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Title: **Assent of Children Participating in Clinical Anesthesia and Surgical Research: Is it Meaningful?**

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Introduction: The issue of assent for children has gained increasing importance given the requirements of the NIH to incorporate children in clinical research. There is, however, some debate regarding the ability of children to make informed decisions about their participation in research and the age or developmental levels at which permission for assent should be sought (1,2). This study, therefore, was designed to examine factors that children use to make decisions regarding participation in clinical anesthesia research and their level of understanding of the elements of informed consent.

Methods: This study was approved by our Institutional Review Board. Children between the ages of 7 and 17 years who had given their assent (plus parental consent) for participation in an ongoing anesthesia study were included. Children were interviewed using a structured interview to determine their understanding of the elements of consent for the study to which they had agreed to participate. These included: the study purpose, protocol, risks, benefits to themselves and to others, alternatives, voluntariness, and freedom to withdraw. Understanding of these elements was scored by two assessors who were familiar with each of the study protocols. A composite score of understanding based on the assessors' scores was derived and compared with the child's perceived level of understanding. Information was also elicited as to who had helped them make their decision and the reason(s) for their participation. Other demographic information was obtained from the parents.

Results: To date, 89 children who had assented to one of the studies were approached for interview and, of these, 68 agreed (with parental permission) to be interviewed (76.4%). Of the 21 who were not interviewed, 11 (52.4%) did not remember being recruited for a study, 7 (33%) declined, and 3 (14.3%) were not available. The mean age of the children was 12.0 ∂ 3.2 yrs and 49.4% were female. On a scale of 0-10, children perceived their overall understanding of their study as 6.8 ∂ 2.7, however, this represented a significant over-estimation compared to the assessors' score of understanding (5.1 ∂ 2.8, $P<0.001$). Based on the assessors' scores, only 45.6% had complete understanding of the risks, 36.2% completely understood the benefits to themselves, 41.4% understood the purpose of the study, 39.7% completely understood the protocol, and 26.2% understood the alternatives. Children over the age of 11 had greater understanding than those 7-10 yrs (5.5 ∂ 2.7 *vs* 2.0 ∂ 1.9, $P<0.001$). Interestingly, parents reported that the age at which they believed assent should be sought was 11.6 ∂ 3.9 yrs. Fifty-five percent of children reported that their parents had been the primary influence in their decision to participate, whereas, 36.9% stated that the decision had been their own. Children ranked their level of stress as 4.6 ∂ 2.9 on a scale of 0-10 (10=most stressed). Three children (4.5%) stated that being asked to be in a study had made them more stressed. Reasons for agreeing to participate in the study included: to help others (24.5%), no risks (11.3%), the benefits (7.5%), "just to try it" (16.9%), and don't know (15.1%).

Discussion: Our results, albeit preliminary, suggest that children approached for their assent to participate in a clinical anesthesia study have minimal understanding of the elements of informed consent and their role as a research participant. If indeed, assent in children is to be meaningful, it behooves investigators to enhance understanding and the environment in which assent is sought.

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2) Susman EJ, et al. J Pediatr, 1992

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Title: **Emergence Behavior in Children: Reliability Between Assessments of Anesthesiologists and PACU Nurses**

Author(s): H.J. Przybylo, MD, Richard D. Martini, MD, Aleksandra J. Mazurek, MD, Charles J. Coté, MD

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Introduction: The terms anxiety, agitation and delirium have been used to describe the behavior of children emerging from anesthesia. (1, 2) To date no study has used psychiatric definitions as described in Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) to make these diagnoses. (3) We used strictly defined signs and symptoms of anxiety and delirium to evaluate children during emergence. This study compared the assessments of post anesthesia care unit (PACU) nurses to anesthesiologists to determine if these behaviors could be consistently scored.

Methods: After Institutional Review Board approval and parental consent, children ages 3 to 7 years were videotaped emerging from anesthesia while in the PACU. Only children who had a caudal block and were free of pain were included. The videotapes were reviewed by a pediatric psychiatrist and a pediatric anesthesiologist to select segments of patients demonstrating signs and symptoms of anxiety and delirium. A demonstration tape was constructed using these examples. A second test tape of 10 different children filmed upon arrival to the PACU with 1 minute segments at five minute intervals for thirty minutes duration was made. These children demonstrated normal, anxious or delirious behavior evaluated by the same signs and symptoms and scored by the investigators. The demonstration tape along with a set of written definitions and instructions were given to the evaluating nurses and physicians. After successfully reviewing the educational materials, 10 PACU nurses and 10 pediatric anesthesiologists evaluated the test tape scoring each of the 10 children at 7 time intervals (70 scores per tape). The test videos of these behaviors were randomly placed on the study tape to prevent learning or bias in scores. All evaluators were blinded as to which clip corresponded to each behavior example. The signs and symptoms of the Chicago Children's Delirium Score are listed in table one. Data were analyzed using the Spearman correlation between nurses, between anesthesiologists, and comparing nurses to anesthesiologists.

Table 1:

Orientation (what's your name? Where are you? Is it day or night?)	Sensitivity to touch (withdraws from parent, from medical staff, from vitals signs, no withdrawal)	Hallucinations: visual (present / absent)
Attention (Able to follow no commands, one command, two commands, multiple commands)	Psychomotor Behavior (normal behavior, mild restlessness, moderate restlessness, severe agitation/combativeness)	Hallucinations: auditory (present / absent)
Recognition (no-one, just parent with hint, parent only, parent and staff)	Perceptual Disturbance (misidentifies self, surroundings, objects, no misidentification)	Hallucinations: tactile (present / absent)

Results: 315 Spearman correlations were carried out for nurses and anesthesiologists and 700 Spearman correlations were carried out between the 10 nurses, 10 anesthesiologists, and the 7 time periods. Correlations are presented in table 2

Table 2:

	Nurses	**Anesthesiologists**	**Nurses & Anesthesiologists**
Mean correlation	0.728	0.786	0.763
Median correlation	0.778	0.832	0.816
Percent significant at the 0.05 level	59.7	73.4	67.9
Percent significant at the 0.01 level	28.9	39.9	37.0
Percent R^2 value ∅0.70	65.1	76.8	71.9
Percent R^2 value ∅0.80	45.4	60.0	56.3
Percent R^2 value ∅0.90	19.7	23.5	24.3

Discussion: Our results indicate both anesthesiologists and PACU nurses are able to reliably score the signs and symptoms of anxiety and delirium as defined by psychiatry. The high correlation within and between groups indicates the ease of use of this system. The development of this tool will allow future studies to differentiate between two different psychiatric abnormalities that are classified interchangeably in present anesthesia literature.

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Title**: Academic Pediatric and Adult Anesthesia Crisis Resource Management Training: A New Educational Approach**

Author(s): RH Blum[*]; JB Cooper[#]; DM Feinstein[+]; DB Raemer[#]; RK Russell[%]; N Sunder[#]

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Introduction: Patient safety is now widely recognized as an important healthcare concern. Many efforts are underway to reduce medical errors and the injuries that result from them. Despite improvements in the safety of anesthesia practice, human error continues to play a substantial role in anesthesia-related accidents and malpractice insurance claims. Many of these errors involve poor team coordination and behaviors.[1,2] In an attempt to potentially improve patient safety, we created a course for academic pediatric and adult anesthesia faculty that addresses the demands of training clinical experts and issues particular to resident supervision. Based on aviation's Crew Resource Management training, Gaba et. al. developed Crisis Resource Management (CRM) training for healthcare, first involving anesthesiologists.[3,4] The concept has been adopted by many centers, applied to different specialties and extended to multi-disciplinary teams. In 2001, the self-insurer covering anesthesiologists at our institutions offered a discount to CRM-trained anesthesiologists. This prompted us to design a course for approximately 300 faculty from our pediatric and adult hospitals.

Methods: Course objectives include teaching CRM principles, stimulating ongoing CRM training and behaviors during clinical training, and improving faculty's debriefing of critical events with residents. We were sensitive to the potential to intimidate or embarrass expert clinical participants and generate resistance beyond that already raised by the seemly arbitrary requirement of the insurance company. The course designers developed challenging simulator scenarios that are unlikely to place individuals in embarrassing situations. Courses begin with a team scenario followed by didactics and debriefings used in other CRM courses. At least one scenario requires response to a resident's call for help. Debriefings include discussion with the simulated resident, who remains in character. Other specific issues that are discussed are the handling of conflict and understanding of the mechanisms of learning at different levels (novice through expert).[5,6] Debriefing principles and skills are emphasized as well as identifying the needs of residents, patients, parents and families, risk management, and colleagues following a critical event. We are currently planning a specific experiment in which we will compare intact pediatric cardiac anesthesia teams to mixed teams that include pediatric and adult anesthesiologists from different institutions. This may lead to important insights related to differences in pediatric vs. adult anesthesiologists and how intact teams differ from the mixed teams that we are currently training.

Results: Approximately 60 faculty participated in the course to date. Multiple criteria were rated in a post-course survey. The average overall course rating is 1.2 on a 5-point Likert-scale (1 = excellent; 5 = awful). Quality of debriefings, realism, and usefulness in clinical practice were all rated highly. Most participants felt this type of training should be repeated at least every two years.

Conclusions: A highly self-rated simulator course for academic anesthesia faculty has been created attempting to address some of their unique needs. While course specifics are not provided, the general concepts can be used to develop similar courses at other centers.

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Title: **Tracheal Dimensions in Sedated Children: Where is the Narrowest Part?**

Author(s): Ronald S. Litman, Eric E. Weissend, Dean Shibata, Per-Lennart Westesson

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Introduction: Conventional wisdom has held that the shape of the child's trachea differs from that of the adult. The infant's trachea is said to be conical in shape with the narrowest part at the level of the cricoid cartilage; the adult trachea is more cylindrical, with the narrowest part at the level of the vocal cords.[1] Textbooks on pediatric anesthesia infer that this shape changes at about the 8th year of life.[2,3] However, no studies have been performed to correlate age with tracheal diameter. The purpose of this study was to determine the age at which the child's trachea becomes shaped like the adult's.

Methods: The institution's IRB approved this study and parental informed consent was obtained. All infants and children presenting for elective MRI of the head or neck under general anesthesia were eligible to participate. Axial scans (3 mm slices) of the trachea from the supraglottic region to the cricoid cartilage were obtained while the children breathed spontaneously under deep sedation with propofol. Transverse and antero-posterior (A-P) tracheal dimensions at the level of the glottic opening, sub-vocal cord region, and cricoid cartilage were measured and compared, and correlated with age.

Results: Data from 99 children were analyzed. In the initial data analysis, males and females were analyzed separately. However, since their results were essentially the same, we report the aggregate results. In all children studied, the narrowest portion of the trachea was the transverse diameter of the vocal cords and transverse diameters were narrower than A-P diameters at the glottic and sub-vocal cord levels. At the level of the cricoid cartilage, nearly all children were either narrower in the transverse dimension or were equal in both transverse and A-P dimensions. Transverse diameters tended to increase linearly in a caudad direction ($P < 0.001$, Figure 1), while A-P diameters did not change relative to tracheal level (Figure 2). These relationships are demonstrated in a representative scan (Figure 3). The ratio between the cricoid and glottic transverse diameters did not change as a function of age ($r = 0.1$, $P = 0.2$).

Discussion: Our data sheds light on the relationships of upper tracheal diameters that was previously unknown. Previous studies in cadaver specimens determined that the cricoid ring, being indistensible, is the narrowest site of the child's trachea. However, this condition is obviously not relevant to many clinical situations. This study demonstrated 2 important findings: (1) In sedated children, the upper trachea gradually widens in a caudad direction, but only for the transverse diameter, and (2) In prepubertal children, the relationship between these diameters is not influenced by age.

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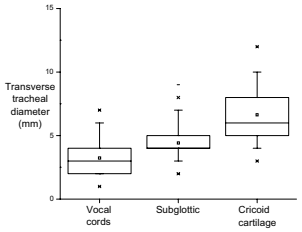
Fig 1.



Vocal cords

Fig 2.

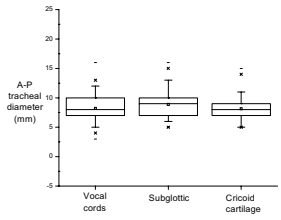
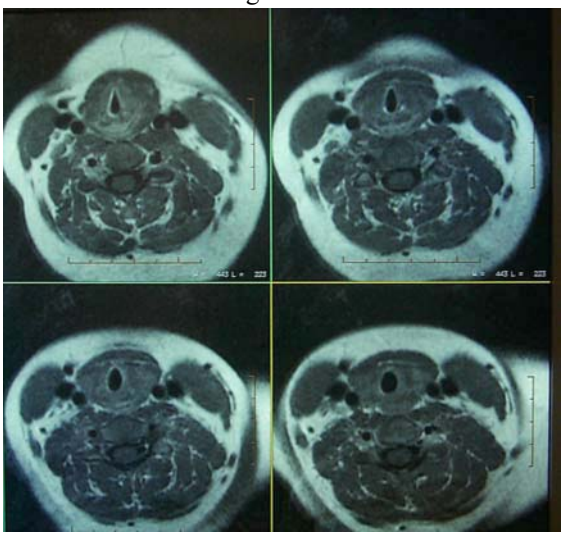


Fig 3.



Cricoid ring

Title: **Comparison of Reinforced and Standard Laryngeal Mask Airways in Children**

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Introduction: Role of laryngeal mask airway (LMA) is quite well established for airway management in pediatric age group. However, most of the studies have focused on the use of standard LMA size 2 which has a tendency to kink. Modification of LMA, the reinforced LMA (RLMA), specially designed for ENT & dental surgery has recently become available which is nonkinking(1). Various authors have reported difficulty in insertion of RLMA due to its extreme flexibility. Present study was thus designed to compare the ease of insertion & placement of reinforced & standard LMA in children.

Methods: After institutional review board approval & informed consent, 100 children (6 mo-10 yrs.) weighing 6.5-30 kg., scheduled to undergo elective surgery under GA were randomized to one of the two groups ,Group A (n=50)—Standard LMA ,and Group B (n=50)—Reinforced LMA. Anesthetic management consisted of inhalational (2-3 % halothane) or intravenous (thiopentone 4-5 mg/kg) induction followed by suxamethonium 2mg/kg. When the depth of anesthesia was judged to be adequate, LMA was inserted using standard method as recommended by Brain, cuff inflated &placement confirmed by chest inflation after gentle IPPV. Monitoring included HR, NIBP, SpO2 and etCO2 (Datex Ohmeda). Ease of insertion was judged by the number of attempts required for successful insertion , time taken and the occurrence of complications like cough, laryngospasm or desaturation. Actual position of LMA in relation to larynx was ascertained by passing a fibreoptic laryngoscope (Pentax) through the tube of LMA up to the grilled aperture and view graded as grade 1 to 4 (depending on whether glottic opening was completely visualized or obscured by epiglottis) (2). Data was statistically analyzed using Fisher's exact test Chi-square test, with significance assumed at $p<0.05$.

Results: Demographic data was comparable in two groups. Mean insertion time was significantly longer in Group B vs Group A (38∂ 6.9 vs 27.39 ∂8.18 sec. respectively) [p<o.o1] With experience insertion time decreased in both groups. Significantly more number of patients in group B required second attempt at insertion (32% vs 6%) [p <o.o5] Fibreoptic grading was not significantly different in two groups with almost 27 & 21 % patients in gr.A & B respectively having grade 3 or 4 placement but not all of these patients had clinical airway obstruction. Desaturation occurred in 4 children in gr. B during insertion (SpO2<90%). There was failure to insert in 1 patient in gr.A & 2 in gr.B (Table)

Discussion: We conclude that reinforced LMA is slightly more difficult to insert as evidenced by more no. of attempts & a longer insertion time .However it provides a satisfactory airway in most of the cases. Insertion time was longer than reported by Brimacombe et al(17 sec.) ,probably because their study was conducted in adults. There was no correlation between fibreoptic grading & clinical airway patency. Further controlled clinical trials are required to establish its role in head & neck surgery.

TABLE 1

	Group A	Group B
1.Ease of insertion- Time(sec)	27. 39 ∂ 8.18 (19- 52) sec.	38 ∂ 6.90 (28 –57)∂ 1
No. of attempts-- one	43	32 11
two	6	16
Failure to insert	1	2
2.Fibreoptic grading -Grade 1	18(38.3%)	17(36.2%) (
Grade 2	16(34.1%)	20(42.6%)
Grade 3	9(19.2%)	8 (17%)
Grade 4	4 (8.5%)	2 (4.2%)
3.Complications- desaturation	0	4 (during insertion)
laryngospasm	5	3
Airway obstruction	2	0

1 $p<0.01$ 11 $p<0.05$ (not significant

All values mean ∂ S.D.

Refs.

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3. Brimacombe J. et al., Can J Anaesth 1999

Title: **Anesthesia for Fetal CCAM Resection by EXIT Procedure**

Author(s): L. Terranova, J.L. Galinkin, C.D. Kurth, A.J. Schwartz

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Introduction: Congenital cystic adenomatiod malformation (CCAM), an abnormality in fetal lung development, can severely compromise cardiopulmonary function resulting in hydrops fetalis or death in-utero. CCAMs warrant open fetal surgery at 19 - 27 wks gestation, to restore cardiac function and allow fetal lung growth. The fetal Ex-Utero Intrapartum Therapy (EXIT) procedure, by comparison, is done near term usually for large neck masses which occlude the airway. The EXIT uses the placental circulation to maintain fetal oxygenation while the fetal airway is established for postnatal survival. In this case, we describe the use of the EXIT procedure to maintain fetal oxygenation to permit resection of a CCAM immediately followed by birth of a pre-term infant.

Case report: This 25y/o. 66kg G3P2 woman had a 27wk gestation pregnancy compromised by a right fetal CCAM complicated by hydrops fetalis. After placement of a fetal thoraco-amniotic shunt to decompress the CCAM, PROM and premature labor ensued. A labor epidural was placed, tocolysis failed, and maternal chorioamnionitis developed. Because typical open, elective fetal CCAM resection was not an option and intra-operative cardiopulmonary failure was likely with postnatal surgery, resection of the CCAM with placental circulatory support was planned through the EXIT procedure.

Preoperatively, the mother received bicitra and metoclopramide, the operating room was warmed to 80 degrees and type-specific and O-negative PRBC's, were available for the mother and fetus, respectively. The epidural was removed due to maternal fever and concern of bacteremia. After standard ASA monitors were placed, the mother was positioned with left tilt, preoxygenated, and a rapid sequence induction with I.V. pentothal, succinylcholine,and fentanyl was performed, followed by orotracheal intubation. A second I.V. and radial a-line were placed. Anesthesia was maintained with 3% expired desflurane. Prior to uterine incision, desflurane was increased to 12% expired for uterine relaxation. Intravenous ephedrine was given to maintain a maternal SBP within 10 % of baseline.

After uterine incision with a hemostatic stapling device, the head, right arm and upper chest of the fetus were delivered. A pulse oximeter on the fetal hand and continuous echocardiography monitored fetal oxygenation and hemodynamics. A level 1 ™ rapid infuser maintained amniotic fluid volume. Fetal anesthesia was supplimented by fentanyl 20mcg IM, vecuronium 0.2mg IM and atropine 0.08mg IM. A right fetal thoracotomy, resection of CCAM and chest tube placement followed. After the wound was closed, the fetus was intubated and hand ventilated while surfactant was administered intra-tracheally. Arterial O2 saturation remained Ω50% despite vigorous hand ventilation with 100% oxygen. After several minutes, oxygen saturation improved, the umbilical cord was clamped and the baby delivered. An hour later, in the NICU bradycardia and hypotension ensued, chest compressions were delivered and a tension pneumothorax discovered. Jet Oscillatory ventilation improved oxygenation and hemodynamics. Anemia was noted a few hours later. Re-exploration of the chest to look for a site of bleeding found the chest dry. However, bleeding was discovered in the abdomen, and the baby expired during re-exploration.

Discussion: This report illustrates the use of the EXIT procedure to resect a CCAM, which would otherwise be in-operable in a preterm postnatal infant. Resection of large CCAM in neonates carries very high mortality from cardiopulmonary collapse, analogous to resection of mediastinal masses in children. In the present case, cardiopulmonary failure was certain, given this risk as well as inevitable premature lung disease and pulmonary hypoplasia from the CCAM. The EXIT procedure with placental circulatory support avoided cardiovascular collapse during resection. Although the infant eventually expired, the resection went smoothly and death resulted from non-pulmonary disease.

Title: **Measuring Coordination of Care and Culture of Safety in ORs and ICUs at Teaching Hospitals**

Author(s): Raz Samandari, MD, Don Goldmann, MD, Dennis Ross-Degnan, PhD

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Context:

A number of studies have shown that hospitals in which patient care is well coordinated have significantly lower morbidity and higher perceived quality of care. The principles of quality improvement tell us that the insights of those in the frontlines can direct efforts to improve the coordination of care and safety attitudes.

Objective:

This study will develop and administer an instrument to measure both coordination of care and safety attitudes at the level of the care provider. In a teaching hospital residents are the initial point of contact with patients. A thorough evaluation of coordination of care and safety attitudes in the OR and ICU of teaching hospitals must take into account the perspectives of nurses, physicians, and housestaff. These insights can guide the implementation of quality improvement initiatives and be subsequently re-administered to evaluate the impact of new initiatives.

Design:

The survey instrument will be assembled after literature review of existing instruments, key informant interviews, and piloting of instrument with residents, nurses and attendings. The use of key informant interviews will supplement the scales and items in the literature review regarding the culture of residency programs and patient care. Survey themes: Coordination of care and Safety attitudes

Data analysis:

1. Reliability analysis:

Each scale will be assessed for internal consistency using Crombach's alpha statistic. (Table: alpha according to sub-scale and each professional group). Only reliable items will be used for hypothesis testing.

2. Descriptive statisitcs:

a. We will aggregate the individual scores of each of the professional groups by averaging the score of the respondents within each professional group. (Table: aggregate scores of participants by hospital unit (ICU, surgery, anesthesia) and by staff (resident, nursing, attending). Descriptive statistics for each sub-scale (eg. mean, SD) will be calculated according to hospital unit (ICU, surgery, anesthesia) and staff unit (resident, nursing, attending). (Table: descriptive statistics by sub-scale).

b. We will compare perceptions (according to each sub-scale) of the three staff groups (resident, nursing, attending) within each unit (ICU, surgery, anesthesia). We will compare perceptions (according to each scale) between the two units (ICU and OR). This comparison will be achieved by separate between subjects analysis of variance (ANOVA). (Table with ANOVA results).

Outcomes:

1. A psychometrically validated instrument that will measure coordination of care and safety attitudes in teaching hospitals.
2. Summary of nurses, physicians, and housestaff's insights into the coordination of care and safety attitudes at a major pediatric hospital.

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Title: **Survey of Obstetric Complications and Pregnancy Outcomes in Pediatric and Non-Pediatric Anestesiologists**

Author(s): V. Gauger, M.D., A.R. Tait, PhD., T. Voepel-Lewis, MSN, RN, P. Rubin, B.S., A. Kostrzewa, M.D.

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Introduction: Obstetric complications such as spontaneous abortion, preterm labor, preterm delivery, low birth weight, and congenital anomalies may be associated with exposure to anesthetic gases. Despite the establishment of guidelines for acceptable maximum levels of environmental trace anesthetic gases, pediatric anesthesia presents some unique problems of waste spillage due to the use of mask inductions, uncuffed endotracheal tubes, and circuits requiring high gas flows. This study was designed to determine whether anesthesiologists working solely or primarily with pediatric patients, having the potential for increased exposure to trace anesthetic gases, experience more complications during their pregnancies than anesthesiologists working primarily with adults.

Methods: Following approval by the Institutional Review Board, questionnaires were sent to all female Society of Pediatric Anesthesia members and to an equal number of randomly selected female American Society of Anesthesiology members. Subjects were asked to answer questions regarding their pregnancy outcomes, work history, and personal habits. The questionnaires contained no identifying information. Subjects were also asked to separately return a card containing identifying information so that respondents could be tracked but anonymity maintained. A second survey was sent to non-respondents after allowing four weeks for the return of the initial survey. Parametric data were analyzed using unpaired t-tests. Non-parametric data were analyzed by Mann-Whitney-U tests and Chi-square with Fisher's exact tests as appropriate. P values <= 0.05 were considered significant.

Results: 1948 surveys were sent and 824 were returned resulting in an overall response rate of 42%. Pediatric anesthesiologists were defined as those having greater than 75% pediatric practice. There were no differences between pediatric and non-pediatric anesthesiologists with respect to race/ethnicity, para and gravida status, social habits, prevalence of co-existing conditions, or use of operating room scavenging and ventilation systems. Pediatric anesthesiologists were statistically older and had more hours of operating room exposure during their pregnancies than non-pediatric anesthesiologists. The two groups had similar incidences of preterm labor, preterm delivery, low birth weight, and congenital anomalies. However, there was a significantly higher prevalence of spontaneous abortion among pediatric anesthesiologists (21.2% vs 15.2%, P=0.023). Given this association, an exploratory analysis was performed of several other factors to determine their contribution to the development of this outcome. Those found to be associated were entered into a logistic regression model with backward selection yielding two independent predictors of spontaneous abortion: increased age and increased frequency of exercise.

Discussion: Our results suggest a relationship between the percentage of pediatric cases one performs and the obstetric outcome of spontaneous abortion. This could possibly be due to an increased exposure to trace anesthetic gases during inhalation inductions and the use of uncuffed endotracheal tubes. Although a cause-effect relationship can not be established, the results suggest a potentially important association.

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Title: **Life Threatening Tension Pneumoperitoneum from Intestinal Perforation during Air Reduction of Intussusception in Children**

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Introduction

Intussusception is the most common cause of intestinal obstruction in children between 3 months and 6 years of age. A portion of the bowel is telescoped into a segment just caudad to it. Venous return for that portion of the bowel is constricted, with associated edema and bleeding from the mucosa. Clinically, patients may present with severe paroxysmal colicky pain that recurs at frequent intervals. In more advanced stages, this may be associated with vomiting, lethargy and fever. Passage of currant jelly stool may be present. The diagnosis is confirmed by hydrostatic enema which is also the method of reduction in most cases. These patients frequently do not present to the operating room and therefore are not seen by anesthesiologists. Those who do require surgical management are patients who failed hydrostatic reduction or those who present in shock or with peritoneal signs. Bowel perforation is possible as a complication of hydrostatic reduction. Patients may present with an acute abdomen requiring emergent abdominal decompression and laparotomy for definitive treatment. We present a patient who developed life threatening tension pneumoperitoneum following attempted air reduction of intussusception.

Case Report

A previously healthy 9-month-old child was brought to the emergency department with a history of abdominal pain, currant jelly stool and vomiting. He was diagnosed with intussusception and air enema was attempted. During the procedure, reduction of intussusception was unsuccessful but free air was noted. Although insufflation was stopped immediately, the child's abdomen was extremely distended. While on transport to the operating room, it was noticed that the child's breathing became more labored and then slowed. Tension pneumoperitoneum was recognized and the child was immediately carried into the operating room. Because of the patient's critical condition, needle decompression was carried out with a 14g angiocath in the upper abdomen. The abdomen deflated visibly, the child immediately regained a more normal pattern of respiration, and the vital signs obtained were within normal limits. A rapid sequence induction with ketamine and succinylcholine was carried out. After the airway was secured, the surgeons proceeded with laparotomy and ileocecal resection. The surgical procedure and the postoperative course were uneventful and the child recovered without sequelae.

Discussion

Hydrostatic reduction is an accepted approach to the nonsurgical management of intussusception. It can be performed using contrast, saline or air. The amount of pressure generated by air enema can be as high as 100mmHg. While air enema is considered safer than barium enema, both can lead to bowel perforation with soilage of the peritoneum by fecal material. Tension pneumoperitoneum is a rare complication of reduction using air. In a series of 246 patients presented by Stein *et al*, successful pneumatic reduction was achieved in 80.9%. Bowel perforation occurred in 2.8% requiring needle decompression of tension pneumoperitoneum in one of those seven cases. Following experience with a prior patient who sustained cardiorespiratory collapse from tension pneumoperitoneum following reduction attempt with air, needle decompression was rapidly initiated in our patient at the first sight of cardiorespiratory deterioration and resulted in immediate clinical improvement. Pediatric anesthesiologists must recognize the possibility of tension pneumoperitoneum as a complication of pneumatic reduction of intussusception and the gravity of this situation. Immediate needle decompression can be life saving and should be considered as part of the initial resuscitation.

