YOUNG'S PEDIATRIC ANESTHESIA REFERENCE SHEET

by

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Young's Pediatric Anesthesia Reference Sheet

Background

It is the goal of every anesthesia provider to facilitate a safe anesthetic for pediatric patients. This provision of a safe anesthetic depends on a clear understanding of the physiologic, pharmacologic, and psychological differences between children and adults. In addition, the anesthesia professional must always be prepared for the unexpected. Accuracy of anesthetic delivery and quality of patient care are also influenced by the availability of quality reference material. While there are many pediatric anesthesia textbooks available, a thorough product review discovered a deficiency of pediatric anesthesia quick reference sheets.

Problem Statement

In the last 50 years many studies have described the causes of age-related morbidity and mortality during the perioperative period. Many of the risks associated with anesthesia, such as cardiac arrest, have decreased dramatically during this time frame (Bhananker et al., 2007). However, the incidence of anesthesia-related morbidity and mortality remains higher in infants than in adults and higher in younger than older children (Murat, Constant, & Maud'huy, 2004).

Typically, anesthesia providers do not acquire equivalent training in adult and pediatric anesthesia. Postgraduate fellowships and continuing education courses are available. However, a large majority of anesthesia professionals have limited experience providing care for pediatric patients. The American Association of Nurse Anesthetists (AANA) currently requires student registered nurse anesthetists (SRNAs) to complete a minimum of 550 total anesthetics. Of those 550, only 35 are required to be pediatric cases (newborn to 12 years), and the requirement for neonates is zero. Statistics from the University of Kansas nurse anesthesia department (2006) illustrate this great difference in pediatric versus adult case numbers. In 2006, the graduating

SRNA class finished with an average of 901 total anesthetics. Of those, only 69 involved pediatric patients. Although this is nearly two times superior to the minimum pediatric case requirement set forth by the AANA, it still means that 92.3% of the SRNAs training involved patients older than twelve, and only 7.7% of their experience was with patients younger than twelve.

Data from the Council on Certification of Nurse Anesthetists (2007) further illustrates this point. In 2006, SRNAs who sat for the national certifying exam graduated their respective programs with an average of 835 total anesthetics. Of those, an average of 100 anesthetics were performed on pediatric patients. These statistics show that on a national level SRNAs are clinically trained in pediatric anesthesia only 11% of the time. With this great disparity in preparation, anesthesia providers often feel great unfamiliarity and stress when presented with pediatric patients.

Purpose

Unfamiliarity and stress in relation to pediatric anesthesia can lead to errors. Errors in pediatric anesthesia lead to increased morbidity and mortality. Three major areas of concern were identified as causative factors for increased stress in the anesthesia provider, and increased morbidity and mortality in the pediatric patient. These include pharmacologic management, pre-operative preparation, and uncommon or emergent cases. The discussion of these three topics illustrates the need for a pediatric anesthesia quick reference sheet.

The first major area of concern in pediatric anesthesia is pharmacologic management. Drug dosing for pediatric patients seems to have great variability and often follows practitioner opinion rather than manufacturer guidelines. One errant dosing method used by anesthesia providers involves a size comparison of pediatric and adult patients. When using this method the

anesthesia provider compares the child's size to a normal adult size, and then adjusts the dose accordingly. For example, a child one-third or one-fourth the size of a normal adult would receive one-third or one-fourth the adult dose respectively. This type of wayward drug dosing is inaccurate and could potentially cause harm to the patient. Such simplified methods for drug dosing are not uncommon given the cumbersome number of steps required to calculate an accurate final dose for this age group. Weight conversions, weight-based dosing, and drug concentration conversions are all steps involved in determining the final pediatric dose.

The second area of concern is preoperative preparation. Preoperative preparation involves formulating the anesthetic plan, equipment set-up, hemotologic calculations, and fluid and blood replacement calculations. Preoperative sedative calculations are also commonly used when the patient is older than 1 year. Pediatric patients require a weight-specific anesthesia set-up. Newborn patients require a different anesthesia circuit, mask, and intubating equipment versus a small child. Given the great variability in patient size, an anesthesia provider's set-up is occasionally unsuitable for the patient's weight, or essential equipment is omitted all together. Having a complete set-up and performing accurate preoperative calculations are essential tasks when the goal is to prevent complications.

The majority of pediatric cases done by anesthesia providers during their training are routine outpatient surgeries. However, occasionally an emergent or uncommon case is presented. These cases generally require rapid set-up due to their urgent nature. Some examples of these cases include acute epiglottitis, gastroschesis or omphalocele, and congenital diaphragmatic hernia. Although all anesthesia providers have received classroom training regarding these cases, the majority rarely see them. "What are the preoperative considerations? Is there any special set-

up? What is the optimal way to manage this case?" These are a few of the questions that an anesthesia provider must be able to answer when presented with these types of cases.

