1. Perioperative intravenous fluid therapy in children: guidelines from the Association of the Scientific Medical Societies in Germany

Sümpelmann R, Becke K, Brenner S et. al.

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Paediatric perioperative intravenous fluid therapy is an area of continuous debate. This article focused on safety and efficacy (compiled by a panel of 12 paediatric anaesthetists and paediatricians). The objective of intraoperative infusion therapy is to maintain or re-establish the child's normal physiological state (normovolaemia, normal tissue perfusion, normal metabolic function, normal acid- base- electrolyte status) and they make the following consensus based recommendations. If preoperative and postoperative fasting times are short, intravenous fluid therapy should not necessarily be performed in children beyond neonatal age who drink sufficient volumes and undergo <1h procedures. Intraoperative background infusion should be a physiologically composed balanced isotonic electrolyte solution (BS) with 1-2.5 % glucose to maintain normal glucose concentrations. But in case of children at risk and longer surgery, blood sugar levels should be measured regularly and glucose administration should be adjusted. Additional BS without glucose can be used in patients with circulatory instability until the desired effect is achieved. Colloids are associated with more adverse drug reactions than balanced electrolyte solutions, but in children with hypovolaemia, colloids can be used intraoperatively where crystalloids alone are not sufficiently effective and blood products are not indicated. In order to avoid hypervolemia, a restrictive approach to giving colloids should be adopted (as infusions and target normal blood volume). Monitoring should be extended in surgery with larger volume turnovers (arterial and central venous catheters). In case of negative trends (central venous oxygen saturation↓, base excess↓, lactate↑), then early countermeasures should be taken. The most common cause of perioperative cardiac arrests in children is an underestimated loss of volume.

2. Therapeutic Hypothermia after In-Hospital Cardiac Arrest in Children

Moler FW, Silverstein FS, Holubkov R, et al

New England Journal of Medicine 2017; **376**: 318-329.

Following their study of therapeutic hypothermia after out-of-hospital cardiac arrest in children in 2015, this group now addresses the paucity of data in the setting of in-hospital cardiac arrest, as a “pathophysiologically distinct population from those who have out-of-hospital cardiac arrest.” This is a randomized trial in 37 children's hospitals across the United States, Canada, and the UK, with a primary outcome of survival with a favourable neurobehavioural outcome at 1-year follow-up (age-corrected standard score of ≥70 on the

Vineland Adaptive Behavior Scales, VABS-II, range 20-160 with higher scores for better function). Of the 2791 patients screened (age: >48 hours and < 18 years), 746 were eligible (in-hospital cardiac arrest, >2min chest compressions, and required mechanical ventilation post circulation return). Exclusions included pre arrest VABS-II score <70. Participants were randomly assigned in a 1:1 ratio to therapeutic hypothermia (target temperature: 33° C) or therapeutic normothermia (target temperature: 36.8°C) for 120 hours. The trial was designed with 90% power to detect a 15% absolute difference in the primary outcome and required 558 patients. The trial was halted because of futility in 2015, and reached only 329 patients. Finding at 1 year, the percentages of children with VABS-II scores of ≥ 70 [257 patients] were not significantly different between treatment groups (36% % [48 of 133 patients] of the hypothermia group vs. 39% [48 of 124 patients] of the normothermia group; relative risk [RR]: 0.92; 95% CI, 0.67-1.27; P =0.63). Among 317 patients who could be evaluated for change in neurobehavioural function, the change in VABS-II scores were also not significantly different (P =0.70). Survival rates at 12 months were 49% [81 of 166 patients] in the hypothermia group and 46% [74 of 161 patients] in the normothermia group (RR: 1.07; 95% CI, 0.85-1.34; P =0.56). The main causes of death were brain death/life support withdrawal and cardiovascular failure in the hypothermia group (39% and 31%) vs. 33% and 38% in the normothermia group. Safety outcomes were similar between treatment groups. Thus they concluded children who survived in-hospital cardiac arrest, therapeutic hypothermia, as compared with therapeutic normothermia, did not confer a significant benefit in survival with a favourable functional outcome at 1 year.

