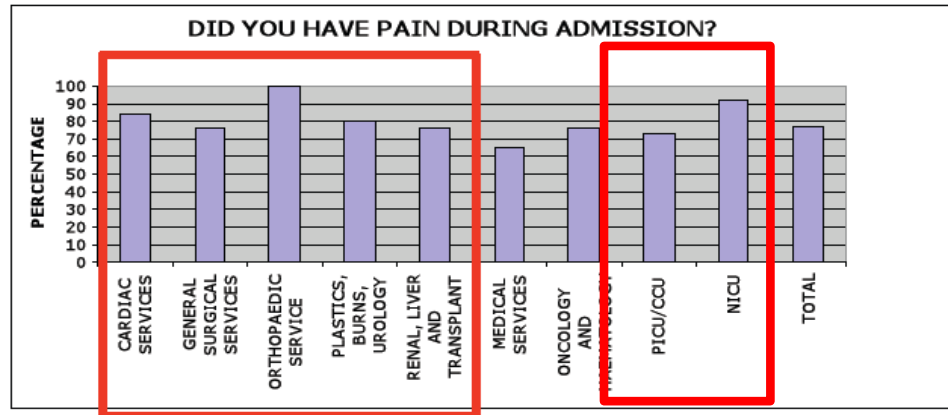
Intrauterine Development of the Pain Pathways



SickKids Inpatient Pain Audit

Taylor EM, Boyer K, Campbell FA. Pain Res Manag. 2008 Jan-Feb;13(1):25-32.

77% of inpatients have pain during admission
44% - moderate-severe in previous 24h



SickKids Inpatient Pain Audit

Taylor EM, Boyer K, Campbell FA. Pain Res Manag. 2008 Jan-Feb;13(1):25-32.

Hospitals are always **painful zones** for the kids especially cardiac and orthopaedic departments as well as intensive care units!



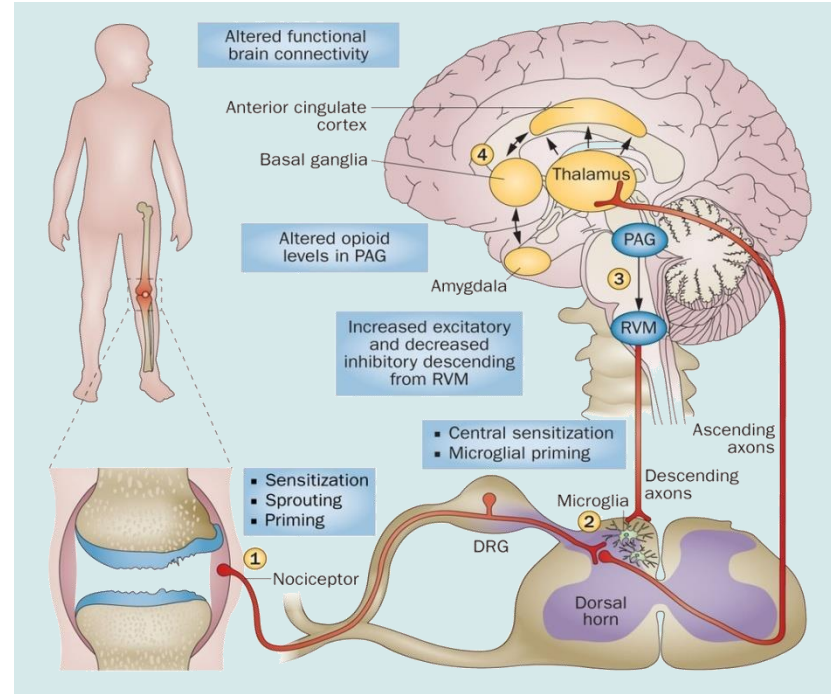
What is pain?

The experience of pain is complex, multifaceted, and
“an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage”
as defined in 2008 by the International Association for the Study of Pain.



Process of nociception

- **Transduction** conversion of pain stimulus into a nerve impulse by sensory receptors
- **Transmission** of nerve impulses from the periphery to the brain and spinal cord
- **Perception** the recognition of these impulses or signals as pain
- **Modulation** whereby descending neuronal tracts from the brain modify the nociceptive transmission in the spinal cord



Negative effects of pain

- Physiological effects
- Behavioral effects
- Hormonal / metabolic responses

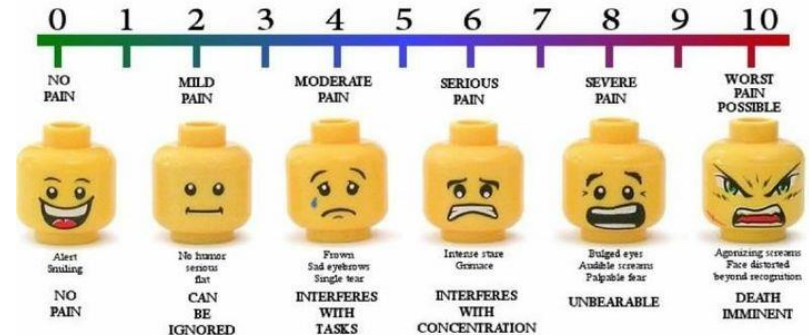
Consider pain as a vital sign



Physiological effects

- **Variations in HR**
 - from tachycardia down to bradycardia
- **variations in BP**
 - from hypertension down to hypotension
- **increased ICP**
 - up to more than two times higher as normal
- **increase in oxygen consumption**
 - oxygen extraction can be increased to ~70%
- **change in color**
 - from hyperperfusion down to hypoperfusion
- **increased or decreased muscle tone**
 - from hypertonus down to hypotonus

Paediatric Pain Assessment Faces



Behavioral effects

- **Crying**

- can vary from high pitched, tense to soft moaning or whining

- **Facial expressions**

- grimacing, quivering of chin
- squeezing eyes shut, furrowed brow

- **Difficult to soothe, comfort or calm**

- **Body movements**

- limb withdrawal, fist clenching
- hypertonicity or hypotonicity

- **State changes**

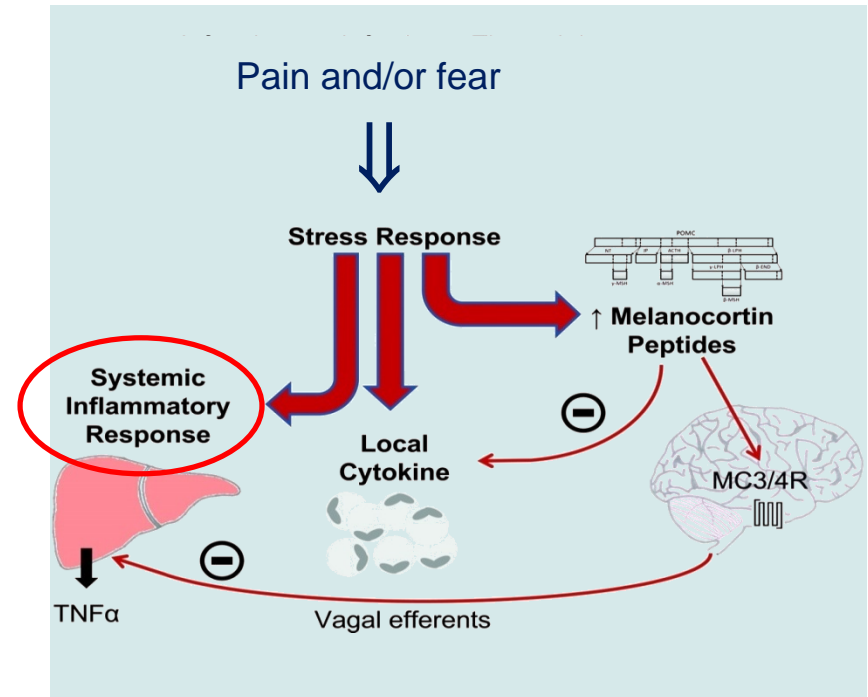
- changes in sleep-wake cycles
- changes in activity levels
- increased fussiness or irritability

Hormonal / metabolic responses

- **Increase** in (endogen) **epinephrine** and **norepinephrine**
- Increase in **growth hormone** and **endorphins**
- **Decrease** in **insulin secretion**
- **Increased** secretion of **cortisol, glucagon,** and **aldosterone**
- Increased **serum glucose, lactate** and **ketones**



