

PEDIATRIC
SURGERY

PEDIATRIC SURGERY

SECOND EDITION

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PREFACE

Advances in the field of surgery vary from one decade to another. Some periods have brought forth a general advance in virtually all areas of surgery, but during the past ten years the great changes have been in cardiovascular surgery. Gross and Blalock began some two decades ago with operations which were performed essentially on the periphery of the heart, but which altered the function of the heart considerably. More recently, the work of Kirklin, Lillehei, and Gibbon has opened up the vast field of intracardiac surgery performed with the aid of the heart-lung machine. This has wrought changes so dramatic that it has become necessary to revise the entire section on cardiovascular surgery in our text; consequently, the second edition is limited to a complete revision of the chapters dealing with congenital heart lesions amenable to surgery.

In this edition, we have recalled to the surgeon such basic physiologic phenomena as the fetal circulation and the alterations which occur after birth, and the basic physiology of cyanosis. In the field of diagnosis, we have stressed the value of the newer technics such as cardiac catheterization, angiocardiology, and particularly selective angiocardiology. In addition, we have included a detailed description of the heart-lung machine, how it operates, what precautions one must take in its use, and the care of the postoperative patient in whom this type of equipment has been utilized during intracardiac surgery. Our evaluation of the results of open heart surgery is subject, of course, to the limitations imposed by the comparatively short period of follow-up. It is hoped that this revised section will prove valuable to the student and also to the physician and the cardiovascular surgeon.

ORVAR SWENSON

FOREWORD

Pediatric surgery, as a special field, is very young when one considers the centuries of recorded medicine. I have had the opportunity over the past forty-five years to observe the greatly widening field of operative procedures now possible for these young patients. Of great importance has been the improvement in preoperative and post-operative care which came from increasing knowledge of the basic sciences. Our present understanding of fluid balance, safer methods of anesthesia, more accurate methods of diagnosis, and control of infections have played major roles. In my early days an operation which lasted as long as an hour was considered as reaching the limit of safety. An open operation of any magnitude within the thorax, let alone an open operation on the heart, was considered impossible.

It is well to remember, then, that though craftsmanship and dexterity are of great importance, they play a rather minor role in the true advances of surgical treatment in this or any age group. What then are the qualities that make the truly great surgeon in this pediatric field? Let me suggest a few. The first will indicate what a careful study and an intelligent reading of the literature may provide. For over fifty years following Hirschsprung's description of the disease that bears his name, the methods of treatment, operative or nonoperative, were focused on the greatly dilated and hypertrophied section of the large bowel. But the cause of this condition lay in the undilated terminal portion of the colon itself. It is the malfunctioning of the nerve supply to this area that causes a physiologic stenosis which, in turn, causes the dilated colon above.

An intellectual curiosity and a careful reading of the original article brought about a method of rational and successful treatment of this condition. For it is interesting to note that the clue to the solution of this surgical problem remained unnoticed in Hirschsprung's original article for more than half a century. He mentioned that usually there were *no* masses of impacted feces in the terminal colon just above the sphincter—that is, in the undilated section. The causative pathology was in this area, and Swenson had the wisdom and vision to realize this and not be content to treat the result, but rather to find the cause.

Other anomalies of development, particularly those of the gastrointestinal tract, require this same approach. The surgeon must have a thorough working knowledge of embryology. All those interested in this field of surgery should read carefully the volume *Congenital Anomalies of the Viscera: Their Embryological Basis* by the late Dr. J. Lewis Bremer.

Congenital atresia of the duodenum is a condition requiring further study. Thirty years ago all such patients died, usually without operation. Now a gratifyingly large percentage of such cases survive operation. But follow-up studies show that about 30 per cent of these survivors are Mongols. The surgeon should consider not only why these malformations occur at all, but in particular why such a large percentage has associated Mongolism. It requires skillful and indeed brilliant surgery to correct this anomaly. The operation must be done in the first few hours of life when the diagnosis of Mongolism obviously cannot be established with certainty. But if 30 per cent of the patients who recover are to be Mongols, should these operations be proudly regarded as "successful," if one considers the patient's success as a member of society?

