Ultrasound-guided mechanical ventilation, F. Mojoli & S. Mongodi

Haemodynamic monitoring: stuff we never talk about, C. Boerma

Animal-assisted activity in the intensive care unit, M.M. Hosey et al.

From command and control to modern approaches to leadership, T. Dorman

Enabling machine learning in critical care, T.J. Pollard & L.A. Celi

The role of autophagy in the metabolism and outcomes after surgery, J. Gunst et al.

Fast-track surgery: a multidisciplinary collaboration, H. Kehlet

The patient voice in Enhanced Recovery After Surgery, A. Balfour & R. Alldridge

The role of physiotherapy in Enhanced Recovery after Surgery in the ICU, T.W. Wainwright et al.

Innovations in monitoring: from smartphones to wearables, F. Michard

Physical rehabilitation in the ICU: understanding the evidence, C. M. Goodson et al.

Optimising nutrition for recovery after ICU, P.E. Wischmeyer

Outcomes after 1 week of mechanical ventilation for patients and families, M. Parotto & M.S. Herridge

Continuing rehabilitation after intensive care unit discharge, S. Evans et al.

The hidden faces of sepsis, what do they tell us? I. Nutma-Bade
Current challenges in paediatric sedation
Report of the Primex Pharmaceuticals Symposium
Euroanaesthesia 2017, Geneva, Switzerland, 4 June 2017

Karin Becke
Head of Department
Department of Anaesthesiology, Paediatric Anaesthesiology and Intensive Care Medicine
Cnopf Childrens Hospital
Hospital Hallerwiese
Nürnberg, Germany
Karin.Becke@diakonieneuendettelsau.de

Claudia Höhne
Consultant
Department of Anaesthesiology and Intensive Care Medicine
University Hospital of Leipzig
Leipzig, Germany
claudia.hoehne@medizin.uni-leipzig.de

Michael Brackhahn
Consultant
Department of Paediatric Anaesthesia, Paediatric Intensive Care and Emergency Medicine
Paediatric Hospital ‘Auf der Bult’
Hanover, Germany
Brackhahn@hka.de

Current challenges and challenges - Dr. K. Becke

Background
An increasing number of diagnostic and treatment procedures are performed outside the operating room. Without sedation even minor procedures such as vaccination can be painful, stressful and lead to severe trauma. Sedation ensures optimal conditions for performing safe and high-quality interventions.

Children are at increased risk from the combination of analgesia and sedation, especially from respiratory complications. The recently published APRICOT study found a higher incidence of severe critical events associated with anaesthesia than previously believed (Habre et al. 2017). Sedation and analgesia for short interventions were performed by paediatric anaesthesiologists (Cravero et al. 2009).

Sedation goals
The goals of paediatric sedation are to:
• Guard the patient’s safety and welfare
• Minimise physical discomfort and pain for the patient
• Control anxiety, minimise psychological trauma, and maximise the potential for amnesia
• Modify behaviour and/or movement so as to allow the safe completion of the procedure (particularly important in radiology)
• Return the patient to a state in which discharge from medical/dental supervision is safe (Coté et al. 2016)

The Safetots.org initiative summarised good perioperative practice as the ‘10 Ns’:
1. No fear
2. Normovolemia
3. Normotension
4. Normocardia
5. Normoxemia
6. Normocarbia
7. Normonatremia
8. Normoglycemia
9. Normothermia
10. No pain

Interdisciplinary framework
Hospitals should take a systematic approach to sedation by defining sedation, qualifications of the team, pre-sedation evaluation and regimes for different interventions.

Procedural sedation
The new pragmatic approach is to distinguish between two types of sedation:
• Minimal sedation or anxiolysis with-
including difficult airway situations and comorbidities.

Fasting prior to sedation is important, with recommended fasting times as follows:

- Solids, 6 hours
- Breast milk/formula (children < 1 year), 4 hours
- As for general anaesthesia, all children should receive clear fluids for up to 2 hours before sedation

**Monitoring**

The minimal standards for deep sedation are ECG, BP, SpO2, and capnography. There may also be specific prerequisites depending on the environment, e.g. telemetrics in the MRI suite.

**Regimes for different interventions**

Standardised interdisciplinary sedation regimes should be devised and implemented in each department, e.g. radiology, oncology, endoscopy. Measures of quality assessment and improvement should be performed continuously.