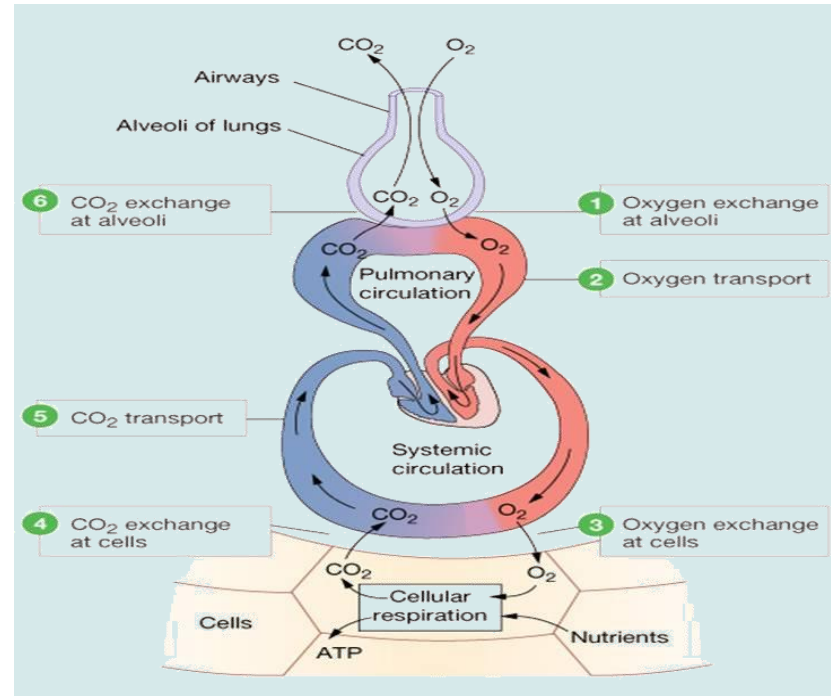
- Can lead to **lactic acidosis**



Important systems

Important systems in postoperative paediatric cardiac management:

- Cardiovascular
- Pulmonary
- Renal
- CNS
- Nutrition
- **Pain management**



O₂ Supply / Demand Imbalance

Four reasons for increased O₂ consumption:

- **Stress / Pain**
- Hyperthermia
- Shivering
- Infection / Sepsis

Table 2 Clinical conditions and their effects on O₂ delivery and O₂ consumption and on venous oximetry

Decrease in ScvO₂/SvO₂

O₂ consumption ↑

Stress
Pain
Hyperthermia
Shivering

O₂ delivery ↓

CaO₂ ↓ (anemia, hypoxia)
Cardiac output ↓

Increase in ScvO₂/SvO₂

O₂ delivery ↑

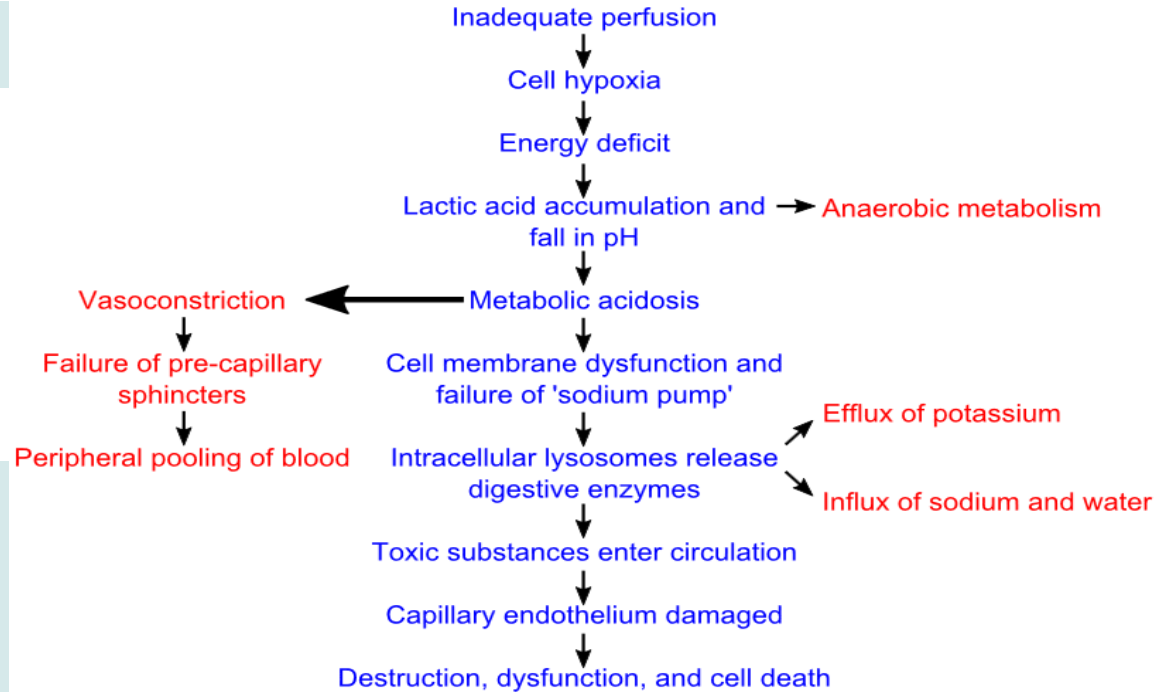
CaO₂ ↑
Cardiac output ↑

O₂ consumption ↓

Analgesia
Sedation
Mechanical ventilation
Hypothermia

O₂ Supply / Demand Imbalance

An **imbalance** between tissue oxygen consumption and delivery appears with the development of **cellular hypoxia** and leads lastly to **cell death**.