Pyloromyotomy for congenital hypertrophic stenosis of the pylorus is now so common and carries such a low mortality that it is properly regarded as a procedure for the surgical resident during his novitiate. The technic is simple, and with modern safeguards the operative mortality is approaching the irreducible minimum of zero. Forty-

five years ago it was 40 per cent or more. The surgeon is treating, successfully to be sure, the result but not the cause. There is an opportunity, possibly, to learn something significant about the use of vagotomy in the treatment of peptic ulcer. There must now be many hundreds of adults who as infants had a pyloromyotomy. A careful study of a series of such patients who are now in the peptic ulcer age group has not yet been made. Nor have I heard reports of any significant number of cases of peptic ulcer developing in these patients.

If a surgeon wishes to develop pediatric surgery, he must have the dexterity of the master craftsman, to be sure; but it is the surgeon with an inquiring mind, with intellectual curiosity and honesty, and with humility who becomes the contributor in his chosen field.

THOMAS HINCKLEY LANMAN

FOREWORD TO FIRST EDITION

Some thirty years ago Sir Lancelot Barrington Ward, Senior Surgeon of Hospital for Sick Children in London, in his book on Abdominal Surgery of Children stated that "The adult may safely be treated as a child, but the converse can lead to disaster."

Since that time there have been tremendous advances and improvements in all branches of medicine and surgery, and this has been particularly true in the field of surgery of childhood. With these advances it becomes even more apparent that not only are children subject to many conditions not found in adult life but their reactions are quite different, and in order to avoid disasters they must be treated differently. To obtain the best results and avoid tragic catastrophes in the surgical problems of early life, special training in this field is required. The difference in the practice of medicine between adulthood and childhood has long been recognized. This recognition is made evident by the enormous number of pediatricians in this country and throughout the world. The difference between pediatric surgery and adult surgery is quite as great as that between pediatrics and adult medicine and perhaps even more important, even though it has not been so widely recognized. Every year more men are concentrating their work and limiting their practice to the surgery of childhood.

This book of Dr. Swenson's describes many factors in diagnosis and therapy which he has found valuable in his wide experience in pediatric surgery as well as some of his personal research which has revolutionized the treatment of certain conditions of early life.

This book should be of the greatest value to every surgeon performing pediatric surgery and of much interest and value to teachers of surgery, pediatricians, and general practitioners, who find it ever more difficult to keep abreast of the times in a constantly changing field.

WILLIAM E. LADD

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ORIENTATION

Laymen and some doctors assume that the risks of operation are immensely greater with infants than with adults. The size of infants, their fragile structure, and their susceptibility to infection have naturally contributed to this idea, particularly in the minds of laymen. Actually, infants have vitality and endurance far beyond that indicated by their size and age. The reason for this is that their organs are new and without the inevitable degeneration that occurs with aging. Consequently, the cardiovascular system is probably never more perfect than during the first few months of life. The heart is relieved of pumping blood through the placental circulation at birth, which may be another factor of its considerable reserve in the newborn. Tolerance to anoxia is greater in newborn infants than in older children. An example of the resilience of infants is their phenomenal recuperation from a general anesthesia. Following repair of an inguinal hernia under general anesthesia, infants rarely vomit, and they retain oral feedings within two or three hours after anesthesia. Another example of infants' vitality is their ability to endure grave post-operative complications and still make complete and permanent recoveries. Thus the past practice of postponing the correction of congenital malformations until the child was seven or eight years old, because the operative risk was then presumed to be less, is not consistent with known facts. In most instances the delay imposes a disadvantage on the patient, who is needlessly handicapped for a number of years, and on the parents, who must endure the worries of caring for the handicapped child. Furthermore, in many cases the functional result of the delayed repair is not comparable to the one that can be obtained by immediate correction of the malformation.