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Group #2 – Equipment and Monitoring

Group Leader: Frank H. Kern, MD

#10 *Correlation of the BIS Monitor with Sedation Scores during Sedation for Mechanical Ventilation in Infants and Children*
Joseph D. Tobias MD, John W. Berkenbosch MD

#11 *Correlation of Venous and Arterial Blood Gases following Cardiothoracic Surgery in Infants and Children*
Joseph D. Tobias MD, John W. Berkenbosch MD

#12 *Measurement of Central Venous Pressure from a Peripheral Venous Site in Infants, Children and Adolescents*
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#14 *Old Versus New Needle Retractable IV Catheters: Are They Really Safer and Whom are They Protecting?*
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#15 *Intraoperative-Thermoregulation Device in Pediatric Liver Transplantation*
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#16 *Interim Analysis of Novel Theroregulation System in Maintaining Intraoperative Normothermia in Infants*
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#17 *Do Evoked Potentials Safeguard Against Spinal Cord Injury in Patients with Neuromuscular Disease?*
S. DiCindio, Mary C. Theroux, Robert P. Brislin

#18 *Bispectral Index Monitoring in Children Undergoing Conscious Sedation*
N. McDermott, T. VanSicle, D. Motas, R. Friesen

Title: **Correlation of the BIS Monitor with Sedation Scores During Sedation for Mechanical Ventilation in Infants and Children**

Author(s): Joseph D. Tobias MD, John W. Berkenbosch MD

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Introduction: During mechanical ventilation, sedative/analgesic medications are routinely titrated to the desired effect based on the clinically assessed needs of the patient. The BIS monitor uses a modified electroencephalogram (EEG) to quantify the effects on the central nervous system of anesthetic and sedative agents resulting in a numeric scale ranging from 0 to 100. The current study prospectively assesses the correlation between the BIS number and a commonly used bedside clinical sedation score, the Ramsay score (1= awake, agitated; 6 = no response).

Methods: This retrospective review was approved by the Institutional Review Board of the University of Missouri and written, informed consent obtained from a parent. The bispectral index (BIS number) was obtained using the BIS monitor (Aspect Medical Systems, Newton, MA) according to the manufacturer's recommendations. Changes to the sedation regimen were not based on the BIS number, but rather titrated according to the clinical needs of the patient. Data collection included simultaneous recording of the BIS number, the Ramsay score, and sedative/analgesic agents and dose at 2-4 hour intervals. The data were collected for a maximum of 5 days or until tracheal extubation. Data were analyzed in the following manner. The median and interquartile range of the BIS value for each Ramsay score were calculated. We also evaluated the efficacy of the BIS monitor in distinguishing between 3 groups of the Ramsay score, designed to categorize clinical sedation as inadequate (Ramsay = 1), adequate (Ramsay = 2 to 4) or oversedation (Ramsay = 5 or 6). To determine the potential for using the BIS monitor when clinical examination was unavailable, we calculated the sensitivity and positive predictive value of various BIS numbers (40 and 50) to differentiate between adequate and inadequate sedation or adequate and excessive levels of sedation using the previously provided definitions. Between group analysis was performed using the unpaired Student's t-test for two groups or the Kruskall-Wallis one-way analysis of variance for three or more groups. A p value of <0.05 was considered significant.

Results: Four hundred twenty-eight data points were collected from 24 patients ranging in age from 1 month to 20 years (5.7 ± 6.1 years) and in weight from 3.2 to 86 kg (26.7 ± 25.6 kgs). Patients were enrolled in the study for 10 to 150 hours. Sedation was primarily provided with infusions of midazolam/fentanyl (16), propofol (6), lorazepam (1) or fentanyl (1). As no significant difference was noted between the groups regarding the agent used for sedation and the correlation of the BIS number and the Ramsay score, the data from the different sedation regimens are included together. For a Ramsay score of 1 to 6, the respective median BIS number was 54, 65, 48, 42, 42 and 36. For the 3 divisions of the Ramsay score (undersedated, adequately sedated and oversedated), the median and range of the BIS numbers were: 54 (44-76), 47 (39-64) and 39 (27-56) respectively. To differentiate adequate from inadequate sedation according to the Ramsay scale, a BIS value of 70 was a sensitive (0.85) indicator of adequate sedation while the positive predictive value was 0.93, implying that greater than 93% of individuals with a BIS number of 70 or less would be adequately sedated. Decreasing the BIS threshold to 60, decreased the sensitivity to 0.72 without altering the positive predictive value (0.93). The BIS number was less efficient in identifying excessive sedation as identified as a Ramsay score of 5 or 6. A BIS number of 40 or less had a low sensitivity (0.55) and a low positive predictive value (0.38) of correlating with excessive sedation as judged by the Ramsay score. Increasing the BIS cut-off to 50, improved the sensitivity (0.70), but did not significantly alter the positive predictive value (0.35).

Discussion: The BIS number correlated with the Ramsay sedation scale and was effectively able to differentiate clinically adequate from inadequate sedation. However, the BIS number was less sensitive in identifying excessive levels of sedation. Future trials are needed to further define the role of the BIS monitor in the Pediatric ICU setting. Since completion of this study, Aspect Medical Systems has introduced an upgrade of their original monitor which offers the potential advantage of eliminating the background EMG activity from interfering with the BIS number which may be particularly advantageous when used in patients not receiving neuromuscular blocking agents.

Title: **Correlation of Venous and Arterial Blood Gasses Following Cardiothoracic Surgery in Infants and Children**

Author(s): Joseph D. Tobias MD, John W. Berkenbosch MD

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Introduction: The intermittent measurement of arterial blood gases (ABG) is performed to assess the adequacy of oxygenation and ventilation. If arterial access is lacking, it has been suggested that venous or capillary values correlate with arterial values. The current study compares the correlation of simultaneously obtained arterial and venous blood gases following cardiothoracic surgery in infants and children.

Methods: This retrospective review was approved by the Institutional Review Board of the University of Missouri. The records of infants and children who underwent cardiothoracic surgical procedures were reviewed and data recorded from patients who had simultaneous measurements of arterial and venous blood gases. Venous blood gases (VBG) were obtained from either the pulmonary artery (PA) or central venous catheter while ABG's were obtained from either a radial or femoral arterial catheter. Patients with a postoperative shunt on intraoperative or postoperative echocardiography were excluded from the study. The veno-arterial PCO2 difference was plotted against the venous oxygen saturation and compared at various levels using a non-paired t-test with a Bonferoni correction for multiple comparisons. Chi-squared comparison with Yates' correction was used to compare the number of samples with a venous-to-arterial PCO2 gradient of 5 mmHg or less in samples with a venous oxygen saturation of $\geq$ 70% to those with a saturation of < 70% and to compare the number of samples with a pH gradient of 0.05 or less in samples with an oxygen of $\geq$ 70% versus those with a central venous saturation of < 70%. All data are presented as the mean $\pm$ SD with $p<0.05$ considered significant.

Results: The cohort for the study included 14 infants and children undergoing cardiothoracic surgical procedures for correction of congenital heart disease. The patients ranged in age from neonates to 48 months (6.2 $\pm$ 2.3 months) and in weight from 2.9 to 16.1 kgs (5.01 $\pm$ 3.15 kgs). Ninety-five simultaneous samples were obtained for venous and arterial blood gas analysis. Sixty-three venous samples were obtained from a central line (49 internal jugular and 14 femoral vein) and 32 were obtained from the PA catheter. The venous-to-arterial difference was 8.9 $\pm$ 3.9 mmHg from samples obtained from central venous catheters and 6.8 $\pm$ 3.1 mmHg from samples obtained from the PA catheter. The venous-to-arterial pH difference was 0.05 $\pm$ 0.02 with samples obtained from central venous catheters and 0.04 $\pm$ 0.02 with samples obtained from the PA catheter (p=NS). The venous-to-arterial CO2 difference was $\leq$ 5 mmHg in 8 of 63 measurements obtained from central venous catheters and 8 of 32 samples obtained from the PA catheter (p=NS). The following results include data pooled from central venous and PA catheters. The venous PCO2 was 45 $\pm$ 9 mmHg while the arterial PCO2 was 37 $\pm$ 7 mmHg with an overall venous-to-arterial difference of 8 $\pm$ 4 mmHg. The venous-to-arterial CO2 difference was 0 to 5 mmHg in 17 samples, 6 to 10 mmHg in 49 samples, and greater than 10 mmHg in 29 samples. There was a significantly greater discrepancy between the venous and arterial values for both PCO2 and pH when the central venous oxygen saturation was less than 70% compared to when the venous oxygen saturation was $\geq$ 70%. With a venous oxygen saturation of $\geq$ 70%, the venous-to-arterial CO2 difference was 0 to 5 mmHg in 13 of 33 values compared to 4 of 62 values when the venous oxygen saturation was < 70% ($p<0.01$). The venous-to-arterial difference for PCO2 was 5.5 $\pm$ 3.1, 9.0 $\pm$ 3.4, 9.9 $\pm$ 3.6 and 10.7 $\pm$ 4.1 mmHg with venous oxygen saturations of $\geq$ 70, 60-69.9, 50-59.9 and < 50% respectively. Similar results were obtained with pH values.

Discussion: In the current cohort of infants and children following cardiac surgery, there was a poor correlation of venous and arterial blood gas values suggesting that venous blood gas values cannot be safely used for clinical decision making in this patient population. The discrepancies between the venous and arterial values were greatest in samples with a venous saturation of less than 70%.

Title: **Measurement of Central Venous Pressure Vrom a Peripheral Venous Site in Infants, Children and Adolescents**

Author(s): Joseph D. Tobias MD, Joel O. Johnson MD, PhD

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Introduction: Measurement of central venous pressure may be indicated in infants and children as a means of assessing intravascular volume status or cardiovascular status. While generally safe, complications may occur with central approaches to the venous system including arterial puncture, pneumothorax and infection. Additionally, in certain populations, access to the central venous system may be limited. Two studies in the adult population have suggested a clinically useful correlation of central venous pressure measurements obtained from a peripheral intravenous site with that obtained from a central catheter (*J Cardiothor Vasc Anes* 2001;15:40-43 and *Anesth Analg* 2001;92:172-179). The current study compares central venous pressure (CVP) measured from a peripheral intravenous cannula with that measured from a central site in infants, children and adolescents.

Methods: The study was approved by the Hospital's Institutional Review Board and verbal, informed consent obtained from a parent. Patients presenting for surgical procedures in which central venous pressure monitoring was thought necessary were included in the study. Following anesthetic induction, a central venous catheter was placed and the position confirmed by x-ray. Using a readily accessible vein, a peripheral intravenous cannula was placed. Central venous pressures were measured from both the peripheral cannula and the central venous cannula using standard pressure transducers leveled at the mid-thorax level throughout the surgical procedure. Continuity of the peripheral venous cannula with the downstream venous system was evaluated by assessing the change in pressure with occlusion of the arm or leg above the peripheral intravenous cannula and a Valsalva maneuver. If no change was noted, data were still collected, but the lack of change was noted on the data collection sheet. The CVP measured from the peripheral cannula and the central venous cannula was recorded every 15 minutes. To avoid biasing the results by over-representation of data from patients undergoing long procedures, the data from each patient were averaged and counted as one data point. Using raw numbers (no negatives or positives) for the whole cohort, the average difference, maximum difference, and range of differences were determined. Statistical analyses included non-paired, two-way t-test and Fisher's exact test. All data are presented as the mean $\pm$ SD.

Results: The cohort for the study included 12 patients ranging in age from 4 weeks to 18 years (9.1 $\pm$ 6.4 yrs) and in weight from 4 to 91 kgs (37.5 $\pm$ 29.6 kgs). The peripheral cannula size was a 24 gauge (1), 22 gauge (1), 20 gauge (2), 18 gauge (3) or 16 gauge (5). The peripheral cannula was located in either an upper extremity (5) or lower extremity (7). No difference was noted in the data in regards to cannula size or placement (upper vs. lower extremity) and therefore all of the data are considered together. The difference, maximum difference and range of difference between the peripheral and central venous pressure was: 3.1 $\pm$ 2.8, 6.2 $\pm$ 3.8 and 5.8 $\pm$ 4.0 mmHg respectively. In 144 of 175 of the points, the absolute difference between the CVP from the peripheral and central catheter was less than 5 mmHg. In 158 of 175 of the points, the CVP from the peripheral cannula was greater than that measured from the central catheter. When the CVP measured from the peripheral catheter was greater than the CVP from the central catheter, the difference between the values was 3.2 $\pm$ 2 mmHg while the difference was 1.7 $\pm$ 1.0 mmHg when the CVP from the peripheral catheter was less than that measured from the central catheter ($p=0.0036$). When the pressure from the peripheral catheter was less than the central catheter pressure, none of the 31 readings were different by 5 mmHg or more compared to 37 of 144 readings when the pressure from the peripheral catheter was greater than that from the central catheter ($p=0.00863$). In 2 of the 12 patients, there was no change noted in the peripheral venous pressure with a Valsalva maneuver or occlusion of the extremity above the peripheral cannula. In these two patients, the difference between the CVP from the peripheral and central cannula was 7.7 $\pm$ 2.4 mmHg compared to 2.2 $\pm$ 1.8 mmHg ($p=0.0035$) in the other 10 patients in whom there was an increase in the peripheral CVP with extremity occlusion and Valsalva maneuver.

Discussion: Our preliminary data suggest that central venous pressure can be measured from a peripheral cannula in infants, children and adolescents provided that there is demonstration of continuity with the downstream venous system as demonstrated by an increase in pressure with occlusion of the extremity above the cannula and a Valsalva maneuver. Since, in most instances, the peripheral CVP measurement was higher than the central CVP measurement and when lower, the difference was minimal, a low peripheral CVP measurement uniformly was indicative of a low central CVP measurement. If situations when time or patient issues preclude central catheter placement, given the above mentioned caveats, this technique may be indicated.

Title: **Predicting Recovery from Deep Neuromuscular Block by Rocuronium in Children and Adults**

Author(s):N Bakara, GF Fine, S Woelfel, M Solak, K Toker, BW Brandom.

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Introduction: When there is no response to a train-of-four (TOF) stimulus, a response to post tetanic stimuli (PTC) may be observed[1]. A relationship between the number of PTC and the time to the first response to TOF (T1) has been described for several muscle relaxants including pancuronium[2] and vecuronium[3]. However, no study has investigated this relationship in children recovering from rocuronium or compared this relationship in children with that in adults.

Methods: After IRB approval and written informed consent from the patient or the parent were obtained, 22 pediatric patients (age 2-5 years mean 3.6) and 20 adults (age 18-60 years, mean 34.6) were studied. All patients had ASA 1 or 2 physical status and were administered general anesthesia requiring tracheal intubation. Anesthesia was maintained with propofol infusion (200 μg/kg/min in children and 50-150 μg/kg/min in adults) and N_2O/O_2 mixture. The infusion of propofol was titrated to maintain hemodynamic variables within 10% of baseline. Fentanyl 1-2 μg/kg was administered in boluses as needed. Neuromuscular blockade was evaluated with accelerometry of the thumb, using PTC and TOF stimulation of the ulnar nerve prior to (baseline) and every 15 seconds after the administration of 1mg/kg of rocuronium.

Results: The first response to PTC and TOF stimulation appeared earlier in children than adults. The time from injection of rocuronium to the appearance of the fourth response of TOF ranged from 27-62 and 37-94 minutes in children and adult subjects respectively. The average time interval between the PTC and T1 was shorter in children than in adults (7 min and 16 min respectively). The relationship between the PTC and time interval between a given PTC and T1 response in both children and adults was exponential (R= -0.64 and –0.81 respectively). **Table 1**

Discussion: As expected children recover from neuromuscular blockade more quickly than adults, after the administration of 1mg/kg of rocuronium. These results confirm and extend those of previous studies.

Table 1: Neuromuscular effect of rocuronium 1mg.kg^{-1} in the two groups of patients
--All data is time in minutes--

	Children		Adults	
	Mean ± SD	Range	Mean ± SD	Range
Injection to first response to PTS	29.8±6.6 (n=22)	(16.2-39.2)	43.3±10.2*(n=20)	(24.0-62.0)
PTC-T1 interval	6.8±3.8 (n=22)	(2.4-16.2)	16.2±5.7* (n=20)	(8.0-27.3)
Injection to T1	36.4±8.7 (n=22)	(21.6-52.3)	56.4±14.9*(n=20)	(30.0-77.6)
Injection to second (T2) response to TOF	40.7±9.4 (n=20)	(25.7-55.1)	62.1±16.7*(n=20)	(34.0-85.2)
Injection to third response (T3) to TOF	43.3±10.5 (n=20)	(26.6-59.6)	67.4±18.0*(n=19)	(36.0-90.8)
Injection to fourth response (T4) to TOF	45±10.4 (n=20)	(27.2-61.6)	69.4±18.5*(n=19)	(37.0-94.0)

*$p<0.05$

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Title: **Old Versus New Needle Retractable IV Catheters: Are They Really Safer and Whom are They Protecting?**

Author(s): Roth AR, TerRahe C, Rae B, Dsida RM, Wheeler M, Przybylo HJ, Coté CJ and other members of the department.

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Introduction: Government regulations have mandated use of retractable needle systems for intravenous (IV) catheters. Although the goal of this mandate is to decrease the risk of accidental IV needle sticks, introduction of this new technology may increase other risks such as exposure to blood. Our experience after 5 months of use with such systems was that successful venipuncture was more difficult to recognize. This seemed to result in additional attempts at catheter placement and less time efficiency for successful insertion. In addition, factors such as unintended needle retraction and the apparent need for additional attempts at venipuncture seemed to result in greater exposure of room personnel to spilled or splattered blood. The purpose of this study was to examine our experience with one brand of retractable needle IV catheter system.
Methods: We undertook a prospective study of old versus new IV catheter technology. Since use of the new IV catheters is mandated and patients are not allowed a choice, the IRB indicated that informed consent was not required. We then assigned catheter type old (JELCO, Johnson & Johnson Medical) or new (Angiocath™ Autoguard™, BD Medical Systems, Inc) by week in the operating room and requested that staff fill out a brief questionnaire regarding: number of catheters used; patient age; patient weight; operative procedure; splashing or spilling of blood on linen, operating room table, floor, skin or clothing of the person inserting the catheter, skin or clothing of other OR personnel; accidental needle stick; and insertion time (defined as time from initial skin puncture to successful running of IV fluid - timed with a stop watch). Participation was voluntary.
Results: A total of 330 catheter insertions were evaluated during 20 operative days. A total of 14 attending anesthesiologists and a variety of residents and fellows participated in the study. The number of IV starts supervised or inserted by each attending varied from 5 to 59. The distribution of cases among surgical populations was equivalent between groups. There were no accidental needle sticks in either group. 9 days were used to collect data on the old catheters and 11 on the new catheters. The mean age was 6.5 ∂ 5.1 years. We analyzed the data in two ways: 1) comparing the old catheter vs. the new for all patients and 2) comparing children ≤ 3 years vs. children > 3 years (Table). Poor flashback was described as a problem in 18 new catheter insertions and no old catheter insertions (p = 0.003)*. When poor flashback was described compared with good flashback there were 2.5 times more catheters used (p = 0.001)**.

	Overall			**≤ 3 years**			**> 3 years**		
	Old (%)	**New (%)**	P value	Old (%)	**New (%)**	P value	Old (%)	**New (%)**	P value
1 catheter	93 (79)	**151 (71)**		19 (56)	**35 (62)**		74 (88)	**116 (74)**	
>1 catheter	25 (21)	**61 (29)**	0.169	15 (44)	**21 (38)**	0.69	10 (12)	**40 (26)**	**0.02***
Any Splatter/spill	11 (9)	**42 (25)**		4 (12)	**13 (23)**		7 (8)	**29 (19)**	
No splatter/spill	107 (91)	**170 (75)**	**< 0.02***	30 (88)	**43 (77)**	0.28	77 (92)	**127 (81)**	0.053*
Total splatters/spills	13	**75**		4	**29**		9	**46**	
Time of insertion (seconds)	77.5 ∂ 113	**102 ∂ 156**	**0.036****	130 ∂ 144	**149 ∂ 200**	0.08	56 ∂ 91	**85 ∂133**	**0.021****

* Chi square analysis ** Levines test for equality of variance

Conclusions: Our study of this brand of retractable IV catheter compared with the old technology revealed a marked increase in splattering/spilling of blood. This was true when examined as exposures per patient as well as total number of places where blood was spilled or splattered. It also took more catheters per patient in children > 3 years of age. Poor flash back was described as a problem in 18 new but no old catheter insertions. If there was "poor flash back", 2.5 times more catheters were used. In addition, although not clinically important, it took longer to successfully establish IV access using the new catheter technology. Our data suggest that although the risk for accidental needle stick may be theoretically reduced, there is an increase rather than a decrease in exposure of operating room personnel to blood products. There also is added cost for increased insertion time and number of catheters. This study was underpowered to estimate factors such as age, weight, ASA status, assessment of ease of IV access, and experience of the person inserting the IV.

Title: **Intraoperative-Thermoregulation Device In Pediatric Liver Transplantation**

Author(s): J. Katz, R.M. Steinberg, M. Kachko, N.Bar-Nathan, E. Shaharabani, Y.Ben-Ari , T.Sheinfeld, E. Mor

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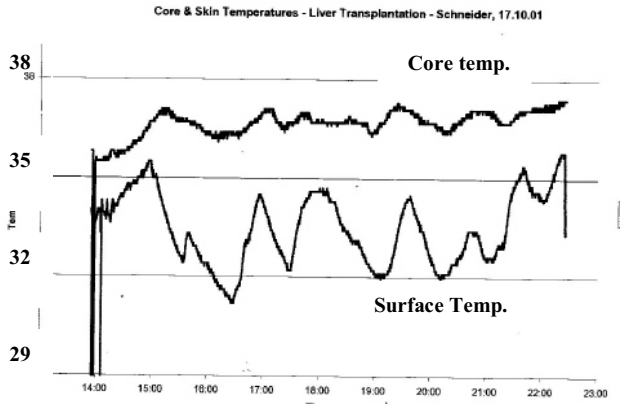
Introduction: One of the main problem during liver transplantation in infants is to maintain normal or near normal core temperature. Prolonged surgery and major hemodynamic changes in addition to loss of biochemical and homeostatic control during the unhepatic phase are the main contributing factors to low body temperature. We describe a new thermoregulation device Allon 2001, that helped us to maintain normorthermia throughout a living-related liver transplant in an infant.

Case Report: The patient was an 11-month-old infant with biliary atresia who underwent Kasai operation at 7 weeks. The indications for transplant included failure to thrive (weight 6.750 kg), hyperbilirubinemia (23.5 mg%) and hypoalbuminemia (2.4 g%). The child was brought to the operative theatre during the hepatectomy in his 25 years old mother who was the donor. The anesthesia was induced, lines were inserted and the thermal device was dressed, covering 4 limbs, back and head, and activated. MTRE's ALLON 2001, combines temperature sensors with a microprocessor controlled unit that supplies water at the required temperature into ThermoWrap™ garment worn by the patient during operation, water is constantly circulated between the ThermoWrap and the control unit. By monitoring the patient's core and skin temperature and then precisely controlling the surrounding water temperature in the garment, body temperature can be controlled and maintained at any level requested by the specific surgery.

Results: A rectal and skin probe measured the child core and surface body temperature. All fluids and blood products (5 x 10cc/kg packed cells, 4 u FFP, 6 u platelets) were infused without a warmer device. Room temperature was kept at 20-21^0_c. The transplant lasted 10.5 hours. Core temperature was maintained throughout the procedure at a mean temp of 36.7^0_c (range 36.6^0_c -37.1^0_c) [Figure].



Conclusions: The Allon 2001 thermoregulation device seems to be an important and a useful tool to maintain normothermia during liver transplantation in small children.

Title: **Interim Analysis of Novel Thermoregulation System in Maintaining Intraoperative Normothermia in Infants**

Author(s): J. Katz*, R. Steinberg, L. Kachko, O. Gelber

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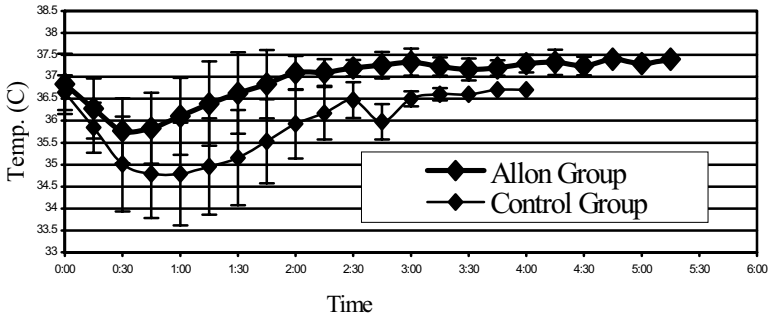
Introduction: Hypothermia is the most common perioperative thermal disturbance mainly resulting from impaired thermoregulation caused by general anesthesia and exposure to cold operating room. Even mild hypotermia has been associated with impaired coagulation and increased blood loss, increased incidence of wound infection, postoperative negative nitrogen balance, shivering and prolonged hospital stay.
The objective of our study was to evaluate the efficacy of a microprocessor controlled body temperature regulation system - Allon 2001, in maintaining body temperature during surgery in infants as compared with routine thermal care.

Methods: After institutional review board approval and informed consent 17 infants undergoing elective major abdominal and thoraco-abdominal surgery under combined general and continuous epidural anesthesia lasting more than one hour were randomized to one of two groups: group A (Allon group) -10 patients and group B (control group) -7 patients, forced-air warmer (BairHugger). Anesthetic management consisted in anesthetic induction with halothane (1-3%) and 70% nitrous oxide in oxygen followed by iv administration of midazolam 0.05 mg/kg and atracurium 0.6 mg/kg. An epidural catheter was inserted and a loading dose of ropivacaine 2mg /kg was injected. Anesthesia was maintained with 65% nitrous oxide and isoflurane. A continuous epidural infusion of bupivacaine 0.125% and fentanyl 1-2 mcg/ml at an infusion rate of 0.2 ml/kg was maintained throughout the operation and in the recovery room. Intravenous fluids were not warmed. In all cases operative room temperature was controlled at 21^0 C. Rectal and skin temperatures were continuously recorded during surgery and for two postoperative hours in the recovery room.
Group A patients were thermoregulated using the Allon 2001 system with infant Thermowrap^{TM} . Group B patients were warmed using an U-shaped tubular forced-air cover positioned around the sides of the patients and held in place with plastic adhesive.
The data were analyzed using unpaired T- tests, with significance assumed at the $P<0.05$ level.

Results There was no inter group difference with respect to age, surgical procedure or starting core temperature: During the first 30 min of anesthesia core temperature decreased in the two groups, to 35.8^{0}C in the Allon group and to 35.0^{0}C in the control group.
In the Allon group core temperatures increased after 30 min and reached 36.5^{0}C after 90min. In the control group core temperatures continued to decrease and only after 60 min began to rise, reaching 36.5^{0}C after 150 min. Differences between the groups were statistically significant after 30 min of anesthesia.



Conclusions: These data indicate that the Allon System warming is more effective than forced air warming in maintaining intraoperative normothermia in infants.

Refs:

1. Nesher N et al; Pediatric Anesthesia 2001
2. Kurz A et al; Anest Analg 1993

Title: **Do Evoked Potentials Safeguard Against Spinal Cord Injury in Patients with Neuromuscular Disease?**

Author(s): S. DiCindio, Mary C. Theroux, Robert P. Brislin,

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Introduction: Optimum monitoring for patients presenting for scoliosis surgery includes somatosensory (SSEP) and motor evoked (MEP) potentials. Neither monitor assesses the integrity of the entire spinal cord; however, used simultaneously, they allow for complete spinal cord assessment. In addition, the reliability of monitoring patients with neuromuscular (NM) disease, especially cerebral palsy (CP), is not certain. We designed a prospective study to evaluate the efficacy of evoked potential monitors in three different patient groups.
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Methods: Institutional Review Board (IRB) approval was obtained and the consent was waived. All patients presenting for spinal fusion were scheduled to have SSEP and MEP monitored. There were three groups. Group A (n = 60) idiopathic scoliosis, Group B (n = 40) NM scoliosis associated with CP and Group C (n = 30) NM scoliosis due to a disease process other than CP. Anesthetic management consisted of oral midazolam (0.5mg/kg) followed by a total intravenous (IV) anesthetic to optimize SSEP and MEP monitoring. This consisted of propofol infusion, sufentanil (.5–1 mcg/kg) bolus followed by an infusion (.1-.3 mcg/kg/hr). Neuromuscular relaxation was at a dosage to optimize MEP monitoring. Temperature and MAP were maintained at >35∀C and >65mmHg, respectively. Recording both afferent SSEP and efferent MEP monitored spinal cord function. In addition to spinal cord monitoring, subcortical ulnar nerve somatosensory evoked potentials were monitored to identify impending brachial plexopathy secondary to prolonged prone positioning **Statistics: Median**, min/max values reported. Kruskal-Wallis, Mann Whitney, Chi square, Dunnett T3.