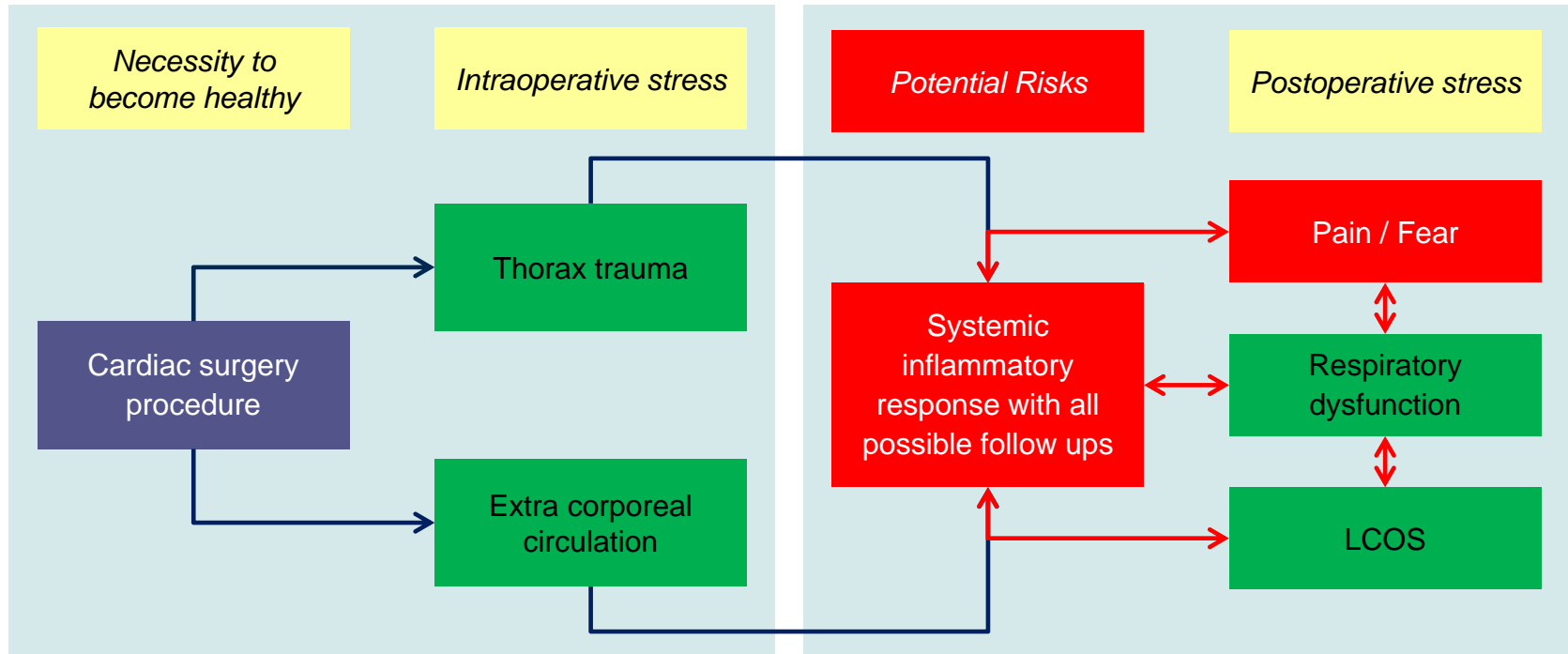
LCOS in paediatric cardiac surgery

Etiology of Low Cardiac Output Syndrome
following congenital heart surgery



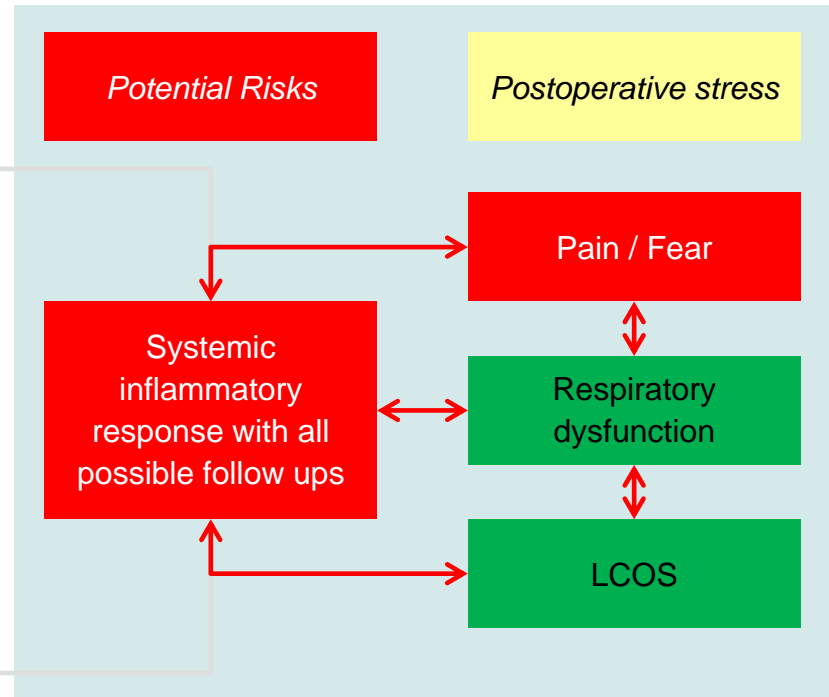
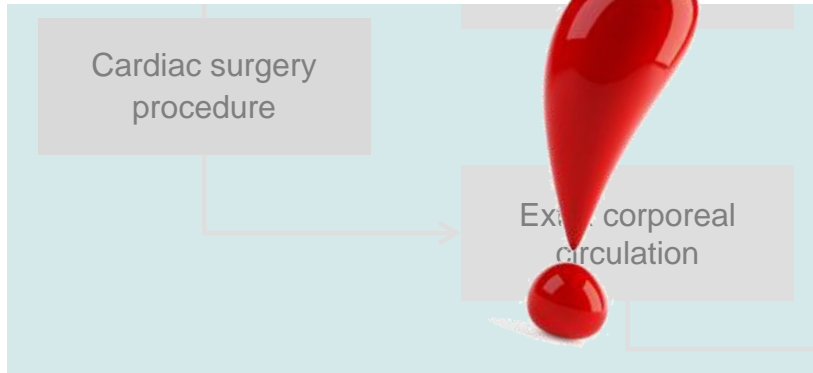
- Loss of AV synchrony
- Residual cardiac lesion
- Post-op. bleeding
- Pulmonary hypertension
- **Stress by pain and / or fear**
- Endocrine derangement (Cortisol, Thyroid, Vasopressin)

Situation by undergoing cardiac surgery

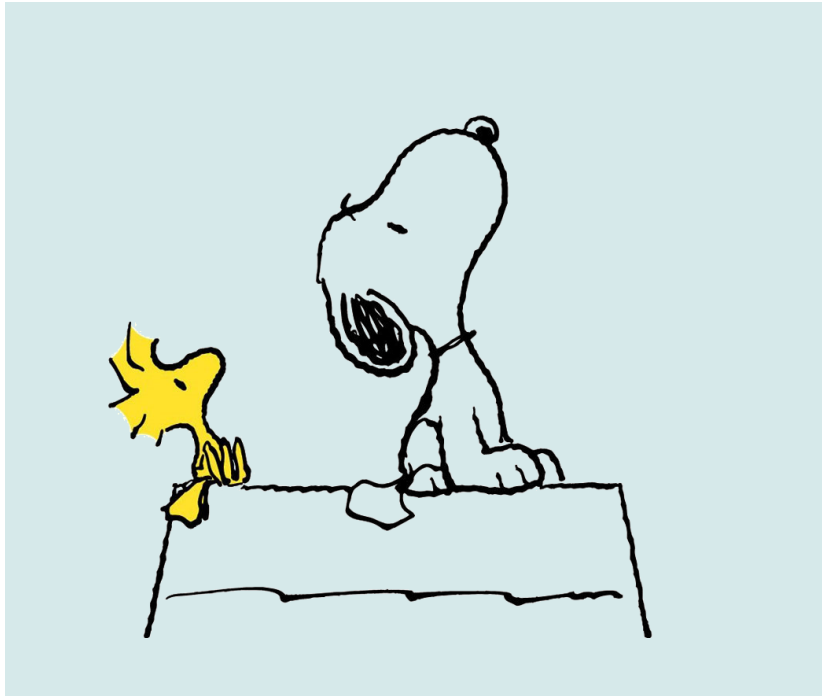


Never forget

Inadequate pain management in postoperative care of children undergoing cardiac surgery can lead to a very big disaster!

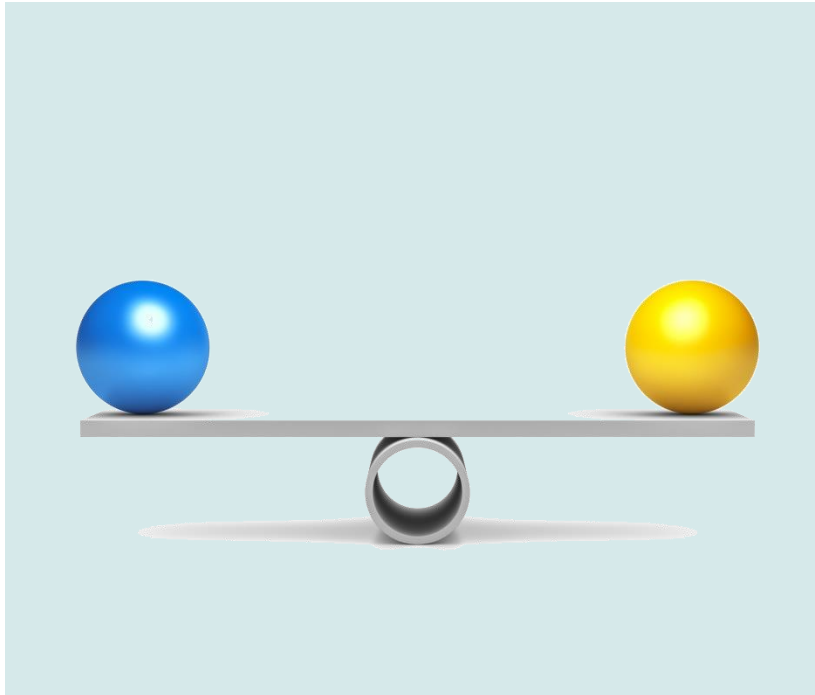


General principles in pain management



- **Anticipate** and **prevent** pain
- Assess pain **adequately**
- Use a **multimodal approach**
- Use non-noxious and **non-painful route** of administration

General principles in pain management



▪ **Balanced or multimodal analgesia:**

- more than one class of analgesic or adjuvant each working in a different way

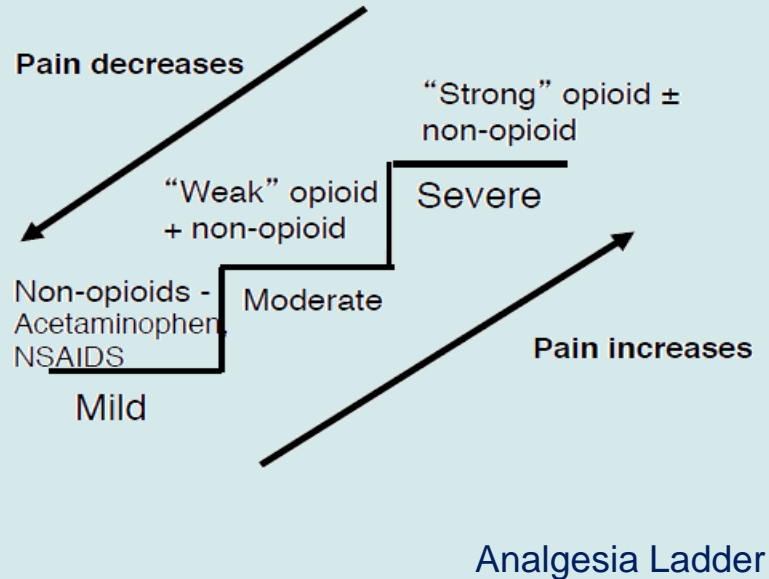


- synergism
- opioid sparing
- reduced risk of tolerance and morphine sensitisation
- reduced side effects and complications

General principles in pain management

- **Medications should be taken**

- by the ladder
- scheduled



- **Pain management is not** the same as **sedation**
- **Anxiolysis** is also an **important need** in postoperative pain control

Pain-related psychological factors important in postoperative pain

Childrens anxiety is associated with increased postoperative pain and analgesic use

- Kain et al., *Pediatrics*. 2006 Aug;118(2):651-8.