Concerns over pharmacologic management, preoperative preparation, and uncommon or emergent cases prompted the development of a compact but informative pediatric anesthesia quick reference sheet. This reference addresses pharmacologic management by including some of the most commonly used anesthetic and emergency drugs in an effort to eliminate guess work dosing. Dosing is already calculated to reduce chances of errors resulting in harm or death. A section on preoperative sedative dosing is also included. Preoperative preparation is addressed by including sections on NPO orders, fluid calculations, and several sections on appropriate equipment set-up. Common and uncommon surgical procedures and emergency procedures are also listed, and include essential information concerning preoperative preparation and anesthesia management of these difficult and often complicated procedures. The overall goal of the reference is to reduce morbidity and mortality in pediatric patients through easy access to critical information.

Literature Review

Recent publications verify the need for an accurate pediatric anesthesia quick reference sheet. The United States Pharmacopeia Center for the Advancement of Patient Safety recently released its seventh report on medication errors titled The MEDMARX® Data Report: A Chartbook of Medication Error Findings From the Perioperative Settings From 1998-2005. The report provides analysis of 7 years of medication errors across the perioperative continuum-outpatient surgery, preoperative holding area, operating room, and the postanesthesia care unit. Data is aggregated into pediatric, adult, and geriatric patient populations and represents the

largest known analysis of perioperative medication errors drawn from healthcare facilities (Hicks, Becker, & Cousins, 2006).

Hicks et al. (2006) reports 2.8% of errors in the preoperative holding area resulted in harm. Untoward outcomes occurred 4.2% in pediatric populations, 7.1% in adults, and 2.6% in the geriatric population. The two most common errors in this setting were wrong time and omission errors.

Within the operating room (OR) 7.3% of errors resulted in harmful outcomes (Hicks et al., 2006). These errors occurred in each of the populations: pediatric (16.7%), adult (11.3%), and geriatric (10.0%). Nine events required intervention to sustain life, and two medication errors caused or contributed to patient deaths. Pediatric errors disproportionately involved improper dose/quantity (32.4%). The U.S. Pharmacopeia report recommended that in the OR setting practitioners have access to accurate standardized *dose charts*, and/or assistive technologies *with proper medication calculations and formulations* so no patient will be at risk of receiving the wrong dose of drug.

In the outpatient surgery (OPS) setting improper dose/quantity errors comprised 35.4% (one-third) of the pediatric errors. Statistics from OR, PACU, and OPS all indicate that pediatric patients are at a higher risk of a medication error involving improper dose/quantity (wrong amount) than are adult or geriatric patients. Medication use in children is particularly prone to error because of the many variations in dosing, age, weight, and the drug formulations (Hicks et al., 2006).

Historically, closed malpractice claims have been used to identify and examine potential causes for adverse anesthesia outcomes. In a closed claims analysis of pediatric anesthesia liability, Jimenez, et al. (2007) compared current data from pediatric malpractice claims to

claims from the 1970s to 1980s. The data from the 1970s and 1980s decades revealed respiratory complications were half of pediatric malpractice claims in the American Society of Anesthesiologists (ASA) Closed Claims Database.

Jimenez, et al. (2007) based the current analysis of claims data on the belief that advances in pediatric anesthesia practice during the 1980s and 1990s would be reflected in liability trends. They reviewed 532 pediatric malpractice claims over three decades (1973–2000). Claims from 1990 to 2000 were reviewed in detail to determine damaging events and injuries. From 1973 to 2000, there was a decrease in the proportion of claims for death/brain death and respiratory events, particularly for inadequate ventilation/oxygenation. However, claims for death (41%) and brain death (21%) remained the dominant injuries in pediatric anesthesia claims in the 1990s. Half of the claims in 1990–2000 involved patients 3 years or younger and one-fifth were ASA 3–5. Cardiovascular (26%) and respiratory (23%) events were the most common damaging events. These findings and others have led to improved practice standards including end-tidal carbon dioxide and pulse oximetry monitoring. After the introduction and use of these monitors, there was a significant reduction in the proportion of respiratory events, as shown in the analysis by Jimenez, et al. (2007), yet there has also been an increase in the proportion of cardiovascular damaging events responsible for death or permanent brain damage.