Results: Age, wt., EBL, data given below. P <. 05 were accepted as significant.

	Idiopathic Scoliosis (n = 60)	Cerebral Palsy (n = 40)	Other (n = 30)	P-Value
Female/Male	54/11	21/19	16/14	.006
Age (yr.)	14.1 (10 – 19)	13.3 (4 – 20)	11.4 (1.7 – 18)	.011
Weight (kg)	53.2 (32.7 – 92.5)	30.6 (13 – 62)	34.0 (10.4 – 57.8)	.000
EBL/EBV % *	29.4% (15.4 – 28.8%)	174.4% (19.6 – 496.3)	55.5% (2.86 –3 6.7)	.000

*EBL given as % of EBV.

There were eight patients who had changes in their baseline-evoked potentials during surgery. Of the eight, one had permanent neurologic deficit after surgery despite standard intervention; i.e. steroids and removal of hardware.

Of the three groups of patients, all patients presenting with idiopathic scoliosis were monitored with EP's; 67% of patients who had scoliosis associated with CP were able to be monitored, and 83% of patients with scoliosis associated with NM disease, other than CP, were able to have monitoring performed.

Conclusions: We conclude that both SSEP and MEP can reliably be monitored in patients with NM diseases. We do not have any false negative results to report. Evaluation of false positive results is difficult to comment upon particularly in patients with neuromuscular scoliosis. There are no established interventions for loss of potentials in patients with baseline neuromuscular dysfunction. However, we took efforts to reverse the loss of evoked potentials without changing the course of surgery. Therefore, we recommend all attempts be made to have SSEP/MEP be performed on all patients presenting for spinal fusion including patients with NM scoliosis.

References: 1. Journal of Bone and Joint Surgery 80-A 1679-1683. 1988
2. Spine 1991; 16 (Suppl.): S 361-4

Group #3 – Techniques

Group Leader: Zeev Kain, MD

#19 *Practical Points About Closed Circuit Anesthesia with Children*
Robert S. Hozman MD, FAAP

#20 *Parental Presence During Anesthesia Induction and Emergence in Children Having Surgery: Impact on Child Behavior and Emergence Distress*
Tripi PA, Palermo TM, Florentino-Pineda I, Goldfinder MM, Williams D, Thomas S

#21 *Anesthetic Considerations for Normothermic Caval Inflow Occlusion*
K.C. Odegard, A. Schure, J.A. DiNardo, A.C. Shukla, D.D. Hansen, P.C. Laussen

#22 *Coagulation Factor Abnormalities in Patients with Single Ventricle Post the Fontan Procedure*
K.C. Odegard, F.X. McGowan, J.A. DiNardo, R.A. Castro, P.C. Laussen

#23 *Out of Sight, But Not Out of Mind: "Virtual" Parental Presence at Emergence*
Yvon F. Bryan MD, David B. Glick MD

#24 *Comparison of On-Site and Off-Site PDA Ligation in Premature Infants*
D.S. Gould, L.M. Montenegro, J.W. Gaynor, P. Stephens, S.P. Lacy, T.L. Spray, J.M. Steven, S.C. Nicolson

#25 *The Safety and Efficacy of Intravenous Pentobarbital for Sedation in Neonates and Infants with Natural Airways for Brain MRI in the Early Postoperative Period following Surgery for Congenital Heart Disease Involving Cardiopulmonary Bypass*
KK Galli, JW Gaynor, KL Peterson, LM Montenegro, JM Steven, DS Gould, SP Lacy, TL Spray, WM DeCampli, SC Nicolson

#26 *Anesthetic Implications of Epicardial Pacemaker Placement in Neonates with Congenital Complete Heart Block and a Structurally Normal Heart*
B.D. Kussman, D.R. Madril, E.P. Walsh, P.C. Laussen

#27 *Anesthetic Implications of Epicardial Pacemaker Placement in Neonates with Congenital Complete Heart Block and a Structurally Abnormal Heart*
D.R. Madril, B.D. Kussman, E.P. Walsh, P.C. Laussen

Title: **Practical Points About Closed Circuit Anesthesia With Children**

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The allometrically-based Brody number, $kg^{3/4}$, has to be multiplied by even larger constants than those used for adult calculations when used for infants and small children. A prime dose must be introduced in order to reach target alveolar and arterial anesthetic concentrations. The ventilatory component is the sum of the volume of the circuit (V_{circ}) plus the functional residual capacity (FRC) of the patient, obviously smaller in younger children. Relatively small arterial doses in comparison to ventilatory prime doses compel practitioners to precisely calculate pediatric dosing requirements during liquid injection techniques. Volume aspirated from the breathing circuit by an agent analyzer should be returned to the circuit so as not to continuously lose a significant portion of the minute ventilation to the scavening system. A sampling rate of 180 mL/min from an adult represents a 2% volume loss per minute while it is a 10% volume loss per minute for a 10 kg. child. (Table 1)

TABLE 1	**Adult**		**Child**	
Wt (kg)		100		10
Brody's #	$kg^{3/4}$	31.6	$kg^{3/4}$	5.6
O_2 Consumption (mL/min)	$10 * kg^{3/4}$	316	$14 * kg^{3/4}$	78.7
CO_2 Production (mL/min)	$8 * kg^{3/4}$	253	$11 * kg^{3/4}$	63
Free H_2O Requirement (mL/hr)	$5 * kg^{3/4}$	158	$6.7 * kg^{3/4}$	38
C.O. (dL/min)	$2 * kg^{3/4}$	63.3	$3 * kg^{3/4}$	16.9
Ventilatory prime dose (mL vapor)		169.00		122.00
Ventilatory prime dose (mL liquid)		0.82		0.59
Arterial prime (mL vapor)		160.00		42.9
Arterial prime (mL liquid)		0.78		0.21
Minute CO_2 production	$8 * kg^{3/4}$	252.8	$11 * kg^{3/4}$	61.6
Normocarbia (% atm)	5%		5%	
VA for normocarbia (mL/min)	$V_ECO_2/.05$	5,056.00	$V_ECO_2/.05$	1,232.00
$MV = V_A + V_D$ (mL/min)	å 3 $V_A/2$	7,584.00	å 3 $V_A/2$	1,848.00

The anesthetic itself may influence the respiratory quotient (RQ). In babies weighing less than 10 kg, a reduced VCO_2 in relation to VO_2 has been noted, yielding respiratory quotients that sometimes were lower than 0.7. Halothane, isoflurane, and enflurane are approximately equipotent inhibitors of thermogenesis, with concentrations of approximately 0.7% resulting in 50% inhibition.
Free water requirements are proportional to caloric demands and are therefore higher in children than adults. (Table 2)

TABLE 2	**Adult**	**Child**
Calories generated from consumption of 1000 mL O_2	4825	4825
Brody's #	$kg^{3/4}$	$kg^{3/4}$
Heat prod/hr	$(10* kg^{3/4}*4825*60) / 1,000$	$(14* kg^{3/4}* 4825*60) / 1,000$
Energy req'd for 1 mL of H_2O to evaporate (cal)	63	63
Heat of vaporization (cal)	540	540
mL water/hr	(10*kg 3/4*4825*60) / (1,000*603)	(14* kg 3/4*4825*60) / 1,000*603)
mL water/hr	å 5* $kg^{3/4}$	å 6.7* $kg^{3/4}$

Cuffless endotracheal tubes result in volume loss to the atmosphere and decreased volume return to the ventilator bellows. Pharyngeal packs may be used to seal the leak or a small-sized cuffed tube may be used. Caution should be taken to maintain the lowest practicable cuff pressure. Flowmeters may be insufficiently precise for use in pediatric patients. Anesthesia machines in the United States have flowmeters capable of oxygen flow rates as low as 50 mL/min, satisfactory for a closed circuit anesthetic in a normothermic child weighing about 5 kg. Older anesthesia machines have flowmeters set to match the metabolic oxygen requirement of the normothermic adult, approximately 250 mL/min., far exceeding the closed circuit oxygen requirement for almost all children. Gas machines with an "ALL GASES" override automatically disable the minimum oxygen requirement.

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Title: **Parental Presence During Anesthesia Induction and Emergence in Children Having Surgery: Impact on Child Behavior and Emergence Distress**

Author(s): Tripi PA, Palermo TM, Florentino-Pineda I, Goldfinger MM, Williams D, Thomas S.

Affiliation: Department of Anesthesiology, University Hospitals of Cleveland, Cleveland, OH 44106

Introduction: Many anesthesiologists allow parent presence during induction of anesthesia in children, however studies have failed to conclusively show that this benefits children or parents. (1) No studies have examined the impact of allowing parent presence during emergence from anesthesia, when children often demonstrate a dramatic degree of distress. Often referred to as emergence delirium, this distress is characterized by restlessness, combativeness, crying, and disorientation. Anxiety caused by rapid awakening in unfamiliar surroundings with unfamiliar people may contribute to emergence distress. (2) The purpose of our study was to examine whether parent presence in the operating room at the time of emergence from anesthesia would reduce the incidence or severity of emergence distress behaviors.

Methods: After Institutional Review Board approval and informed consent, a randomized and controlled trial of parent presence at emergence was conducted in a sample of 100 ASA class I and II children, ages 18 months to 9 years, having inguinal or penile surgery. Eight children were excluded from the study due to deviations from the protocol. Children in the study group (n=46) were allowed a parent present both at induction and at emergence once active ventilatory support was no longer necessary. Children in the control group (n=46) were allowed a parent present at induction and in PACU after transfer of the child to nursing care. All patients were premedicated with oral midazolam (0.5 to 0.75 mg/kg) mixed with acetaminophen. Anesthesia was induced with sevoflurane/nitrous oxide and maintained with isoflurane/nitrous oxide by mask or laryngeal mask, supplemented by caudal blockade using 0.125% bupivacaine (1 ml/kg) with epinephrine. No opioids or muscle relaxants were given.

The following measures provided data: 1) Demographics and Medical History questionnaire, 2) Sleep Habits questionnaire (SHQ), 3) Operating Room Behavior Rating Scale (ORBRS), 4) a 7-point Likert-type cooperation scale, 5) Posthospital Behavior questionnaire (PHBQ), and 6) State-Trait Anxiety Inventory (STAI) to measure parental anxiety. Emergence behaviors were monitored at 5 minute intervals in PACU. Severe emergence distress in a patient was defined as a cooperation score of 5 or greater (1-total cooperation, 7-total uncooperation) and by a summation of ORBRS scores (severe distress defined as >1 SD above the mean for all patients).

Results: The experimental and control groups were comparable for age, gender, race, parental education level, and previous surgery. Using the cooperation scale, four children from each experimental group (8/92=9%) had severe emergence distress. One way ANOVA showed no significant group differences on emergence distress. There were no group differences regarding recovery time, opioid requirements, and postoperative behavior changes at 1 week and 4 weeks. We also examined factors that may relate to children's emergence behaviors. Children described as clingy/dependent ($X^2 = 5.57$, $p<.06$) and children with frequent temper tantrums ($X^2=7.44$, $p<.02$) were more likely to have emergence distress behaviors. Parent satisfaction was very high in both groups (mean 6.7 of 7). No relationships were found between sleep behaviors, parent anxiety and emergence behaviors.

Discussion: Our findings do not support the hypothesis that parent presence during emergence from anesthesia will decrease the incidence and severity of emergence distress behaviors in children. It is likely that other factors such as pain and disorientation are greater contributors to these behaviors than separation from parents. Our data does suggest that patients with a history of temper tantrums or separation anxiety are at greater risk for developing emergence distress. Further study is needed to find effective interventions for prevention and treatment of emergence distress behaviors in children.

References: 1. *Journal of Clinical Psychology in Medical Settings* 1999;6:405-426
2. *Anesthesiology* 1997;87:1298-300.

Title: **Anesthetic Considerations for Normothermic Caval Inflow Occlusion**

Author(s): K.C.Odegard, A. Schure, J.A. DiNardo, A.C.Shukla, D.D.Hansen, P.C.Laussen

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Introduction: The technique of normothermic caval inflow occlusion (IO) was first introduced in 1951 to facilitate the surgical treatment of semilunar valve stenosis, the primary advantage being the avoidance of cardiopulmonary bypass (CPB). Percutaneous balloon dilation of stenotic pulmonary and aortic valves in the catheterization laboratory is now preferred to treat these lesions. As a result, inflow occlusion is an infrequently used technique nowadays. Nevertheless, it remains a useful technique in some patients with complex single ventricle congenital cardiac disease who require an atrial septectomy. The surgical technique of IO is well known, but the potential significant anesthetic considerations have not been previously described.

Methods: Retrospective 10-year chart review of demographic, anesthetic technique and outcome data for children undergoing IO.

Results: Eleven children, median age 3 months (range 3 days-3 years) and weight 3.7 kg (range 2.7-15.7 kg), underwent IO for atrial septectomy. All patients had complex single ventricle defects with restrictive atrial septums compromising atrial mixing or contributing to pulmonary venous hypertension. None of the patients were suitable for balloon septostomy because of technical considerations, i.e. hypoplastic pulmonary venous atrium or hypertrophied atrial septum. In addition to IO, 7 also had a pulmonary artery band placed and 1 a BT shunt. There was 1 intraoperative death (9%), but all other patients survived to discharge. Anesthetic technique included high dose fentanyl (>50 mcg/kg) in 10/11 patients; 3 patients required mechanical ventilation in the CICU prior to surgery and 8 were induced and intubated in the OR. There were no complications related to induction of anesthesia. A median sternotomy was used for all cases. After pericardiotomy, a side-clamp was placed on the right atrial (RA) free wall and an incision made in the RA prior to placing the vascular clamps used to occlude caval return. Prior to application of the clamps, patients were hyperventilated with 100% O_2. During IO, the SVC and IVC inflow was occluded, ventilation held, the RA clamp released, the heart allowed to empty, and the septum primum excised. After excision of the septum, one caval clamp was released initially to de-air the atrium. The RA side-clamp was then reapplied and the other caval clamp released. Mean duration of IO was 87.7 ∂ 25.5 seconds. At the time of release of the second caval clamp, 10/11 patients were transfused (mean 18.5 ∂ 8.8 cc/kg RBC) and received bolus of calcium gluconate (range 30-150 mg/kg) and bicarbonate (range 0.3-3 mEq/kg). Inotropes were administered to 6/11 patients; 2 continued to receive dopamine started in the ICU prior to surgery, 4 were started on dopamine after IO (2 patients received bolus of epinephrine for hypotension). Dysrhythmias occurred in 4/11 patients; 2 VF (1 VF after release of the vascular clamps and successfully treated with cardioversion and lidocaine, and 1 VF occurred during IO but was refractory to resuscitation efforts) and 2 AF (both successfully cardioverted). There were no postoperative seizures or overt neurologic complication, nor end organ injury; mean duration of postoperative mechanical ventilation was 2.2 ± 1.6 days with 1 patient extubated in the OR.

Conclusion: Although an uncommon technique, IO is useful in patients who require longer-term palliation with an atrial septectomy and are unsuitable for percutaneous catheterization techniques. CPB is an obvious alternative, but previous studies have reported a low mortality and morbidity rate using IO, and the potential complications related to CPB are avoided in what is often a hemodynamically unstable patient population. Nevertheless, IO requires close cooperation between the surgeon and anesthesiologist with meticulous attention to detail. A short period of IO is critical. After IO, dysrhythmias may occur and resuscitation with volume and vasoactive drugs is often necessary. These must be used with caution, however, because rebound hypertension may occur commonly, possibly secondary to endogenous catecholamine release.

Title:**Coagulation Factor Abnormalities in Patients with Single Ventricle post the Fontan Procedure**

Author(s): K.C.Odegard, F.X. McGowan, J.A. DiNardo, R.A. Castro, P.C.Laussen

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Introduction: Thromboembolic complications in post Fontan patients have been reported to be as high as 20-33% (1). The high incidence of thromboembolic complications may be secondary to alterations arising from the Fontan physiology; but abnormalities of the coagulation system have also been implicated (2). Coagulation factor concentrations and activities mature significantly and at varying rates after birth, with some not approaching adult values until late childhood/teens (3). This study evaluated pro- and anticoagulant factor levels in children with single ventricle physiology post the Fontan procedure, using normal children as age-matched controls.

Methods: With informed consent, coagulation factors were assayed in 20 children (mean age 7.9 ± 3.4 years, range 4.5-15.5 years) with single ventricle cardiac defect who previously had undergone the Fontan procedure. Mean follow-up from the Fontan procedure was 3.8 ∂ 2.2 years. Healthy children (n = 19, mean age 8.3 ∂ 2.9 years, range 4.2-15 years) without congenital heart disease were assayed as controls. Specific clotting assays included: Factors II, V, VII, VIII, IX, X, Protein C and S, plasminogen, fibrinogen and antithrombin III. Liver function tests were measured by standard assays. Data were analyzed using unpaired T-test (significance $p < 0.01$)

Results: The mean ∂ SD concentrations of protein C, factors II, V, VII, IX, X, plasminogen, fibrinogen and ATIII were all significantly lower in the Fontan children compared to age-matched controls (Table). Most patients had liver function levels within the normal range. There were no correlations between the few liver function abnormalities and factor abnormalities.

Discussion: This study demonstrates decreased levels of both pro- and anticoagulant factors in children who have undergone the Fontan procedure. Previous studies, examining only a limited number of clotting factors, and not using age-matched controls, suggested that factor abnormalities are primarily the result of the Fontan operation and physiology. We have previously demonstrated, however, that low coagulation factor levels occur earlier in the staged management of single ventricle disease. This suggests that these abnormalities are not due to the peculiarities of the Fontan physiology alone. Whether these abnormalities demonstrated in our study represent a continuous slow maturation of coagulation factors in an otherwise well balanced system, are part of a genetic predisposition, or result from other hemodynamic or pathophysiologic abnormalities remains to be determined.

	Controls	Post Fontan	P Value	Control range 25% - 75%	Post Fontan N < 25%
Protein C	97∂ 26	68 ∂ 14	< 0.0001	76 - 116	16 / 20
Protein S	87∂ 19	80 ∂ 14	< 0.1715	74 - 95	8 / 18
Factor II	96 ∂ 18	71 ∂ 11	< 0.0001	82 - 106	18 / 20
Factor V	108 ∂ 26	74 ∂ 27	< 0.0002	82 - 120	14 / 20
Factor VII	100 ∂ 27	55 ∂ 18	< 0.0001	81 - 112	18 / 20
Factor VIII	103 ∂ 25	107 ∂ 68	< 0.2671	85 - 122	10 / 20
Factor IX	84 ∂ 22	66 ∂ 31	< 0.0139	67 - 99	13 / 20
Factor X	92 ∂ 19	72 ∂ 16	< 0.0006	79 - 105	15 / 20
Plasminogen	96 ∂ 14	82 ∂ 19	< 0.0133	83 - 103	13 / 20
AT III	107 ∂ 13	82 ∂ 24	< 0.0003	101 - 117	17 / 20
Fibrinogen	314 ∂ 109	242 ∂ 65	< 0.00171	246 - 342	10 / 20

Control and post-Fontan values: mean +/- SD. All values expressed as % activity, except for fibrinogen (mg/dl). P value: controls vs. post-Fontan mean values. Control range 25%-75% represents upper and lower quartiles; N<25% represents the number of post-Fontan patients with factor levels < lower quartile of control subjects.

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Title: **Out of Sight, But Not Out of Mind: "Virtual" Parental Presence at Emergence**

Author(s): Yvon F. Bryan M.D., David B. Glick M.D.

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Introduction: Anesthesiologists have made great efforts to increase the comfort of pediatric patients scheduled for surgical procedures and diagnostic studies by allowing parents to be present at the induction of general anesthesia. Numerous studies have demonstrated the advantages and positive effects that parental presence has on children at the time of induction. (1) However due to the heightened risk and unpredictability of emergence from anesthesia relatively few studies have been done to look at the potential benefits of parental presence at emergence. (2) Emergence may be the time during which the child is most in need of the parent to decrease the fear of being alone while awakening from anesthesia. A recent case at our hospital gave us the chance to develop a novel approach for addressing the question of parental presence at emergence from anesthesia without the conventional risks.

Case report: A 4 year old girl with end stage renal disease presented to the interventional radiology suite for revision of a clotted central line required for dialysis. The patient and her family who were from Saudi Arabia did not speak English and were accompanied by a translator who informed us that the parents wished to be present during the child's entire anesthetic. The parents were very insistent about being in the room for the induction of and emergence from anesthesia so they could comfort their child by speaking to her in Arabic. We explained that their presence at induction was common practice for us but that certain factors precluded their presence at emergence including the cramped quarters of the fluoroscopy suite, the unpredictability of emergence and the multitude of life threatening complications that could require immediate intervention such as the risk of vomiting, aspiration, airway obstruction and the potential for laryngospasm necessitating airway management. In order to please the parents and in an attempt to provide a comfortable familiar environment for the child to awaken from anesthesia without compromising the workplace of the anesthesiologist, we decided to make digital recordings (.wav format files) of the father in Arabic giving several commands commonly used at emergence. With the help of the interpreter, we labeled these recordings in English. The statements were "open your eyes", "you are doing fine", and "don't worry". We also had the father include a personal message to his daughter about giving her some chewing gum after they left the hospital. At emergence, we played these Arabic commands to her. She was calm, relaxed and opened her eyes after she heard her father's voice in the room, and she was extubated without problems. She even smiled after she heard the comment offering her the bubble gum. The parents and the interpreter were very appreciative of our undertaking and of allowing their child to have her parent's "virtual" presence at emergence. She was transported to the PACU with her parents and was discharged one hour later to the dialysis unit.

Discussion: Previous work we have done has demonstrated that translating commands used at emergence for non-English speaking patients helps the anesthesiologist prepare for emergence and time extubation. (3) We believe that using familiar sounds and language for children during emergence may help them remain calm and potentially decrease the confusion and restlessness usually observed at this time. This may attenuate emergence agitation and delirium in children undergoing non-painful diagnostic procedures requiring general anesthesia. It may be that "virtual" parents should be present during this time in order to decrease the fear and disorientation experienced by children. We did not, however, increase the risk or complexity of the emergence and extubation by bringing a "virtual" family member into the room. This case demonstrates the benefits of being able to give emergence commands to children in a familiar voice and also facilitate a family's wish to be "present" during the emergence. The attractiveness of this approach is that the benefits of parental presence at emergence were accrued without the usual attendant risks and logistical difficulties.

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Title: **Comparison of On-Site and Off-Site PDA Ligation in Premature Infants**

Author(s): D.S. Gould, L.M. Montenegro, J.W. Gaynor, P. Stephens, S.P. Lacy, T.L. Spray, J.M. Steven, S.C. Nicolson

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Introduction: Patent ductus arteriosus (PDA) often produces hemodynamic and respiratory derangement in premature infants. This is manifest as respiratory insufficiency requiring escalating ventilatory support and myocardial dysfunction necessitating the use of inotropic infusion(s). When medical therapy fails, surgical ligation is indicated. Because of the risks associated with transfer of these unstable neonates from the neonatal intensive care unit (NICU) to the operating room, a team from our institution routinely performs ductal ligation at the NICU bedside. Some patients however, are transferred from referring hospitals to our facility for surgical therapy. In an attempt to minimize the risks inherent in transferring these neonates, a team (cardiac surgeons, cardiac anesthetists, OR nurses) offered to perform ductal ligation in the NICU of our six referring facilities. Neonatologists cared for the postoperative patients in conjunction with the travelling team. We retrospectively reviewed our experience.

Methods: After Institutional Review Board Approval, the charts of premature neonates who underwent PDA ligation by our team in a NICU between March 1996 and November 2001 were reviewed. Data abstracted included: institution where the procedure was performed, gender, gestational age, birthweight, weight at time of surgery and courses of indomethacin. Ventilatory parameters (Fi02, PIP, PEEP) and use of inotropic support were used as surrogate indicators of severity of illness at both time of surgery and 96 hours post-operatively. Number and type of complications were noted.

Results: 54 patients met the criteria for inclusion. 28/54 (52%) underwent ligation in our NICU (Group 1) and 26/54 (48%) were performed at 6 referring NICU's.

	Group I	**Group II**	***p* –value**
Gender (M/F)	13/15	11/15	
Gestational Age (wks)	26.0∂2.5	26.3∂2.7	0.48
Birth Weight (kg)	0.91∂0.45	0.83∂0.28	0.89
Courses of Indomethacin (#)	2.5∂1.7	2.0∂1.0	0.22
Surgical Weight (kg)	1.02∂0.58	0.97∂0.38	0.84
Ventilatory Settings on DOS			
Fi02	0.37∂0.15	0.42∂0.20	0.33
PIP (mmHg)	17∂7	20∂4	0.71
Ventilatory Settings 96 hrs post-op			
Fi02	0.36∂0.12	0.41∂0.16	0.23
PIP (mmHg)	19∂7	19∂4	0.21
Inotropic Support on DOS (%)	32	34	
Inotropic Support @ 96 Hrs (%)	21	23	

The incidence of surgical complications did not differ between groups: 2 in group I (bleeding, pleural effusion) and 3 in group II (pneumothorax (2), air leak). There were no anesthetic related complications. Four patients died, none within 96 hours of surgery and none related to procedure.

Discussion: The data demonstrates that an experienced team can safely perform PDA ligation in critically ill infants without incurring the risks inherent in patient transport. Additionally, the patient can continue to be cared for by the neonatology team most familiar with the baby's medical and social concerns, and the patient's family is minimally inconvenienced.

Title: **Safety and Efficacy of Intravenous Pentobarbital for Sedation in Neonates and Infants with Natural Airways for Brain MRI in the Early Postoperative Period Following Surgery for Congenital Heart Disease Involving Cardiopulmonary Bypass**.

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Introduction: Children under 6 months of age routinely require sedation for noninvasive, diagnostic imaging such as magnetic resonance imaging (MRI). Challenges of sedation for such procedures include their remote locations, limited monitoring systems, lack of stimulation and prolonged recovery. Various sedation protocols employ opioids, benzodiazepines, chloral hydrate, propofol and barbiturates. Complications reported range from sedation-specific signal abnormalities[1] to failed sedation and respiratory depression with cardiac arrest requiring resuscitation.[2-3] To date, no large series evaluating sedation in neonates and infants either in this setting or in the early postoperative period following cardiopulmonary bypass (CPB) have been published. Children with congenital heart defects (CHD) who have undergone surgery with CPB present a unique subset of physiologic derangements within the first two postoperative weeks. We report our experience with intravenous pentobarbital for sedation in neonates and infants under 6 months of age with natural airways undergoing MRI of the brain in the early postoperative period following surgery for CHD.

Methods: After approval from the Institutional Review Board, we reviewed the charts of patients less than 6 months of age enrolled in an approved protocol, involving MRI of the brain within 2 weeks of surgery for CHD involving CPB. Data collected included: demographics, vital signs before, during, and after the procedure, procedure duration, pentobarbital dose, and time to post-procedure enteral feeding as a measure of recovery time.

Protocol: Routine monitors (ECG, SpO2, BP, EtCO2) were established on the MRI table using MRI-compatible equipment (Invivo Research Laboratories, Orlando, FL). Patients were bundled in several blankets layered with hot packs (Allegiance Healthcare Corp., McGaw Park, IL) prior to scanning. Sedation was titrated to spontaneous eye closure and lack of gross movement. Additional sedation was titrated for patient movement as assessed by motion artifact on scan and direct visualization. Upon completion of their scans, patients were recovered in the CICU by a team of nurses, intensivists and cardiologists.

Results: Of the 82 patients to be evaluated, 73 records were available for review. All patients were sedated by the cardiac anesthesia service. Scanning was successfully completed in all patients, and no cardiopulmonary events occurred. Median age the time of study was 31.67 days (range 7-165), with a median weight of 3.46 kg (range 1.52-7). Scans were performed on POD 6.7 (median, range 3-10), and lasted 40.3 minutes (median, range 23-70). Vital signs before, during, and immediately after the procedure are shown in table 1. Median pentobarbital dose was 4.99 mg/kg (range 1.43-10.34). For the 62 patients feeding enterally, median time to first feeding was 30.2 minutes (range 10-75). Our protocol has permitted the safe and effective sedation of patients under 6 months with natural airways, for acquisition of MRI scans of the brain, within the first 2 weeks of surgery for CHD involving CPB.

