9 Anesthesia and Perioperative Safety in Children: Standards of Care and Quality Control

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9.1 Introduction

The perioperative care of infants and children requires specialized facilities and represents a challange for anesthesiologists. Many factors are involved in a positive outcome from surgery and anesthesia in children and both are down to strict organization and management and also to the experience of the clinical team [1].

Pediatric anesthesia presents a specific set of problems, as the age of the patients can vary widely (from premature neonates and infants to children and adolescents), each group having a specific anatomy, physiology, metabolism, and pathology; this makes pediatric anesthesia a highly specialized area within the wider disciplines of anesthesia and intensive care.

It has long been known that experienced surgical and anesthesia staff decrease mortality and morbidity in young patients considerably. Mortality associated with anesthesia has drammatically decreased from 6 per 10,000 of the population in the period 1947–1956 to 0.36 per 10,000 of the population in 2000 [2,3].

The reasons for this improvement can be ascribed to a new patient approach, the introduction of new drugs with better safety profiles, new and advanced technologies in patient monitoring and management, the adherence to approved standards of care and quality of care criteria and, furthermore, to a new training and educational system for health-care providers characterized by specific training in pediatric anesthesia and critical care.

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M. Astuto (ed.) *Pediatric Anesthesia, Intensive Care and Pain: Standardization in Clinical Practice*. Anesthesia, Intensive Care and Pain in Neonates and Children
DOI: 10.1007/978-88-470-2685-8_9, © Springer-Verlag Italia 2013

9.2 Safety in Pediatric Anesthesia

Epidemiological data regarding anesthesia-related mortality and morbidity in pediatric patients are scarce. An interesting paper published in 2001 by Tay and colleagues [4] presented data regarding the spectrum of perioperative incidents seen in Singapore during 10,000 anesthesiological procedures in the period between 1997 and 1999.

The authors performed an audit for every case that required the presence of an anesthesiologist. On one side of the audit form, the attending anesthesiologist wrote a narrative description of the incident. The authors reported 297 incidents in 278 patients with the higher percentage of critical events in infants under 10 kg of weight. Most of the incidents happened during patient management and involved the respiratory system (approximately 78%), with laryngospasm being the most frequent cause.

This occurred most frequently during the immediate postinduction period compared with extubation or recovery time, and it was probably due to the stimulation produced by the transfer from the parent's lap onto the operating table [5].

Hemorrhage and hypotension were the most common incidents affecting the cardiovascular system. Only a few cases of dysrhythmias were reported: ventricular tachycardias, frequent ventricular ectopics, type II atrioventricular block, and bradycardia.

In contrast, Cohen and colleagues reported that dysrhythmias were the most frequent cardiovascular problem in children undergoing surgical procedures and anesthesia [6]. Organ impairment is not the only anesthesia-related incident. Other can be ascribed to the following elements.

9.2.1 Pharmacological Events

- Allergic reactions (antibiotics, local anesthetics, nonsteroidal anti-inflammatory drugs).
- Blood transfusion reaction.
- Syringe mislabeling.
- Incorrect administration [7].
- Drug toxicity [8,9].

Vigilance, by monitoring the depth of anesthesia to prevent an overdose, careful drug labeling, strict compliance with guidelines and recommendantions with regard to drug management and storage, all contribute to a significant reduction of anesthesia-related mortality.

9.2.2 Equipment Problems

- Disconnection of the breathing circuit.
- Occlusion of the breathing circuit.
- Anesthesia equipment malfunction.

9.2.3 Technique Difficulties

General anesthesia with regional techniques are always combined to guarantee a good intra- and postoperative pain control. Despite the high number of regional procedures performed, incidents are quite rare [4].

It is evident from the literature that the prevention of anesthesia-related incidents calls for many steps to be taken during the perioperative time. Before surgery patients should be carefully assessed and, if necessary, stabilized (blood pressure, heart rate, hydro-electrolyte and acid-base balance). All equipment and drugs should be strictly checked. The maintenance of anesthesia always requires the presence of the physician, and continous vigilance and patient monitoring as described in the guidelines.

Adherence to basic monitoring standards is essential to prevent errors, even if anesthesia is performed by an experienced and conscientious anesthesiologist. The necessary support and the implementation of national and local quality programs aimed at detecting critical situations or errors that may compromise patient safety, and strategies and protocols aimed at preventing and controlling recurrent errors, are essential to reduce anesthesia-induced mortality and morbidity [10].