Pain anxiety significantly associated with pain intensity and functional disability 2 weeks after discharge

Pain catastrophizing - associated with pain unpleasantness
Girls - higher levels of acute postoperative anxiety & pain unpleasantness.

- Pagé MG, Stinson J, Campbell F, Isaac L, Katz J. *Pain Res*. 2012;5:547-58

Effects of analgesia

- Reduces anxiety and stress response
- Reduces respiratory complications
- Reduces cardiovascular complications
- Reduces autonomic effects



The perfect analgesic



PERFECT

- **Effective** and **quick onset**
- **Safe** / no side-effects:
 - no CNS or cardiorespiratory depression
 - no constipation
 - no nausea
- No drug interactions
- **Cheap**
- No withdrawal, dependence, tolerance, addiction
- Useful in **all patient populations**
- Reversible effect
- Acceptable duration of effect (long, short)

The perfect analgesic

PERFECT

- Unfortunately this perfect analgesic doesn't exist!



Pharmacological substances

- Paracetamol
- NSAIDs
(Nonsteroidal Anti-Inflammatory Drugs)
- Opioids
- NMDA antagonists (f.e. Ketamine)
(N-Methyl-D-aspartate antagonists)
- Alpha-2 agonists (f.e. Clonidine)

Non-opioid analgesics	Paracetamol
	NSAIDs (including COX-2 inhibitors)
Weak opioids	Codeine
	Tramadol
Strong opioids	Morphine
	Pethidine
	Oxycodone
Adjuvant	Ketamine
	Clonidine, Dexmedetomidine

Used painkiller in children



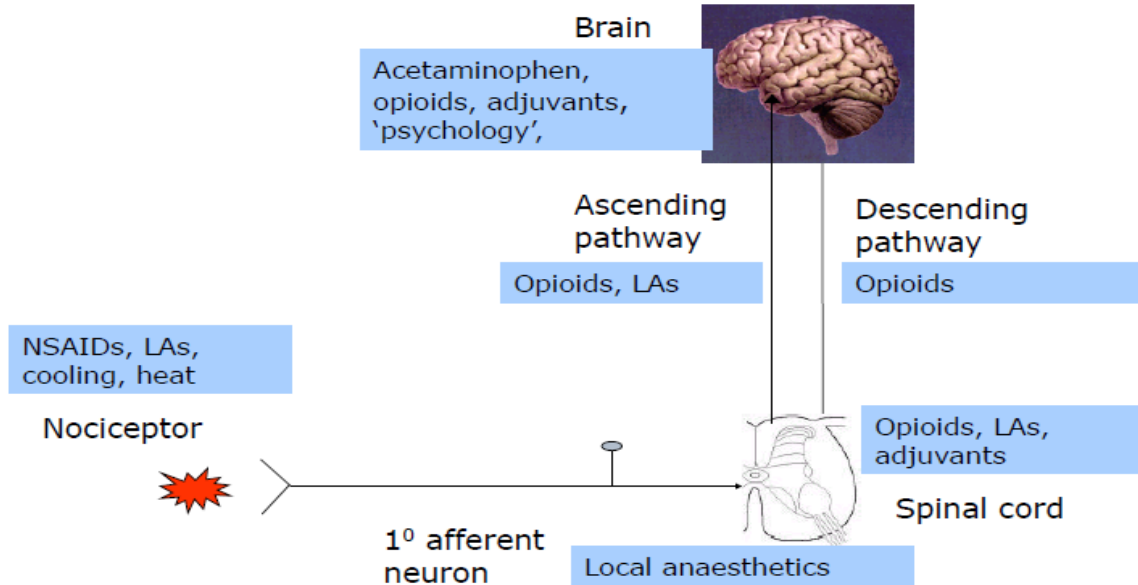
- **Mild to moderate pain relief**
 - Acetaminophen (Paracetamol)
 - NSAIDs
- **Moderate pain relief**
 - Tramadol
 - Codeine
- **Severe pain relief**
 - Morphine
 - Nalbuphine
 - Ketamine

4 most used painkiller in children undergoing cardiac surgery

- Mild to moderate pain relief
 - **Acetaminophen (Paracetamol)**
 - **NSAIDs**
- Moderate pain relief
 - Tramadol
 - Codeine
- Severe pain relief
 - **Morphine**
 - Nalbuphine (part. antagonist)
 - **Ketamine**

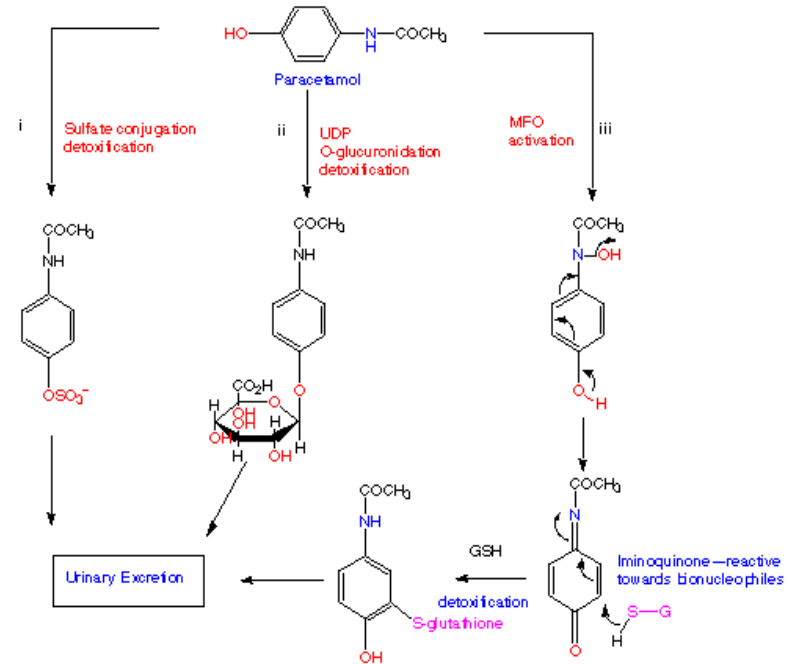


Mechanism of action



Acetaminophen (Paracetamol)

- Inhibits COX-3 (cyclooxygenase 3) in the hypothalamus, very low activity on COX-1, possible 5-HT (5-hydroxytryptamine) activity
- No anti-inflammatory properties
- mild **analgesic**, good **antipyretic**
- First-line treatment if no contraindication
- **Morphine sparing effect** in pediatric patients
- Good **safety profile**
- **Contraindicated** by server **liver impairment**
- Metabolized in liver; half life is ~ 2-3 hours



Acetaminophen (Paracetamol)

- **Dose per weight:**



" Don't step on it... It makes you cry "

- IV application
- 15 kg or more:
 - 15 mg/kg in 30 min Q 6 H
- Less than 15 kg
 - 15 mg/kg in 30 min Q 6 H
- Peak analgesic effect of IV paracetamol occurs in 1 hour, duration 4-6 hrs
- Also oral or rectal application possible

Acetaminophen (Paracetamol)

- **NAPQI** (N-acetyl-p-benzoquinone imine) is a **toxic byproduct** produced during the metabolism of Acetaminophen
- It is normally produced only in small amounts, and then almost immediately detoxified in the liver
- The dosage at which Acetaminophen causes toxicity usually is **10 g in the average adult**
- The **dosage is much lower in children**, adapted to the weight
- The antidote **N-acetylcysteine** acts as a precursor for glutathione

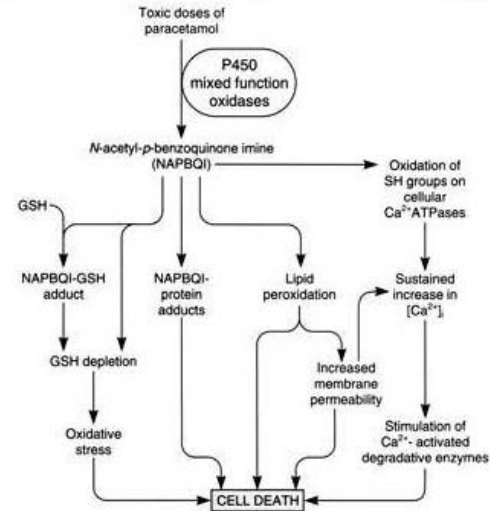


Fig. 49.1 Potential mechanisms of liver cell death resulting from the metabolism of paracetamol to N-acetyl-p-benzoquinone imine (NAPQI). (GSH = glutathione) (Based on data from: Boobis A R et al. 1989, and Nelson S D, Pearson P G 1990 Annu Rev Pharmacol Toxicol 30: 169) See also Figure 13.1.

