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Complications of
**PEDIATRIC
SURGERY**

Prevention and Management

WELCH

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SURGERY
Prevention and Management

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Central Nervous System

PREFACE

American pediatric surgery has evolved largely over the past thirty-five years. Currently more than four hundred surgeons devote their entire time to the surgical care of children. This work follows the publication of textbooks and standard reference works in the field, the Journal of Pediatric Surgery, formation of the American Pediatric Surgical Association and the formal recognition of pediatric surgery as a specialty through the awarding of a certificate of proficiency to qualified examinees under the aegis of the American Board of Surgery. This volume logically follows and joins the W. B. Saunders series beginning with the classic work of Artz and Hardy, *Complications in Surgery*.

The goal of this text is to provide surgeons in all specialties who operate upon children with authoritative and detailed advice on the prevention and management of complications that will inevitably occur during the operation or the postoperative period. It is the ultimate surgical postgraduate course and we should all take it. Complications often occur elsewhere. Patients are then referred to a specialized institution for subsequent care and management. Little is learned from this convenient process. One can lecture about staying out of trouble, the zenith of surgical luck or skill, yet as the scope of surgery widens, as new procedures evolve and the surgical tour de force becomes common, major complications will occur at a predictable rate. Having avoided traditional traps and pitfalls, next most important is realistic acceptance that an error has occurred. Delay or unwilling recognition of a complication sets the stage for rapid deterioration of the patient. Corrective surgery may be required when the patient's resources are low. Any unsolved problem will result in complications at least as bad as anticipated.

The surgical audit conducted by most university teaching services is more than a requirement. It is a statement of responsibility to our patients, a fountain of new surgical information, and the most instructive conference of the week. Surgical errors include: error in diagnosis (ED), error in judgment (EJ), error in technique (ET), and error in management (EM). The late I. S. Ravdin added trying to play God (TPG). Such a conference, painful on occasion, has been held weekly from 1967 to 1981 at Children's Hospital Medical Center under the stewardship of Dr. Judah Folkman. Collected complications provided a data base for a full table of contents. Thirty four chapters were assigned to recognized authorities representing 21 major pediatric surgical departments in the United States and Canada. Analysis of similar complications at other institutions revealed a remarkably high correlation as to the type of complication, rate of occurrence, and result of treatment.

I wish to express my gratitude to my secretary, Suzanne Danais, for preparation of manuscripts, for assuming day to day editorial responsibili-

ties, and for good natured but vigorous pursuit of tardy contributors. I would like to thank all members of the W. B. Saunders staff, particularly Lisette Bralow, Associate Medical Editor, and Grace Gulezian, Production Manager. Both made my editorial duties pleasant and instructive. Finally I would like to thank the contributors who took time from their surgical practices and their families to prepare manuscripts for this important work. We hope it will diminish suffering and expedite recovery in our little patients who require surgical treatment.

Kenneth J. Welch, M.D.

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GENERAL

1

Robert M. Smith, M.D.

Complications of the perioperative period of pediatric surgery start with those related to anesthesia. Table 1-1 suggests many but by no means all of the complications of pediatric anesthesia. To emphasize the more important rather than the more exotic, complications have been coded to indicate their relative incidence and severity. Severity is judged on the bases of mortality (or duration of nonfatal effect), degree of injury, physical suffering of the patient, emotional distress of the patient and parents, and social and financial effect on patient, family, and community. The following discussion will concern early recognition of the more important complications, as well as their treatment and prevention. References are given for details of pathophysiology that are beyond the scope of this chapter.

FATAL COMPLICATIONS

Many discussions entitled "Complications" touch on a variety of mishaps but avoid consideration of the most serious, namely death. Although it is an unpleasant note upon which to open, it seems proper to face the most important problem first.