3. Tight glycemic control in critically ill children

Agus MSD, Wypij D, Hirshberg EL, et al; for the HALF-PINT Study Investigators and the PALISI Network

New England Journal of Medicine 2017; **376**: 729-741

In the HALF-PINT study (Heart And Lung Failure – Pediatric Insulin Titration Trial), the investigators randomly assigned 713 critically ill children with hyperglycemia (excluding cardiac surgery patients), aged 2 weeks to 17 years from 32 paediatric hospitals to two groups between 2012 and 2016. 360 patients were assigned to a lower-target range of glycemic control (4.4-6.1 mmol/l) and 353 patients to a higher-target range (8.3-10mmol/l), using continuous glucose monitoring and explicit methods for insulin adjustment. The primary outcome was the number of intensive care unit (ICU)-free days up to day 28. The trial was stopped early in September 2016 due to the lack of benefit and evidence of the possibility of harm. Results from the intention-to-treat analysis indicated no significant difference in median number of ICU-free days between the lower-target and higher-target groups (19.4 days [IQR, 0-24.2] vs. 19.4 days [IQR, 6.7-23.9, respectively; P =0.58). However,

the rates of healthcare-associated infections (3.4% vs. 1.1%; P =0.04) and severe hypoglycemia (5.2% vs. 2.0%; P =0.03) were significantly higher in the lower-target group. There was no significant difference in mortality, severity of organ dysfunction and number of ventilator-free days. Study limitations include a lag between onset of hyperglycemia and treatment, lack of blinding and no third study group in which hyperglycemia was not treated.

4. Effects of an alveolar recruitment manoeuvre guided by lung ultrasound on anaesthesia-induced atelectasis in infants: a randomised, controlled trial

Song I-K, Kim E-H, Lee J-H, et al

Anaesthesia 2017; **72**: 214–222

This prospective randomised, controlled trial included 40 children (< 1 year, ASA 1 or 2), having elective minor surgery under GA, requiring tracheal intubation. 20 were randomly allocated to the recruitment manoeuvre group and 20 to the control group. GA protocol was standardised. Following tracheal intubation, volume-controlled ventilation delivered a TV of 8 ml.kg−1, PEEP of 5 cmH2O and 40% oxygen, at an age-dependent rate, maintaining ETCO2 4.6–5.9 kPa, with I:E of 1:2. A standardized lung ultrasound examination was performed 1 min after starting mechanical ventilation of the lungs and again at the end of the surgery. The recruitment manoeuvre was performed just after each lung ultrasound examination; under ultrasound guidance, a stepwise increase in airway pressure from 10 cmH2O by 5 cmH2O increments with a 0.4 inspired oxygen fraction was applied manually until no collapsed lung areas were visible on ultrasound. The maximum airway pressure was limited to 40 cmH2O. Significant anaesthesia-induced atelectasis occurred in approximately 50% of patients, within 1 min of commencing mechanical ventilation. On the second lung ultrasound examination, there was significantly less consolidation in the treatment group compared with the control group (25% vs. 80%; p = 0.001). There was a greater probability of atelectasis in neonates compared with older patients. Duration of anaesthesia did not correlate with lung ultrasound scores for consolidation or B-lines. Pre-oxygenation with 100% O2 could have been the cause of the atelectasis in the first few minutes. No complications were encountered. Limitations: ultrasound cannot detect lung hyperinflation, although peak inspiratory pressure was limited; ultrasound is operator-and patient-dependent (same experienced operator for all examinations); results may be different in children with lung disease or those who are critically ill. **A lung ultrasound-guided recruitment manoeuvre accompanied by PEEP significantly reduced the incidence of anaesthesia-induced atelectasis.**

5. Success rate of pneumatic reduction of intussusception with and without sedation

Feldman O, Weiser G, Hanna M, et al

Pediatric Anesthesia 2017; **27**: 190–195

A retrospective cohort study evaluating the success rate of pneumatic reduction of intussusception (PRI) with and without sedation was conducted at two Israeli teaching hospitals. The hospitals use similar PRI protocols, although one provides sedation for PRI and one does not. Electronic patient files were examined for all patients (3 - 96 months) who had ileocolic intussusception between 2008 and 2015. The sedation cohort and the nonsedation cohort included 124 and 90 patients and the two groups were comparable. Multivariate regression analysis was performed to adjust for the independent effects of potential confounders. Sedation involved propofol as a single agent, or in combination with ketamine, midazolam or fentanyl. PRI under propofol-based sedation had a slightly higher success rate than PRI without sedation (89.5% vs. 83.3% adjusted OR 1.2, 95% CI 1.1-5.3). They found no statistical difference between the groups for early intussusception recurrence. There were no severe adverse events related to sedation recorded and all the procedures were completed. They did not identify any cases of bowel perforation during the procedure in the nonsedation group vs. 3/124 (2.4%) in the sedation group. All three patients who developed bowel perforation during the procedure were 5 months of age or younger, and so clinicians should be especially careful using propofol-based sedation in the younger age group. Limitations: retrospective chart review; two-center study. **In this cohort, PRI using propofol-based sedation had a slightly higher success rate than PRI without sedation; however, the safety of this practice is yet to be determined.**