Table 1

Vital Sign	Baseline	Intra-procedure	Post-procedure
SBP (mm Hg)	83 (64-110)	81 (62-104)	84 (68-112)
DBP (mm Hg)	46 (29-76)	44 (28-56)	46 (30-65)
HR (bpm)	140 (89-170)	138 (86-170)	139 (88-164)
RR (bpm)	47 (32-68)	42 (26-58)	46 (28-62)
SpO2 (%)	87 (58-100)	89 (62-100)	89 (62-100)
Temperature (C)	36.6 (35.9-37.4)		36.4 (35.3-37.2)

SBP, systolic blood pressure; mm Hg, millimeters mercury; DBP diastolic blood pressure; HR (bpm), heart rate in beats per minute; RR (bpm), respiratory rate in breaths per minute; SpO2, pulse oximetry; C, degrees centigrade

1. Filippi C.G. et al., American Journal of Neuroradiology 2001
2. Cote C.G. et al., Pediatrics 2000
3. Malviya S. et al, British Journal of Anaesthesia 2000

Title: **Anesthetic Implications of Epicardial Pacemaker Placement in Neonates with Congenital Complete Heart Block and a Structurally *Normal* Heart**

Authors: B.D. Kussman, D.R. Madril, E.P. Walsh, P.C. Laussen

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Introduction: There is little information available regarding the anesthetic management of neonates with congenital complete heart block (CCHB) and a structurally normal heart undergoing epicardial pacemaker placement. This report summarizes our experience over the past six years.

Methods: A retrospective chart review of neonates with CCHB and a structurally normal heart, who underwent anesthesia for epicardial pacemaker placement between 1996 and 2001, was performed. Charts were reviewed for demographic data, timing of surgery, ventricular function, invasive monitoring, anesthetic technique, heart rate (HR) variability, intraoperative hypotension (20% decrease from baseline), use and response to chronotropic and inotropic agents, use of temporary pacing, and timing of extubation.

Results: All patients (n=6) had an epicardial VVI pacemaker (EPM) placed through a subxyphoid incision. Demographic and perioperative data are shown in Table 1. Ketamine was used for induction in all patients, except patient #3 who received thiopentone. Anesthesia was maintained with N_20/O_2/volatile agent, except patient #5 who received high dose narcotic anesthesia. Intraoperative bradycardia occurred only in one patient (#6). This patient had the lowest resting HR and received ephedrine 2mg with increase in systolic blood pressure (SBP) of 10 mmHg and no change in HR, followed later by two 1 μg boluses of epinephrine with increase in SBP of 12 mmHg and HR of 20 beats per minute (bpm). Transcutaneous pacing was not used in any patient. Indications for postoperative mechanical ventilation were poor cardiac function (#6), slow emergence from anesthesia (#3), or planned postoperative ventilation (#5).

Table 1. Demographic and Perioperative Data

Patient	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**
Weight (kg)	3	2.5	3.2	4.1	2.7	2.9
Gestational age (weeks)	36	35	37	41	38	36.7
EPM on day of life	4	2	2	16	1	1
Ventricular function by echocardiography	Normal	Normal	Normal	Mild - mod LV dysfn.	Normal	Mild LV, mod RV dysfn.
Arterial line	No	No	No	Yes	No	No
Central venous line	No	No	No	No	No	No
Heart Rate (bpm):						
Lowest - highest (preop)	52 - 110	46 - 53	48 - 51	89 - 102	40 - 47	42 - 52
First value in OR	44	50	44	90	40	38
Lowest - highest (OR)	42 - 58	48 - 56	40 - 56	78 - 82	38 - 42	30 - 38
Atropine (response)	Yes (nil)	Yes (nil)	No	No	No	Yes (nil)
Inotrope (response)	No	No	No	No	No	Yes (diminished)
Intraop hypotension	No	No	No	No	No	Yes
OR time (minutes)	100	115	74	104	118	161
Extubation	On arrival ICU	On arrival ICU	Day 1 post op	In OR	Day 1 post op	Day 4 post op

Discussion: A baseline ventricular heart rate less than 40 bpm together with decreased ventricular function by echocardiography suggests that significant hemodynamic instability may occur intraoperatively. Invasive monitoring and a central venous line for inotropic/chronotropic agents should be considered in this circumstance. Atropine appears to offer no benefit, and the response to catecholamines is diminished. Transcutaneous pacing in the OR may be beneficial and should be immediately available.

Refs:

Title: **Anesthetic Implications of Epicardial Pacemaker Placement in Neonates with Congenital Complete Heart Block and a Structurally *Abnormal* Heart**

Authors: D.R. Madril, B.D. Kussman, E.P. Walsh, P.C. Laussen

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Introduction: Congenital complete heart block (CCHB) may be associated with a structural cardiac defect in about 25 % of cases (1). There is little information available regarding the anesthetic management of neonates with CCHB and a structurally abnormal heart undergoing epicardial pacemaker placement.

Methods: A retrospective chart review of neonates with CCHB and a structurally abnormal heart (any defect except patent foramen ovale or patent ductus arteriosus (PDA)), who underwent anesthesia for epicardial pacemaker (EPM) placement between 1995 and 2001, was performed. Charts were reviewed for demographic data, ventricular function, heart rate (HR) variability, timing of surgery, invasive monitoring, anesthetic technique, intraoperative hypotension (20% decrease from baseline), use of chronotropic and inotropic agents, use of temporary pacing, postoperative ventilation, and length of ICU stay.

Results: Six patients were identified; demographic and perioperative data are shown in Table 1. Four patients required emergent intubation and ventilation for hemodynamic instability and placement of temporary epicardial pacing wires (TEPW). This was done through a subxyphoid incision under narcotic/relaxant anesthesia, with a central venous line for inotrope administration. In one patient (#5), atropine was used shortly after birth without any effect, and isoproterenol decreased the blood pressure without change in heart rate. This patient died from cardiac failure and complications of prematurity on day of life (DOL) 8 prior to receiving a permanent pacemaker. In patient 2, following ligation of PDA and pulmonary artery banding, ventricular fibrillation ensued requiring CPR and ECMO support of the circulation; the patient survived and a permanent pacemaker was placed on DOL 15 with up to 40% decreases in blood pressure despite dopamine. For the permanent pacemaker procedures, an arterial line was placed in all but one patient (unsuccessful attempt) and all had central venous access. Anesthesia was narcotic-based, supplemented with N_2O, midazolam and/or low concentrations of isoflurane.

Table 1. Demographic and Perioperative Data

Patient	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**
Lesion	Heterotaxy, CAVC	{SLL}-TGA, single LV	Heterotaxy, transitional AVC	Heterotaxy, CAVC, DORV	Heterotaxy, AVC, small LV	Ventricular Septal Defect
Weight (kg)	3.2	2.5	3.0	2.0	1.7	2.7
Gestational age (weeks)	39	37	37	33	31	35
Ventricular fn. on first Echo	Good	Good	Good	Good	Depressed	Good
Baseline HR (range)	70 (38-84)	40 (40-58)	88 (60-88)	63 (37-73)	40 (40-50)	32 (32-40)
Procedure – TEPW (day of life)	1	Nil	Nil	1	1	1
Location	OR			OR	ICU	ICU
Lowest HR (bpm)	38			37	40	32
Largest decrease systolic BP	30%			15%	20%	30%
Inotrope	Dopamine			Dopamine	Dopamine	Dopamine
Procedure (day of life)	EPM (17)	PDA ligation & PA band (3)	PDA ligation & EPM (9)	PDAligation + PA band & EPM (2)	Nil	EPM (5)
Lowest HR	120 V-paced	45	88	165 AV-paced		120 V-paced
Largest decrease systolic BP	30%	Cardiac arrest	20%	15%		35%
Inotrope	Dopa, Milrin	Dopa, Epi	Dopa, Epi, Isopro	Dopa, Epi		Dopa
Ventilation / ICU stay (days)	6 / 24	9 / 18	9 / 27	27 / 42	Deceased	9 / 10

CAVC, complete atrioventricular canal, TGA, transposition great arteries; DORV, double outlet right ventricle.

Discussion: Temporary pacing, together with mechanical ventilation, invasive monitoring and inotropic support, is likely after birth in the neonate with CCHB and a structurally abnormal heart. Prematurity may increase the need for earlier, aggressive intervention. Significant hemodynamic instability may occur intraoperatively, despite temporary pacing and inotrope use.

Ref: Michaëlsson M. et al., Cardiovasc Clin, 1972

Group #4 – Pain/Regional

Group Leader: Santhanam Suresh, MD

#28 *Serial Supraorbital and Supratrochlear Nerve Blocks for the Management of Persistent Frontal Headaches in Adolescents*
Suresh S., Wheeler M, Patel A, Cot C

#29 *Epidural Techniques in Children undergoing Coarctation of the Aorta: Short and Long Term Follow Up*
John Morris BS, David A. Rosen MD, Kathleen R. Rosen MD,
Robert A. Gustafson MD, Elizabeth R. Nelson MPH

#30 *P6 Acupoint Injection is an Effective Prophylactic Intervention for Postoperative Nausea and Vomiting*
Shu-Ming Wang MD, Zeev N. Kain MD

#31 *A Survey of Pediatric Preoperative Patients' Usage of Complementary and Alternative Medicine*
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#32 *Intravenous Versus Thoracic Epidural Analgesia Post Pectus Excavatum Repair: A One Year Retrospective Review*
J.S. Apuya, I.E. Soliman, K.M. Fertal

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#34 *Comparative Efficacy of Caudal Ketamine with or without Bupivacaine in Paediatric Infraumbilical Surgery*
O.O. Nafiu, I. Kolawole, R.A. Salam, E.O. Elegbe

#35 *Cost Analysis of Epidurography: Plain X-ray vs. Fluoroscopy*
P.G. Fuhr, G. Merritt

#36 *Pediatric Medical Acupuncture Service*
Yuan-Chi Lin, MD, MPH, Aimee B. Bioteau, BS

Title: **Serial Supraorbital And Supratrochlear Nerve Blocks for The Management of Persistent Frontal Headaches in Adolescents**

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Introduction: Children often report headaches that are usually transient. However, there are certain conditions that predispose adolescents to persistent headaches. These include craniotomy, head injury, and frontal sinusitis. The frontal area is supplied by the first branch of the trigeminal nerve (V1). We reviewed our experience in the chronic pain clinic with the use of nerve blockade with local anesthetics for the management of recurrent headaches.
Methods: An audit of the pain treatment database was performed. Patients treated for headaches with a supraorbital and supratrochlear nerve block in the chronic pain clinic at Children's Memorial Hospital between January 1997 and December 2001 were included in the study. All patients were seen by a neurosurgeon or neurologist and pathological conditions leading to a headache including increased intracranial pressure, recurrence of tumor or acute sinusitis were ruled out prior to their visit to the chronic pain clinic. All patients were seen by a psychologist and were instructed in relaxation techniques and visual guided imagery. They also received a trial of oral anti-convulsants and tricyclic antidepressants. If, after four weeks of conservative therapy, there was no improvement of symptoms, bilateral supraorbital and supratrochlear nerve blocks were performed using 0.25% bupivacaine. Patients were given instructions to reschedule for another block if their VAS pain score did not improve to less than 4 out of 10 after the first block. All blocks were performed at bi-weekly intervals. A descriptive analysis of the treatment results was performed.
Results: Nine patients required serial supraorbital and supratrochlear nerve blocks. The mean age of the patients was 17.9 years (range 14 –23); there were 3 males and 6 females. Diagnoses prior to consultation with the pain clinic included s/p brain tumor surgery (N=2); s/p multiple frontal ventriculo-peritoneal (V-P) shunt revisions (N=2); s/p head trauma (N=2); chronic sinusitis (N=3). The average number of nerve blocks required was 4 (range 1 – 10, See Table). One patient recovered completely after a single block. Patients with multiple V-P shunt revisions received the greatest number of nerve blocks. Sinusitis patients required fewer nerve blocks; 1 patient deferred further blocks after an initial block and decided to choose alternative medicine (acupuncture).
Discussion: Frontal headaches from causes other than migraine can be debilitating and difficult to treat. Peripheral nerve blocks have been shown to be effective in the management of pain following migraine headaches. To our knowledge, this is the first time supraorbital and supratrochlear nerve blocks are described for management of chronic frontal headaches that are not migraine in origin. Our population, although mainly young adults, was followed in our pediatric hospital for their underlying conditions; most were able to resume their normal activities after the serial blocks. The two patients with V-P shunts had previously received multiple shunt revisions due to persistent headaches despite indistinguishable changes to their ventricular size on CT scans. Since the introduction of the blocks, 1 patient has not had a V-P shunt revision in 4 years and the other has had only 1 shunt revision in the past year. Sinusitis patients seem to respond best to these nerve blocks. We theorize that persistent frontal headaches of multiple etiologies may have a neuropathic component and the nerve blocks relieved the pain by breaking the pain cycle as described previously for other neuropathic conditions (1).

Diagnosis	Age	Gender	Number of Blocks	Outcome
S/p Suprasellar tumor resection	19	M	1	Resolved
S/p Optic glioma resection	23	M	3	Resolved
S/p Head Injury	19	M	3	Resolved
S/P Head Injury	20	F	6	Resolved
Multiple V-P Shunts	23	F	9	Resolved
Multiple V-P Shunts	17	M	10	Continues serial blocks
Sinusitis	15	F	2	Resolved
Sinusitis	16	F	1	Resolved
Sinusitis	14	F	1	Changed to alternative medicine

1. Abram SE: Clin.J.Pain 2000; 16: S56-S61

Title: **Epidural Techniques in Children Undergoing Coarctation of the Aorta: Short- and Long-Term Follow Up.**

Author(s): John Morris BS, David A. Rosen MD, Kathleen R. Rosen MD, Robert A Gustafson MD, Elizabeth R. Nelson MPH

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Introduction: Using epidural techniques in children undergoing cardiothoracic procedures where bypass is utilized remains somewhat controversial because of the concerns of heparinization and the potential for an epidural hematoma formation and ensuing neurologic injury. The other type of case where controversy persists is in repair of coarctation of the aorta. Unlike the bypass situation repair of the coarctation has a well-documented incidence of neurologic complications, with a reported incidence of 0.15%(1). Because of these fears there has been some reluctance to performing epidural techniques in these patients. There is, however, no data to suggest whether epidural techniques would in fact increase or decrease the incidence of neurologic complications. On the surface adding two techniques with a small individual incidence of neurologic complications might increase the overall risk. Some of the medications used in the epidural space have the potential for free radical scavenging, so that in the face of ischemia injury may be minimized. The purpose of this study was to examine the use of epidural techniques for coarctation repair specifically looking for neurologic injury.

Methods: This study was approved by the WVU institutional review board for studies involving human subjects. Data was collected prospectively and retrospectively. Patients were anesthetized, intubated and then turned on their side for placement of an epidural catheter. Catheters were placed via the thoracic approach for older children >15 kg and via the caudal approach and fed up for the smaller children. The medications given through the catheter were dictated by the case, but were predominantly narcotics (morphine or hydromorphone), local anesthetics (bupivacaine or lidocaine), and more recently clonidine. Patients were closely followed in the postoperative period for any neurologic injury.

Results: Sixty-seven patients have been examined. The median weight was 4.5 kg with a median age of 2 months. 50 catheters were placed via the caudal approach, 1 via the lumbar, 15 via the thoracic, and 1 by single dose injection. Of those placed via the caudal route 38 were able to be fed to the thoracic level. In 85% of the patients the primary narcotic was morphine. Hydromorphone was used in the others. In those patients receiving local anesthetics bupivacaine was used 62% of the time with lidocaine used for the remainder receiving local anesthetics. Clonidine was only used in 2 of the patients. Bleeding during epidural placement occurred in 4 patients, 2 of these were with caudal catheters fed to the thoracic region and 1 in a catheter left in the caudal region. 1 patient had bleeding with a thoracic placed catheter. A clear fluid was aspirated in 1 patient with a caudal catheter fed into the thoracic region. Follow-up has been up to 6 years. No neurologic symptoms that could be related to spinal cord ischemia or the epidural itself have been identified. 1 child had bilateral leg pains at night noted on their 1year follow up, but this had resolved by the 5 year follow up. Post coarctectomy mesenteric arteritis was not seen. 13 patients needed postoperative nitroprusside infusion and 20 were discharged with antihypertensives, captopril being the most common.

Discussion: While this study does not prove that epidural techniques are safe for children undergoing repair of coarctation of the aorta it does significantly add to the body of evidence. Bleeding on placement of epidural catheters did occur, but in this limited series was of no apparent consequence. The bleeding was less (84 pts. out of 1073 pts.) than reported in our large series of other pediatric patients undergoing non-coarctation procedures.(2) Potential for migration of the catheter into the subarachnoid space was seen when the catheter was fed from the caudal region. To prove that the epidural is protective will take significantly more subjects. Epidural techniques providing anesthesia and analgesia were also able to facilitate the regulation of the post-operative blood pressure control. This was accomplished by the lack of pain, a sympathectomy from local anesthetics, and from alpha blockade with the use of clonidine. Clonidine augments the analgesia from the local anesthetic and narcotics with minimal side effects, and controls the blood pressure by direct antihypertensive effects. A study comparing epidural clonidine to local anesthetics in pediatric coarctation repairs is indicated.

References:

(1)Connoly JE. Prevention of spinal cord complications in aortic surgery. Am J Surg 1998;176:92-101
(2) Rosen DA, Kathleen KR, Gustafson RA, Nelson ER, Kenamond LK. Long-Term Follow-up in children undergoing cardiothoracic procedures with epidural Anesthesia/Analgesia. 2001 American Society of Anesthesiologist Annual meeting program A-1298 p 292.

Title: **P6 Acupoint Injection is An Effective Prophylactic Intervention for Postoperative**

Author(s): Shu-Ming Wang MD[1], Zeev N Kain MD[1,2,3]

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Introduction: Current literature indicates that P6 acupuncture and related stimulations are effective treatments for postoperative nausea and vomiting (PONV) in adults[1]. There are, however, paucity of data and inconsistent results regarding the use of P6 acupuncture as prophylactic treatment of PONV in children. We designed the following study to determine whether P6 acupoint injections can be used as a prophylactic treatment for preventing PONV in children

Methods: After Institutional Review Board approval and informed consent/assent, children age 7-16 year, ASA I-II undergoing general anesthesia and ambulatory surgery were randomly assigned to the following four groups: Group I- IV saline + bilateral P6 acupoint injections; Group II-IV droperidol + bilateral P6 sham stimulation; Group III-IV saline + bilateral sham point injections; and Group IV- IV saline + P6 sham stimulation. The perioperative anesthetic technique was standardized in all subjects. The incidence of PONV was evaluated in Post Anesthesia Care Unit (PACU) by nursing staff who were blind to the group assignment. Nausea is defined as an unpleasant sensation associated with awareness of an urge to vomit. All incidence of nausea was determined either by spontaneous patient reporting or by direct inquiry made by the investigating team every 15 minutes throughout the PACU stay. A visual analog scale (VAS) was used to assess the need for nausea rescue therapy. When nausea VAS score greater than 20, rescue medication was administered immediately, if the score is less than 20 ,the patient's complaint was reassessed after 5 minutes and medication was administered only if symptoms persisted. Retching/vomiting episodes as labored, spasmodic rhythmic contraction of respiratory muscle with or without the gastric content, respectively. All incidence of retching and vomiting were recorded as they occurred throughout the PCAU stay. At 24 hours postoperatively, a blind research assistant telephone the parents of all children and inquired about the presence or absence of vomiting that occurred after discharge from the PACU.

Results: There were a total of 190 children participated in this study. Three children were found to have major protocol violations and were excluded from the study (Two patients received IV morphine and one patient received IV propofol). Thus, data from a total of 187 subjects were analyzed and are presented. Group I- IV saline + bilateral P6 acupoint injections (n=50); Group II-IV droperidol + bilateral P6 sham stimulation (n=49); Group III-IV saline + bilateral sham point injections (n=43); and Group IV- IV saline + P6 sham stimulation (n=45).There were no differences among the various study groups in regards to baseline demographic characteristics such as age and history of previous PONV. There were al significant differences between the four study groups in regard to perioperative variable such as surgical procedures, episodes of pain , total narcotic usage, surgical time and time to clear liquid intake and time to discharge. Incidence of nausea in the PACU was significantly lower in acupoint groups as compared to the sham point group (32% vs. 56%, p=0.029), and P6 sham group (32% vs. 64%, p=0.002), but not as compared to the droperidol group (32% vs. 46%, p=0.18). Similarly, subjects in the acupoint group had a significantly lower incidence of vomiting in the PACU as compare to the sham point group (12% v. 33%, p=0.026) and P6 sham group (12% vs. 31%, p=0.029). The combined incidence of early PONV was also lower in the acupoint group as compared to the sham group (p=0.045) and P6 sham group (p=0.004). At 24 hours after surgery, however, the incidence of late PONV was similar among the four study groups (p=ns).

Conclusion: in children, bilateral P6 acupoint injections are effective for the prevention of POVV during the early postoperative period.

Title: **A Survey of Pediatric Preoperative Patients' Usage of Complementary and Alternative Medicine**

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Introduction: There is an increasing interest in the usage of complementary and alternative medicine (CAM) in America. Tsen et al reported that 22% of adult pre-surgical patients use herbal remedies.[1] Spigelblatt et al surveyed alternative therapies in the pediatric population and found that 11% of children consulted one or more alternative practitioners in 1994.[2] One recent study revealed that seven out of ten pediatric pain center in Northern America offers alternative therapies for pediatric pain management.[3] The growing emphasis on the consumer-chosen and market-driven health services suggest that alternative therapies can play a large role in the future health care system.

Methods: This study was approved by the hospital's Committee on Clinical Investigation. A questionnaire was distributed to all patients Ω18 years old presenting for a preoperative evaluation over a period of 8 months (March 2001-October 2001) as part of their preoperative visit with pediatric anesthesiologist. The questionnaire recorded age and gender and listed different alternative therapies as well as commonly used herbal remedies. The patient or legal guardian was asked whether or not the patient had tried any of the CAM therapies in the last year.

Results: Over a period of 8 months, March 2001-October 2001 1,100 surveys were given to patients at their pre-operative visit. 1,021 (93%) surveys were completed. Of the 1,021, 301 (29.5%) had tried one or more alternative therapies in the past year. The female/ male patient ratio was 1.2:1 with an average age of 9.2∂5.7 year-old (2 months-18 years). The most commonly used alternative therapies were herbal remedies 43.5%, massage 27.9%, chiropractic 17.3%, acupuncture 14.3%, homeopathic remedies 12.3% and biofeedback 5.3%. Of the herbal remedies used, Echinacea was most common, 20.6%, followed by Aloe 15.9%, Cranberry 6.6%, St. John's Wort 3.3% and Goldenseal 2.6%.

Discussion: Our study indicates that CAM therapies are commonly used in the pediatric preoperative patients. With approximately 30% of the pediatric pre-surgical population having tried one or more alternative therapies within a year of having a surgical procedure, it is crucial that the medical profession understand the implications and are made aware of any potential drug interactions or side effects that may occur while treating a patient. Additional concern is added because it has been previously found that less than 40% of patients disclose the use of complementary and alternative therapies with their physicians if not specifically asked.[4,5] Many herbs contain elements, which may be unsafe and may cause interactions with anesthetics and drugs. For example, while St. John's Wort may be commonly used to treat mild depression, its mechanism is uncertain and physicians must be aware that it may significantly affect blood concentrations of many prescribed medications, which could lead to severe interactions.[6] Echinacea which is commonly used to prevent and treat common infections such as respiratory tract infections and the common cold could cause hepatoxicity if used beyond 8 weeks.[7] Echinacea should not be used with other known hepatoxic drugs or immunosupressants. There is an increasing rate of CAM use among pediatric preoperative patients. It is necessary and critical that the anesthesia pre-operative visit include a discussion about previous complementary and alternative medicine use.

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Title: **Intravenous Versus Thoracic Epidural Analgesia Post Pectus Excavatum Repair: A One Year Retrospective Review**

Author(s): J.S. Apuya, I.E. Soliman, K.M. Fertal

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Introduction: Thoracic epidural catheter placement provides adequate analgesia with fewer pulmonary complications for post- operative pain management challenges, such as these encountered after pectus excavatum repair (PER). Some surgeons, however, continue to request intravenous analgesia for their patients after PER. We retrospectively reviewed the charts of 13 adolescents who underwent PER during a twelve month period and examined the use of epidural versus intravenous analgesia for post-operative pain control.

Methods: After obtaining IRB approval, the charts of 9 males and 4 females with a mean age of 14 yrs, were retrospectively reviewed. Group I (n=6) received intravenous morphine PCA (IV), while group II (n=7) received thoracic epidural infusion of bupivacaine 0.1% and fentanyl (E). Pain and sedation scores as well as side effects (nausea, vomiting, desaturations defined as$SaO_2 < 90$ requiring supplemental O_2, decreased respiratory rate, and pruritus) were recorded. The incidence of urinary retention was not compared due to the presence of a foley catheter in all patients receiving an epidural catheter. Times to oral intake and hospital discharge were compared. Statistical analysis was performed using the t test. P values Ò0.05 were considered statistically significant.

Results: There was no difference between the two groups with regards to age, sex, time to oral intake and discharge from the hospital. Although pain scores were initially similar in both groups, statistically significant differences were noted between the 2 groups at 36 and 60 hours. There were no statistically significant differences noted in the incidence of sedation, nausea, vomiting, desaturation, or pruritus between the two groups. One patient in each group had a decrease in respiratory rate. Problems related to epidural catheter placement in group II a leak at the catheter site in one patient and pain at the site in another.

Conclusion: Thoracic epidural analgesia, with the combination of opiates and local anesthetics provide an efficacious alternative to intravenous analgesia in patients after PER. Patients in group II (E) were able to ambulate and perform incentive spirometry with lower pain scores compared to those in group I (IV). Pain was better controlled at the time of discharge in group II (E).

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PAIN SCORES

	PACU	6 hours	12 hours	24 hours	36 hours	48 hours	60 hours
Group I (IV) Mean	3.6	4.5	4.3	4.5	3.8	4	5.5
Group I (IV) St Dev	2.6	2.4	2.7	2.6	2.8	1.9	2.6
Group II (E) Mean	7.4	3.4	2.4	2.8	1.3	2.7	0
Group II (E) St Dev	1.4	3.3	3.0	3.2	0.8	2.1	0
P values	.005	0.5	0.25	0.3	0.05*	0.3	.01*

* statistically significant

Title: **Subarachnoid Block in an Infant with Epidermolysis Bullosa for Apligraf Application**

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Introduction: Epidermolysis Bullosa (EB) is a rare genetic skin disorder conferring fragility at the dermal/epidermal junction. It is clinically evident as variably sized friction blisters or bullae which often resist healing, ultimately forming disfiguring scars and contractures. Depending on the type of EB, blisters can occur in oral or respiratory mucosa. Types of EB are distinguished by their pattern of inheritance (dominant vs. recessive), and by the protein genetically altered (collagen 7 for EB dystrophica; laminin 5 for EB junctional; and keratin 5 or 14 for EB simplex). Varying degrees of clinical severity within each type are ascribed to different gene mutations (splicing defect, nonsense mutation, or missense mutation). Invoking anesthetic strategies which minimize or eliminate oral and tracheal manipulation is essential for individuals with EB involving these epithelia. Apligraf (Organogenesis) is a relatively new type of skin covering which can protect blistered, disrupted skin for up to 2-3 months. Debridement of the recipient's dermis optimizes Apligraf viability. We describe our anesthetic management of a young infant with EB during application of Apligraf.

Case Report: A born at term now 3 month old 6.4 kg female infant with EB dystrophica recessive was scheduled for her second Apligraf application to the dorsum of each foot. By one month of age, she had developed oral lesions and poor feeding necessitating placement of a G-tube-an uneventful GETA. At 6 weeks of age she had the first application of Apligraf to the G-tube site and to the dorsum of each foot, as these sites were chronically blistered. This was done under mask GA with sevoflurane. She was otherwise healthy. The procedure was estimated to require 60 minutes of immobility and anesthesia in the lower extremities. Since there was an absence of a history of prematurity or lung disease and to facilitate lack of movement during the subarachnoid block placement, we induced the patient in the lateral position with sevoflurane using a mask with lacrilube (petroleum based ophthalmologic ointment) on its cushion. A piece of Webril was placed between the patients skin and our masking fingers. After gentle skin (lesion-free area) prepping, 3.6 mg of bupivacaine in 8.25% dextrose with 50 mcg epinephrine was injected into the subarachnoid space at the L4-5 level through a 1.5 inch 22 gauge spinal needle. The head of the bed was elevated 15 degrees, and non-invasive monitors were applied (adhesives removed). The patient remained calm and awake throughout the uneventful procedure. She went directly to phase 2 recovery and stayed until she demonstrated lower extremity movement and fulfilled standard discharge criteria.