Because of difficulties in determining the true cause of operative deaths, few reliable data relate to pediatric anesthesia.^{38, 43} The report of Beecher and Todd⁶ in 1954 supported the current estimate of one death per 1500 anesthetics for adults.¹³ It was generally believed at that time that children were "poorer anesthetic risks,"⁷³ with an expected death rate of approximately one per 1000 anesthetics. Although inclusive studies were not made, many articles mentioned anesthetic deaths in children,^{10, 18, 22} frequently caused by posttonsillectomy bleeding problems,^{2, 32, 49} hyperpyrexia and

seizures during appendectomy,⁷⁰ and aspiration of vomitus during reduction of Colles' fractures in healthy children.⁶⁶ For many years the Anesthesia Study Commission instituted by Ruth in 1945^{32, 54, 58} did much to point out such errors. For the next 20 years the term "cardiac arrest" was used to designate but not explain deaths that occurred during more extensive surgery. These deaths were undoubtedly caused by blood loss, increasing hypoxia, or airway obstruction of a more subtle nature that went unnoticed until arrest occurred.^{47, 62, 66, 72}

Figures now available show that anesthetic mortality for both adults and children is far less than it was 25 years ago. Fatal anesthetic complications are to be neither expected nor excused in patients of any age. Although surgical mortality is relatively high in the perinatal period, such deaths are due chiefly to prematurity and to serious congenital defects rather than to anesthetic or surgical complications or preventable errors. The records of five anesthetic deaths among 89,000 patients, one anesthetic death among 29,000 patients, and one anesthetic death among 50,000 patients (from Boston,⁶⁴ Salt Lake City,²⁴ and Philadelphia,¹⁹ respectively) document the success attained in pediatric hospitals.

Because the incidence of anesthetic mortality is so low, generalizations about its causes have relatively little significance. At present, anesthetic deaths in healthy children should be, and are, an extreme rarity when special equipment and skillful anesthesiologists are available. Fatal complications of anesthesia do occur, however, as noted in news items and legal reports. In some instances they may be traced to inadequate anesthetic skills, but they more frequently result from a lack of overall facilities for supportive care and observation.^{14, 15}

TABLE 1-1 ANESTHETIC COMPLICATIONS LISTED IN REFERENCE TO BODY SYSTEMS AND CODED FOR SEVERITY AND INCIDENCE*

Central Nervous System

Death (A-4)
Temporary fear, anxiety, terror (C-1)
Behavior disorders (C-3)
Hypoxic damage
Mental retardation (B-4)
Dementia (A-4)
Spasticity (B-4)
Blindness (B-4)
Peripheral nerve injury (C-4)

Thermic Disorders

Hypothermia, shivering (D-1)
Nonmalignant hyperthermia (D-4)
Malignant hyperthermia (A-4)

Respiratory System

Hypoxia, hypercarbia (B, C-3)
Hypocarbica (C-3)
Respiratory obstruction
Anatomic, tongue, secretions (D-1)
Pathologic, inflammation, tumor (C-3)
Spasm, aspiration, hiccoughs (B-2)
Atelectasis, pulmonary edema (B-2)
Pneumothorax, pneumomediastinum (B-3)
Respiratory depression
Drug overdose, sensitivity, abnormal response (C-3)

Complications of Endotracheal Intubation

Endobronchial intubation (C-3)
Physiologic trauma, hypoxia (C-3)
Blocked, kinked tube (C-3)
Extubation spasm (C-2)
Postintubation tracheitis (C-3)
Subglottic stenosis (B-4)

Cardiovascular System

Tachycardia (D-2)
Bradycardia (C-3)
Asystole (cardiac arrest) (A, B-3)
Arrhythmias (D-1)
Hypertension (C-1)
Hypotension (C-2)
Pulmonary hypertension (C-3)
Shock (B-3)
Cardiac failure (B-3)
Volume overload (B-3)
Volume depletion (C-2)

Gastrointestinal System

Nausea, vomiting (D-2)
Gastric distention (D-2)
Intestinal ileus (C-3)
Gastric rupture (B-4)
Esophageal and rectal trauma (C-3)

Hepatorenal System

Hepatotoxicity (B-4)
Acute renal failure (B-3)

Iatrogenic Complications

Drug overdosage, toxicity, sensitivity, interaction (B, C-3)
Anesthetic pollution, explosion
Monitoring complications
Vascular damage, burns, hypothermia, electrical injury (B-4)
Transfusion reactions
Damage to skin, eyes (C-3)
Oxygen toxicity (B-4)
Retrolental fibroplasia (B-4)

Equipment Failure

Separation of breathing apparatus (B-3)
Faulty endotracheal tube cuffs

***Code** Severity: A = fatal or catastrophic; B = major; C = moderate; D = minor. Incidence: 1 = 1/10 cases; 2 = 1/100 cases; 3 = 1/1000 cases; 4 = < 1/1000 cases.