**Documentation and follow-up**

Sedation should be documented as for general anaesthesia. After deep sedation the patients should go to the recovery room and be monitored. There needs to be defined discharge criteria, information for patients and families on behaviour at home, and what to do in case of complications and a contact telephone number.

**In-hospital paediatric sedation - areas for improvement - Prof. C Hohne**

Adverse events in paediatric sedation have a prevalence of around 4.8%. To minimise the potential for adverse events, there are a number of areas where improvements are possible, including fasting times, patient monitoring and new drugs.

**Fasting times**

Fasting times are as for general anaesthesia. Liquids may be taken up to 2 hours before the procedure, or for up to 4 hours before in infants under 12 months. Food can be taken by children over 12 months until 6 hours before sedation. Gastric content volume is highly variable and independent of fasting time (Schmitz et al. 2011). Beach and colleagues (2016) found that nil by mouth for liquid or solids is not an independent predictor for aspiration—rather age, ASA status, comorbidities or the procedure itself were predictors. If we have a planned procedure, and it is not known if the child has fasted or not, it may not be necessary to postpone due to risk of aspiration. Current specified fasting times are safe, but are often exceeded, leaving children hungry and thirsty (Engelhardt et al. 2011). An observational study by Dennhardt and colleagues found that optimised fasting times decreased ketone body concentration and stabilised mean arterial pressure (Dennhardt et al. 2016).

**Monitoring**

With mild sedation, oxygen, heart rate and ventilation are monitored, and the anaesthesiologist can still communicate with the child. For deeper sedation, monitoring is as for general anaesthesia, including blood pressure, oxygen saturation and capnography. All vital signs should be recorded and documented, and age-appropriate equipment used (Côté et al. 2016).

**Drugs**

Drugs for sedation need to be short acting, safe, with predictable effects and keeping the airway patent. Propofol is commonly used for moderate and deep sedation, and is safe when administered by paediatric anaesthesiologists. It has a short recovery time, and if there are haemodynamic and respiratory events, these are easily treated. Careful use is advised in case of aortic or mitral stenosis/pulmonary hypertension due to the vasodilation effect (Tobias 2015). Ketamine or dexmedetomidine alone or in combination may be used either intravenously or intranasally. Dexmedetomidine could be a good alternative for patients with difficult airways. However, with the exception of propofol, most drugs are used off-label, and new drugs are needed.

**A novel oral solution for paediatric sedation** - Dr. Michael Brackhahn

Midazolam is used routinely for premedication in paediatric anaesthesia, but in many countries it is used off-label. Oral midazolam is used for anaesthetic premedication and for diagnostic and therapeutic procedures, e.g. sutures, IV placement, CT or MRI scans.

Oral midazolam solution is a well-known benzodiazepine with sedative, hypnotic, anxiolytic, amnesic, skeletal muscle relaxant and anticonvulsant properties, and it is an excellent alternative to drugs that require invasive administration routes. Currently available oral midazolam solutions have a bitter taste, which are poorly accepted by children.

ADV6209 is an innovative 0.2% oral midazolam formulation initially developed in 2008 through collaboration between anaesthesiologists and pharmacists at CHU d’Amiens-Picardie in Northern France. The objectives were to develop a more acceptable oral midazolam formulation, for use in pre-medication before general anaesthesia and moderate sedation, before and during therapeutic and diagnostic procedures. ADV6209 does not have the bitter taste of currently available preparations and so is better accepted by children. The solution has no preservative, lactose or colorants, and is currently undergoing regulatory submission in the EU.

As part of its development, ADV6209 was investigated in a phase II study involving 37 paediatric patients, who received premedication before general anaesthesia at Amiens University Hospital (Guittet et al. 2016). The sedative effect was measured after the patients received a single dose administration of ADV6209 at a mean midazolam dose of 0.27 mg/kg. The findings of the phase II study were compared to previous literature reports. In the trial satisfactory sedation was achieved in 78.4% of the patients, 30 minutes after administration of ADV6209. There was no significant difference between the overall responder rate obtained with ADV6209 and the literature findings observed with other oral midazolam formulations.

ADV6209 was well accepted by children of various ages. ADV6209 was a safe and efficacious sedative at the dose investigated. The recommended dose of ADV6209 is 0.25 mg/kg, with a maximum dose of 20mg.

**References**

For full references, please email editorial@icu_management.org or visit https://iii.km/dt4