Principles and Practice of

Pediatric Anesthesia

Editors
Snehalata H Dhayagude
Nandini M Dave

Foreword
VM Divekar

JAYPEE

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To our families
For their support and patience
&
To all our little patients who inspire us to do better

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Foreword

Pediatric surgery has made tremendous progress in the last three decades, because of the great advances in pediatric anesthesia. Pediatric anesthesia is now considered a superspecialty needing special skills and knowledge. Pediatric anesthesia has made the impossible possible. I am happy to state that this book is the result of great efforts taken by senior and experienced pediatric anesthesiologists from across the Indian subcontinent. They have shared their knowledge and personal experiences in their respective chapters. This book provides a systematic, comprehensive and accurate compilation of wide ranging topics pertaining to pediatric anesthesia.

It is said that children are not miniature adults, but differ anatomically and physiologically with different pharmacokinetics and pharmacodynamics. This has been well dealt with in the Basic Principles Section. All the pediatric specialties, radiological imaging procedures, cardiopulmonary resuscitation, etc. have been well written by specialists; a special mention is made on monitoring, interpretation of chest radiographs, electrocardiographs, vascular access and ultrasound-guided regional blocks.

The chapters on airway problems, special situations and medical problems, and syndromes will be very useful in day-to-day practice. I recommend this book as a valuable update on pediatric anesthesia. I am certain it will be useful to postgraduate students and pediatric anesthesiologists as a reference book, on the shelf of every hospital operation theater and library.

I appreciate the sincere efforts and congratulate the editors for this informative and well-organized book on the subject.

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Preface

Sir Robert Reynolds Macintosh has quoted almost 5 decades back; "Theme of clinical academic practice of anesthesia should be based on triad of Science, Safety and Simplicity". The first two words, Science and Safety, will hold true at all times. However, Simplicity has to be considered in different context. The success with complexity of pediatric surgical procedures and demand for excellence in anesthesia can be achieved only by incorporating technically advanced complex anesthesia machines, monitoring systems, special skills and various complex invasive procedures.

It is time to pen down what has changed. Humongous developments have occurred in the scientific arena of pediatric anesthesia. Knowledge and understanding have expanded in all branches of pediatric anesthesia. The unique developmental aspects regarding anatomical, physiological, pharmacological, psychological and surgical conditions that require special attention and thought make pediatric anesthesia distinct. The landscape of modern pediatric anesthesia is vast in the true sense.

The purpose of this book is to provide a clear roadmap for understanding principles and practical approach to pediatric anesthesia. Our mission is translated into offering comprehensive text covering wide range of pediatric anesthesia and allied topics. We have divided the text into six sections: Basic Principles, Anesthetic Management, Subspecialty Anesthesia, Special Problems and Situations, Anesthetic Techniques, and Notes on Allied Topics. Appendices provide quick reference to pediatric drug dosages, syndromes, and handy formulae.

All the contributing authors are experienced pediatric anesthesiologists and teachers in the field, and they have offered current perspectives on the subject of their chapters. Along with compiling scientific information, each one has added their individual experience and clinical expertise for more practical and realistic application.

The book begins with a page on historical milestones in pediatric anesthesia.

In the first section of "Basic Principles", along with anatomical growth and physiological characteristics at various stages of development and essentials of pharmacology, we have intentionally included chapters on pediatric chest X-ray and electrocardiogram. Senior pediatric cardiologists and radiologists have comprehensively described normal electrocardiogram and chest radiographs respectively, along with illustrations in different clinical scenarios.

In the second section of "Anesthetic Management" the entire process of anesthetizing a child, from the evaluation of physical status, along with anesthesia techniques and monitoring, fluid and transfusion therapy, various methods of pain management, including regional techniques, ventilation strategies are compiled in detail. Anesthesiologist's role in the assessment and management of difficult airway is described with excellent illustrations.

In the third section of "Subspecialty Anesthesia", the authors have detailed current perspectives of anesthetic management in different surgical branches along with chapters devoted to anesthesia in remote locations and also in the neonate for various surgical procedures. All the chapters bring us up-to-date on safe, effective and efficient perioperative practices.

The fourth section on "Special Problems and Situations" comprises of a chapter dealing with management of common medical conditions anesthesiologists face in day-to-day practice written by pediatricians, and a chapter on anesthetic management of some rare and some not so rare conditions needing special considerations. This section also includes an important chapter on cardiopulmonary resuscitation in keeping with the AHA 2015 guidelines. Pediatric anesthesiologists should also be aware of all types of complications during anesthesia, and so a separate chapter is devoted to complications during anesthesia.

The fifth section on "Anesthetic Techniques" includes a chapter on vascular access describing indications, safe techniques and complications and a chapter on ultrasound-guided regional blocks with good compilation of appropriate pictures.

The sixth section on "Notes on Allied Topics" offers pertinent information on safety and quality, ethical issues and utility of simulation in pediatric anesthesia.

The "Appendices" are intended to provide an information capsule on syndromes, drug dosing guide, and handy formulae and tables.

We are delighted to include a "Photo Gallery" which showcases various rare conditions encountered in clinical practice.

We offer our sincere thanks to all the authors for sharing their knowledge and expertise. We thank Shri Jitendar P Vij (Group Chairman), Mr Ankit Vij (Group President) and Mr Tarun Duneja (Director–Publishing) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, for their support and encouragement. We hope that this book will be well received and will offer comprehensive information to practising anesthesiologists, and to postgraduate students aspiring to become pediatric anesthesiologists.