9.3 Training and Education

Many countries have developed guidelines about pediatric health care, even though currently there are no agreed standards for the European Community as a whole [11–13].

Nevertheless, the Federation of European Associations of Paediatric Anaesthesia (FEAPA; now the European Society for Paediatric Anaesthesiology, distributed practical recommendations with the purpose of creating desiderable standards for pediatric anesthesia services in Europe.

With regard to education in pediatric anesthesia, anesthesiologists must have specific training in the management of the pediatric patient and sufficient ongoing training to keep these skills up to date.

It is essential to bear in mind that all training should be competency-based with continous assessment and supervision. The number of procedures to be undertaken by a physician in training should only be taken as a guide and not as a legal requirement, even if it should be preferable to closely follow the FEAPA recommendations. The recommendations are subdivided into different categories according to the different career goals of each trainee [14].

9.3.1 All Trainees in Anesthesia (Regardless of Their Future Career)

A minimum of 3 months of continuous training provided in a specialist pediatric center in a University hospital, a large Children's Hospital or a District (nonspecialist) Hospital with a large pediatric department, or a combination thereof, that have all the facilities required for the management of children, is suggested. It is not only important to perform a sufficient number of procedures, but also for those procedures to involve a mixed-age group of patients:

- 10 infants less than 1 year of age (minimum two neonates).
- 20 children aged 1–3 years old.
- 60 children aged 3–10 years old.

At the end of the training period, all specialists in anesthesia and intensive care should be able to safely perform anesthesia procedures for common surgery in children over 3 years old and also to keep up to date with pediatric resuscitation and the stabilization of infants and children prior to transfer to a specialized center.

9.3.2 Trainees Interested in Pediatric Anesthesia

A further training module of at least 6 months continuous training is recommended. These specialists may work in units or hospitals in which they would be expected to undertake a minimum of half a day pediatric anesthesia per week (less than 50% of their working time) in pediatric activities. They should keep up to date with specific pediatric issues and they should periodically attend a specialized surgical center to maintain or improve their knowledge and expertise.

9.3.3 Trainees Who Want to Specialize in Pediatric Anesthesia

A further module of continuous training lasting for a minimum of 1 year and taking place in a specialized center is recommended. The surgical case mix should be extensive and should include emergency cases. Moreover, trainees are required to spend either 1 or 2 months in a pediatric intensive care unit, though not considering this as full training in this area as many countries require an additional period of training of up to 2 years.

Specialists in pediatric anesthesia are those physicians who spend at least 50% of their working time involved in the care of infants and children and who are qualified in the management of pediatric anesthesia, in resuscitation and emergency care, in the treatment of pain, and in the early stabilization of children requiring intensive care.

At the end of all formative steps, trainees will be expected to have attained knowledge of:

- The anatomical, physiological, and pharmacological differences between children and adults.
- The principles of resuscitation, and emergency and intensive care for children of all ages.
- The principles of safety and quality of pediatric care (e.g., transporting infants from a hospital to a specialized center).
- Technical skills (e.g., airway management, regional anesthesia, and analgesia).
- Medico-legal issues specific to pediatric practice (e.g., informed consent and clinical research).

These recommendations underline the importance of having a specialized clinical team and a pediatric intensive care bed available when necessary. Only in this way can services be delivered safely and promptly so as to handle emergencies effectively.

Agreement with these recommendations is not fully widespread in Italy. In 2006, Astuto and colleagues started to conduct a first survey to evaluate if the guidelines distributed by FEAPA had been adopted by the Italian postgraduate schools of anesthesia and intensive care or whether other training was being carried out. All the

Table 9.1 Initial survey carried out to evaluate the adoption of the FEAPA guidelines by Italian postgraduate schools of anesthesia and intensive care

Questionnaire
1. Does the school provide peditric training? If yes: what is the duration?
2. Are there a minimum number of procedures to perform during the training period?
3. Does the trainee have a test at the end of the training period?
4. Does your department have a team of anesthetists dedicated to pediatrics?

directors of the 37 Italian schools of anesthesia and intensive care were contacted and informed about the survey. A questionnaire, containing four simple questions (see Table 9.1), was distributed and the answers were collated in an electronic database and processed to obtain relevant information [15].