- Analgesic, Antipyretic, Anti-inflammatory
- Block cyclooxygenase (COX) enzyme → ↓ prostaglandin synthesis
- COX-2 → Prostaglandins → pain, inflammation, fever
- COX-1 → Prostaglandins → gastric protection, hemostasis

- Avoided in:
 - infants less than 6 months (?)
 - children with aspirin or NSAID allergy
 - renal or hepatic failure
 - coagulation disorders
 - peptic ulcer disease
 - significant risk of haemorrhage (?)

NSAIDs

Nonselective COX inhibitors

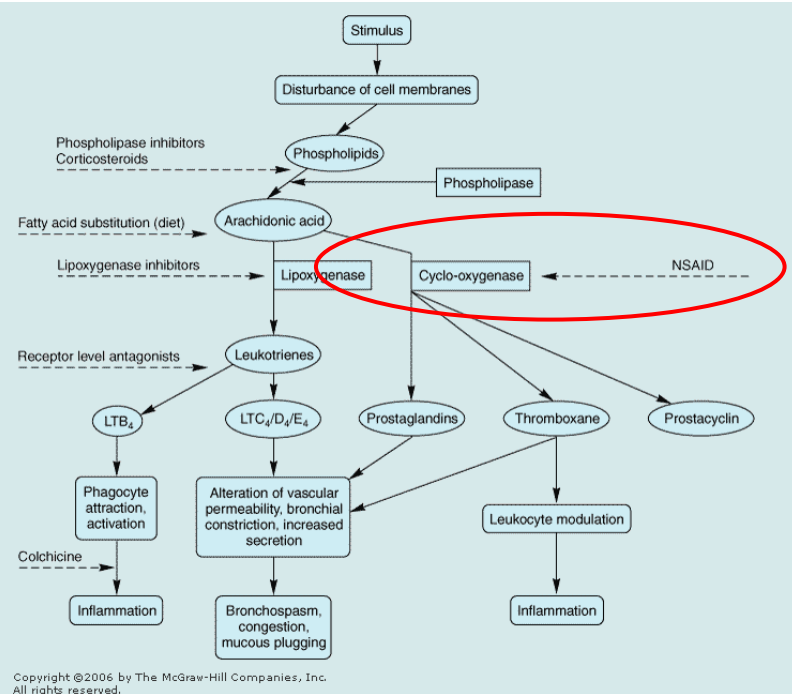
- **Salicylates:** Aspirin.
- **Propionic acid derivatives:** Ibuprofen, Ketoprofen, Flurbiprofen.
- **Fenamate:** Mephenamic acid.
- **Enolic acid derivatives:** piroxicam, Tenoxicam.
- **Acetic acid derivatives:** Ketorolac, Indomethacin.
- **Pyrazolone derivatives:** Phenylbutazone, Oxyphenbutazone.

Preferential COX-2 inhibitors:

- Nimesulide, Diclofenac, Aceclofenac, Meloxicam, Etorolac.

Selective COX-2 inhibitors:

- Celecoxib, Etoricoxib, Parecoxib.



▪ **Ketorolac**

- IV NSAID (available p.o.)
- dose 0.5 mg/kg/dose Q 6 H
- onset after 10 minutes
- maximum i.v. dose 30 mg Q 6 hours
- do not use more than 5 days
- significant increase in side effects after 5 days
- monitor renal function

▪ **Ibuprofen**

- Oral NSAID (available rectal)
- dose 5 to 10 mg/kg Q 6 to 8 hours
- the recommended maximum daily dose is 40 mg/kg
- potent antipyretic, analgesic
- Ibuprofen should be avoided in patients with severe hepatic disease

- Used for thousands of years to produce:
 - euphoria
 - analgesia
 - sedation
 - relief from diarrhea
 - cough suppression

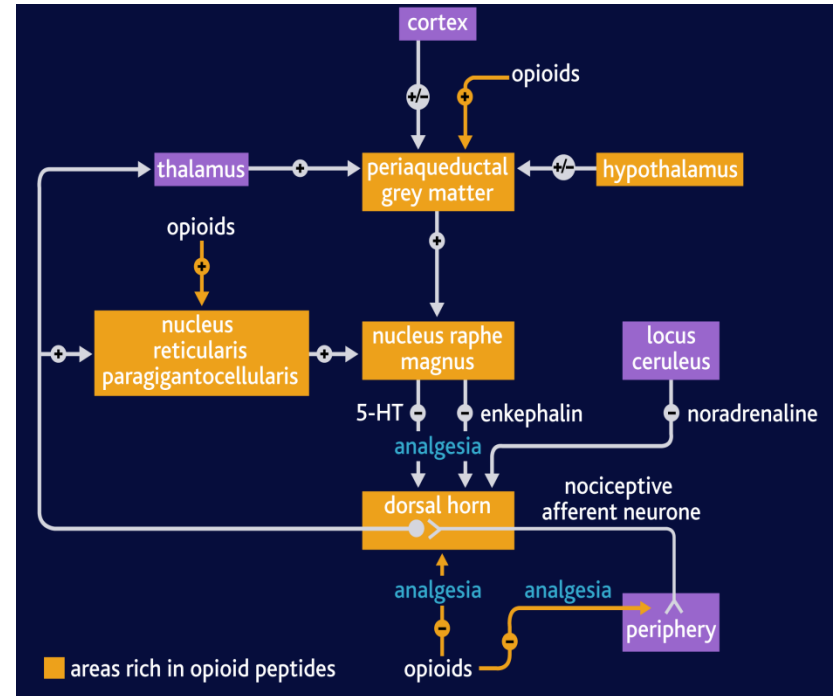
- Used medicinally and recreationally from early Greek and Roman times
- Opium and laudanum (opium combined with alcohol) were used to treat almost all known diseases
- Morphine was isolated from opium in the early 1800's and since then has been the most effective treatment for severe pain

- Natural opioids occur in 2 places:
 - in the juice of the opium poppy (morphine and codeine)
 - as endogenous endorphins
- All other opioids are prepared from either morphine (semisynthetic opioids such as heroin) or they are synthesized from precursor compounds (synthetic opioids such as fentanyl)



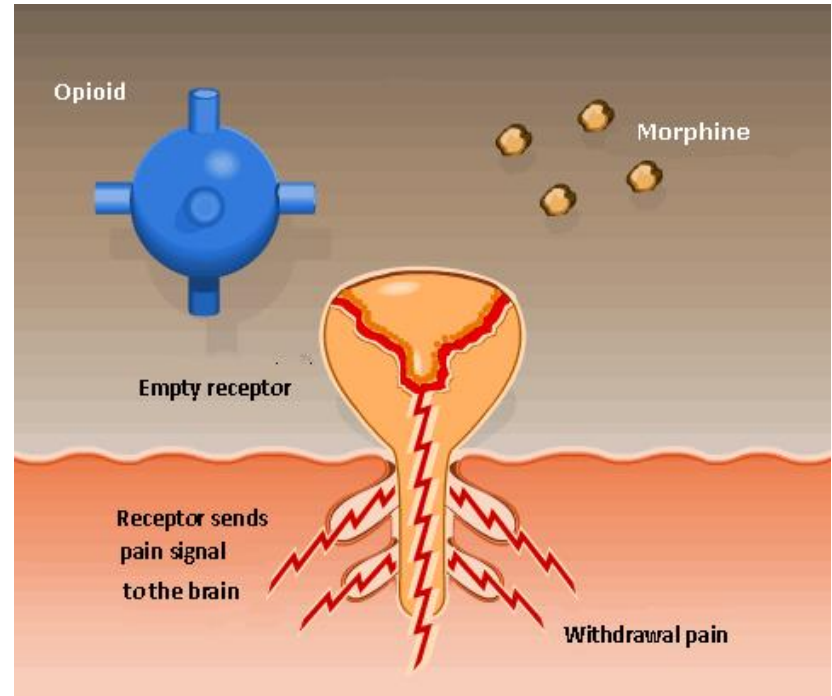
Mechanism of action

- Reduction or inhibition of neurotransmission, due largely to opioid-induced presynaptic inhibition of neurotransmitter release:
 - involves changes in transmembrane ion conductance
 - increase potassium conductance (hyperpolarization)
 - inactivation of calcium channels