Discussion: Apligraf is a protective skin covering useful in patients with chronic EB lesions. Because its application must be preceded by dermal debridement and it lasts 2-3 months, repeat anesthetics may be necessary. In patients with EB involving oral or respiratory epithelium, airway manipulation should be minimized. Subarachnoid blocks offer a potentially useful alternative.

Title: **Comparative Efficacy of Caudal Ketamine with or without Bupivacaine in Paediatric Infraumbilical Surgery.**

Author(s): O. O Nafiu, I Kolawole, R.A Salam, E.O Elegbe

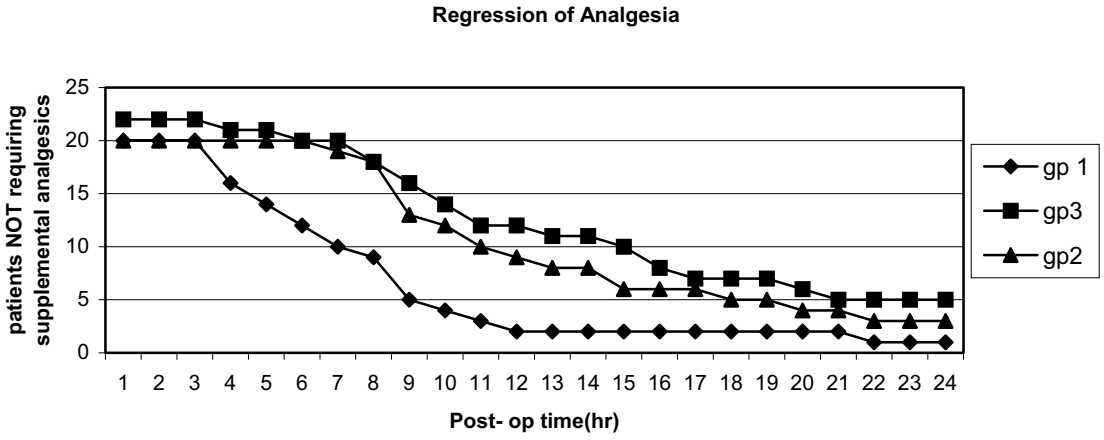
Affiliation: Department of Anesthesia, Korle Bu Teaching Hospital, Accra, Ghana.

Introduction: Caudal bupivacaine provides effective analgesia for inguinal and penoscrotal surgery.[1] Previous work has shown that caudal administration of ketamine in children can significantly prolong the duration of post -operative analgesia.[2] Although caudal analgesia is widely used in developed countries, it is still under -utilized in developing countries. This study was designed to compare the analgesic efficacy and side effect profile of caudal ketamine with or without bupivacaine at the Korle Bu Teaching Hospital, Accra, Ghana.

Methods: Following ethics committee approval and parental/guardian informed consent, 62 unpremedicated ASA I-II, children aged 2-8 years undergoing elective urologic or lower abdominal surgery were randomized into three groups. After induction of general anesthesia, all patients received caudal block under aseptic condition using a 23G hypodermic needle. Group I (n=20) received a caudal injection of plain 0.125% bupivacaine $1mlkg^{-1}$. Group II (n=22) received caudal ketamine $0.5mgkg^{-1}$, diluted with Normal saline using the same weight –related volumes. Group III (n=20) patients received a similar dose of local anesthetic mixed with ketamine $0.5mgkg^{-1}$. All patients were monitored for SpO2, HR, and BP. The duration of surgery, need for supplemental per-operative opiates, haemodynamic and respiratory parameters were noted. Postoperatively, a blinded post anesthesia care unit (PACU) nurse assessed the quality of analgesia using a modified pain score. Degree of sedation, side effects such as nausea and vomiting, muscle weakness, urinary retention and shivering were also noted. Intravenous morphine was prescribed for all the patients and the decision to administer this was left to the nurses. Patients were given supplementary analgesia if their observational pain score was greater than 4 (OPS 0-10). Parametric data were analyzed using Student's t test. PΩ0.05 was considered significant.

Results: No additional analgesic was required in any of the study groups intraoperatively. There was no significant difference in the objective pain score while the patients were in the PACU. The number of patients requiring no supplemental analgesia as time elapsed is shown in Fig. 1.The median time to first analgesia was significantly longer in group III (median 15.5h) than in group I (median 8.5h) ($p < 0.05$). There was no significant difference in the time to first analgesia between patients in group II and the other two groups.

Conclusion: The addition of 0.5mgkg-1 of ketamine to caudal 0.125% plain bupivacaine significantly decreased the need for rescue analgesics in the first 24hr post operative period in pediatric patients undergoing elective inguinal and lower abdominal operations. Caudal administration of ketamine alone provided analgesia of similar quality and slightly longer duration than 0.125% bupivacaine but this was not statistically significant. The frequency of complications was not significantly different in the three groups.



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Title: **Cost Analysis of Epidurography: Plain -ray vs. Fluoroscopy**

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Introduction: Epidural analgesia is an effective method of post-operative pain control among pediatric patients. Placement of epidural catheters under general anesthesia is a common practice in this population, but verification of catheter location and more importantly of its function is often ambiguous until the patient is awakened. Epidurography is a tool that can be utilized during general anesthesia to assess the location of the epidural catheter tip, as well as cephalo-caudal and lateral spread of contrast medium within the epidural space. Misplaced catheters can be diagnosed and replaced before emergence from general anesthesia. Two options for radiologic imaging in the standard operating room are single image modalities such as plain x-ray and real-time fluoroscopy from portable "c-arms." We studied a group of patients who were undergoing placement of epidural catheters for post-operative analgesia with the assistance of post-placement epidurograms and analyzed the added time and cost of these epidurograms. Furthermore, we compared the image quality of the two modalities to determine differences in their reliability.

Methods: Twenty total patients were studied, ten patients were assigned to epidurograms with x-ray technique. The other ten patients were assigned to epidurograms using fluoroscopy. All were performed with 0.1cc/kg myelogram contrast dye. Time interval data was collected in a fashion blinded to the radiology technicians. Radiology fees and operating room charges specific to the epidurogram were determined for each patient. This data was analyzed by group to give an average time and cost added to the procedure in comparison to epidural catheters placed without a post-placement epidurogram. Additionally, the anesthesiologist's reading of segmental epidural spread was compared to the radiologist's reading to determine a difference in the quality of image the two modalities provided.

Results: This study is on-going, however, preliminary results including the first eight patients reveal three out of four plain x-rays required assistance of a radiologist to determine location of the contrast media. Alternatively, in four out of four studies using fluoroscopy, the anesthesiologist was able to determine the location of contrast, including one study that revealed an intravenous catheter placement. Cost data will be collected after all twenty patients have been studied.

Discussion: In this on-going study, conclusions about cost and modality will be made after collection of data on all twenty patients. In the future, we plan to expand our study of epidurography to include prediction of epidural catheter function for post-operative analgesia compared to epidural catheters placed without the aid of epidurography.

Title: **Pediatric Medical Acupuncture Service**

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Introduction: Acupuncture as a therapeutic intervention is widely practiced in the United States. Our Pediatric Medical Acupuncture Service was established at the end of 2000. We report our recent experience in integrating acupuncture into our pediatric pain and symptom management program.

Methods: This study was approved by the Institutional Review Board at Children's Hospital and a written informed consent was obtained prior to the acupuncture treatment. We included all the pediatric patients, who are eighteen-year-old or less. Visual analog pain scales (VAS), from 0 to 10, were utilized for pain score evaluation. The patient received treatment at weekly intervals for the duration of six sessions acupuncture treatment. Chronic conditions may require visits for maintenance treatment at appropriate intervals. The VAS score was obtained from the patient during each visit. We compare the VAS score before the first acupuncture treatment vs. at the conclusion of the therapy or the last visit of the year. Paired t-test was utilized for statistical analysis.

Results: Two hundred and forty three pediatric patients received acupuncture treatment from 1/01 to 12/01. There were 167 females and 76 males. The patients' age ranged from 6 months to 18 years old, in average 14.3 ± 3.9 (mean ± S.D.) year-old. Patients received 8.4 ± 6.4 sessions of acupuncture treatment. In Regard to the region of the chief complaint at the initial consultation among these patients include: pain in the head (23%); pain in the neck, shoulder, and arm (10%); pain in the chest (6%); abdominal pain (25%); pain in the pelvis (4%); pain in low back, hips and lower extremities (30%); and others (2%). The mean VAS pain scores at the initial consultation before the first acupuncture treatment was 8.3 ∂ 1.4. The mean VAS pain score at the conclusion of the acupuncture treatment or at the last visit of year 2001 was 3.3 ± 1.6. The overall VAS pain score was significantly reduced by 5.0 ± 1.5 ($p<0.01$). There were no reported side effects or complications related to the acupuncture treatment.

Discussion: Acupuncture is part of traditional Chinese medicine and has been in existence for at least 2,000 years. There are promising results support the efficacy of acupuncture and acupuncture may be useful as an adjunct treatment or an acceptable alternative or be included in a comprehensive management program.[1] Our experience indicates that acupuncture can be safely and successfully incorporated into our pediatric pain management practice. This data does not control for placebo effects of acupuncture. Further prospective randomize studies are needed to evaluate the short and long term effect of acupuncture in pediatric population.

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Group #5 – Pharmacology I

Group Leader: Myron Yaster, MD

#37 *Respiratory Effects of Propofol in Pediatric Patients Undergoing Out-of-OR Deep Sedation*
Michael Seropian MD, FRCPC and Dale Harrison, MPH

#38 *Evolution of a Ketamine Sedation Program as an Alternative to General Anesthesia for Pediatric Interventional Radiology*
Keira P. Mason, MD, James A. DiNardo, MD, David Zurakowski, PhD,
Victoria E. Karian, MSN, CPNP, Linda Connor, RN, Patricia E. Burrows, MD

#39 *Teaching Flexible Fiberoptic Intubation of Infants and Children: Does a Videoscope System Improve Skill Acquisition?*
M. Wheeler, MD, A.G. Roth, MD, C. Heffner, RN, C.J. Cot , MD

#40 *Early Introduction of Oral Analgesics for Patients with Sickle Cell Crisis on PCA*
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#41 *Clinical Experience with Tramadol in Patients with Sickle Cell Anemia*
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#42 *Pediatric Deep Sedation Service*
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N. Patel, M. Taylor, V. Shankar

#43 *Pharmacokinetics of Orally Administered Intravenous Fentanyl in Children Undergoing General Anesthesia*
M. Wheeler, MD, P.K. Birmingham, MD, C. Heffner, RN, C.J. Cot , MD

#44 *The Use of a Patient Simulator to Evaluate Rescue Capability for Pediatric Sedation Critical Events*
JP Cravero, GT Blike, J Jensen

#45 *Sedation during Mechanical Ventilation in Infants and Children: Dexmedetomidine versus Midazolam*
Joseph D. Tobias MD, John W. Berkenbosch MD

#65 *Comparison of the Costs and Efficacy of Ondansetron and Dolasetron in the Prophylaxis of Postoperative Vomiting (POV) in Pediatric Patients Undergoing Ambulatory Surgery*
Olutoyin Olutoye, MD; Ellen Jantzen, MD; Lisa Fazi, MD; Rhonda Alexis, MD;
Mark Schreiner, MD; Mehernoor Watcha, MD

Title: **Respiratory Effects of Propofol in Pediatric Patients Undergoing Out-of-OR Deep Sedation**

Author(s): Michael Seropian MD, FRCPC and Dale Harrison, MPH

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Introduction: Pediatric sedations outside of the operating room (out-of-OR) are becoming increasingly common. However, complications and adverse events that are typically easily managed in the OR may cause potentially significant clinical difficulties in practice outside of the OR as a result of the lack of appropriately trained personnel, emergency equipment and facilities, for example. The literature mostly contains retrospective reviews and studies, by non-anesthesiologists describing a wide variety of procedures with airway obstruction and apnea rates as high as 12% and 2%, respectively[1]. Increasing numbers of non-anesthesiologists (e.g., pediatricians) are using propofol to provide sedation for procedures performed in the clinic, office, and ward. New JCAHO standards and definitions of sedation emphasize the importance of investigating and reporting the frequency and nature of respiratory and airway interventions to help establish necessary skills and clinical guidelines for performing such sedations. Thus, the purpose of this retrospective chart review is to provide a report of the frequency of respiratory and airway interventions and events/complications for out-of-OR pediatric propofol sedation.
Methods: Data are reported on pediatric (age < 18 years) patients receiving anesthesiologist-provided "propofol-only" sedation for out-of-OR procedures between January and September 2001 at our institution. Patients were monitored with pulse oximetry and non-invasive blood pressure (NIBP). Data are summarized for propofol dose received (mg/kg), sedation and recovery time, incidence of significant respiratory events/complications and interventions used to resolve them. Demographic data are also presented. Desaturation is defined $SaO_2 < 92\%$.
Results: Data from a total of 773 patients are reported. The total incidence of respiratory events was 17.6% (n=136). Only 13.7% (n=106) required some form of intervention. 13% (n=102) of patients desaturated. The primary intervention was blow-by-O_2 and given in 97% (n=99) of patients with desaturation. The overall incidence of other events/complications, such as coughing, apnea or airway obstruction requiring intervention, was 0.9% (n=7, 3 experienced multiple events).

Table 1. Demographics

	Mean	Min	Max	Std. Dev
Age (years)	5.6	0.02	17.8	± 4.2
Weight (Kg)	22.4	3.0	132.0	± 14.0
Propofol (mg/kg)	5.4	0.4	30.0	± 2.0
Sedation Time (min)	31.2	5.0	330	± 27.7
Recovery Time (min)	4.0	0.0	66.0	± 4.9

Table 2. Procedure

Department	Cases	%
Hem-Oncology	427	55.2
Radiation Oncology	119	15.4
Eye Procedures	64	8.3
CT	50	6.5
Other	113	14.6

Discussion: The incidence of respiratory events requiring some form of intervention is relatively low at our institution (13.7%). However, these types of events/complications and their interventions should not be ignored because the potential for increase in morbidity is possible with less experienced/trained clinicians. Airway obstruction and apnea were rare and below published rates[1,2,3]. Other studies may not accurately represent desaturation (our primary event) and the increasing oxygen requirements of patients as a result of the use of prophylactic O_2. The author does not necessarily recommend the use of arbitrary prophylactic O_2 (except in specific circumstances), as it may delay the recognition of an increasing O_2 requirement in a given patient. The familiarity of anesthesiologists with propofol and airway management, as well as, the pharmaco-dynamic profile of propofol may influence the low incidence of intervention techniques other than blow-by-O_2. Our lower mean propofol dose (as compared to other studies[1]) will also contribute to this. Non-anesthesiologists using propofol must be prepared to pre-empt, identify and resolve such issues as apnea, airway obstruction and clinically significant desaturation. Similarly, the presence of airway equipment sufficient to provide full respiratory support must be present. It is important to establish complication/event rates and intervention techniques that other practitioners may use as a reference for practice.

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Title: **Evolution of a Ketamine Sedation Program as an Alternative to General Anesthesia for Pediatric Interventional Radiology**

Author(s): Keira P. Mason, MD*†, James A. DiNardo, MD*, David Zurakowski, PhD#, Victoria E. Karian, MSN, CPNP†, Linda Connor, RN†, Patricia E. Burrows, MD†

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Purpose: At our institution, a majority of pediatric interventional radiological procedures require general anesthesia. A collaboration between the Departments of Anesthesia and Radiology enabled this prospective study to determine whether ketamine sedation could successfully replace general anesthesia, to create a safety profile for ketamine and to establish a protocol for ketamine administration by credentialled radiology nurses under the auspices of radiologists.

Materials and Methods: Between November 2000-January 2001, a designated anesthesiologist delivered ketamine sedation to 38 infants and children for interventional radiological procedures which would have typically required general anesthesia. Different dosages and methods of ketamine administration (intramuscular and intravenous) were utilized to achieve maximal sedative and analgesic effect. Ketamine administration by intravenous (1-2 mg/kg every 20 minutes as needed) or intramuscular (3-5 mg/kg) bolus was chosen for desired sedation intervals of less than 10 minutes. For longer sedation intervals, the initial bolus was followed by an infusion of 50-150 mcg/kg/min for the duration of the surgical stimulation. Induction times, adverse events, duration of sedation and recovery times were recorded.

Results: All procedures were successfully completed and there were no sedation failures. After review of the data, a ketamine sedation protocol with strict guidelines was developed. This protocol required demonstration of prerequisite levels of clinical skills, knowledge and expertise from both the radiologists and nurses prior to being credentialled to administer ketamine. Prior to becoming a nursing sedation program, this protocol required acceptance at three subsequent levels of hospital committees: Radiology Sedation Committee, Hospital Sedation Task Force and ultimately, the Pharmacy and Therapeutics Committee.

Conclusion: Ketamine sedation may be a safe and effective alternative to general anesthesia for some pediatric interventional radiology procedures. Collaboration between the Departments of Anesthesia and Radiology is important for the development of a safe and successful ketamine sedation program. This is the first report describing the use of intravenous ketamine infusion for pediatric sedation, and the only report describing the creation and adoption of a formal ketamine protocol for nursing sedation in pediatric radiology.

Title: **Teaching Flexible Fiberoptic Intubation of Infants and Children: Does a Videoscope System Improve Skill Acquisition?**

Author(s): M. Wheeler, MD, A.G. Roth, MD, C. Heffner, RN, C. J. Coté, MD

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Introduction: Flexible fiberoptic endotracheal intubation has become a standard management technique for pediatric patients with airways that are known or suspected to be difficult to manage by mask ventilation or by standard methods for placement of an endotracheal tube.[1] This essential skill must be taught to anesthesiology trainees during residency. Traditionally, flexible fiberoptic scopes used for intubation do not have an attached camera and monitor and thus only the operator is able to view the progress of the intubation. Our theory is that the attachment or integration of a video camera and television monitor (video-assisted technique) would allow the attending anesthesiologist to view the airway as the resident attempted intubation thus allowing for better direction and supervision. This should in turn lead to more rapid acquisition of skill with this technique and/or faster completion of intubation.

Methods: Karl Storz Endoscopy has developed a new fiberoptic scope for pediatric endotracheal intubation that integrates a Micro-Video-Module into the fiberoptic scope. We propose to recruit 20 anesthesiology residents with similar previous experience in adult fiberoptic intubation, but who are novices in pediatric fiberoptic intubation (all CA2's). Residents will be randomly assigned to one of two groups. Group 1 will intubate children using the traditional fiberoptic scope technique and Group 2 will intubate children using the video-assisted technique. Residents will be supervised by one of two attending anesthesiologists. Each resident will intubate 15 children. After IRB approval and parental consent, patients to be studied will be those presenting for elective outpatient or same day surgery who require general oral endotracheal anesthesia, are healthy, have normal airways, and are ages 1-6 years. Patient demographic data will be collected. Time from the facemask removal to resident's report of visualization of tracheal rings (T-1), time from scope tip placement in the patient's mouth to resident's report of visualization of tracheal rings (T-2), time to pass the endotracheal tube over the scope into the trachea (T-3), and confirmation of ETT in the trachea by presence of $ETCO_2$ (T-4) will be recorded. The number of attempts, failures and complications, if any, will also be recorded. Both the resident and attending will subjectively rank either comfort or degree of proficiency, respectively, on a 5-point scale. Comparisons will then be made between groups to determine if one teaching system is superior to the other for skill acquisition (Mann-Whitney test; a p value < 0.05 is considered to be significant).

Results: To date, 10 residents have been enrolled in the study: 4 in the video-assisted group and 6 in the traditional scope group. There were no differences between groups in patients' age, weight or height. No complications have occurred. T-1 and T-2 were significantly longer in the traditional scope group compared to the video-assisted group; T-3 and T-4 were not significantly different. The mean number of intubation attempts was significantly greater in the traditional group. The mean attending score for degree of proficiency was significantly better in the video assisted group (Table).

	T-1 (seconds)	**T-2 (seconds)**	**T-3 (seconds)**	**T-4 (seconds)**	**Attempts (N)**	**Proficiency Score (higher number = better)**
Traditional (old)	34.3 ∂ 6.9	30.8 ∂ 6.2	14.2 ∂ 3.9	11.0 ∂ 1.0	1.43 ∂ 0.16	3.62 ∂ 0.39
Video (new)	23.7 ∂ 19.0	18.7 ∂ 4.0	17.3 ∂ 7.9	11.3 ∂ 1.2	1.10 ∂ 0.13	4.27 ∂ 0.32
P value new vs old	**0.03**	**0.02**	0.67	0.67	**0.02**	**0.04**

Discussion: In infants and children, video-assisted fiberoptic intubation appears to be a simpler skill to teach and perform and therefore acquire proficiency in than is traditional fiberoptic intubation. This conclusion is based on the shorter times for T-1 and T-2, i.e., the time of visualization of the tracheal rings by the resident from either removal of the facemask or placement of the scope tip in the patient's mouth. The reduced number of attempts for successful intubation, and the subjectively greater proficiency of the residents in the video-assisted group as compared to those who used the traditional technique also support this conclusion. Not surprisingly, the times for passing and confirming $ETCO_2$ (T-3 and T-4), skills that are visually independent, were similar between groups. This finding supports a comparable skill level between the 2 groups. Our study suggests that the ability of the teacher to see what the student sees results in more rapid skill acquisition and shorter time to guide the scope into the trachea which should reduce the potential for patient complications such as O_2 desaturation. The authors recommend the video-assisted technique for teaching fiberoptic intubation of infants and children to residents.

Refs: 1. Wheeler M, Coté CJ, Todres ID: Pediatric Airway in *A Practice of Anesthesia for Infants and Children.* Coté CJ et al, eds. WB Saunders. Philadelphia. 2001.

Supported by an equipment grant of both the traditional and video scopes from Karl Storz Endoscopy-America.

Title: **Early Introduction of Oral Analgesics for Patients with Sickle Cell Crisis on PCA**

Author(s): I.T Cohen MD, J.C. Finkel MD, D Cochran RN, M Vaughan RN

Affiliation: Department of Anesthesiology, Children National Medical Center, Washington, D.C.

Introduction: The effectiveness of PCA in children with sickle cell anemia occlusive crises is well described[1-3]. At our institution, since October of 1998, a sickle cell clinical pathway utilizes combined mode PCA (demand mode plus a continuous infusion) in children greater than seven years old. Until this year patients, with decreasing pain assessment, were weaned from the combined format to the demand mode alone and then to oral analgesics. Starting this year, in order to speed and smooth transition from PCA, oral analgesics are now initiated upon stopping the continuous infusion. We have reviewed the results of this change in practice.

Methods: In accordance with the sickle cell pathway, all patients after admission from the emergency medicine department were started on combined mode PCA with either morphine or hydromorphone. With improved self-assessment on age appropriate pain scales, PCA dosages were decreased 20%. In 2000 patients were transitioned off PCA to acetaminophen with codeine (1-2 mg/kg) q 4-6h. In 2001 patients were transitioned from the combine mode to PCA demand mode and P.O. analgesics (acetaminophen with codeine (1-2 mg/kg) or tramadol (1-2mg/kg) q 4-6) with a continued wean. Data were collected from clinical pathway reports, pain management team notes and patient medical records. Total number of patients treated, average length of stay (ALOS), percent of patients readmitted within 30 days and complications were assessed. Data were compared using Student t-test and chi-square analysis.

Results: A total of 304 admissions, 194 in 2000 and 110 in 2001, for painful vaso-occlusive crises were enrolled in the sickle cell clinical pathway. No complications were reported with the simultaneous use of oral analgesics and demand mode PCA. There were no significant differences found between the two treatment groups in terms of average length of stay (3.62 days vs. 3.59 days) or readmission rate (23.2% vs. 17.2%).

Discussion: Early introduction of P.O. analgesics had no significant effect on ALOS or readmission rate in patients in painful vaso-occlusive crises secondary to sickle cell anemia. This may reflect the fact that three to four days is the minimal ALOS that can be achieve in children with this diagnosis or that other multiple factors also influence length of stay. It was hypothesized that early transition to PO medication would reduce the readmission rate by detecting side effects and lack of compliance with these medications but this was not observed. Replacing continuous infusions with “around the clock” P.O. analgesics appears to be safe in this patient population but with no apparent benefit.

Refs:

1. McPherson et al., Am J Med Sci, 1990
2. Shapiro et al., J Pain Symptom Manage, 1993
3. Ackerman et al., South Med J, 1993

Title: **Clinical Experience with Tramadol in Patients with Sickle Cell Anemia**

Author(s): I.T. Cohen, J.C. Finkel, D. Cochran, M. Vaughan

Affiliation: Department of Anesthesiology, Children National Medical Center, Washington, D.C.

Introduction: Tramadol, an analgesic for mild to moderately severe pain recently made available in the United States, has been reported to be effective in the pediatric population with side effects paralleling those found in adults and minimal risk of respiratory depression[1]. In addition, not being a controlled substance, tramadol can be dispensed in school. These attributes offer many advantages to children with painful sickle cell crises who often require numerous and frequent interventions. The purpose of this study was to review our clinical experience with this medication in patients admitted for vaso-occlusive crises.

Methods: In accordance with the sickle cell pathway at our institution, all patients after admission from the emergency medicine department were started on combined mode PCA (demand plus infusion) with either morphine or hydromorphone. With improved self-assessment on age appropriate pain scales, patients were weaned and then transitioned from PCA to either acetaminophen with codeine (1-2 mg/kg) or tramadol (1-2mg/kg) q 4-6h. Data were collected from clinical pathway reports, pain management team notes and patient medical records. Total number of patients treated, percent of patients readmitted within 30 days and complications were assessed. Data were compared using chi-square analysis.

Results: Of 110 admissions for painful sickle cell crises, 44 received tramadol while 66 received acetaminophen with codeine. Seven patients (16%) registered complaints concerning tramadol: 3 complained of dizziness, 2 complained of dizziness, nausea and vomiting, and 2 stated that the medication was not effective in treating their pain. There was no significant difference observed in the readmission rate for the two treatment groups: 18.2% for acetaminophen with codeine and 15.9% for tramadol.

Discussion: Our preliminary results show no advantage in using tramadol in patients with pain secondary to sickle cell vaso-occlusive crises. The incidence of side effects and readmission within 30 days was similar in those patient treated with acetaminophen with codeine. Our results may reflect the importance of determining the appropriate dose for each individual patient and the community pharmacy availability of this recently approved medicine as well as the intrinsic difficulties of treating this complex disease.

Refs:

1. Rose et al., Anesthesiology, 2001

Title: **Pediatric Deep Sedation Service**

Author(s): S.L. Hersey, R. Barr, K. Chruchwell, J. Deshpande, S. Hays, M. Karadash N. Patel, M. Taylor, V. Shankar

Affiliation: Division of Pediatric Critical Care and Anesthesia, Vanderbilt Children's Hospital

Introduction: Safe, effective provision of procedural sedation for children remains controversial and problematic. Deep sedation is usually required for successful completion of even brief procedures, and there are insufficient numbers of pediatric anesthesiologists to provide this service. In the interest of maximizing both humane and safe care of our patients, we have established an inpatient deep sedation service utilizing pediatric intensivists and advanced pediatric nurse practioners. We report our initial experience with this service.

Methods: All providers of pediatric sedation at Vanderbilt University Medical Center must take and pass the interactive CD-ROM sedation instruction course, and have current PALS certification. In addition to these basic requirements, the deep sedation providers attend additional didactic lectures and must demonstrate appropriate hands-on airway skills in the pediatric operating suite. Any inpatient or oncology patient can be referred to the service, where they are evaluated by an intensivist and scheduled for sedation. All patients are appropriately NPO, receive a focused pre-sedation evaluation including ASA functional status evaluation, and are prescribed a sedation plan according to individual practitioner preference. An advanced nurse practitioner and a pediatric intensivist who are not involved in the procedure perform the sedations in a designated room adjacent to the PICU or in the procedure room of the Pediatric Oncology Clinic. Monitoring consisted of ECG, NIBP, and pulse oximetry recorded every 5 min., according to ASA and AAP guidelines. Level of sedation is reported via a standardized scale (1-5 awake-unresponsive). All patients were discharged to the inpatient ward or hematology/oncology clinic after reaching a PARR score of 8. Demographic data, drugs, and dosages used, ASA status, procedure, diagnosis, and significant complications are reported.