While babies' vitality is substantial, operations upon them can be performed with safety only when the infants' physiologic variations from adults are appreciated. Newborn infants have some immaturity of their respiratory systems. Their response to respiratory stress is by an increase in rate. As their tidal volume is small, this response is not as efficient as an increase in depth of respiration would be. The renal system also is probably immature and can be more readily overloaded by injudicious administration of parenteral fluids than can mature organs. The endocrine apparatus may also be incompletely developed, for the blood steroid levels are lower than normal for a few days after birth. The response to surgical stress varies from the adult pattern. There is a slower appearance of circulating steroids than in a mature individual. Those persons caring for infants before, during, and after operation will not achieve the best results unless these variations in physiologic response are appreciated.

Surgeons concerned with malformations of the newborn must be prepared to recognize and deal properly with the various pathologic entities commonly encountered. It is a mistake to consider that an infant is merely a small version of an adult and as such is subject to the same diseases as an adult. For instance, a partial duodenal obstruction due to malrotation with an associated volvulus of the small intestine is an entity practically never encountered in adults. Unless the surgeon is cognizant of the condition, its signs, symptoms, x-ray diagnosis, and surgical treatment, he may overlook it or fail to correct it adequately when it is found. Only when the surgeon is completely familiar with the unique pediatric surgical lesions and their proper treatment will he achieve optimum results.

An additional problem with infants is that

the history must be obtained from the parents or other observers, and this often makes it difficult to secure a concise, accurate description of symptoms. The examination of infants and children is more difficult than that of adults because infants and children frequently do not cooperate, and the surgeon who desires to be successful in pediatric surgery must become acquainted with, and proficient in the use of, the special technic required for the examination of children.

The surgeon must also be conversant with the problems of dehydration and electrolyte imbalance in infants and children, for situations that arise before and after operation may differ in some respects from those of adults. Infants have a relatively larger surface area per unit of weight than adults, and fluid loss may occur rapidly and clinical manifestations may be more profound. A knowledge of formula composition and intervals of feeding is essential for the proper postoperative care of pediatric patients.

Adults tolerate a rough surgical technic more readily than infants. In no field of surgery does gentleness pay a greater reward than in operations on infants. Precision is of utmost importance. It must be remembered that the newborn is only a fraction of the size of an adult. The intestine is proportionately smaller and thinner, and each suture used in performing an anastomosis must be placed with a great deal more precision than in a similar situation in an adult. Only by constant experience in operating on infants does the surgeon develop and maintain skill in the dissection of small structures and in their accurate reconstruction.

These facts have been reviewed here to emphasize that the pediatric surgeon needs special knowledge, skills, and technics in addition to his broad basic training in general adult surgery if he is to provide the best possible care for surgical pediatric patients.

Not only must the pediatric surgeon be specially trained, but he must also have available small, fine instruments and other equipment which are essential in the performance of his tasks.

A group of skilled professional personnel is a great aid in the diagnosis and care of the surgical pediatric patient. A pediatrician completely versed in child care is invaluable, particularly when serious complications are present. A radiologist who is familiar with all the obscure conditions encountered in pediatric surgery and with their radiologic detection is of great assistance. Various diagnostic procedures, such as bronchography, are dependent on the cooperation of the radiologist and the surgeon. A pathologist trained to recognize the tumors and anomalies that occur in pediatric patients is of great help to the surgeon during operations.

Of more importance even than these specialists is an anesthesiologist trained and experienced in the care of child patients, because the infant's safety depends to a large extent on him. A skilled anesthesiologist can provide such necessary conditions for the operation as proper relaxation of abdominal musculature which is an immense help to the surgeon.