Mechanism of action

- Mechanism of action via opioid receptors
 - μ - receptor
 - κ - receptor
 - δ - receptor



Mechanism of action

- **Delta receptor:**

- it is unclear what delta's responsible for

- **Two types of Mu receptors:**

- **Mu-1:** located outside spinal cord, responsible for central interpretation of pain
- **MU-2:** located throughout CNS, responsible for respiratory depression, spinal analgesia, physical dependence, and euphoria
- **Kappa receptor:** modest analgesia, dysphoric effects

Response	Mu-1	Mu-2	Kappa
Analgesia	★	★	★
Respiratory Depression		★	
Euphoria		★	
Dysphoria			★
Decrease GI motility		★	
Physical Dependence		★	

Pharmacological effects

- **Sedation and anxiolysis**
 - drowsiness and lethargy
 - apathy
 - cognitive impairment
 - sense of tranquility
- **Depression of respiration**
 - main cause of death from opioid overdose
- **Cough suppression**
 - opioids suppress the “cough center” in the brain
- **Pupillary constriction**



Pharmacological effects

▪ **Nausea and vomiting:**

- stimulation of receptors in an area of the medulla called the chemoreceptor trigger zone causes nausea and vomiting
- unpleasant side effect, but not life threatening

▪ **Gastrointestinal symptoms:**

- opioids relieve diarrhea as a result of their direct actions on the intestines

▪ **Other effects:**

- opioids can release histamines causing itching or more severe allergic reactions including bronchoconstriction
- opioids can affect white blood cell function and immune function

▪ **Important:**

- Development of tolerance and addiction

- **Most widely used** and studied opioid in children
- **Safe and effective in all ages**
- **Drug of first choice by severe pain**
- Can be given by the subcutaneous, intramuscular, intravenous, epidural, intraspinal, and rectal routes
- Continuous or intermittent infusion of the dose is adjusted according to individual analgesic requirements

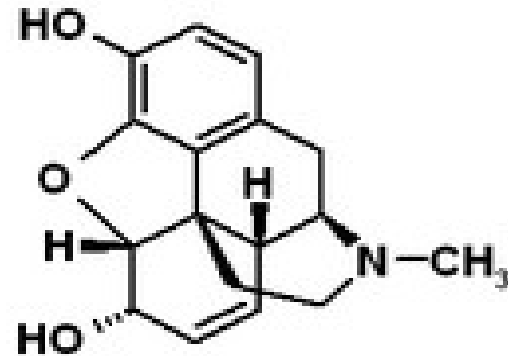
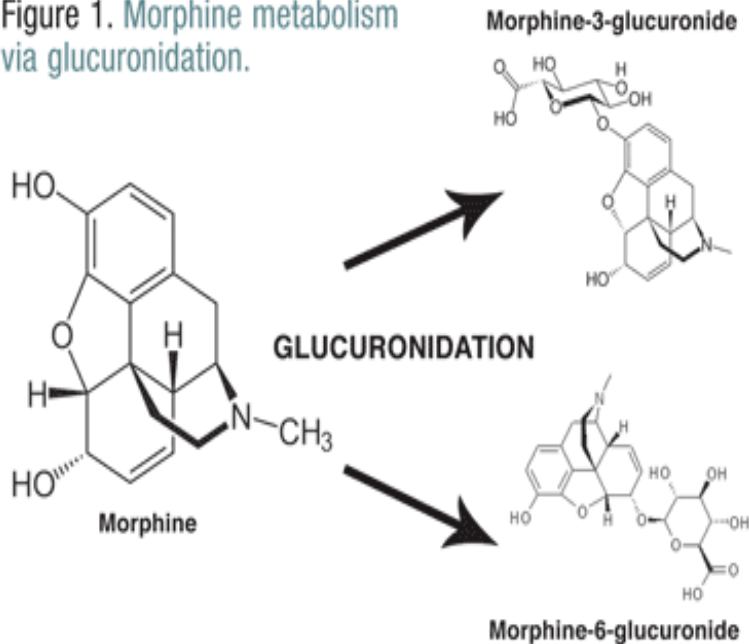


Figure 1. Morphine metabolism via glucuronidation.



- **Dose: 0.05 - 0.1 mg/kg IV dose Q 4 H**
- **Continuous application: 10 – 60 mcg/kg/h**
- There is no maximum dose per day
- Metabolism:
 - hepatic glucuronidation: morphine-3-glucuronide (M3G) and -6-glucuronide (M6G)

Morphine cardiovascular effects

- Cardiovascular effects of Morphine lead to **vasodilatation**, thus a **decrease** in **systemic and pulmonary arterial pressure**
- Morphine causes the release of histamine
- **Suppression of central adrenergic tone**
- Suppression of reflex vasoconstriction

Afterload ↓

Preload ↓

SVR ↓

PVR ↓

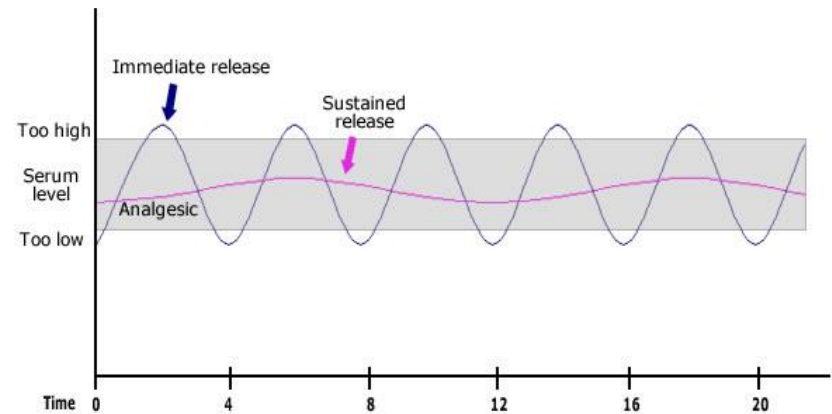
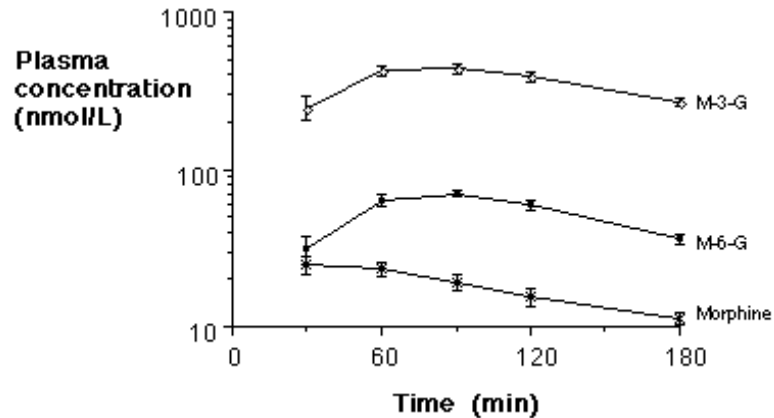
Myocardial
O₂ demand ↓

Myocardial
contractility ((↓))

Morphine pharmacokinetics

- Elimination halftimes for morphine following bolus i.v. administration is about 1.7-4.5 hours
- Oral application route is defeated by the 1st pass metabolism
- Intramuscular and subcutaneous application routes are not recommended in postoperative cardiac critical care because of unstable resorption by disorders in peripheral circulation
- Following bolus administration onset time is relatively slow (15-30 minutes) because:
 - morphine exhibits relatively low lipid solubility
 - at physiological pH, morphine, a weak base, is primarily ionized
 - the ionized form does not favor passage through the lipid membrane
 - accordingly, only about 10% - 20% of molecules are un-ionized

- Best routes of application are i.v. bolus doses or continuous infusion by syringe pump!



Agonists and Antagonists

- **Opioid Agonists:**

- Morphine, Codeine, Meperidine, Fentanyl, Sufentanil, Methadone, Tramadol, etc.