Snehalata H Dhayagude
Nandini M Dave

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SECTION 6: NOTES ON ALLIED TOPICS

APPENDICES

Historical Milestones in Pediatric Anesthesia

Snehalata H Dhayagude

Old anesthetic practice centuries ago comprised of "Hypnosis and trance", "Application of cold", "Pressure over peripheral nerves and blood vessels", "Alcohol intoxication", and "Ingestion of herbal concoctions". "Whisky nipple" had been used as sedative supplement to local anesthesia in infants for major surgical procedures and "wine" was used for pain relief for circumcision surgery for millennia.

- 1540—Paracelsus, Swiss Physician discovered Ether
- 1774—Joseph Priestley liberated Oxygen and obtained Nitrous oxide
- 1842—Dr Crawford Long used Ether inhalation for amputation of toe for 8year old child
- 1846 October 16th—WTG Morton demonstrated use of ether for tooth extraction. Every year 16th October is celebrated as "World anesthesia day".
- 1847—First recorded anesthetic deaths in children aged 11 years and 15 years
- 1857—Dr John Snow reported 100 cases of inhalational anesthesia with chloroform in children less than 1 year old
- 1858—Dr John Snow published text on chloroform and other inhalational anesthetics
- 1884—Freud and Karl Koller invented local anesthetic drugs
- 1898—August Bier of Germany introduced spinal anesthesia and used it in children also
- 1902—Cushing coined the word "Regional Anesthesia"
- 1907—James Gwathmey voiced his concern for children's preoperative anxiety and later tribromoethanol as rectal sedative agent became popular around 1928
- 1910—Dr Tyrell Gray published detailed paper of spinal anesthesia in more than 100 children
- 1919 onwards—Ralph waters investigated toxicology of chloroform and pharmacology of cyclopropane. He invented cuffed endotracheal tubes, laryngoscopic blades, oropharyngeal airways, Carbon dioxide absorption canisters and precision controlled anesthetic vaporizers
- 1923—Sir Ivan Magill demonstrated the use of double lumen insufflations catheter for a cleft palate case
- 1930—Dr Charles Robson practiced both open drop ether and cyclopropane with tracheal intubation in kids. He advocated preinduction fasting for 4 hours in kids. He established pediatric anesthesiology in USA and Robert Cope established it in UK
- 1930—Dr Philip Ayre developed a pediatric anesthesia breathing system to be used with tracheal tube—Tpiece, valveless, non-rebreathing unit with low dead space and low resistance
- 1930—Lamont and Harmel developed miniaturization of to and fro canisters for closed system anesthesia apparatus for the use of cyclopropane
- 1933—Cambell wrote an article on caudal anesthesia in children
- 1935—Leech and Leigh (1946) experimented with morphine, scopolamine, and pentobarbital for sedation and analgesia to improve perioperative experience in children
- 1937—Guedel described clinical signs of anesthetic depth and introduced airways
- 1939—Leven and Ladd performed multiple procedures for repair of tracheoesophageal fistula
- 1940—Ladd mentioned importance of supportive warming, significance of correction of electrolyte balance and intraoperative charting of clinical signs of anesthetic depth
- 1942—Griffith and Johnson from Montreal used "curare", a relaxant in anesthesia
- 1948—M Digby Leigh from Canada authored book on "Pediatric Anesthesia"
- 1950—Dr Jackson Rees modified Ayre's T-piece open circuit by attaching a valve-less open-ended

bag at the other end of tubing, which helped monitor spontaneous respiration or assist breaths intermittently. He advocated controlled respiration in infants with reduced tidal volumes and breathing rate of 60–80/min

- 1950—Halothane was invented in UK, introduced in practice in 1956. WT Salter stated "Without vision and research the professions die"
- 1951—Pediatricians' Holliday and Segar derived a formula for administration of intravenous fluids in children based on daily caloric requirement. The 4-2-1 rule used by anesthesiologists to calculate hourly fluid administration is based on this
- 1950's—Virginia Apgar standardized method of neonatal assessment at birth, coined as APGAR score
- 1963–65—Dr George Gregory and his mentor WK Hamilton (San Francisco) applied continuous positive airway pressure to infants with respiratory distress syndrome and demonstrated dramatic improvement
- 1970—Dr Alvin Hackel developed highly coordinated regional emergency transport system for sick infants and children
- 1981—Dr George Gregory reported, a series of PDA ligations in premature infants using high dose fentanyl technique
- 1980's and 1990's—Pediatric anesthesia grew beyond operation theaters in to outpatient clinics, procedural rooms, pain clinics. Technologically advanced monitoring equipment became available—pulse oximetry, capnography, automated blood pressure and electrocardiography—all into one multi-parameters' monitor. Safer inhalational anesthetics—Isoflurane and Enflurane were introduced
- 1987—'Society of Pediatric Anesthesia' was formed
- 1991—Dr Elliot Crane and Dr Don Tyler hosted first 'World Conference of Pediatric Pain'
- 1995 onwards—Sevoflurane, Desflurane were introduced with better safety profile
- 1980-2000 – Developments in pediatric anesthesia
  - Addressing pain response in neonates
  - Understanding narcotics in infants
  - Pediatric pain management
  - Awareness and management of apnea in premature infants
  - Evidence to help formulate preoperative fasting guidelines
  - Growth of day-care surgery
  - Safe procedural sedation
  - Evolution of pediatric cardiac anesthesia as subspecialty
  - Anesthesia education and formation of societies
  - 2006—Formation of "Indian Association of Pediatric Anesthesiologists" (IAPA).

SECTION 1

Basic Principles