Postoperatively, an infant's condition may deteriorate with appalling rapidity, and the baby's survival depends upon these changes being detected and treatment instituted promptly. Following operation, the surgeon must visit the small patient frequently and, in addition, have a competent house staff of pediatric surgical interns and residents available in the hospital 24 hours a day. Such professional coverage is essential to prevent unnecessary complications and postoperative deaths. Also, such specially trained house surgeons are needed to maintain the parenteral fluid apparatus and the complicated gastric, thoracic, and urinary drainage systems often indispensable to the infant's postoperative care.

Often the nurses' role in the care of surgical pediatric patients is unappreciated. Their special skills and experience provide for the child's comfort and the prompt, effective administration of postoperative orders. In addition, their close observation of the patient in the postoperative period enables them to call attention to complications in the incipient

stages, when prompt remedial measures will prevent a disaster.

The laboratories and their personnel engaged in bacteriology, blood typing, and chemistry all contribute to the care of the sick child, and their help may be crucial in the management of postoperative complications. Of particular importance is the ability of the chemistry laboratory to perform microdeterminations so that electrolyte concentration can be checked on small quantities of blood secured from heel pricks. Ten millimeters of blood necessary for standard macrotechnics, especially when daily determinations are required, may be difficult or impossible to obtain postoperatively in a small sick infant.

It is possible to perform simple straightforward operations without all these elaborate facilities and to secure acceptable results. However, the outcome of complicated operations such as correction of esophageal atresia is dependant to a large extent on all the skilled personnel and complete laboratory facilities which have been discussed.

The pediatrician and surgeon have a grave responsibility in caring for infants and children with anomalies because they are being repaired for a life of perhaps 70 years or more. Children with malformations have mechanical problems which if corrected will per-

mit them to lead perfectly normal and long lives. The surgeon who makes the first effort to correct a deformity has the opportunity of producing the most acceptable and enduring result. If he fails, the next procedure in most instances will be less successful than a properly conceived and adequately performed initial operation.

No man in American medicine has been more cognizant of these important requirements of pediatric surgery than Dr. W. E. Ladd, nor has anyone been more diligent in pointing out the differences between adult and pediatric surgery to his medical and surgical colleagues. Two decades ago Dr. Ladd initiated a movement in American surgery which has provided, and which will continue to provide in the future, better care for infants and children requiring surgery. Not only was Dr. Ladd one of the first to appreciate the value of special methods in dealing surgically with children, but he also demonstrated by his own results the vast improvements which could be achieved by adapting technics to the problems peculiar to infants and children instead of using pathologic concepts and technics unmodified from adult practice.

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THE HISTORY AND THE PHYSICAL EXAMINATION

Obtaining a history and performing a physical examination of an infant or child present problems not encountered in caring for adult patients. The history of a child's illness must be secured from parents, relatives, or friends rather than from the patient, and in appraising such a history it is important to evaluate the reliability and accuracy of the narrator's information. Generally mothers are careful observers; having cared for the child in good health they are quick to perceive deviations from normal behavior. The tendency to disregard some seemingly irrelevant information which the mother supplies should be resisted, for these observations often may help in making a diagnosis of some obscure disease.

It is normal for parents to be disturbed when their child is ill, and it is wise for the doctor to dispel their anxiety by permitting them, without delay or interruption, to describe their child's illness. In this way, without leading questions, the examiner is given an unbiased account of the child's troubles. The examiner can then ask questions that will fill in gaps in the present illness and secure a full prenatal, past, and family history. It is helpful for the doctor by appropriate questions and observations to gain some insight into the family's economic and emotional home situation, for this information may be invaluable in appraising the child during his hospital stay and in planning follow-up care.

During the time consumed in the history taking, especially when it is conducted in the physician's office, the child will have an opportunity to become accustomed to new surroundings and acquainted with the physician. It is a common mistake for the examiner to deny the child this period of accommodation

and to proceed hastily with the examination. Haste may provoke the child to be uncooperative and make the examination difficult to perform and the findings hard to evaluate.