Results: 334 sedations are reported, representing the first 19 months of service. All patients were referred from the pediatric oncology service, evaluated by an intensivist, and scheduled for sedation. Demographic data are presented in Table 1. 310 patients (93%) required a bone marrow biopsy with/without aspiration, lumbar puncture with/without intrathecal chemotherapy, or a combination of the two; 24 patients (7%) had other procedures. The average duration of the procedures was 17.2 min. 331/334 patients (99%) received propofol (average dose-4mg/Kg); 50 of these were supplemented with fentanyl, with or without midazolam; one patient received benadryl. The 3 patients that did not receive propofol received ketamine and midazolam. All patients reached a sedation score of 4 or 5, with 5 representing unresponsiveness to all stimulus. Hypotension (>20% decrease from baseline) was the most common complication (62/334-19%); 7 of those (2% of patients) were thought by the attending physician to require treatment consisting of a 10-20 mg/kg fluid bolus. There were no long-term sequelae of these transient episodes. Saturations <95% occurred in 3/334 (.9%) of the patients with transient apnea requiring bag/valve/mask ventilation, which briefly resolved without consequence. All three of these patients received propofol. Recovery time was recorded in 86 of the sedations (it was not initially documented on the sedation records): average time was 14 min.

Table 1.

Age		Weight (Kg)		ASA Status	
Average	9 yrs	Average	37 Kg	I	3%
</=1y	5			II	23%
1-5y	120			III	74%
5-18y	209				

Conclusion: Pediatric oncology patients require multiple invasive painful procedures. Increasing volume and complexity of this population led to reassessment of the provision of sedation for these procedures. A training and credentialing system for sedation was already in place at Vanderbilt, and the Sedation and Analgesia Committee approved the addition of a deep sedation service run by the pediatric intensivists with appropriate additional didactic and airway management training. Adverse events were consistent with the known effects of propofol, and were evaluated and treated in a timely manner without sequelae. We believe pediatric intensivists with appropriate training can safely and effectively perform deep sedation for children, including ASA III patients.

Title: **Pharmacokinetics of Orally Administered Intravenous Fentanyl in Children Undergoing General Anesthesia**

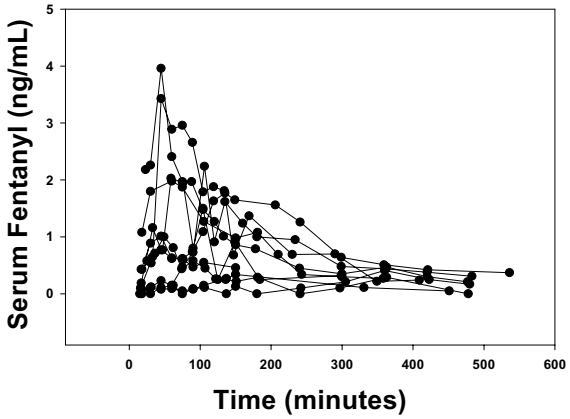
Author(s): M. Wheeler, MD, P.K. Birmingham, MD, C. Heffner, RN, C. J. Coté, MD

Affiliation: Children's Memorial Hospital. Department of Pediatric Anesthesiology. Northwestern University Medical School. Chicago, IL.

Introduction: Previous studies of the fentanyl Oralet® performed by our group suggested a larger fraction of gastrointestinal uptake than described in adults.[1,2] We therefore postulated that intravenous formulation given orally should produce similar serum levels for a given dose.

Methods: After IRB approval and parental consent, 10 healthy (ASA PS 1 or 2) children scheduled for surgical procedures requiring overnight hospitalization, analgesia and with minimal blood loss were enrolled. Undiluted intravenous fentanyl was given orally in a dose of 10-15 mcg/kg. This was followed by two 5 ml aliquots of water that were "swished and swallowed". Two mL samples of blood were taken from a peripheral IV placed after induction of anesthesia at the following times: 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 180, 240, 300, 360, 420, 480, and 600 min following fentanyl ingestion. Serum was separated and frozen at -20˚ C for later analysis. Fentanyl stock solutions were prepared at 0.01, 0.1, 1.0, and 10 ng/σL. Standard curves consisted of plasma fortified with fentanyl at 0.05, 0.08, 0.1, 0.5, 1, 2, 3, 5, 10, 25, 50 and 100 ng/mL. Quality controls were prepared in duplicate or triplicate at 0.1, 0.5, 1.0 ng/mL and 10.0 ng/mL. Deuterated internal standards (FT-d5) were added to 250 σL of plasma (final concentration = 0.5 ng/mL). Ammonium hydroxide (50 µL) was then added to adjust pH (>9.0) and specimens extracted with butyl chloride: acetonitrile (4:1; v/v). After centrifugation, the organic phase was transferred to clean, silanized glass tubes and solvent evaporated at <40∀C under a stream of air. Extracts were reconstituted in mobile 0.1% formic acid: methanol (9:1 v/v). Analyses were performed on a Thermo TSQ7000 LC/MS/MS in ESI mode (electrospray ionization). Peak/height ratios were calculated and the concentration of each analyte was determined from least-squares regression analysis of standards. Intra-and inter-assay coefficient of variation for fentanyl was < 18% at 0.1 ng/mL, < 10% at 0.5 and 1.0 ng/mL, and < 5% at 10 ng/mL.* Preliminary pharmacokinetic analysis consisted of area under the curve (AUC) calculated by the trapezoidal rule.

Results: The mean age was 7.9 ∂ 1.9 y. Mean weight was 28.2 ∂ 10.2 kg. The mean AUC was 242 ∂ 154 ng≤min≤ml^{-1}. Individual serum concentration time curves are illustrated in the figure. Patients were observed from 10 to 25 min after fentanyl administration and prior to anesthetic induction. No episodes of nausea, vomiting, or desaturation were noted preoperatively. No episodes of desaturation occurred postoperatively.



Discussion: Our preliminary interpretation of these concentration time curves suggests that the intravenous formulation of fentanyl is rapidly absorbed with a prolonged and flat concentration profile similar to that which we found in our previous studies of the fentanyl Oralet®.[1,2] The oral administration of the intravenous formulation of fentanyl may provide a reasonable alternative method for fentanyl administration.

Refs: 1. Anesth Analg. 86:66-70, 1998.
2. Submitted for publication.

*Assays performed by The Center for Human Toxicology, University of Utah, Salt Lake City, UT.

Title: **The Use of a Patient Simulator to Evaluate Rescue Capability for Pediatric Sedation Critical Events**

Authors: JP Cravero, GT Blike, J Jensen

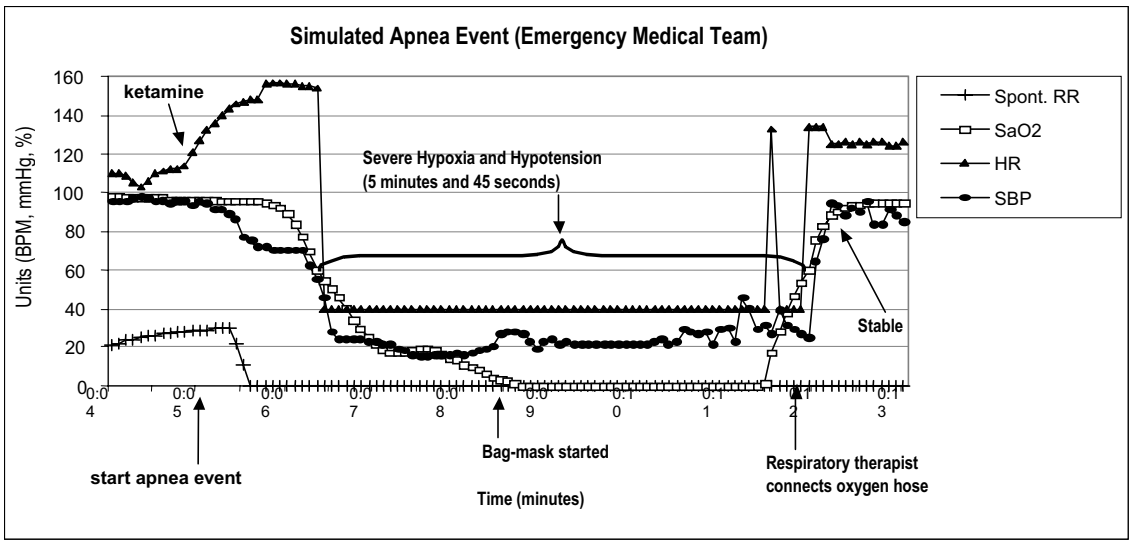
Affiliation:Dartmouth Hitchcock Medical Center

Introduction: Current JCAHO recommendations regarding sedation require that providers of sedation have the skills to "rescue" patients from a sedated state that is one level "deeper" than that which is intended. For pediatric patients this would require sedation providers to rescue a child from states of deep sedation and anesthesia. We sought to test the ability of different providers (working in various units where pediatric sedation is provided) to rescue patients from rare - but not unheard of – critical sedation events. In the past patient simulators have been used widely to train and test anesthesiology care providers, this project represents the first use of this technology to evaluate existing sedation rescue systems in the actual sites where pediatric sedation is provided.

Methods: A pediatric simulator manufactured by METI Corporation was used throughout this investigation. This simulator uses computer algorithms driving an animated mannequin to mimic the physiology and anatomy of a 4 year old child. The simulator was taken to 3 locations in the Children's Hospital at Dartmouth where pediatric sedation is provided – CT scanner, PACU, and Emergency Department. We scheduled the cases as per routine and at the time of the sedation we informed the personnel that they would be sedating the simulator and to proceed as per protocol. Permission was obtained from our Code Blue Committee to create and videotape sedation related "codes" using the simulator as our patient. When needed a "code" was called and team members responded without knowledge that this was a simulated event.

In each instance we programmed an apneic/laryngospasm event to occur 2-3 minutes after sedation had been induced. Sedation providers chose their own route of administration, monitors, and drug for sedation. A videotape was taken of the sedation and resuscitation. In addition the simulator's computer recorded blood gases, blood pressure, heart rate, pulse oximetry, cardiac output, and respiratory rate throughout the course of the sedation. Data from different units were compared for time to respond to apnea, length of time with severe hypoxia, and ability to mobilize resources to resuscitate the patient.

Results: Physiologic data was represented graphically over time. The data from an emergency department case using ketamine for sedation is displayed below:



Comparison of the data revealed wide variation between providers in the time to "rescue" with severe hypoxia ranging from 7 minutes in our CT scanner when pediatric residents delivered sedation to 1 minute in the PACU when anesthesiologists were involved.

Conclusion: We report the first use of a pediatric patient simulator to quantify the ability of sedation providers to rescue patients from sedation critical events.

References: Marshall RL et. al. Journal of Trauma-Injury Infection & Critical Care. 51(1):17-21, 2001

Morgan PJ et. al. Canadian Journal of Anaesthesia. 48(3):225-33, 2001

Title: **Sedation During Mechanical Ventilation in Infants and Children: Dexmedetomidine Versus Midazolam**

Author(s): Joseph D. Tobias MD, John W. Berkenbosch MD

Affiliation: Departments of Anesthesiology & Pediatrics, The University of Missouri, Columbia, MO 65212

Introduction: Sedative and/or analgesic agents are commonly administered to alleviate the anxiety and discomfort associated with mechanical ventilation. Dexmedetomidine is a centrally acting, alpha-2 adrenergic agonist which is currently FDA approved for short term (24 hours or less) sedation of adults during mechanical ventilation. We report our initial experience with a prospective, randomized trial comparing the efficacy of dexmedetomidine with midazolam for sedation during mechanical ventilation in infants and children.

Methods: The study was approved by the Hospital's Institutional Review Board and written , informed consent obtained from a parent. The patients were randomized to receive either midazolam or dexmedetomidine for 24 hours. At the completion of the first 24 hours of infusion, if ongoing sedation for mechanical ventilation was still necessary, the patient could be switched to the other medication. During the initial stabilization period and prior to obtaining informed consent and randomization, sedation was provided with incremental doses of midazolam (0.1 mg/kg repeated as necessary). Dexmedetomidine was started at 0.25 mcg/kg/hr and midazolam was started at 0.1 mg/kg/hr. The infusions were supplemented as needed with intermittent doses of morphine (0.1 mg/kg). If the patient required multiple doses of morphine, the dexmedetomidine infusion was increased in increments of 0.25 mcg/kg/hr and the midazolam infusion was increased in increments of 0.1 mg/kg/hr. An assessment of the level of sedation was made every 2 hours using the Ramsay score (1 = agitated, 6 = non-responsive), the BIS number, heart rate and blood pressure. Statistical analyses included Fisher's exact test and non-paired, two-tailed t-test. All data are presented as the mean $\pm$ SD.

Results: To date, 8 patients have received midazolam and 8 have received dexmedetomidine. The mean infusion rate of midazolam was 0.20 $\pm$ 0.04 mg/kg/hr and the mean infusion rate of dexmedetomidine was 0.27 $\pm$ 0.05 mcg/kg/hr. The remainder of the results are outlined in the table below.

	midazolam	**dexmedetomidine**	**p value**
Age (months)	31 $\pm$ 45	47 $\pm$ 70	NS
Weight (kgs)	16 $\pm$ 20	20 $\pm$ 27	NS
Gender (male/female)	5M/3F	5M/3F	NS
Duration of infusion (hrs)	15.3 $\pm$ 7.7	14.0 $\pm$ 7.0	NS
Infusion rate changes (total)	13	2	$p<0.05$
Morphine boluses (total, mean)	27, 3.4 $\pm$ 1.5	14, 1.8 $\pm$ 1.8	NS
Morphine use (mg/kg/24 hr)	0.69 $\pm$ 0.45	0.33 $\pm$ 0.34	p=0.09
BIS number	60 $\pm$ 11	56 $\pm$ 7	NS
Ramsay score	3.5 $\pm$ 0.7	3.8 $\pm$ 0.6	NS
Patients with Ramsay score of 1	5 of 8	1 of 8	p=0.06
Total Ramsay scores of 1	9	2	p=0.06
Heart rate (beats/minute)	134 $\pm$ 31	125 $\pm$ 19	$p<0.01$
Systolic blood pressure (mmHg)	94 $\pm$ 19	94 $\pm$ 23	NS
Diastolic blood pressure (mmHg)	51 $\pm$ 17	48 $\pm$ 14	NS

Discussion: Dexmedetomidine in a dose of 0.25 mcg/kg/hr provides equivalent sedation to midazolam at 0.2 mg/kg/hr. We noted no significant hemodynamic changes with dexmedetomidine except for a lower baseline heart rate when compared with the midazolam group. With dexmedetomidine, there was a decreased need for changes in the infusion rate as well as a trend toward decreased supplemental morphine use. Although the overall level of sedation was equivalent, there were more patients in the midazolam group that demonstrated episodes of inadequate sedation (Ramsay score = 1).

Title: **Comparison of the Costs and Efficacy of Ondansetron and Dolasetron in the Prophylaxis of Postoperative Vomiting (POV) in Pediatric Patients Undergoing Ambulatory Surgery**

Author(s): Olutoyin Olutoye, M.D., Ellen Jantzen,M.D., Lisa Fazi, M.D., Rhonda Alexis, M.D., Mark Schreiner, M.D., Mehernoor Watcha, M.D.

Affiliation: Dept of Anesthesiology & Critical Care Medicine, Children's Hospital of Philadelphia, University of Pennsylvania, Philadelphia, PA

Introduction: Postoperative vomiting (POV) after ambulatory surgery remains a major cause of patient distress, delayed hospital discharge, unanticipated hospital admission and increased use of resources leading to a higher cost of care. Traditional anti-emetics such as droperidol and metoclopramide have limited efficacy and are associated with sedation, dysphoria and extra-pyramidal side effects. Serotonin antagonists such as dolasetron and ondansetron are more effective, associated with fewer side effects, and their prophylactic use has become popular in pediatric patients (1). Dolasetron was approved by the FDA for use in children based on efficacy data for chemotherapy-induced emesis, and the pediatric intravenous dose of dolasetron 350 mcg/kg recommended in the package insert was based on pharmacokinetic data (2). There are no published data on the efficacy of this dose of dolasetron in preventing POV in children. This study was designed to determine the lowest dose of dolasetron equivalent to ondansetron 100 mcg/kg IV, which is the FDA approved dose for the prophylaxis of POV in children undergoing surgery.

Methods: A total of 202 healthy ASA 1 –2 children aged 2-12 years of age, undergoing superficial ambulatory (Day –Case) surgery were enrolled in this double-blind, randomized, controlled study with IRB approval and written informed consent from parents or legal guardians. Patients were excluded if they had an ASA physical status of 3 or higher, were undergoing emergency surgery, had gastro-eseophageal reflux, prolonged QT syndrome, allergies to the study drugs or were either currently receiving or scheduled to receive drugs known to have anti-emetic effects (e.g., propofol, anti-histamines, steroids). We also excluded patients if the anesthetic plan included the administration of epidural drugs. Patients were randomized to receive either ondansetron 100 mcg/kg IV, or dolasetron in a dose of 45, 175, 300 or 700 mcg/kg, IV during a standardized anesthetic regimen. The assigned study drugs were administered within 15 minutes of the end of the procedure, residual neuromuscular blockade antagonized and the trachea extubated with the patient awake. Severe postoperative pain (CHEOPS score > 6) was managed with morphine 50 mcg/kg IV and mild-moderate pain with oral acetaminophen-codeine mixture. Demographic data, duration of anesthesia and surgery, times to awakening, achieving preset discharge criteria, use of rescue analgesic and antiemetic drugs and the incidence of postoperative emesis during phase 1 and 2 PACU stay were recorded. Phone calls were made at 24 hours and 5 days after surgery to determine the incidence of post-discharge emesis, recovery characteristics and satisfaction. The primary end-point was the incidence of complete response, defined as the absence of POV symptoms. Power analysis was based on a test for trends across proportions (logistic model) assuming a success rate of 70% and 40% with the most and least effective dose respectively, a significance level of 0.05 and power of 80%. P values of <0.05 were considered statistically significant.

Results: There were no significant differences between the study groups in demographic data, patients with previous POV or motion sickness, surgical procedure, duration of surgery and anesthesia or times to achieving discharge readiness. The incidence of early (0-6 hr) and 24 hour emesis was higher in the dolasetron 45 mcg/kg group compared to the dolasetron 175, 350 and 700 mcg/kg groups and to the ondansetron group. There were no significant differences in emesis rates between the dolasetron 175, 350 and 700 mcg/kg groups or between these groups and the ondansetron 100 mcg/kg group.

	Dolasetron 45 mcg/kg	Dolasetron 175 mcg/kg	Dolasetron 350 mcg/kg	Dolasetron 700 mcg/kg	Ondasetron 100 mcg/kg
Early emesis (0-6 hr)	43%	27% *	21% *	19 % *	21% *
24 hr emesis	49 %	36 % *	29 % *	19 % *	22 % *
NNT (95% confidence limit)	3.7 (2.2 –19) ¶	7.0 (2.9 - Ð)¶	13.6 (3.6 - Ð)¶	30 (5 -Ð)†	N/A
Rescue antiemetics	12 %	3 %	3 %	6 %	2 %

¶ NNT = Number of patients who would need to receive ondansetron 100 mcg/kg IV to prevent POV symptoms in 1 patient who would otherwise have developed this complication if this dose of dolasetron was administered.

† NNT= Number of patients who would need to receive this dose of dolasetron to prevent POV symptoms in 1 patient who would otherwise have developed this complication if ondansetron 100 mcg/kg IV was administered

*P < 0.05 vs dolasetron 45 mcg/kg

Discussion : The lowest dose of dolasetron with acceptable equivalent efficacy to ondansetron 100 mcg/kg was 175 mcg/kg.

References: (1) Rose JB & Watcha MF: BJA 1999; 83: 104-117 (2) Package insert Anzemet ®

Group #6 – Pharmacology II

Group Leader: C. Dean Kurth, MD

#46 *Prolonged Exposure to Ketamine did not Decrease Brain Derived Neurotrophic Factor Levels in Developing Rat Brains*
S.G. Soriano, H. Hayashi, and J.C. Ibla

#47 *Duration of Preoperative Fast Affects Blood Pressure Response in Halothane in Infants*
R.H. Friesen, J.L. Wurl

#48 *In Children, Pre but not Postsurgical Caudal Block Attenuates the Stress Response Associated with Anesthesia and Surgery*
S.N. Khalil, E. Hanna, A. Farag, R. Govindaraj, A.Z. Chuang

#49 *In Children, Midazolam Premedication, Preemptive Analgesia and Light Level of General Anesthesia may Contribute a Low Incidence of Postoperative Vomiting*
S.N. Khalil, A. Farag, E. Hanna, R. Govindaraj, A.Z. Chuang

#50 *Vomiting after Strabismus Correction in Pediatric Patients*
Eugene K Betts, MD, Laurie J Yates, MHS, CRNA

#51 *Postoperative Vomiting after Tonsillectomy in Pediatric Patients*
Eugene K Betts, MD, Christina Mondy, MS, CRNA, Jill A Nesley, MS, CRNA

#52 *Rofecoxib Administration to Pediatric Patients Undergoing Adentonsillectomy*
Paul W. Sheeran, MD; John B. Rose, MD; Rosetta Chiavacci, RN, Lisa Fazi, MD

#53 *Utility of Airway Exchange Catheters in Pediatric Patients with a Known Difficult Airway*
L W Faberowski, MD, C Nargozian, MD

#54 *Absence of Direct Protective Effect of Isoflurane Against Mild NMDA Toxicity in Primary Mixed Neuronal-Glial Cultures*
Wise-Faberowski, Lisa MD; Aono M MD; Pearlstein, Robert PhD; Warner, David MD

#64 *Does Myoplasmic Calcium Regulation by the Sarcoplasmic Reticulum Respond Differently to Sevoflurane in the Young?*
MW Konig, M Lin, TE Nelson, L Groban

Title: **Prolonged Exposure to Ketamine Did Not Decrease Brain Derived Neurotrophic Factor Levels in Developing Rat Brains**

Author(s): S.G. Soriano, H. Hayashi, and J.C. Ibla

Affiliation: Department of Anesthesia, Children's Hospital and Harvard Medical School, Boston, MA 02115

Introduction: We previously reported that prolonged rather that acute exposure to ketamine, an n-methyl d-aspartate (NMDA) receptor antagonist, results in accelerated neurodegeneration in developing rat brains (1). Although the mechanism of NMDA receptor mediated apoptotic neurodenegeration in the developing brain is not clearly defined, several lines of investigation points towards depletion of target-derived trophic factors. Synaptogenesis appears to be partly dependent on access to a limited supply of neurotrophic factors. In an in vitro model of chronic alcohol exposure in developing neurons, Bhave et al reported antagonism of the NMDA receptor resulted in a reduction in brain derived neurotrophic factor (BDNF) levels.(2) Furthermore, addition of NMDA to the culture medium increased endogenous production of BDNF. Lastly, addition of NMDA or BDNF in the culture medium substantially decreased the number of apoptotic cells. Activity-mediated NMDA receptor stimulation leads to enhances BDNF binding to its counter receptor TrkB resulting in neuronal survival.(3) These data taken together strongly supports the vital role of BDNF in neuronal cell survival in the developing brain. We hypothesize that prolonged exposure to anesthetic drug-mediated NMDA receptor inhibition leads to a reduction of neuronal stores of BDNF, thereby leading to acceleration of neurodegeneration in the developing brain.

Methods: With approval of the Investigational Review Board, postnatal day 3 (P_3) and postnatal day 7 (P_7) rat pups received 7 ip doses of either saline or ketamine (25 mg/kg/dose) at 90-minute intervals over 9 hours. Twenty-four hours after the initial exposure to the anesthetic drugs, brains from pups in each group were frozen and total RNA and total protein were extracted using standard techniques. BDNF mRNA were analyzed using reversed transcription polymerize chain reaction (RT-PCR) technique with BDNF primers commercially obtained from Clontech. The resultant cDNA were analyzed by agarose gel electrophoresis. BDNF protein levels were determined with commercial ELISA kit Emax (Promega) and a HTS 7000 Bio Assay reader (Perkin Elmer).

Results: There were no visible differences in RT-PCR BDNF cDNA levels between the two groups. Total BDNF protein levels for the saline and ketamine-treated groups were 14.5∂1.9 and 24.1∂3.1 for the P_3 rats (*$p<0.01$) and 42.4∂12.9 and 56.0∂8.7 P_7 rats, respectively ($p=0.09$). Although the ketamine-treated P_7 group had higher levels of BDNF, it did not reach statistical significance.

Conclusions: Prolonged exposure does not decrease BDNF mRNA expression or total protein levels in developing rat brains. In contrast, there was a trend for increased BDNF protein levels after ketamine exposure. Increased BDNF levels have been reported after experimental paradigms of hypoxia-ischemia and hypoglycemia coma.(4) These data suggests that the ketamine-induced neurodegeneration may not be due to deprivation of trophic factors. Instead, prolonged ketamine exposure may result in hypoxic or hypoglycemic insults. We previously reported that prolonged exposure to ketamine not only accelerated neurodegeneration but also attenuated weight gain in P_7 rat pups. Taken together, these findings lead us to speculate that prolonged ketamine administration may lead to a form of neuronal injury that mediates neurodegeneration. Further studies are needed to identify the mechanism of ketamine induced neurodegeneration and malnuitrition.

References:

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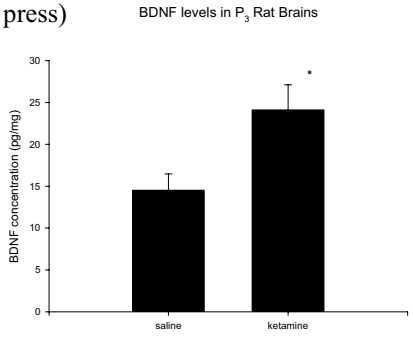

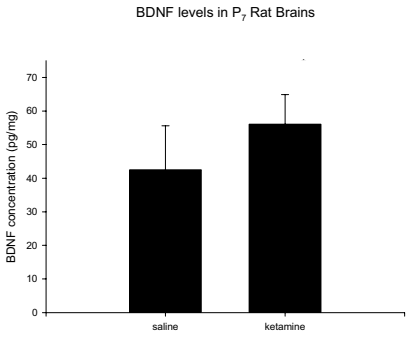

Title: **Duration of Preoperative Fast Affects Blood Pressure Response to Halothane in Infants**

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Introduction: Preoperative fasting guidelines have been developed in order to minimize the risk of hypoglycemia and dehydration in infants and children (1). Several factors contribute to wide variations in actual fasting times, including inappropriate instructions, poor compliance, and disruptions of the surgical schedule. Significant hypotension is common during halothane anesthesia in infants and children and is age-related (2). This study was undertaken to determine whether prolonged preoperative fasting is associated with greater risk of hypotension during halothane anesthesia.

Methods: 245 unpremedicated, ASA physical status I-III pediatric patients without cardiac or pulmonary disease were divided into five age groups: term neonates (n=47), 1-6 mo (n=50), 6 mo-2 yr (n=50), 2-6 yr (n=50), 6-12 yr (n=48). Preoperative fasting time was not controlled but was recorded. Anesthetic induction was achieved with halothane in oxygen and air via mask. Vecuronium 0.1 mg/kg was administered intravenously. During normocapnic manual ventilation by mask, endtidal halothane was maintained at 2 MAC for 10 min to allow myocardial uptake of halothane while surgical stimulation and tracheal intubation were avoided. Within each age group, patients were grouped by duration of preoperative fast (0-4 hr, 4-8 hr, 8-12 hr, >12 hr). Changes in heart rate (HR), systolic (SBP), mean (MBP), and diastolic (DBP) blood pressure from preinduction to 10 min were compared among fasting groups within each age group.

Results: In the neonatal group, no statistically significant differences were noted among the fasting groups, but fasting duration exceeded 8 hr in only 3 patients. In the 1-6 mo age group, the changes in SBP and MBP were significantly greater in infants fasting 8-12 hr than in those fasting 0-4 hr. No statistically significant differences were noted in the older age groups.

Discussion: At equipotent halothane concentrations, term neonates and infants 1-6 mo of age experience greater depression of BP than do older children (2). The results of this study demonstrate that prolonged preoperative fasting is associated with an even greater decrease in BP in infants 1-6 mo of age. This exacerbation of the already significant hemodynamic depression observed in infants during halothane anesthesia underscores the importance of adherence to published fasting guidelines.