Although outcomes for pediatric patients undergoing anesthesia have improved over the years, further work is needed to clarify some mechanisms of injury and to develop interventions to maximize patient safety. An awareness of frequently encountered complications during pediatric anesthesia may lead to earlier detection and treatment of perioperative problems, consequently leading to better outcomes. Careful preoperative assessment and adequate planning

of an appropriate anesthetic are still the cornerstones of safe pediatric anesthetic practice (Edomwonyi, Ekwere, Egbekun, & EdomwEluwa, 2006).

Project Design and Review

In an effort to reduce closed claims cases in pediatric anesthesia, and following recommendations from Hicks, et al. (2007), the design of a pediatric anesthesia quick reference sheet was undertaken. The design focused on three foundational topics including: accurate pediatric drug dosing, preoperative equipment set-up with helpful calculations, and anesthetic management of common and uncommon pediatric cases. All information included was obtained from anesthesia textbooks, drug package inserts, and current anesthesia publications (see Appendixes A).

Drugs and dosages were selected based upon their widespread use in pediatric anesthesia as well as manufacturer recommendations. Recent anesthesia texts, pediatric drug guides, and drug package inserts were all used as part of the pharmacologic review. In several cases there was variability in dosage recommendations from reference to reference. Manufacturer recommendations were primarily used in these cases. Drug dosages also varied depending on use. Dexamethasone, for example, has a dose of 0.15 mg/kg for antiemetic use, and a dose of 0.5 mg/kg for airway swelling and allergic reaction. Some drugs were excluded based upon infrequent use in pediatric anesthesia and/or package insert recommendations.

During the lengthy pharmacologic review, one major area of concern arose. There has been a general lack of approval of many medications for populations of pediatric patients. Nearly 80% of currently approved medications have language within the drug package insert that excludes children of varying ages. Many of the drugs used in the operating room and the intensive care unit have similar language. Common examples of drugs used in daily anesthetic

practice include bupivacaine (until further experience is gained in children younger than 12 years, administration of bupivacaine injection is not recommended) and Alfenta (clinical data to support the use of Alfenta in patients under 12 years of age are not presently available. Therefore, such use is not recommended). Such disclaimers are placed in the package insert because the contents of the package insert must, by law, be based on adequate, well-controlled studies involving children. Any use of a drug that is not specifically described in the package insert is considered unapproved or "off label". The reason for the lack of labeling for children is that the appropriate controlled clinical trials were never supported by industry, and the Food and Drug Administration (FDA) did not have the legislative power to force the pharmaceutical companies to perform pediatric studies (Litman, 2004). Several commonly used drugs in pediatric anesthesia were excluded from the reference sheet because of the package insert language. Other drugs were included with warnings printed in the dosage calculation section.

Once the initial design was completed, a peer review group was selected from senior students attending the University of Kansas Nurse Anesthesia Program. In addition, a pediatric anesthesiologist reviewed the reference sheet. All reviewers were given the same guidelines for completing the peer review (see Appendixes B), and a time frame of two months was allotted for its completion.

Seven of twelve peer reviews were completed in the appropriate time frame. Recommendations for change were shared with all members of the peer review group. Suggestions were then analyzed for their overall contribution, and weighed against the foremost obstacle of limited space availability. Changes in formatting, drug dosing, spelling, grammar, and content were all made from the peer review. Some sections, such as pediatric cardiovascular anesthesia, were completely eliminated. Several other sections, including malignant

hyperthermia and local anesthetics, were added. All seven reviewers who participated in the process were presented with the final version of Young's Pediatric Anesthesia Reference Sheet. A final oral review was then conducted with each reviewer, and final changes were made. The majority of the final changes were related to formatting and getting all information to fit within two pages in a readable manner.

The completed reference is titled, *Young's Pediatric Anesthesia Reference Sheet*. It is an invaluable resource for anyone who administers pediatric anesthesia. The two page reference is packed full of essential information on a letter size sheet. It is laser printed with vibrant colors and is finished with a thick laminate for protection and durability. The standard sheet with lamination measures 9" x 11.5". This reference provides quick and easy access to a variety of pediatric information. Although the sheet is titled as a pediatric anesthesia reference, its use extends beyond anesthesia. It is an excellent reference for anyone who does pediatric care including pediatric intensive care units, neonatal intensive care units, emergency departments, urgent cares, emergency medical services, and life-flight.