6. Paravertebral block in paediatric abdominal surgery—a systematic review and meta-analysis of randomized trials

Page EA, Taylor KL

British Journal of Anaesthesia 2017; **118** (2): 159-166

Paravertebral block (PVB) has an accepted role in adult thoracic surgery. The benefits of PVB include lower risk of sympathetic block and neuraxial injury. This review asks: in paediatric abdominal surgery conditions, does paravertebral block, compared with all other techniques, result in improved clinical outcomes? Inclusion criteria were RCTs with paediatric participants 0–18 years of age, with any level of PVB for a surgical operation in which an incision was made in the abdomen. The primary outcomes were pain scores and requirement for rescue analgesia. Six RCTs were included, with a total of 358 participants. All studies described single-shot PVB techniques. The meta-analysis demonstrates that PVB provides a beneficial effect on pain scores at 4–6 h but not at 24 h in children after

abdominal surgery. The reduction in pain scores is minimal at both time points and results are based on a meta-analysis of only four trials. PVB did not reduce PONV and seemed to be associated with more block site tenderness. In the subgroup analysis of hernia repair, pain scores were reduced by a standardized mean difference of −1.19 at 4–6 h postoperatively. The benefit was maintained at 24 h in this subgroup. There was a small benefit of PVB in reducing rescue analgesia but not for time to first analgesic requirement. Although improvements in pain scores were minimal for PVB, the comparators in two of these studies were other regional anaesthetic techniques. One study reported reduced length of stay with the use of PVB. The parental and surgeon satisfaction scores are favourable for PVB compared with caudal and ilioinguinal block. Surgeons and parents were not blinded and may be biased. Parents may appreciate the longer duration of analgesia and the absence of weak legs in their child. Parental satisfaction may influence surgeon satisfaction. Limitations: All trials had small sample sizes and there was great heterogeneity in the trial methods. **PVB is an acceptable alternative for abdominal surgery in children.**

7. Transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) in children: a randomized controlled trial

Humphreys S, Lee-Archer P, Reyne G, et al

British Journal of Anaesthesia 2017; **118** (2): 232-238

A prospective RCT to determine if THRIVE safely prolongs time to hypoxia (apnoeic oxygenation time) in children and whether it enables any CO_2 clearance. Inclusions: children and infants ≤10 yrs, healthy heart and lungs, ASA I-II, non-obese, normal airway assessment, no known upper airway obstruction, suitable for inhalation induction. Methods: Randomised 1:1 THRIVE:control, stratified 0-6mths, 7-24mths, 2-5yrs, 6-10yrs, not blinded. Standard induction with 60% N2O and 4-8% sevoflurane, followed by fentanyl and rocuronium. Sevoflurane and N20 were discontinued and the child was maintained with a propofol infusion +/- bolus. Bag and mask ventilation with PEEP of 5cmH2O was continued for 3 mins aiming at $P_{ET}O_2$ >90% and $P_{ET}CO_2$ 35-45 mmHg. Transcutaneous CO_2 was also monitored. Control group: jaw support and removal of O2 mask. Apnoea time was recorded from time when $P_{ET}O_2$ >90% until SpO2 reached 92%. THRIVE group: jaw support and Optiflow THRIVE applied with flow rates 0-15kg at 2L/kg/min, 15-30kg 35L/min, 30-50kg 40L/min, >50kg 50L/min. The intervention was terminated once apnoea time had exceeded twice the apnoea time published in an earlier paper. Results: 47 participants. THRIVE increased the safe apnoeic time significantly in all 4 age groups. No participant in THRIVE arm desaturated less than 99.6%. In both arms there was a significant increase in tcCO2 from pre- to post- apnoea and the rate of change was similar in both arms. There were no complications, but hypercarbia seems to be a limiting factor.

8. Early postoperative oral fluid intake in paediatric day case surgery influences the need for opioids and postoperative vomiting: a controlled randomized trial

Chauvin C, Shalber-Geyer AS, Lefebvre F, et al

British Journal of Anaesthesia 2017; **118** (3): 407-14

Postoperative distress is difficult to interpret in children under 4 years.