Patience and a sincere effort to gain the child's confidence will prevent such unfortunate episodes. Often during the conversation with the parents the child will of his own accord approach the physician, and this is a sure indication that the child has gained confidence in the doctor and will be cooperative during the examination. When children have been informed by their parents of what the visit to the doctor entails, they will usually approach him without fear. Children enjoy being the center of attention, and the examiner will be successful if he keeps this fact in mind. In coping with timid or uncooperative children, various approaches should be tried such as offering the child a toy or, better still, suggesting to the child that he come over and show the examiner some toy he has or some part of his clothing which is obviously new. Children are justly proud of their best and newest clothing and will often forget their shyness and insecurity in their eagerness to show off a new dress or jacket. When the child has made a voluntary approach to the doctor, his situation can be made more secure by conversing with him about his brothers, sisters, pets, school, and other activities. Following a few minutes of such conversation, permission to perform an examination is readily obtained from the child. After the child has given his consent, the doctor rarely fails to conduct a satisfactory examination.

Occasionally, regardless of how assiduously the child's confidence is courted, it becomes necessary to use force to examine the child. In such situations, it is advisable to ask

the parents to leave the examining room and permit the doctor and nurse to proceed with the examination. Asking the parents to leave the room will often quiet the child, and in other instances permitting the parents to return to the examining room will insure a co-operative attitude on the child's part.

In examining infants, the use of a feeding during the procedure is extremely helpful, for it quiets the baby so that chest auscultation and abdominal palpation can be performed satisfactorily. When it is inadvisable for the infant to have fluids orally, a nipple containing cotton soaked in 5 per cent glucose solution can be offered to the child.

In conducting a general examination of a child, the first step is to remove all clothing so that the whole body may be inspected. Often a rash which is the key to the diagnosis will be overlooked if part of the clothing is permitted to remain on the child during the examination. It is important to turn the patient over and look for rashes on the back and extremities as well as on the neck, chest, and abdomen. At the same time the color of the skin can be noted, and cyanosis, icterus, or pigmentation can be detected without disturbing the child. Observations of the child's posture and movements are important, for they may give clues to the nature of the illness. In acute appendicitis, the child's posture will be stooped, his gait deliberate; and when he lies down he will often recline on his right side with his legs flexed.

A surgeon is primarily concerned with pathology in a localized area; nevertheless it is important that he perform a complete examination. An abdominal pain may be related to an upper respiratory infection, and unless the signs of inflammation are sought for in the ears, nose, and throat the possibility of mesenteric adenitis will be overlooked and an incorrect diagnosis of appendicitis made. Abdominal pain may also be related to pneumonia, so that examination of the chest is imperative.

In planning the examination, the simple manipulations which are not uncomfortable to the patient should be performed first. It is

a good idea to begin with percussion and auscultation of the chest. Permitting the child to become familiar with the stethoscope will divert his attention during this part of the examination. The heart sounds are then elicited, and percussion for determination of heart size and position is performed. Blood pressure should be taken to determine if hypertension exists or if there is a differential in arm and leg blood pressure so that coarctation of the aorta will not be overlooked in the asymptomatic stage.

After the chest has been examined, it is well to proceed to the abdomen. In evaluating a child's reaction to abdominal palpation, the doctor must be careful not to ask repeatedly if palpation of the abdomen, particularly of localized points, produces pain. The examiner will often gain false positive findings by insistent questioning concerning abdominal tenderness. It is better to divert the child's attention during the abdominal palpation by conversation concerning unrelated situations. Simple questions about the child's associates and activities are useful. The child readily becomes an active participant in a conversation about school, games, and pets, and his attention is diverted from the examination so that the doctor can determine the areas of true tenderness by observing the child's facial expression. When the examination is conducted in this manner, voluntary spasm is not usually encountered. If the patient does exhibit abdominal muscle spasm, constant general pressure will often overcome it and thus differentiate it from true spasm. Talking to the child about things other than abdominal tenderness and observing his face for signs of discomfort are also of value in examining the occasional child who is stoical and who will not indicate when abdominal palpation produces pain.