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Title: **In Children, Pre ut ot Postsurgical Caudal Block Attenuates the Stress Response Associated with Anesthesia and Surgery**

Author(s): S.N. Khalil, E. Hanna, A. Farag, R. Govindaraj, A.Z. Chuang

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Introduction: Surgical stress stimulates the release of catecholamines and cortisol, both of which have anti-insulin action resulting in an increase of plasma glucose concentrations.[1] The aim of this study was to compare in children the stress response to anesthesia and minor surgical procedures, following pre or postsurgical caudal block.

Methods: Institutional and parental consents were obtained. Eighteen healthy children, 1-7 yrs old, scheduled for elective outpatient urologic or lower abdominal procedures were enrolled. Children were premedicated with oral midazolam 0.5 mg/kg. Halothane and nitrous oxide and oxygen anesthesia was induced via mask. Anesthesia was maintained with halothane, nitrous oxide and oxygen 30%. Halothane concentration was decreased to an end-tidal of 0.6% in children who received the presurgical caudal block. However, halothane end-tidal was 1.2% or higher in children who received postsurgical caudal block. No sedatives or narcotics were administered intraoperatively. Two intravenous cannulas were placed, one to withdraw blood samples and the second to maintain fluid balance using lactated Ringer's solution.
Children in group 1 (N=10) received presurgical caudal block, 0.2% ropivacaine, 1 mL/kg; those in group 2 (N=8) received postsurgical caudal block, 0.2% ropivacaine, 1 mL/kg.
Blood samples were withdrawn at:

a) Baseline (immediately after anesthesia induction).
b) 15 min after surgical incision.
c) 30 min after completion of surgery.

Statistical Analysis:
-Data within each group were analyzed using the paired t-test to compare 15 and 30 min samples with baseline.
-The 2-sample t-test was applied for data between the two groups.
-A P-value <0.05 was considered significant.

Results:
-Demographic data were similar.
-There was a significant difference between the two groups in the increase in blood glucose when comparing the 15 (P=0.025) and 30 min (P=0.04) blood samples with baseline.
-In group 2, there was a significant increase in blood glucose in the 15 (P=0.001) and 30 min (P=0.004) blood samples compared with baseline (Table 1).

Conclusion: In children, pre but not postsurgical caudal block attenuates the stress response associated with anesthesia and surgery.

Refs. 1. T. Oyama, Amsterdam Elsevier, 1983

Table 1. Changes in Blood Glucose Compared with Baseline

Time	Presurgical Caudal	Postsurgical Caudal
15 min after surgical incision mg/dL	18 ∂ 32	53 ∂ 24*
30 min after completion of surgery mg/dL	11 ∂ 30	42 ∂ 26*

* P < 0.05 using paired t-test

Title: **In Children, Midazolam Premedication, Preemptive Analgesia and Light Level of General Anesthesia May Contribute to a Low Incidence of Postoperative Vomiting**

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Introduction: In children, the incidence of postoperative vomiting (POV) after orchiopexy and hernia repair is 54-58% and after penile procedures is 37-49%. 1 It was our clinical impression that our routine anesthesia care to children scheduled for outpatient urologic or lower abdominal procedures was associated with a lower incidence of POV. The aims of this prospective study were to determine the incidence of POV at the hospital and for the first 24h from awakening time and to evaluate the effect of age on POV.

Methods: Institutional and parental consents were obtained. One hundred and ten healthy children, 1-7 yrs old, scheduled for elective urologic or lower abdominal operations were enrolled. The surgical procedures included circumcision, hypospadias repair, orchiopexy, hydrocelectomy and inguinal herniorrhaphy. All children were fasting and premedicated with midazolam, 0.5mg/kg PO. Anesthesia was induced via mask and consisted of halothane and 60% nitrous oxide in oxygen. An intravenous (i.v.) cannula was placed, and fluid deficit and intraoperative losses were replaced with lactated Ringer's solution. Glycopyrrolate 5 ug/kg iv was given. With the patient in the left lateral position a presurgical caudal block, 1 ml/kg of bupivacaine 0.25%, or ropivacaine 0.2%, was then placed, using a short-bevel 22 g needle. Halothane concentration was adjusted to an end-tidal of 1.2 % before surgical incision. If a child did not respond to surgical stimuli, halothane was decreased to an end-tidal of 0.6%. The airway was maintained with a facemask, laryngeal mask, or an endotracheal tube. Intravenous rocuronium 0.5 mg/kg iv was administered to facilitate placement of the endotracheal tube. Intravenous neostigmine 50 ug/kg and i.v. glycopyrrolate 10 ug/kg were given to reverse residual muscle weakness. No antiemetics were given.
An independent observer recorded incidence of vomiting (including retching) in the hospital and for 24 h after the awakening time (the time the child first responded to verbal commands). The independent observer contacted parents the next day to determine vomiting after hospital discharge.

Statistical analysis: Fisher's exact test was performed to compare the incidence of vomiting in younger (<2y) and older (>2y) patients. A P value <0.05 was considered significant.

Results: All the caudal blocks provided adequate intraoperative analgesia; halothane concentration was decreased in all cases to an end-tidal of 0.6% and narcotics were not administered intraoperatively.
The incidence of POV at the hospital and for the 24 h study period was low, and age did not affect it (Table).

Conclusion: In current anesthesia care, several factors could have contributed to the low incidence of POV, including using midazolam premedication, providing preemptive analgesia, avoiding narcotics intraoperatively, administering of glycopyrrolate, maintaining hydration and administering light level of halothane anesthesia.

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Incidence of Postoperative Vomiting

Number of patients	Age (year)	Hospital Vomiting N/ %	24h Vomiting N / %
110	1-7	13/12 %	14/13 %
66	>2	9/14 %	10/15 %
44	<2	3 / 7 %	4 / 9 %

Title: **Vomiting after Strabismus Correction in Pediatric Patients**

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Background: Postoperative vomiting (POV) is a major source of dissatisfaction for pediatric patients and their parents. A review of the literature found only one study which stratified patients by the type of operation[1] and that the lowest incidence of POV was obtained in patients who received low dose ondansetron combined with dexamethasone[2]. The roles of nitrous oxide (N2O) and anesthetic agent in POV are also unclear.[3,4] We hypothesized that the substitution of air for N20 has no influence on the incidence of POV in pediatric patients undergoing recession strabismus correction under propofol anesthesia with prophylactic ondansetron and dexamethasone.

Methods: After Human Assurance Committee, ie, IRB, approval with waiver of written informed consent per DHHS policy, all patients presenting for recession strabismus correction at the MCG Children's Medical Center were entered into a sequential trial using historical controls. Data were collected on 23 sequential patients. With the first 20 patients, after inhalational anesthesia induction with 8% sevoflurane in 70% N2O and 30% oxygen, an intravenous route was established, mivacurium (0.2 mg/kg) and antiemetic prophylaxis, with low dose ondansetron (0.05 mg/kg) and dexamethasone (0.15 mg/kg), were administered. N2O and sevoflurane were then discontinued and the patient's trachea intubated. Following tracheal intubation, a propofol infusion was started using a syringe pump, with an initial rate of 200 mcg/kg/min, with 70% N20. The propofol infusion was titrated to maintain the patient's mean blood pressure within 30% of baseline and the patient's extraocular muscles immobile; bolus doses of mivacurium will administered as needed to maintain the immobility of the eye muscles. Similarly, in the next 10 patients, before and after tracheal intubation, air was used instead of N2O. All patients received intravenous ketorolac (0.5 mg/kg, maximum of 30 mg) at the conclusion of surgery for postoperative pain relief.

Power calculation: In the absence of anti-emetic measures using ondansetron, propofol, dexamethasone and avoiding morphine, the historical incidence of postoperative vomiting in this group of patients have variously been reported as 23, 32, 37, 46, 48, 50, 58, 62, 71, and 73%. Using a one-sample test of proportions with an incidence of 50% and an anticipated reduction to 20%, a power of 0.90 and a significance level of 0.05, the calculated required sample size is 21/group.

Results: The results are shown in the table. There were no statistically significant intergroup differences in the gender ratio, mean weight or procedures between the N2O and air groups. One patient in the air group vomited postoperatively.

Table	n	M:F	Age (yrs)	Wt (kg)	Horizontal muscles (n)	Vertical muscles (n)	Both muscles (n)	Vomited in PACU (n)	Vomited after discharge (n)	Vomited postop (n)	vs 0.5 p<
N2O	20	8:12	5.5	28.6	12 (60%)	6 (30%)	2 (10%)	0.0 (0%)	0.0 (0%)	0 (0%)	0.01
Air	10	5:5	4.3	20.9	9 (90%)	1 (10%)	0 (0%)	1 (10%)	0.0 (0%)	1 (10%)	0.05

Discussion: Due to the low frequency of vertical muscle recession in this group of patients, no conclusions can be drawn regarding the frequency of vomiting in these subgroups. In this group of patients, anesthetic levels of propofol, when combined with the intraoperative use of ketorolac, for postoperative pain relief, and intraoperative antiemetic doses of ondansetron and dexamethasone, conferred almost complete protection from postoperative vomiting irrespective of whether or not N2O was used.

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Title: **Postoperative Vomiting after Tonsillectomy in Pediatric Patients**

Author(s): Eugene K Betts, MD, Christina Mondy, MS, CRNA, Jill A Nesley, MS, CRNA

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Background: Postoperative vomiting (POV) is a major source of dissatisfaction for pediatric patients and their parents. The new harmonic scalpel minimizes tissue trauma resulting in less postoperative pain and the possibility of a lower incidence of POV. A review of the anesthetic literature found only two studies that even mention the surgical method. Various studies indicate that dexamethasone has some antiemetic properties, ondansetron is a better antiemetic than droperidol or metoclopramide, and that, in equipotent doses, atropine is less emetogenic than glycopyrrolate, propofol less than sevoflurane, and fentanyl less than morphine. We hypothesized that the substitution of air for N20 has no influence on the incidence of POV in pediatric patients undergoing T&A under propofol/fentanyl anesthesia with prophylactic ondansetron and dexamethasone.

Methods: After Human Assurance Committee, ie, IRB, approval with waiver of written informed consent per DHHS policy, all ASA 1-2 patients presenting for tonsillectomy, with or without adenoidectomy, were entered into a sequential trial using historical controls. In the N2O group, after inhalational anesthesia induction with 8% sevoflurane in 70% N2O and 30% oxygen, an intravenous route was established, mivacurium (0.2 mg/kg), fentanyl (1 ug/kg) and antiemetic prophylaxis, with low dose ondansetron (0.05 mg/kg) and dexamethasone (0.15 mg/kg), were administered. N2O was then discontinued and the patient's trachea intubated. Following tracheal intubation, a propofol infusion was started using a syringe pump, with an initial rate of 200 mcg/kg/min, and 70% N20 in 30% oxygen. Isoflurane (0.8% end-tidal) was added to supplement the propofol and N2O. The propofol infusion is titrated to maintain the patient's mean blood pressure within 30% of baseline; bolus doses of mivacurium were administered as needed to maintain the immobility of the patient. In the air group, air was substituted for N2O.

Power calculation: In the absence of anti-emetic measures using droperidol, granisetron, metoclopromide, ondansetron and propofol, and avoiding morphine, the historical incidence of postoperative vomiting in this group of patients have been reported as 11, 22, 35, 62, 63, 70 and 88%. Using a one-sample test of proportions with an incidence of 50% and an anticipated reduction to 20%, a power of 0.90 and a significance level of 0.05, the calculated required sample size is 21/group.

Results: The results are shown in the table. Since a historical incidence was used, an intergroup analysis of the differences in the gender ratio, mean weight or procedures was not possible.

Table	n	M:F	Age (yrs)	Wt (kg)	Electro-cautery (n)	Harmonic scalpel (n)	Vomited in PACU (n)	Vomited after discharge (n)	Vomited postop (n)	vs 0.5 p<
N2O	43	27:16	7.3	33.3	16 (41%)	27 (69%)	4 (9.3%)	6 (14.0%)	9 (20.1%)	.01
N2O	16	11:5	7.4	32.2	X		1 (6.2%)	4 (25.0%)	5 (31.2%)	ns
N2O	27	17:10	7.2	33.8		X	3 (11.1%)	2 (7.4%)	4 (14.8%)	.01
Air	46	21:25	7.1	31.0	23 (50%)	23 (50%)	7 (15.2%)	3 (6.1%)	8 (17.4%)	.01
Air	23	10:13	7.3	31.8	X		2 (8.6%)	1 (4.3%)	2 (8.6%)	.01
Air	23	11:12	6.7	30.3		X	4 (17.4%)	2 (8.7%)	6 (26.1%)	.05

Discussion: No comparisons can be made between the groups or subgroups, only between the (sub)groups and the assumed historical incidence of vomiting of 50%. In this study, all anesthetic and surgical technique combinations, except for N2O and electrocautery dissection, were effective in reducing the incidence of postoperative vomiting. The combination excepted may due to the small sample size in this subgroup as the selection of surgical technique was part of a RCT surgical study. Although not a part of this study, it was noted that fentanyl provided inadequate postoperative pain relief in the PACU; rescue was provided with morphine. A repeat study using morphine rather than fentanyl intraoperatively is planned.

Title: **Rofecoxib Administration to Pediatric Patients Undergoing Adenotonsillectomy**

Author(s): Paul W. Sheeran, M.D.; John B. Rose, M.D.; Rosetta Chiavacci, R.N., Lisa Fazi, M.D.

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Introduction: Rofecoxib is a selective COX-2 inhibitor that does not interfere with platelet function and has been associated with fewer bleeding complications than other NSAIDs [1-3]. Our aim was to evaluate the safety and efficacy of rofecoxib administration to pediatric patients undergoing adenotonsillectomy (T&A).

Methods: We conducted a double blind, randomized, placebo-controlled study of rofecoxib in 45 ASA 1-2 patients over 4 years old undergoing outpatient T&A. The use of rofecoxib in this patient population is investigational. All patients received either rofecoxib 1 mg/kg (max 25 mg) or placebo and midazolam 0.5 mg/kg (max 15 mg) PO 30 minutes preoperatively. All patients underwent mask induction (O_2/N_2O and sevoflurane) and endotracheal intubation. Anesthesia was maintained with desflurane and O_2/N_2O. In addition, morphine 50 mcg/kg IV, acetaminophen 30 mg/kg PR, dexamethasone 0.5 mg/kg IV (max 10 mg) and ondansetron 0.1 mg/kg IV (max 4 mg) were administered. Following awake extubation in the OR, patients were taken to the PACU. CHEOPS scores were obtained on arrival in the PACU. Wong Baker Faces Scale (FACES) was obtained at discharge from the PACU and the DSU. Morphine 0.025 mg/kg IV was administered for pain in PACU. Outcome measures included morphine required in the PACU, Admission CHEOPS, PACU Discharge Faces score, and DSU Discharge faces score.

Results: There were 23 patients in the rofecoxib group and 22 patients in the placebo group. The rofecoxib and placebo groups were similar with respect to age (mean age = 7.2 ∂ 1.8 yrs vs. 7.6 ∂ 2.2 yrs, respectively), weight (mean weight = 24.2 ∂ 6.1 kg vs 26.3 ∂ 8.4 kg, respectively) and sex (13 male/ 10 female vs 12 male/10 female, respectively). Likewise, Anesthesia time (49.8 ∂ 8.7 minutes vs 48.1 ∂ 8.4 minutes, respectively) and surgical time (19.3 ∂ 5.3 minutes vs 18.0 ∂ 7.1 minutes, respectively) were comparable. There were no differences between the rofecoxib and placebo groups in bleeding (mean EBL = 59 ∂ 45 cc vs. 58 ∂ 35 cc, respectively), median CHEOPS (range) scores [9 (6 – 13) vs 9 (6 – 13)], median FACES (range) scores [2 (0 – 5) vs 3 (0 – 5), respectively], mean total morphine dose (39.2 ∂ 28.1 mcg/kg vs. 38.9 ∂ 32.1 mcg/kg, respectively), mean PACU times (70 ∂ 18 min vs 73 ∂ 34 min, respectively), or mean DSU times (106 ∂ 30 min vs 110 ∂ 44 min, respectively).

Discussion: Rofecoxib administration to pediatric patients undergoing T&A did not result in increased bleeding. Rofecoxib, however, was not found to improve pain scores or decrease PRN morphine use.

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Title: **Utility of Airway Exchange Catheters in Pediatric Patients with a Known Difficult Airway**

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Introduction: The successful introduction by the American Society of Anesthesiologists of the algorithm to manage the patient with a difficult airway has addressed those individuals who need to be intubated. Similarly, efforts to formulate an algorithm to manage the airway in a patient whose airway has become difficult and now needs to be extubated so as to breathe on their own has been prompted. One method is the use of an airway exchange catheter (CAEC). Extubation over a CAEC has been successfully demonstrated in adult patients. However, this method of extubation has only been described in a few pediatric patients. Thus, the usefulness of inserting the CAEC prior to extubation in pediatric patients with a known difficult airway has yet to be determined.

Methods: After Institutional Board approval 20 pediatric patients were prospectively evaluated. Pediatric patients with at least one risk factor for a difficult tracheal reintubation were sequentially enrolled. Risk factors for difficult tracheal reintubation included difficult intraoperative intubation, airway edema secondary to surgical manipulation or cervical immobility or instability. Mechanical ventilation was weaned per operating room or ICU protocol. After the administration of 100% oxygen, the CAEC was carefully inserted through the internal lumen of the existing endotracheal tube (ETT). Size of the CAEC was determined based on the size of the existing ETT. Size 8, 11 and 14 CAEC's were used for ETT sizes 3.5-4.5, 5.0-6.0 and 6.5- 7.0 mm, respectively. The depth of insertion was determined by the external markings of the existing ETT. After placement of the CAEC the existing ETT was removed and the CAEC was secured with cloth tape. Humidified oxygen at flows of 2-6 L/min was supplied using the supplied adapter to maintain oxygen saturations greater than 95%. The CAEC remained in place for a minimum of 5 minutes, unless in the judgment of the clinicians at the bedside it was necessary to remove it sooner and no longer than 6 hours. Reintubation over the CAEC occurred for respiratory distress as determined by the intensive care physician. An airway emergency cart was readily available at each child's bedside should reintubation over the CAEC fail.

Results: Twenty pediatric patients were enrolled in the study. The median age was 114 +/- 75 months (range 0.1 to 252 months). The most common surgical procedure was cleft palate repair with the most common diagnosis being Pierre Robin. One child met the additional criteria of cervical instability. All children met the criteria for difficult intubation, 70% of whom required fibreoptic intubation in preparation for the surgical procedure. Risk for reintubation was met for all children based on the criteria of difficult airway alone; however, 50% of the children had the additional criteria of postoperative airway edema. The CAEC was successfully placed in all patients. The CAEC remained in the trachea for a median duration of 64 minutes +/- 40 min (range 5-320 minutes). Respiratory distress necessitating reintubation occurred in 5 (25%) of the children. All children were successfully reintubated with the assistance of the CAEC, no child developed oxyhemoglobin desaturation ($SpO_2 < 90\%$). One child failed to respond to tracheal extubation twice, the CAEC was used for both extubation trials. There were no adverse events documented.

Discussion: Attainment of extubation criteria alone does not reliably assess the patency of the airway while the ETT is in place. In fact, there are no criteria to adequately assess the patency of an airway whether adult or pediatric prior to extubation. The risk of reintubation after extubation in adult surgical ICU's ranges from 4.4% to 19%; however, there are no reported reintubation rates for pediatric patients. More importantly, the risk of reintubation in a child with a difficult airway has not been addressed. Our reintubation rate of 25% identifies this potential risk. The CAEC is a useful and effective tool for giving children with a known difficult airway and at risk for a difficult reintubation a trial of extubation. As supported by this study, the ability to provide supplemental oxygen through the CAEC during reintubation diminishes the potential for hypoxia while maintaining the ability to reintubate the trachea. In addition, the CAEC is rigid enough to support its use as a guide to reintubation yet pliable enough to minimize airway trauma. As previously demonstrated in adults, the CAEC provides a means of safely providing a trial of "reversible" extubation while maintaining the ability to provide supplemental oxygenation.

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Chipley PS et al: Chest 1994; 3:961-2.

Title: **Absence of Direct Protective Effect of Isoflurane Against Mild NMDA Toxicity in Primary Mixed Neuronal-Glial Cultures**

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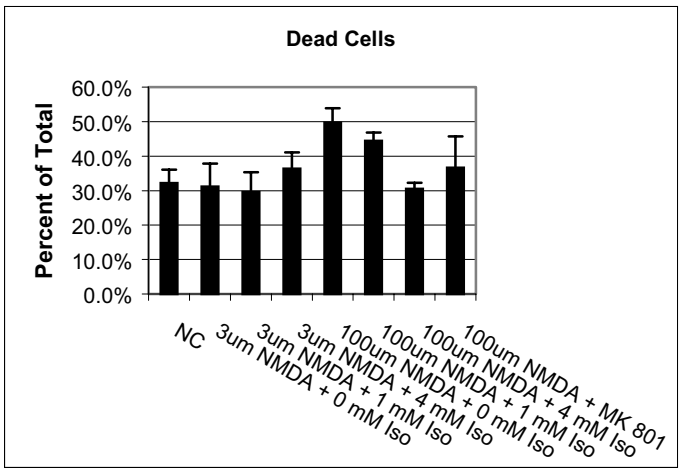
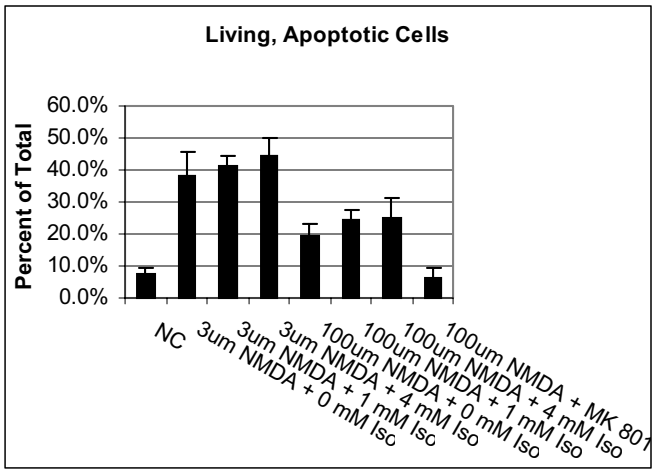
Introduction: Volatile anesthetics, such as isoflurane, are known to ameliorate experimental brain damage when administered during an ischemic insult. However, recent studies have found that the protection provided by isoflurane in experimental models are temporary in nature, such that the protection is no longer detected when analysis are done 14 days after exposure even though protection was observed at 24 hours after exposure. This evidence created doubts in the ability of isoflurane to efficiently reduce brain damage. This study attempts to investigate this issue, and to further study the effects of isoflurane against NMDA induced excitotoxicity in mixed neuronal/glial cell culture system.

Methods: Mixed neuronal-glial cultures were prepared from fetal Sprague-Dawley rat brains at 18 days of gestation. A stock solution of the volatile anesthetic isoflurane, dissolved in culture medium, was prepared using a modification of the method of Blanck and Thompson. Mature cultures (13-16 days *in vitro*) were washed with BSS and dissolved anesthetic (0 mM, 1 mM, and 4 mM isoflurane). The addition of N-methyl-D-aspartate (NMDA-3 uM or 100uM) immediately followed. The cultures were returned to the incubator and maintained at 37˚ C for 30 min. Then, the medium containing the dissolved isoflurane and NMDA was removed. The activity of lactate dehydrogenase (LDH) released into the media was measured 24 hrs after exposure, directly followed by a Hoechst/Propidium Iodide double stain. MK-801 (10μM) was used as a positive control.

Results: Exposure of the neuronal/glial cultures to 3 σM NMDA primarily induced apoptotic cells while exposure to 100 σM resulted in a peak amount of cell death. Treatment of cultures with media containing dissolved isoflurane during NMDA exposure produced a dose-dependent change, as seen in the isoflurane dose response against 100 σM NMDA. MK-801 (10σM) provided near complete protection against 100 σM NMDA. While co-treatment with isoflurane reduced the number of cell death and cell lysis, the same concentration of isoflurane had no apparent effect on NMDA-induced apoptosis. 3 σM NMDA induced the same amount of apoptosis regardless of isoflurane treatment.





Discussion: It can be reasonably concluded that isoflurane did not prevent apoptosis as induced by 3 σM NMDA in mixed neuronal/glial cultures. Morphological study using Hoechst staining also revealed that isoflurane protection against 100 σM NMDA was not compensated by the same level of increased apoptosis. Isoflurane simply prevents necrosis, without further inducing apoptosis in the process. Thus, the anesthetic protection provided by isoflurane is not compromised by neuronal apoptosis as a mechanism of delayed neuronal death. Further investigation is required to elucidate the duration of isoflurane neuroprotection.

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Kudo M et al Anesthesiology 2001; 94:303-312.
Kawaguchi et al Anesthesiology 2000; 92:1335-42.

Title: **Does Myoplasmic Calcium Regulation by the Sarcoplasmic Reticulum Respond Differently to Sevoflurane in the Young?**

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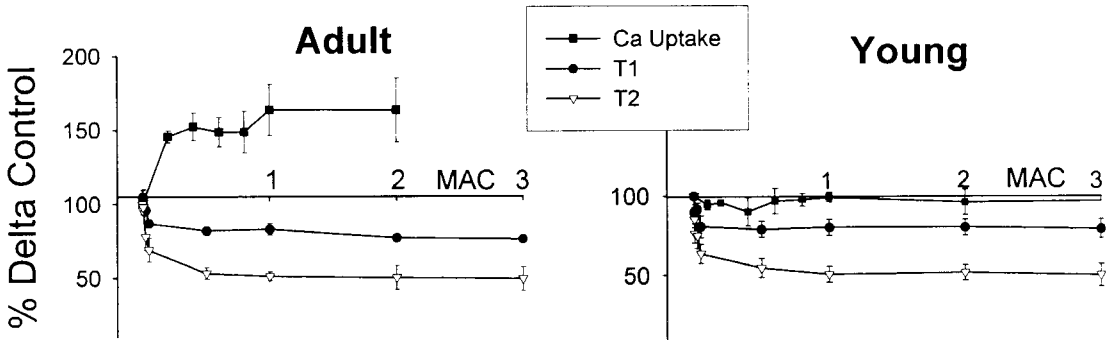
Introduction: Volatile anesthetics influence the function of transmembrane proteins, SERCA1 and the RYR1-channel, that are critical to myoplasmic calcium regulation by the sarcoplasmic reticulum (SR) (1). These membrane proteins undergo structural and functional changes both during intrauterine and postnatal development (2). Because these changes could alter the response to volatile anesthetics, we postulate that the SR of young muscle might respond differently to sevoflurane than would that of adult muscle.

Methods: After ACUC approval, light and heavy fraction SR membrane vesicles were isolated from the white muscle of anesthetized, post-weaned (age=6 weeks, n=5) and adult (age = 6 months, n=5) New Zealand rabbits (1). The effects of sevoflurane on Ca^{2+} uptake rate by SERCA1 (in light SR vesicles) and Ca^{2+} release by RyR1 (in heavy SR vesicles) were quantitated spectrophotometrically using the Ca^{2+} dye indicator Arsenazo III. In the SERCA1 studies, sevoflurane concentrations ranged from 0.2 to 2 times MAC and the effects on uptake rate were normalized to ethanol (no anesthetic) controls. In the RyR1 studies, both the amount of Ca^{2+} per mg SR added to initially saturate the SR vesicles and the amount required to induce the first Ca^{2+} release was determined (T1) during exposure to subclinical (0-0.05 times MAC) and clinically relevant concentrations (0.5-3 times MAC) of sevoflurane. The amount of Ca^{2+} necessary to induce release in previously saturated vesicles, a measure of the "high-affinity" Ca^{2+} activating site on RyR1, was also established (T2). Responses between young and adult were compared with repeated measures ANOVA. Significance was $p<0.05$.