231 patients randomised to a control group (CG) (n=117) and a liberal group (LG) (n=114). Inclusions: 6 months to 4 years old, ASA I-III, day surgery under general anaesthesia in a single centre, September 2013 to June 2014. Exclusions: anaesthetic or surgical constraints preventing oral intake in the immediate postoperative period, known digestive pathology predisposing to postoperative vomiting (POV). LG: offered 10ml/kg apple juice if the FLACC score ≥4. If FLACC score remained ≥4 then intravenous (IV) analgesia was administered, as per institute protocol. CG: received IV opioids if the FLACC score was ≥4 and no oral fluids until their return to the ward. Primary end point: incidence POV in first 3 postoperative days, secondary end point: total opioid dose and time in PACU. Statistics and analysis: children were not forced to drink, so if randomised to LG and refused a drink then data put with CG data for analysis. Results: LG group, with early oral intake, had reduced incidence POV (11.4% vs. 23.9%). LG group also had reduced opioid analgesia administration (14% vs. 35%) with total dose of opioid 0.18 mg/kg vs. 0.20mg/kg in CG and a shorter PACU stay (53 vs. 65 mins). All differences were statistically significant and there were no complications. Limitations: No blinding

9. Analysis of Unplanned Intensive Care Unit Admissions in Postoperative Pediatric Patients

Landry EK, Gabriel RA, Beutler S, et al

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The first large multi-institutional data set analysis, the National Anaesthesia Clinical Outcomes Registry (NACOR, USA), to establish the rate of unplanned postoperative ICU admissions in paediatric patients and to characterise associated risk factors (previously only single centre studies). Inclusions: immediate postoperative admissions or after recovery room stay, not planned preoperatively, <18 years old, between 2010 and 2015, with specific outcome data recorded. Exclusions: ASA VI or missing ASA data. Results: Of 4 542 867 cases with reported outcomes, 324 818 were eligible cases. There were 211 unplanned admissions to ICU; giving a risk of 0.065%. Risk factors: Patient related: age <1year (OR 2.26) compared to 12-18 yr olds, ASA>III (OR 4.39) compared to ASA≤2. No gender

difference. Surgical related: longer cases 61-180 mins (OR 3.73), +180 mins (OR 6.45) compared to shorter cases, out of hours cases 1700 to 0700 (OR 2.38) compared to in hours cases, head & upper abdominal surgery, radiological procedures. Anaesthetic related: Other anaesthesia (RA, neuraxial) reduced risk compared to GA (OR 0.53) Limitations: not able to determine causality, only 16% of database was able to meet inclusion/exclusion criteria, NACOR is a voluntary database so many fields were unfilled leading to possibility of strong bias, only considered unplanned admissions from theatre or recovery (other studies used 48hr post operative window).

10. Tramadol vs dexmedetomidine for emergence agitation control in pediatric patients undergoing adenotonsillectomy with sevoflurane anesthesia: prospective randomized controlled clinical study

Bedirli N, Akçabay M, Emik U

BMC Anesthesiology 2017; **17**: 41.

A prospective randomised double blind study comparing the use of dexmedetomidine to tramadol in patients undergoing adenotonsillectomy to reduce emergence agitation. Inclusions: ASA I-II, 2 to 12 yrs old, undergoing adenotonsillectomy. Exclusions: patients with developmental delay, cardiac disorder, psychological disorder, epilepsy, allergy to study medications. Method: standard anaesthetic induction with 8% sevoflurane and 60% N2O. IV fentanyl 1mcg/kg and rocuronium 0.6mg/kg were administered and intubation was performed. Group T received tramadol 2mg/kg whilst group D received dexmedetomidine 1mcg/kg. In both groups the tramadol and dexmedetomidine were made up into 10ml of solution to allow the anaesthetist to be blinded to intervention. Results: Of 80 enrolled patients, 77 were randomised to two groups. Group D compared to group T had significantly lower heart rate and blood pressure at 10 minutes into surgery. They also had significantly longer time to extubation (6.8 vs. 3.2 mins p=0.0012), time to discharge from recovery (37.6 vs. 15.2 mins p=0.0013), and were significantly more drowsy for up to 45 mins in the postoperative period. There was no significant difference between the groups for postoperative morphine requirements, postoperative nausea and vomiting, or postoperative agitation.

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