The front page contains information about airway management including sizing for endotracheal tubes (ETT), laryngoscope blades, laryngeal mask airways (LMA), oral airways, face masks, and the anesthesia circuit and reservoir bag. It also includes sizing information for arterial and central venous catheters. There is a section outlining normal vital signs (blood pressure, heart rate, respiratory rate, and hemoglobin). Minimum alveolar concentrations of inhalational anesthetics for the pediatric patients of various ages are listed. Dosage information is given for induction drugs, analgesics and opioids, neuromuscular blockers, neuromuscular blockade reversal agents, adrenergic agonists, antiemetics, diuretics, antibiotics, and emergency medications. A section is also included that gives dosage guidelines for blood products including

packed red blood cells, fresh frozen plasma, platelets, and cryoprecipitate. All information is weight based for patients 1kg to 35 kg, and drug dosages are pre-calculated for each weight to help reduce the chance of improper dose/quantity errors.

The back page contains important information for preoperative preparation. The first section outlines current NPO order guidelines. The next section outlines the essentials of the pediatric set-up and what to have on the machine. A section on preoperative sedatives for patients greater than 1 year old includes dosage information for commonly used sedative medications. The next sections give excellent information regarding fluid management, how to estimate blood volume and blood loss, and calculations for fluid and blood replacement.

Finally, the rest of the back page provides anesthetic management guidelines for common, uncommon, and some emergent pediatric cases. These sections provide preanesthetic and intraoperative guidelines for the management of acute airway obstruction, congenital diaphragmatic hernia, cystic fibrosis, gastroschesis, hydrocephalus and ventricular shunts, hypertrophic pyloric stenosis, malrotation and volvulus, myelomeningocele, myringotomy and tympanostomy tube placement, necrotizing enterocolitis, omphalocele, prematurity, tonsillectomy & adenoidectomy, tracheoesophageal fistula, trisomy 21, upper respiratory infection, local anesthetics, single shot caudal, and the acute phase of the malignant hyperthermia protocol.

Following completion of *Young's Pediatric Anesthesia Reference Sheet*, a website was designed to facilitate sales and distribution to anesthesia providers. An e-mail database was built that includes all nurse anesthesia program and anesthesiology residency programs. The reference was first released on November 17th, 2007, to the SRNAs and anesthesiology residents at the

University of Kansas Medical Center. This initial release allowed for testing of the website. It also allowed for any further review of the reference sheet before its national release.

One month following its release to anesthesia students at the University of Kansas Medical Center, *Young's Pediatric Anesthesia Reference Sheet* was released on a national level. A mass e-mail was sent out to all nurse anesthesia and anesthesiology programs. The e-mail included information about the reference and a flier for distribution to students and staff. Since the initial e-mailing, the website has received over 300 new visitors per month, and over 100 reference sheets were sold in a matter of just eight weeks. All feedback on the reference has been very positive, and there have been no recommendations for changes at this time.

Conclusion

Current research supports the need for a pediatric anesthesia reference. In an effort to reduce morbidity and mortality in the pediatric patient, Young's Pediatric Anesthesia Reference Sheet was designed and marketed to anesthesia providers. The reference has been well received and has sold well over 170 copies since its release in November 2007. There are plans to increase the credibility of the reference with further reviews from pediatric anesthesia specialists. As evidence becomes available the reference sheet will be updated in order to provide anesthesia providers with the latest information. A follow-up study or survey would be appropriate to discover if the reference sheet helped providers avoid error or harm to any patient.

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Appendixes A

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the ASA Committee on Pediatric Anesthesia.

Appendixes B

Peer Review for Young's Pediatric Anesthesia Reference Sheet

Thank you for your participation. Please review the pediatric anesthesia reference sheet using the criteria listed below. Make comments in the sections below and feel free to write on the reference sheet where appropriate. Please return your reference sheet with corrections to me no later than October 1st, 2007. Thank you for your help in advance.

Sincerely,

Bradley Young

Page 1 of Young's Pediatric Anesthesia Reference Sheet

- Make comment on readability and format. Does it appeal to the eye and is the outline easy to follow?
- Is all the information listed under the age & weight, airway, lines, and vitals sections appropriate?
- Are the drug dosages listed appropriate?
- Are the drug calculations correct?
- Are there drugs listed that you feel should be omitted?
- Are there drugs not listed that you feel should be included?

Page 2 of Young's Pediatric Anesthesia Reference Sheet

- Make comment on readability and format. Does it appeal to the eye and is the outline easy to follow?
- Is the information listed under NPO orders, pediatric set-up, fluid management, estimated blood volume, & allowable blood loss accurate? Is there another section that you feel should be included?

- Is the information on the various diseases accurate and relevant? Are there diseases that should be excluded? Are there diseases that should be added?
- Finally: Please make corrections to spelling grammar, abbreviations, punctuation, etc.