From the analysis of the completed questionnaires, it appeared that a minimum training in pediatric anesthesia is mandatory in the majority (92%) of the schools of anesthesia which took part in the survey. In 60% of the schools, training lasted for 3 months.

With regard to the minimum number of procedures provided for trainees by the FEAPA recommendations, including a large case mix and patients from all age groups, the results showed that only few institutions (29%) involved in a postgraduate educational program comply with these requirements.

Moreover, even though trainees should be formally evaluated both during and at the end of their pediatric training, the survey revealed that although Italian residents undergo formal assessment of their knowledge of and practice in pediatric anesthesia, the timing and form of such evaluation is not always standardized.

Currently, training in pediatric anesthesia is not a prerequisite for the anesthesia board examination in Italy, although those teaching hospitals that allow trainees to attend specific training have a dedicated group of pediatric anesthesiologists as supervisors for residents.

9.4 International Perspective

Other experiences worldwide have demonstrated that good training programs in pediatric anesthesia and intensive care were developed over 5 years ago and are now well established [13]. Comparing the results from Italian surveys with international educational systems, it is possible to state that resident training differs across the five continents.

In 2007, in a set of six surveys, Dent and colleagues reported on Australasian physician training in the emergency department involving pediatric patients [16–18]. One year later, the Australian and New Zealand College of Anaesthetists (ANZCA) approved a training sequence encompassing:

1. An initial 2-year prevocational medical education training period.

2. A 5-year period of ANZCA-approved training, during which period Fellows have to perform a minimum 50 half-day sessions of clinical activity, including anesthesia procedures in different surgical subspecialties (i.e., general surgery, neurosurgery, otolaryngology) and clinical management of important childhood conditions both in preoperative assessment and in emergency care (i.e., respiratory infections, prematurity and its complications, neonatal emergencies, congenital cardiac disease, facial anomalies affecting the airway) [19].

In Japan, training in pediatric anesthesia was evaluated by Shimada and colleagues, who reported that only a very low percentage of interviewees practiced pediatric anesthesia daily, while many did not practice it at all. These poor results are likely due to the fact that almost all anesthesia schools did not provide specific pediatric training, even if it was considered mandatory by the Japanese Society of Anesthesiologists [20].

Few studies on pediatric anesthesia have been published for the African continent. Some surveys report that only a few anesthesiologists were able to provide safe pediatric anesthesia [21] and there are no guidelines for anesthesia training.

In Chile, South America, thanks to the help of the World Federation of Societies of Anaesthesiologists, training in pediatric anesthesia is well established and consists of a training period lasting from 6 months to 1 year [22].

In North America, the situation changed in 1975 when Smith [23] described in his survey the development of pediatric anesthesia in the USA, indicating its importance. He also described an approved third-year residency offered by seven pediatric centers, which represented the first example of an experimental standardization in pediatric anesthesia training [23].

9.5 Clinical Setting

Pediatric patients are not small adults and so they need not only specialized medical staff but also a fit and suitable environment with all the appropriate facilities provided for them. The presence of parents is essential during the various clinical steps, including special areas like intensive care units or operating theaters [24].

Parents should be involved in all the aspects of the decision-making process and, for this reason, good and clear communication is fundamental for quality of care. Communication also involves the children, according to their age and comprehension ability. In the right circumstances, the young patients' consent should also be obtained.

Overnight accommodation should be available for parents whose children require admission to hospital, particularly if in critical situations.

Even technologies have to be specifically tailored to pediatric patients: warming devices should be available in the operating theater; the anesthesia equipment should provide mechanical pulmonary ventilation for children of all ages and weight; age-adjusted equipment and disposable items should be available for general and regional anesthesia.

9.6 Conclusions

Pediatric anesthesia should undoubtedly be viewed as a subspecialty addressing the entire pediatric population (from pre-term neonates to teenagers), which requires specific anatomical, pathophysiological, pharmacological, and anesthesiological knowledge. To prevent incidents and to guarantee optimal quality of care, many European countries have developed national guidelines to help health-care providers to work according to best practice principles.

Neverthless, there are many differences among national health systems; for this reason, FEAPA attempted to summarize all the requirements needed to foster an optimal pediatric environment in a unique document, which contains the main recommendations with regard to organization, safety, training and education, and clinical services and facilities.

However, strict adherence to all of these recommendations and guidelines is needed to reach the ultimate goal of "best practice" and thereby maximun safety for all our children.

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