CLINICAL PEDIATRIC NEPHROLOGY

Edited by Ellin Lieberman

Clinical Pediatric Nephrology

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Preface

This book is written for physicians caring for infants and children with renal disease. The selection of material for presentation is based on the experience gained on a large renal service for over a decade. The decision to include specific topics and contributors results from the conviction that the university-based nephrologist is in a special position to gain insight into the diagnosis and management of children with diverse renal disorders. From this vantage point it is both a privilege and a responsibility to disseminate information to the medical profession at large. The topics selected for discussion are ones about which a great deal of information has been accumulated during the past decade but which has not always been critically reviewed or brought together in one source.

An underlying theme of the entire text is that a great deal of information can be gleaned from the history, the physical examination and the interpretation of selected uncomplicated and inexpensive laboratory tests and diagnostic procedures. From the editor's perspective, consultation has all too often been needed or requested because the referring physician had not been provided with a sufficient data base from which to proceed with systematic decision making. This text has been designed to help meet that need.

The first section is devoted to an approach to diagnosis of both common and unusual disorders of the kidney seen in childhood and adolescence. The objective of the entire section is to develop means of problem solving in the most efficient and least invasive manner. The format of the chapters within this section may differ from one another slightly because of their content, but the underlying principle remains the same.

The second section contains chapters written by authorities in the field of clinical pediatric nephrology who are devoted to the care of children with renal diseases. Most of these chapters focus only on treatment. In a few chapters background information has been included as a preface to management because the abnormalities requiring treatment could not be understood without more information.

The third section includes three unrelated but important chapters which are referred to throughout the text. These are the interpretation of laboratory data, the application of renal biopsy to a study of glomerular disease, and the use of the computer in clinical nephrology.

If the care of children with renal disease is facilitated by having the information in this book readily available, then the editor's goal will have been realized.

ELLIN LIEBERMAN, M.D.

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This book has come to be because of the following people, whose roles can only be briefly summarized but are deeply appreciated. The initial impetus to become a physician and to honor the precepts of the best in clinical practice can be traced to Dr. Henry W. Louria. The other indefatigable supporter is Dr. Henry W. Louria, Jr. A rewarding career in pediatric nephrology has been possible because of the help of Dr. Sydney S. Gellis, of the entire community at Childrens Hospital of Los Angeles, and of colleagues from a sabbatical year at the University of California, San Francisco, Dr. Malcolm A. Holliday (UCSF) and Dr. Cyril Chantler (Guy's Hospital, London, England).

The abiding faith that a book such as this is needed has been derived from members of the Division of Nephrology at Childrens Hospital of Los Angeles, both past and present and from Dr. Carl Trygstad (Harbor Hospital, Torrance, California and UCLA). Special gratitude is extended to Dr. Carl M. Grushkin and Dr. David L. Olson for assistance in the many tasks beyond their call of duty.

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Ms. Jeane Gullihur has provided continuing editorial and secretarial assistance in the preparation of this manuscript.

Finally, I am indebted to my husband Dr. Harry M. Lieberman and to our children, Deborah, Susie and Willie for helping me turn a dream into a reality.

Contents

1

Workup of Hypertension in a Child or Adolescent

Ellin Lieberman, M.D.

DEFINITION

Levels of systolic and diastolic blood pressure that demarcate normal from abnormal are not available for large samples from different populations that have had serial yearly blood pressure recordings. Nevertheless, operational guidelines derived from several studies can be applied so that infants and children with hypertension can be readily identified. Hypertension is defined as brachial artery cuff pressure, either systolic or diastolic, or both, obtained in the supine position, equal to or greater than the levels that have been reported for children (Table 1-1). These values are acceptable as the upper limits of normal for age and sex; in the 11 to 15-year-old age group, the levels are close to values regarded as abnormal for young adults. Individuals whose measurements reach these upper limits deserve continuing medical supervision rather than attributing the findings to fortuitous circumstances.

Values for premature and full-term babies obtained by auscultation and palpation[2, 25, 31] and by the flush method,[24, 30, 40] by the Doppler ultrasound technique[13, 25] and by use of various oscillometric techniques[22, 31, 42] are summarized in Table 1-2 even though the total number of observations is small.