- **Opioid Agonist / Antagonist + partial Agonist:**

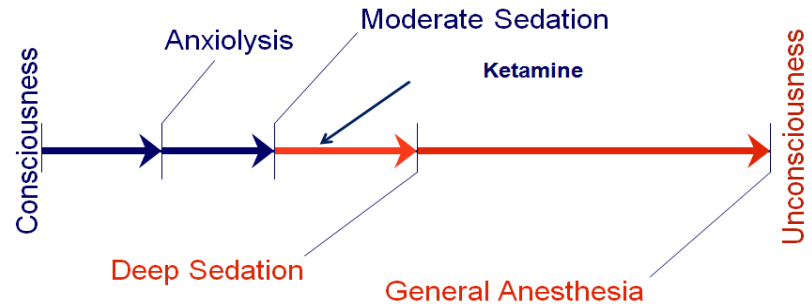
- Pentazocine, Nalbuphine, Butorphanol, Buprenorphine

- **Opioid Antagonists:**

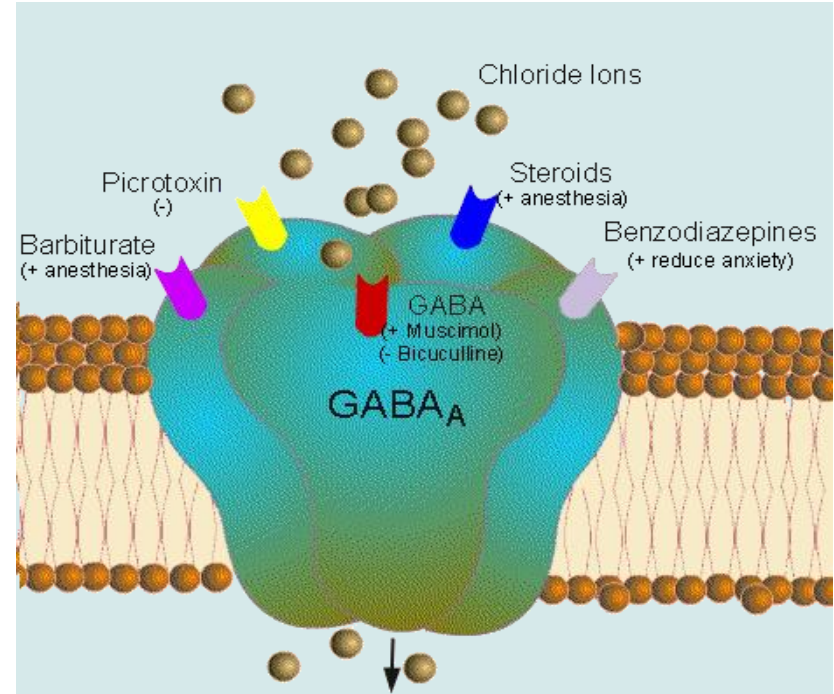
- Nalorphine, Naloxone, Naltrexone, Naltrindole, Nalmefene

DRUGS	MU	KAPPA
<i>Pure Agonists</i>	Agonist	Agonist
<i>Agonist-Antagonist</i>	Antagonist	Agonist
<i>Pure Antagonists</i>	Antagonist	Antagonist

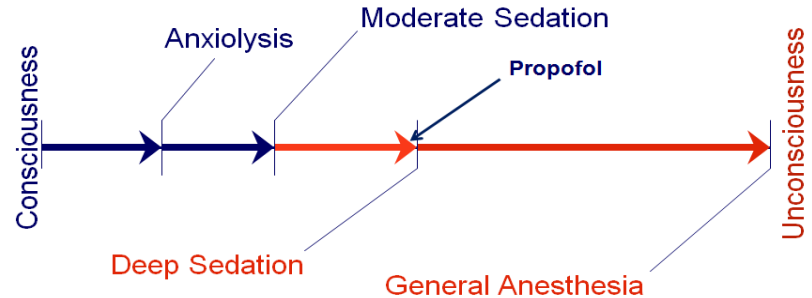
- N-Methyl-D-aspartate (NMDA) receptor antagonists
- Parenteral anaesthetic agent with amnestic and analgesic properties
- rapid onset
- useful for short, painful procedures
- Dissociative anesthesia may not produce reliable immobility
- May produce transient hypertension and increased HR
- Contraindicated with head trauma, increased ICP



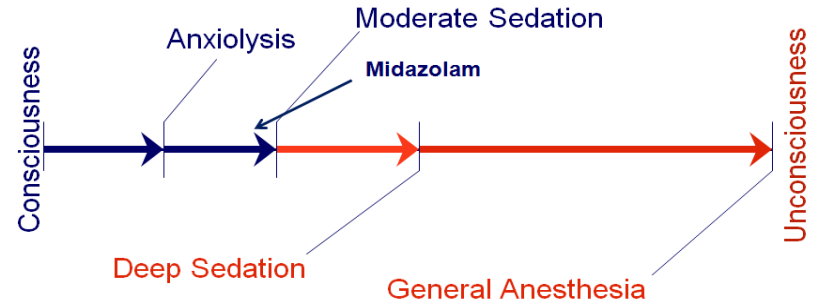
- Propofol works by increasing GABA-mediated inhibitory tone in the CNS
- Propofol decreases the rate of dissociation of the GABA from the receptor, thereby increasing the duration of the GABA-activated opening of the chloride channel with resulting hyperpolarization of cell membranes



- Sedative, anesthetic, amnestic, anticonvulsant
- Respiratory and cardiovascular depression
- Use only in mechanically ventilated patient
- Hypotension occasionally limits its use
- Rapid onset, short duration
- Onset <1 min, peak 2 min, duration 4-8 min
- Clearance not changed in liver or kidney disease
- Highly lipid soluble
- Metabolised by conjugation in the liver
- Increases triglycerides



- Belongs to the Benzodiazepines
- Rapid onset (1 - 3 min) and relatively rapid offset
- Expected duration: 60 - 90 minutes
- Anxiolysis plus amnesia, no analgesia
- Anti-convulsant
- Hemodynamic stability
- Reversible with Flumazenil (specific antagonist)
- Produces "true" moderate sedation in children
- Versatile + painless routes of administration



Our protocol



Propofol

Ketamine

Morphine

Ibuprofen /
Ketorolac

Midazolam

Paracetamol

- Sedation with Propofol by ventilated patients coming out from OR when extubation is expected within the first 4 hours

Propofol



Our protocol

- Sedation with Propofol by ventilated patients coming out from OR when extubation is expected within the first 4 hours
- By expected extubation time more than 4 hours but less than 24 hours we are giving Propofol and Morphine additional as pain killer

Propofol

Morphine



Our protocol

- Sedation with Propofol by ventilated patients coming out from OR when extubation is expected within the first 4 hours
- By expected extubation time more than 4 hours but less than 24 hours we are giving Propofol and additional Morphine as pain killer
- **By need of long term ventilation (> 24 hours) we change to Midazolam and Morphine**

Midazolam

Morphine



Our protocol

- After extubation regularly application of Morphine i.v. max. 0.1 mg/kg/ Q 4 H or continuously with 10 – 60 mcg/kg/h
- Additional application of Paracetamol i.v. Q 6 H



Morphine

Paracetamol

Our protocol

- After extubation regularly application of Morphine IV max. 0.1 mg/kg/ Q 4 H or continuously with 10 – 60 mcg/kg/h
- Additional application.of Paracetamol i.v. Q 6 H
- To prevent the risk of vomiting we give Ondansetron regularly 4 Q H

Ondansetron

Morphine

Paracetamol



Our protocol

- All painful postoperative procedures (f.e. removing drains) are done under Ketamine anaesthesia

Ketamine



Our protocol

- Regularly on the second postoperative day we are shifting our patients to normal ward under pain management with Paracetamol and Ibuprofen or Ketorolac



Ibuprofen /
Ketorolac

Paracetamol

Our protocol

- Regularly on the second postoperative day we are shifting our patients to normal ward under pain management with Paracetamol and Ibuprofen or Ketorolac
- At the 6th day we stop Paracetamol and also Ketorolac (if it was used) and continue with Ibuprofen orally as long as it is needed.