At times with children it is impossible to gain their confidence and conduct a satisfactory abdominal examination. This is particularly true of the two-year-old and three-year-old age groups. In such situations it is permissible to administer Nembutal rectally to quiet the child and to provide conditions

for an adequate abdominal examination. Children who will not permit a satisfactory abdominal examination are usually hyperactive, and a moderate dose of Nembutal will not produce such a deep sleep that true tenderness or spasm cannot be detected.* After such medication a child is usually in a light sleep, and it is possible by observing his face to detect areas of localized abdominal tenderness; certainly the spasm occurring under these conditions can be relied upon. Under no circumstances should medication be administered to a child with abdominal pain until the attending surgeon has had an opportunity to see the patient and to make a preliminary examination.

Often patients with an acute retrocecal appendix will have a normal abdomen on examination, and it is not until palpation is directed to the flank above the iliac crest that tenderness and spasm are elicited. This maneuver is frequently omitted by surgeons because of haste or failure to appreciate the value of such tenderness in making the diagnosis of an acute retrocecal appendix. Flank tenderness must be clearly differentiated from costovertebral angle tenderness which is elicited by pressure at the costal phrenic angle and which is a sign of renal inflammation.

Testing for rebound tenderness in children under 10 or 12 years of age is of no value, for often a false positive response is observed which is probably the child's normal reflex reaction to the sudden release of pressure on the abdominal wall and not a response due to peritoneal irritation. In older children, cough tenderness should always be used as a check on rebound tenderness. It is impossible to elicit cough tenderness in young children because it is difficult to induce small children to cough. Auscultation of the child's abdomen is extremely important in order to determine

the absence or presence of peristalsis. A series of high pitched sounds occurring at frequent intervals is a physical sign that can be relied on and is indicative of intestinal obstruction.

Considerable information can be gained from rectal examination, and this examination can be performed without upsetting the child, provided that a few precautions are taken. In the first place, the child must be given a notion of what the examination involves, and this can be conveyed by explaining that rectal examination is similar to administration of an enema or to taking a rectal temperature. Most children have had these experiences. The second thing is to explain to the child that he must bear down to relax the anal sphincter and to permit the examiner's finger to be inserted with a minimum of discomfort. If his cooperation is obtained, the child will not be disturbed by the examination, and the examiner can make an accurate appraisal of conditions within the pelvic cavity.

In about 10 per cent of children with appendicitis, the appendix is pelvic in position, and examination of the child's abdomen may be negative. Rectal examination, when there is a simple appendicitis, reveals excruciating right-sided pelvic tenderness. The abscess which forms after perforation of the appendix may be detected as a pelvic mass.

The extremities should be observed, the reflexes tested, and an attempt made to elicit Kernig's sign; and the neck should be carefully examined for rigidity. It is then well to proceed with examination of the eyes, ears, nose, and throat. In patients with acute abdominal complaints, it is extremely important to be sure of the status of the eardrums to exclude otitis media. Pharyngeal and tonsillar infection must be excluded by careful inspection of the mouth and throat. It is well to leave to the end of the examination those maneuvers which are definitely uncomfortable to the patient, and undoubtedly examination of the ears and throat presents more difficulties than any others. During the course of the examination, some idea of the patient's emo-

* An average dose would be 2 mg. of Nembutal per pound of body weight, up to 30 pounds. For larger children, a proportionate part of the adult dose, computed by weight, is suitable. The medication is given in a capsule which has been perforated in several places with a needle and is administered by inserting the capsule into the rectum.

tional status is gained. In dealing with an extremely apprehensive child, the surgeon must realize that many of the positive findings are probably not accurate. On the other hand,

an extremely stoical child may lead the examiner to underestimate the reactions to various parts of the physical examination unless he is alert to the child's emotional reactions.