Results: 1. Ca^{2+} uptake rate (RyR1): The adult group showed a 50% increase in Ca^{2+} uptake rate from control at all MAC levels ($p<0.001$) (fig. 1) whereas in the young group, Ca^{2+} uptake rate was not altered by any concentration of sevoflurane (fig. 2). 2. Ca^{2+} release (SERCA1): Sevoflurane, in both age groups, produced a significant dose-dependent reduction (between 0 and 3 times MAC) in the amount of Ca^{2+} necessary to load the SR vesicle and stimulate Ca^{2+} release in (T1) (figs. 1 and 2). The amount of Ca^{2+} necessary to produce calcium induced calcium release in saturated SR vesicles was reduced by 50% (T2) ($p<0.0001$) at anesthetic levels between 0 and 0.5 times MAC (figs. 1 and 2). No age differences in T1 and T2 were observed.



Discussion: Sevoflurane significantly influences two of the primary regulatory mechanisms of calcium homeostasis in rabbit skeletal muscle; Ca^{2+} uptake via SERCA1 and Ca^{2+} release via the RYR1 channel. This effect appears to be age-specific with respect to SERCA1 function as calcium uptake rate was increased by sevoflurane in the adult SR only. In contrast, the age effects on anesthetic-modulated RyR1 function were not different. Whether the lack of a sevoflurane effect on SR Ca uptake in the young is due to a structural or functional alteration in SERCA1 remains unclear. Finally, our calcium release T2 data represent the first demonstration for a volatile anesthetic effect on the high affinity Ca^{2+} binding site on RyR1.

References:

1. Anesthesiology 1988;69:571-7.
2. Circ Res 1994;75:503-10.

Group #7 – Physiology and Co-Existing Disease

Group Leader: Francis X. McGowan, Jr., MD

#55 *Risk Factors for Venous Thromboembolism in Pediatric Trauma*
Monica S. Vavilala, Avery B. Nathens, Gregory J. Jurkovich, Ellen Mackenzie, Frederick P. Rivara

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#61 *The Dantrolene Binding Site on the Skeletal Muscle Ryanodine Receptor Comprises Amino Acids 590-609*
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#62 *Association of Congenital Heart Malformations and ABO Blood Types Among Patients at Children's Hospital*
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#63 *Anesthetic Management of a Patient with Pulmonary Hypertension in Jackknife Position for Posterior Anal Rectoplasty*
Aarti Sharma, M.D., Serle K. Levin, M.D.

Title: **Risk Factors for Venous Thromboembolism in Pediatric Trauma**

Author(s): Monica S. Vavilala, Avery B. Nathens, Gregory J. Jurkovich, Ellen Mackenzie, Frederick P. Rivara

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National Study on Costs and Outcomes of Trauma Care†

Background: Venous thromboembolism (VTE) is a major source of morbidity in critically ill adults following injury. Data regarding VTE in pediatric patients are lacking.

Methods: Pediatric (age < 16 years) trauma patients with VTE were identified from a large administrative database collated from 19 states across the United States. Risk factors for VTE were identified using multivariate techniques.

Results: Risk of VTE increased with age and Injury Severity Scores (ISS). VTE was clearly associated with vascular, head, thoracic, abdominal, lower extremity, and spinal injuries. Craniotomy, laparotomy, and spinal operations were also associated with VTE. The greatest procedural risk of VTE was in children with venous catheters. (Table I)

Conclusions: Older children with high ISS scores, major vascular injury, craniotomy, or CVC are at risk for VTE. These data may help guide strategies geared toward screening and prophylaxis in injured children.

Table I: Independent risk factors for venous thromboembolism in pediatric trauma.

Parameter	Adjusted relative risk (95% CI)
Major vascular injury	17.6 (6.-51.2)
Central venous line	6.8 (1.9-23.3)
Severe spine injury	5.1 (1.2-21.8)
Craniotomy	5.0 (2.1-11.9)
Age	
<5	reference
5-9	2.0 (0.5-7.8)
10-14	5.0 (1.5-16.7)
Severe head injury	4.8 (2.4-9.7)
Severe thoracic injury	2.7 (1.2-5.9)
Open reduction/internal fixation of lower extremity fracture	2.5 (1.2-5.4)
Laparotomy	2.3 (0.9-6.1)
Injury Severity Score	
<9	reference
9-15	5.8 (2.4-13.6)
16-24	7.4 (2.5-21.4)
Ó25	21.4 (8.4-54.3)

Title**: The Lower Limit of Cerebral Autoregulation in Healthy Children During < 1 MAC Sevoflurane Anesthesia**

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Introduction: In adults, the lower limit of cerebral autoregulation (LLA) is defined as a MAP of 60 mmHg (1). The LLA in healthy children has not been identified. The aim of this report is to describe the LLA in healthy children.

Materials and Methods: Static cerebral autoregulation testing was performed in the operating room during < 1 MAC sevoflurane anesthesia in children 6 months - 14 years of age (2). Mean middle cerebral artery flow velocities (Vmca) were continuously recorded using transcranial Doppler ultrasonography (TCD). Mean arterial pressure (MAP) was increased with infusion of intravenous phenylephrine incrementally titrated to the greater of: 1) either 20% above baseline MAP or 2) 80 mmHg (< 9 years), or 90 mmHg (9 -14 years). The LLA was identified during autoregulation testing. The LLA was defined as the MAP below which Vmca sharply decreased. The lower limit reserve (LLR) was defined as the difference between baseline MAP and LLA. The autoregulatory reserve (ARR;%) was defined as the LLR divided by MAP X 100.

Results: There were 9 subjects < 2 years (Group 1), 11 subjects 2-5 years (Group II), 8 subjects 6-9 years (Group III), and 8 subjects 10-14 years (Group IV). MAP increased with age (R^2= 0.42) and older children (Groups III and IV) had a higher MAP compared to young children (Groups I and II). There was no difference in LLA between older and younger children. The LLR was greater in older children compared to younger children. The ARR was significantly higher in older children compared to younger children. (Table 1)

Discussion: There are no age related changes in the LLA. Older children have a greater LLR and ARR compared to young children. These findings may have implications for managing hemodynamics in children at risk for secondary brain injury.

Groups	**I-II**	**III-IV**	**p**
Age (yrs)	< 6	6-14	---
N =	20	16	---
Baseline MAP (mmHg)	70 ± 8	82 ± 10	**0.0001**
LLA (mmHg)	59.5 ± 8.2	58.5 ± 17.3	NS
LLR (mmHg)	11.6 ± 10	24.5 ± 11.8	**0.007**
ARR (%)	15.7 ± 12.3	30.3 ± 15.7	**0.002**

Table 1: Age, MAP, LLA, LLR, ARR in anesthetized children.

References:

a. Paulson OB, et al., Cerebral autoregulation. Cerebrovasc Brain Metab Rev 1990
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c. Drummond JC. The Lower Limit of Autoregulation: Time to Revise Our Thinking? Anesthesiology 1997.

Title: **The Anesthetic Implications for Infants with Glycogen Storage Disease Type II (Pompe's disease)**

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Introduction: Glycogen storage disease type II (GSD-II, Pompe's disease) is an autosomal recessive condition. The severe infantile variant is usually a uniformly fatal genetic muscle disorder. It is characterized in the first few months of life by generalized hypotonia and a hypertrophic cardiomyopathy that becomes dilated at end-stage (1,2). A recent phase I/II clinical trial utilizing recombinant human Ŭ-glucosidase enzyme (Ŭ-GE) therapy has improved the short-term outcome for these infants (2). As a result infants who would previously have been unlikely to undergo elective general anesthesia are now presenting for permanent central line placement and repeated quadricep muscle biopsies to assess (Ŭ-GE) therapy efficacy. Severe hypertrophic obstructive cardiomyopathy often results in small ventricular volume and dynamic ventricular outflow tract obstruction, which makes these infants extremely sensitive to changes in preload and afterload. Echocardiographic measurement of left ventricular mass and assessment of any outflow tract obstruction should be undertaken preoperatively. The anesthetic plan requires meticulous attention to pre-induction intravascular volume status, maintenance of systemic vascular resistance, control of heart rate, attention to adequate coronary artery perfusion and may require intravascular monitoring. These steps are essential to minimize myocardial ischemia and the potential for sudden cardiac arrest. We report 5 patients with GSD-II undergoing 11 anesthetics over a 1 year study period.

Results

Patient demographics (Mean values ± S.D) 5 patients 11 anesthetics

		Anesthetic 1 n=5	Anesthetic 2 n=5	Anesthetic 3 n=1
Age	**months**	5.2 ± 3	7.8 ± 3.1	7
Weight	**kg**	6.1 ± 1	7.3 ± 1.2	7.4
2 D Left Ventricular Mass	**gm/m^2**	276 ± 82	159 ± 47	129
End Diastolic Vol Index	**ml / m^2**	33 ± 9	47 ± 9	63
End Systolic Vol Index	**ml / m^2**	16 ± 6	24 ± 8	28
Ejection Fraction	**%**	52 ± 14	49 ± 9	56

Anesthetic outcomes: 10 of 11anesthetics were uneventful. There was no mortality. One patient receiving propofol had an intra-operative cardiac arrest early on in the series and underwent an uneventful second and subsequent third anesthetic.

Anesthetic techniques and 2DLV mass at time of anesthesia in gm/m^2

	1st anesthetic	2DLV	2nd anesthetic	2DLV	3rd anesthetic	2DLV
Patient 1	T S F	366	N K S	160		
Patient 2	N S P [CA]	191	K F M	166	K M F	129
Patient 3	N S F	240	S K F	186		
Patient 4	N S F K	362	N S K	209		
Patient 5	N K F	221	N K F	72		

T= Thiopentone, N= N_2O, S = Sevoflurane, P= Propofol, F= Fentanyl, M= Midazolam [CA] =Cardiac Arrest

Discussion: The ejection fraction is not as useful a measurement as the 2 DLV mass in these patients. The ejection fraction does not convey the extent of end systolic and diastolic ventricular volumes or outflow tract obstruction. By paying strict attention to the maintenance of preload, afterload and adequate coronary perfusion, myocardial ischemia can be prevented in these infants peri-operatively. Prior to (Ŭ-GE) therapy and left ventricular mass reduction, the first anesthetic is usually the more difficult. Propofol may not be the most suitable sole anesthetic agent in patients with the infantile variant of pompe's disease.

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Title: **Clotting Parameters and Thromoboelastography in Children with Neuromuscular and Idiopathic Scoliosis Undergoing Posterior Spinal Fusion**

Author(s): B. Randall Brenn MD, Mary C. Theroux MD, and Robert W. Akins Ph.D.

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Introduction: Children with neuromuscular scoliosis (NMS) have greater blood loss than children with idiopathic scoliosis (IS) during posterior spinal fusion (PSF) (1). Abnormal clotting parameters and decreases in coagulation factor levels have been reported after moderate (25%) blood volume loss in NMS patients (2). We compared standard tests of coagulation and thromboelastography (TEG) in patients with NMS and IS at baseline and after 15% estimated blood volume loss during PSF.

Methods: After institutional review board approval and informed consent, 17 patients with NMS caused by spastic quadriplegic cerebral palsy and 17 patients with IS undergoing PSF were enrolled. Standard tests of clotting including prothrombin time (PT), partial thromboplastin time (PTT), fibrinogen (FIB), platelet count (PLT) and celite activated whole blood TEG were performed after induction of anesthesia (baseline) and after 15% estimated blood loss as measured by suction volume and sponge weights. No blood or blood products were given between the baseline and 15% blood loss sampling. Data was reported as mean and standard deviations for interval data, and statistical analysis using t-test for interval data, and chi-square for nominal data was performed.

Results: There were no differences between the NMS and IS groups with respect to gender distribution, and age. The average weight of the NMS group was significantly lower than the IS group (33.5 kg vs. 55.2 kg, $p<0.001$*). Only 14 of the 17 patients with idiopathic scoliosis lost 15% of their blood volume. Results for PT, PTT, platelet count, fibrinogen levels, reaction time (r), k-time (k), and Maximum amplitude (MA), ionized calcium (iCa), magnesium (Mg) at baseline and 15 % blood loss are given in the table.

Group(n)	**PT base (min)**	**PTT base (min)**	**PLT base (K/㎖)**	**FIB base (mg/dl)**	**r base (min)**	**K base (min)**	**MA base (mm)**
NMS(17)	11.3 ° 0.56	35.4 ° 3.1	241 ° 91	275 ° 53	4.8 ° 1	1.6 ° 0.6	65 ° 8
IS(17)	10.7 ° 0.70	32.8 ° 4.2	266 ° 45	288 ° 81	5.0 ° 0.6	1.3 ° 0.4	70 ° 4
Significance	p=0.008*	p=0.046*	p=0.34	p=0.60	p=0.53	p-0.11	p=.07
Group(n)	**PT 15% (min)**	**PTT 15% (min)**	**PLT 15%(K/㎖)**	**FIB 15% (mg/dl)**	**r 15% (min)**	**K 15% (min)**	**MA 15% (mm)**
NMS(17)	13.0 ° 1.1	45.3 ° 8	181 ° 67	180 ° 34	4.3 ° 1.4	2.2 ° 2	58 ° 14
IS(14)	11.9 ° .9	37.3 ° 4.8	198 ° 91	197 ° 33	4.3 ° 1.5	1.3 ° 0.4	67 ° 5
Significance	p=0.01*	p=0.003*	p=0.56	p=0.19	p=0.99	p-0.12	p=0.027*
Group(n)	**iCa base (mg/dl)**	**iCa 15% (mg/dl)**	**Mg base (meq/l)**	**Mg 15% (meq/l)**			
NMS(17)	1.17 ° 0.07	0.97 ° 0.13	1.71 ° 0.23	1.30 ° 0.23			
IS(14)	1.18 ° 0.06	1.13 ° 0.05	1.71 ° 0.20	1.58 ° 0.22			
Significance	p=0.72	p=0.001*	p=0.89	p=0.006*			

Conclusions: There was a significant difference in the baseline PT and PTT values between the two groups even though the baseline values were within normal limits. After mild blood loss (15% estimated blood volume) patients with NMS had significantly greater increases in PT and PTT, and significantly narrower MA on the TEG. Calcium and Magnesium levels were also significantly lower in the NMS group after 15% blood volume loss. These data point to a multifactorial coagulopathy in NMS patients after mild blood volume loss.

References: 1. Anesth Analg 1995;80:336-42 2. Anesthesiology A-1245,V93,No 3A,Sep 2000

Title: **Self-Mutilation in Young Children following Neonatal Brachial Plexus Injury**

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Introduction: Neonatal brachial plexus injury is rarely associated with pain as the child matures. However, some preverbal infants and toddlers exhibit self-mutilation of their affected extremity possibly as a manifestation of pain (1). This study was designed to characterize the clinical presentation of self-mutilation secondary to neonatal brachial plexus injury.
Methods: After IRB approval, an electronic chart review of 309 patients that presented to the brachial plexus center from 1990 until the present was performed looking for evidence of self-mutilation behavior in patients with neonatal brachial plexus injury. 281 patients from this clinic were identified as having a neonatal brachial plexopathy. A full chart review was performed on those patients identified as having evidence of self-mutilation behavior. Self-mutilation behavior was defined as excessive mouthing of any part of the affected limb, biting of the affected limb and loss of any parts of the affected limb secondary to biting and infection.
Results: 7 patients were identified as self-mutilators. The age when they exhibited this behavior ranged from 12-48months of age. The affected limb was splinted in these patients to prevent contractures. Only one patient exhibited signs of neuropathic pain prior to surgery (pt. 4). She had pain at 8 months with physical therapy and her affected limb colder than her other limb. She underwent an interscalene block at age 12 months prior to a shoulder release and underwent another block at 17 months to treat presumed neuropathic pain. The incidence of self-mutilation is 2.3%. Chi-square test demonstrated a significant relationship between surgical intervention and self-mutilating behavior.

Table 1. Demographics of the patients with self-mutilating behavior.

Pt.	Age at behavior	Time after surgery to behavior	Sex	Age at surgery and surgical procedure	Self-mutilation behavior	Therapy
1	22 m	13 m	M	9 m-brachial plexus exploration	Biting index finger and thumb	Pain service consult Splinting
2	12 m	7 m	M	5 m -neurolysis & sural nerve grafting	Biting of fingers with eschars present	Splinting
3	35 m	12 m	M	21 m-tendon transfers	Biting of fingers especially index finger & partial loss of nail bed	Splinting
4	14m	1 m	F	12m-shoulder release 24 m- tendon transfers	Nail biting of fingers especially L index finger with nail bitten off	Interscalene Block x2 Splinting
5	18m	12 m	M	6m- neurolysis &sural nerve grafting	Mouthing along forearm	Splinting
6	17m	7 m	F	10 m- neurolysis 26 m-humeral osteotomy	20 m biting of thumb and small finger with eschar, scarring	Splinting
7	13m	8 m	M	5m-neurolysis & sural nerve grafting	Awakening at night and rarely biting R hand	Splinting

Table 2: Incidence of self-mutilation behavior with and without surgery. (* $p < 0.05$)

	No surgery	Surgery prior to behavior*
Self-mutilation behavior	0	7
No self-mutilation behavior	147	134

Discussion: Self-mutilation behavior in our population occurred more frequently in children who had had prior surgery. A prospective review of patients in Saudi Arabia determined an incidence of 4.7% and that it was more common in children with severe palsies (2). The incidence in our population was much less. Reasons for the difference are speculative but could be related to early intervention and physical therapy. We also found that our patients exhibited this behavior at a young age 18.7∂8.0 months and within 13 months of surgery.
Ref: 1.Rossitch E et al., Pain 1992. 2. Al-Qattan MM., Journal of Hand Surgery 1999

Title: **The Relationship Between Spasticity and Acetylcholine Receptors in Cerebral Palsy**

Author(s):MC. Theroux, RE. Akins, F Miller, Dabney K,Shah S

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Introduction: A prior study examining neuromuscular junctions (NMJs) in children with cerebral palsy (CP) found abnormal acetylcholine receptors (AChRs) in a subpopulation of children with cerebral palsy[1]. The current study examines the relationship between these abnormal AChRs with the 'spasticity levels' of individual muscles commonly affected in CP.
Methods: After Institutional Review Board approval and informed consent, as part of a larger study, 39 children with spastic CP undergoing tendon release or osteotomy were enrolled in the study. Prior to surgery, patients had the degree of spasticity assessed in the muscles to be biopsied. Based on this assessment, muscle samples were divided into three categories: 1 = low level of spasticity, 2 = moderate level of spasticity, and 3 = high level of spasticity. During surgery, biopsies were collected from motor innervation sites of Gracilus, Vastus Lateralis, or Gastrocnemius. To score the presence of ExJ-AChRs, eight-micron thick cross-sections were immunofluorescently stained for acetylcholine esterase (AChEase) using a monoclonal antibody and counter-stained with tetramethylrhodamine-conjugated alpha-bungarotoxin to directly detect AChRs. The limits of each NMJ were defined as the extent of AChEase staining, and samples were scored positive for extrajunctional acetylcholine receptors if at least 20 % of the alpha-bungarotoxin staining extended beyond this AChEase defined limit.
Results: In the current analysis, a total of 48 biopsies were assessed. There were two populations of NMJs evident by histological staining. (**Normal)**: If AchRs were distributed within the area stained by ACHEase; **(Abnormal):** If AchRs were distributed beyond (>20%) of the area stained by ACHEase. The proportion of NMJs found to be abnormal was tabulated. Results are summarized in Table 1. Gastrocnemius at the spasticity level of (1) does appear to have the lowest proportion of abnormal receptors. However, both Gracilus and Gastrocnemius have no significant difference in the distribution of AchRs at higher levels of spasticity.

Percent of NMJs with Abnormally Spread AChRs as a function of Spasticity

Spasticity Level	1	2	3	P(by Chi-Square)
Gracilus	**34**	**36**	**37**	**NS**
Gastrocnemius	**3**	**29**	**32**	**<.001**

Discussion:A previous study suggested that roughly 30% of children with cerebral palsy and spastic quadriplegia had abnormally distributed AChRs[1]. Other clinical studies contribute indirect evidence suggesting the up-regulation of AChRs in children with spasticity[2,3]. As a preliminary report, our findings do not strongly support a general relationship between AChRs and spasticity level.

References: 1. Theroux M.et al, Anesthesiology, In Press.
2. Theroux, M et al, Anesthesia.& Analgesia.1994.
3. Hepaguslar H et al, Anaesthesia, 1999.

Title: **The Dantrolene Binding Site on the Skeletal Muscle Ryanodine Receptor Comprises Amino Acids 590-609.**

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Introduction: Dantrolene (DN) and azumolene (AZ) inhibit Ca^{2+} release from skeletal muscle SR by inhibiting Ca^{2+} release from sarcoplasmic reticulum (SR) via the ryanodine receptor Ca^{2+} channel (RyR1). Both drugs should be useful in the therapy of malignant hyperthermia, but only the former is FDA approved for this purpose. Defining the molecular target(s)of DN and AZ will likely lead to a better grasp of the molecular mechanism of action of these drugs and the mechanics of intracellular Ca^{2+} release in skeletal muscle. In order to directly identify the intracellular target(s) of DN, we have designed and synthesized a pharmacologically active photoaffinity analog of these drugs, [^{3}H]Azidodantrolene (^{3}HAZD). [1,2] This DN congener specifically photolabels both RyR1 and a proteolytic N-terminal channel fragment composed of the first 1400 amino acids. We now report tentative mapping of the dantrolene binding site on the N-terminus of RyR1 using expressed RyR1 and synthetic channel domain peptides.

Methods: Rabbit skeletal muscle RyR1 and green fluorescent protein (GFP)-tagged RyR1 N-terminus (aa 182-1608) were cloned and expressed in Chinese Hamster Ovary (CHO) cells, whose intracellular membranes were collected by centrifugation after sonication of harvested cells. Sarcoplasmic reticulum (SR) was prepared from rabbit fast twitch skeletal muscle by cycles of differential centrifugation.[2] The presence of RyR1 and expressed N-terminus in these membranes was demonstrated by Western blotting with polyclonal anti-rabbit skeletal muscle antibody. Domain peptides of the RyR (DP1-2c & s [c, cardiac and s, skeletal, corresponding to aa 601-639 (RyR2) and 590-628 (RyR1), respectively], DP1[identical sequence in RyR2 (601-620) and RyR1 (590-609)], DP4 (RyR1, 2442-2477), DP7 (RyR1, 543-576), and peptide A (aa 671-690, skeletal muscle DHPR-ζ1 subunit II-III loop)) were synthesized, and purity demonstrated. Proteins were photolabeled in buffer (20 mM PIPES, pH 7.0, ± 500 σM AMP-PCP and 400 nM ^{3}HAZD ± 300 σM AZ) using UV light (366 nm) for 2 x 1 min at room temperature. Photolabeled proteins were subjected to SDS-PAGE, electroblotted onto PVDF membranes and autoradiography and Western blots with monoclonal (mAb) anti-RyR1 antibody performed. MAb anti-RyR1 was used to inhibit ^{3}HAZD photolabeling of RyR1.

Results: Expressed RyR1 is specifically labeled with ^{3}HAZD, as are both DP1-2c & s and DP1. Expressed GFP-N-terminus, DP4, and peptide A are not labeled at all and DP 7 shows low level specific ^{3}HAZD photolabeling. Photolabeling of expressed RyR1 is AMP-PCP dependent, while that of DP1-2c & s, DP1 and DP7 are not. Labeling of DP1-2 and DP1 was not inhibited by DP4, ryanodine, or atropine. RyR1 and DP1 sequence containing peptides were recognized by mAb anti-RyR1, and this antibody specifically inhibited ^{3}HAZD photolabeling of RyR1 in SR.

Conclusions: Our data demonstrate that heterologously expressed RyR1 binds DN. The AMP-PCP dependence of this binding is consistent with our previous data both on ^{3}HAZD photolabeling of RyR and [^{3}H]DN binding to skeletal muscle SR, and indicates that accessory, muscle-specific proteins are not required for dantrolene binding. Specific ^{3}HAZD photolabeling of RyR domain peptides occurs only with the DP1 containing peptides. The inhibitory action of mAb-anti-RyR1 on ^{3}HAZD photolabeling of RyR1 identifies its epitope (aa 590-609) as the dantrolene binding site. Since DP1 is contained within the RyR1 N-terminus, the lack of photolabeling of the expressed N-terminus with ^{3}HAZD suggests loss of conformational nativity in the absence of the rest of the channel.

References:

1. Palnitkar, et al., J. Med. Chem. 42:1872, 1999
2. Paul-Pletzer, et al., Biochemistry, 40:531, 2001

Title: **Association of Congenital Heart Malformations and ABO Blood Types Among Patients at Children's Hospital**

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Based on an observation that congenital cardiac malformations occur in a disproportionate group of individuals with a given blood group, a pilot study was performed. The following questions were asked:

1. Is there is an association between congenital heart defects (CHD) and ABO blood type?
2. Is there a difference within the patient population at Childrens Hospital (cardiac vs. non-cardiac), compared to the US population?
3. Are there identifiable subsets of CHD significantly associated with blood type?

Data was collected from patients undergoing cardiac surgery or catheterization during 2000-2001 at Children's Hospital, Boston (TCH). Demographic criteria included permanent residency or citizenship of United States.

Table I: Cardiac and non-cardiac patients and their blood type distribution

Groups	Type O	Type A	Type B	Type AB	RH neg	RH pos
TCH cardiac N= 1035	474 (46%)	384 (37%)	132 (13%)	45 (4%)	141 (14%)	894 (86%)
TCH non-cardiac N=4	233 (46%)	187 (37%)	54 (11%)	30 (6%)	60 (12%)	444 (88%)
US population * N=13.6 million	5,984,000 (44%)	5,712,000 (42%)	1,360,000 (10%)	544,000 (4%)	2,040,000 (15%)	11,560,000 (85%)

TCH= Children's Hospital, Boston; * US general population data from American Association of Blood Banks, 2000.

Table II: Congenital heart malformations and blood type distribution

Subgroup	N	Type O	Type A	Type B	Type AB	RH neg	RH pos
1) HLHS, IAA	213	94 (41%)	85 (40%)	25 (12%)	9 (4%)	35 (16%)	178 (84%)
2) TOF, TOF/PA	128	56 (44%)	46 (36%)	22 (17%)	4 (3%)	20 (16%)	108 (84%)
3) heterotaxy, TAPVC	84	38 (45%)	30 (36%)	13 (16%)	3 (4%)	13 (16%)	71 (84%)
4) ASD, VSD	337	155 (46%)	128 (38%)	38 (11%)	16 (5%)	43 (13%)	294 (87%)
5) Congenital heart block	16	9 (56%)	4 (25%)	2 (12%)	1 (6%)	3 (19%)	13 (81%)
6) PA/IVS, TA	83	39 (47%)	31 (37%)	6 (7%)	7 (8%)	11 (13%)	72 (87%)
7) TGA	159	88 (55%)	46 (29%)	21 (13%)	4 (3%)	21 (13%)	138 (87%)

Statistical analysis of the ABO blood group distribution data comparing patients with cardiac malformation and the US population demonstrated a significant difference between groups ($p=0.002$, Pearson chi-squared test with Yates's correction).

The TCH cardiac group was significantly lower in Type A (37 % vs. 42 %; $p=0.002$) and higher in Type B (13% vs. 10 %; $p=0.0$) when compared to the general US population. Comparison between TCH cardiac and non-cardiac patient population (13% vs. 11%) did not reveal a significant difference ($p = 0.40$), but suggested a trend toward a higher prevalence of blood Type B in the cardiac group ($p=0.06$).

In analyzing cardiac subgroups, we found a significantly higher rate of blood Type B among subgroup 2 (conotruncal malformations; n=128) when compared to the US population, (17% vs. 10%, $p=0.01$, chi-squared test with Yates's correction).

Conclusion: There is a significant difference in ABO blood type distribution between the TCH cardiac patients and general US population. This warrants further investigation.

Title: **Anesthetic Management of a Patient With Pulmonary Hypertension in Jackknife Position for Posterior Anal**

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Pulmonary hypertension is one of the many challenging situations for an anesthesiologist. Positioning a patient with pulmonary hypertension in the jackknife position compromises the altered pulmonary physiology.

Patients with untreated pulmonary hypertension can take a progressive downhill clinical course because of right-sided heart failure.

This clinical case is a presentation of a 15 month old child. This child had preexisting dynamic pulmonary hypertension, secondary to bronchopulmonary dysplasia and an atrial septal defect. He underwent posterior sagittal anal rectoplasty in the jackknife position ,which contributed to worsening of his pulmonary pathophysiology. Nitric Oxide was used as one of the modalities to decrease pulmonary vascular resistance and get the child through the surgery successfully.

All means of decreasing pulmonary vascular resistance with special emphasis on Nitric Oxide will be elucidated in the discussion. We will also include the role of various factors that regulate the pulmonary circulation, such as innervation, humoral mediators, and mechanical properties.

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