Ibuprofen

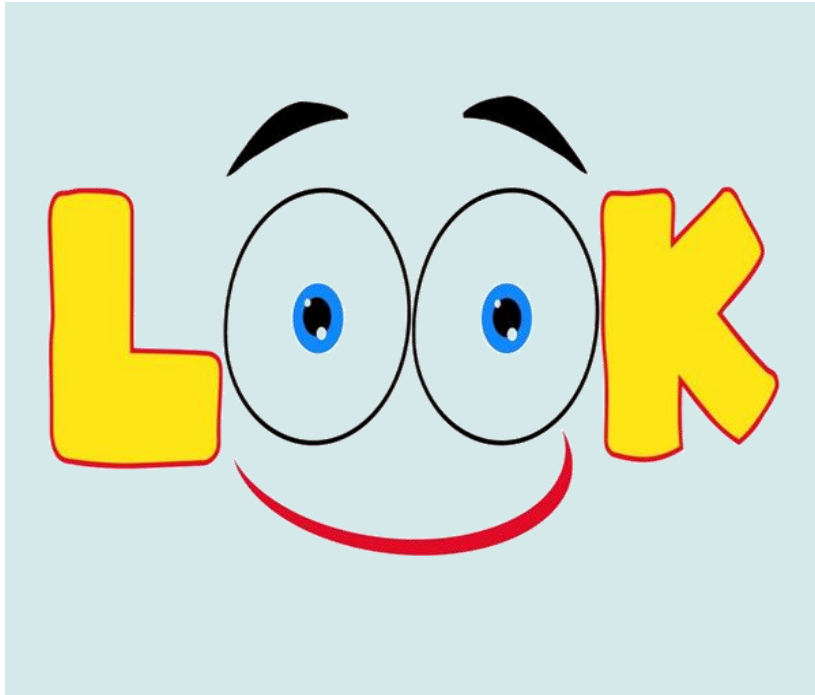
Take home messages

The highly complex paediatric patients with congenital or acquired heart disease require **interprofessional teamwork and collaboration** to ensure high quality outcomes with low mortality and morbidity.

1.



Take home messages



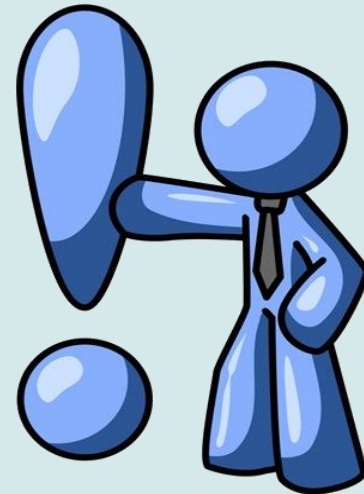
Anticipation and prevention are the most important **keys for recognition, diagnosis, and successful management** of all potential risks and complications in the postoperative critical care of paediatric cardiac patients

2.

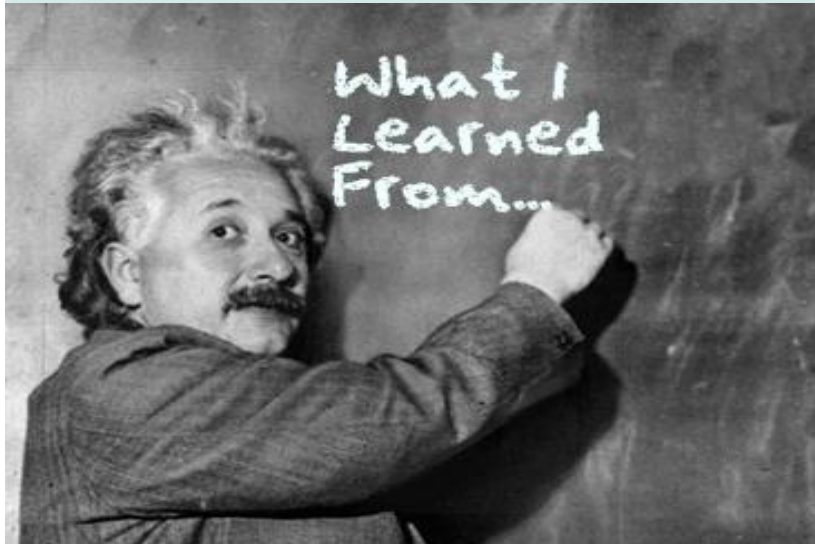
Take home messages

Hospitals are always **painful zones** for the kids especially cardiac and orthopaedic departments as well as intensive care units.

3.



Take home messages



Consider pain as a **vital sign**.

4.

Take home messages

Inadequate pain management in postoperative care of children undergoing cardiac surgery can **lead to a very big disaster!**

5.



Take home messages

I just need
the main ideas



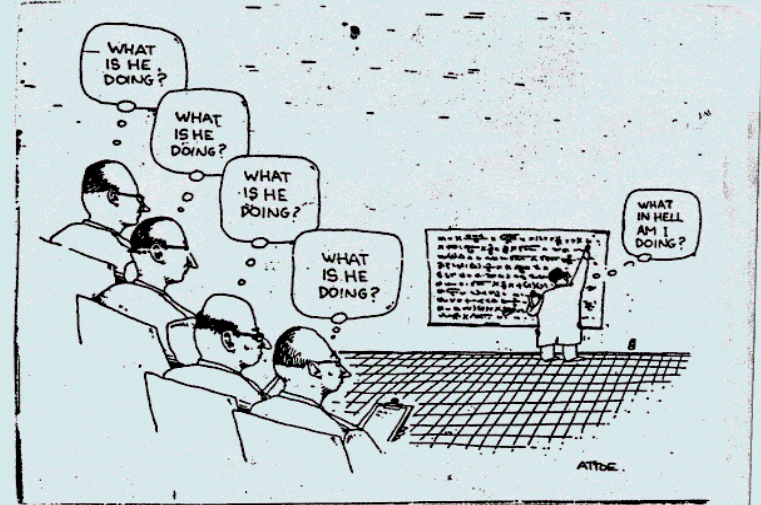
- **Anticipate** and **prevent** pain
- Assess pain **adequately**
- Use a **multimodal** approach
- Use non-noxious and **non-painful route** of administration

6.

Take home messages

- **Pain management is not the same as sedation**
- **Anxiolysis is also an important need in postoperative pain control**

7.



Take home messages



- Effects of **successful analgesia**:
 - **Reduces anxiety and stress response**
 - Reduces respiratory complications
 - Reduces cardiovascular complications
 - **Reduces autonomic effects**

8.

Take home messages

- Unfortunately there doesn't exist a perfect analgesic
- In ICU we are able to manage all possible side effects

9.



Take home messages



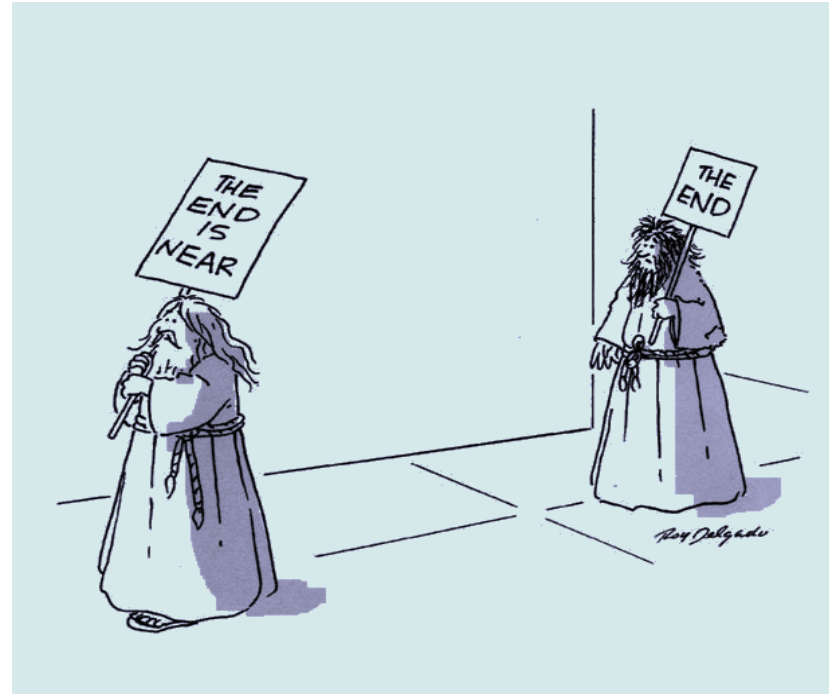
- **Most used painkiller** in children undergoing cardiac surgery:
 - **Acetaminophen (Paracetamol)**
 - **NSAIDs**
 - **Morphine**
 - **Ketamine**

10.

Take home messages

- **Morphine is**
 - **the most widely used** and studied opioid in children
 - **safe and effective in all ages**
 - has important positive effects we want in paediatric cardiac critical care

11.



Take home messages

Propofol

Ketamine

Morphine

Ibuprofen /
Ketorolac

Midazolam

Paracetamol

- Use a structured and successful protocol for postoperative pain management in paediatric cardiac critical care

12.

Take home messages

Never let a child stay in pain!

13.



Thank you for your attention

The End.



Thank you for your attention



"NO YOU CAN'T ASK A QUESTION."

Yes, you can!