TECHNIQUE OF BLOOD PRESSURE DETERMINATION

The blood pressure is determined by auscultation of Korotkoff sounds over the artery just distal to the blood pressure cuff. The recorded levels of systolic and diastolic pressures are indirect reflections of systemic pressure, which nevertheless permit assessments of whether the patient is normotensive or hypertensive.

The systolic pressure is regarded as that level at which the first sounds are heard and the diastolic pressure as that level at which the sounds disappear. In an occa-

TABLE 1-1. Blood Pressure Values for Children

Age (years)	*Sex*	*Systolic (mm. Hg)*	*Diastolic (mm. Hg)*
1 month-3	Male, female	100	65
3-6	Male, female	110	70
6-8	Male, female	115	75
8-11	Male, female	115	75
11-13	Male, female	130	75
13-15	Female	130	80
13-15	Male	130	75

TABLE 1–2. Blood Pressure Values for Infants

	Systolic (mm. Hg)	*Diastolic (mm. Hg)*
Premature infants	80	45
Full-term infants	90	65

sional patient, Korotkoff sounds are audible almost to 0 mm. Hg, and in this instance it is useful to record the level at which the sounds become muffled as well as when they disappear.

Measurement of blood pressure by auscultation is ordinarily feasible in children over 3 years of age and often in younger children when adequate time is allotted for relaxation and for repeated measurements. Because of the difficulties in obtaining accurate measurements in infants less than 12 months of age, alternative techniques have been developed. The flush method is performed as follows: A blood pressure cuff is placed around an extremity; the portion of that limb distal to the cuff is compressed by an elastic wrapping (e.g., a wide soft-rubber drain); the cuff is rapidly inflated to 200 mm. Hg; the elastic wrapping is removed and the cuff pressure released at a rate of about 5 mm. Hg per second. The earliest discernible flush (due to filling of dilated capillaries in the temporarily ischemic part) is considered to be the end point.[40] The Doppler ultrasound technique depends on sending ultrasonic waves through the soft tissues overlying a peripheral artery and recording their reflection from the arterial wall. A specially designed cuff is placed on the limb so that the ultrasound transducer recessed in the cuff bladder is directly over the artery. The cuff is inflated and slowly deflated. When the cuff and systolic pressures equalize, the arterial wall moves and causes a change in the ultrasound field. The change (Doppler shift) is converted to audible sounds like Korotkoff sounds. At the diastolic point, there is marked diminution in arterial wall motion with a corresponding decrease in pitch and volume or disappearance of the sounds.[25] The advantages of this method are accuracy, adaptability to premature and full-term infants and usability by personnel who are not specially trained observers.

The correct cuff size is one that comfortably covers two thirds of the length of the upper arm, so that its bladder (the inflatable portion) is wide enough and long enough to encircle the arm's girth. In babies a 5-cm. cuff is needed to avoid spuriously high readings.[32, 34] Other cuff sizes in approximate relation to age are 9 cm. for 3 to 8-year-old children and 12.5 cm. for children who are older. Accurate indirect blood pressure measurements may be difficult to obtain in individuals with obese arms because the standard adult cuff (12.5 by 22.5 cm.) may be too short to encircle the upper arm adequately.[24] In this instance use of a longer cuff (14 by 40 cm.) or a leg cuff will provide greater reliability.

The blood pressure should be measured with the patient at rest and in as relaxed a setting as possible to ameliorate the effects of psychologic stress.[6, 8] Borderline values or episodically abnormal values require that additional measurements be obtained, on at least three separate occasions, in both arms in the standing, sitting and supine positions. In those patients in whom doubt remains whether they are truly hypertensive, it is useful to teach a family member or the patients themselves to record pressures at home and to keep a written account of the levels. Children and adolescents must not be categorized as hypertensive unless at least two measurements are decisively abnormal.[32] Asymptomatic patients with borderline levels

should be followed and regarded as suspicious only; detailed diagnostic workup and treatment must await emergence of clearcut hypertensive recordings. In an acutely symptomatic patient in whom antihypertensive therapy must be instituted rapidly (see Chapter 19) one abnormal blood pressure measurement is sufficient for the diagnosis of hypertension.

Sources of error in blood pressure measurement in children include inappropriate cuff size, poorly functioning equipment (cuff, stethoscope and manometer) and observer error. Mercury manometers should be checked to make certain that the column of mercury falls without leaving droplets on the sides of the glass cylinder, that the mercury meniscus returns to the zero level and that the column of mercury does not fall on its own without release of the valve on the bulb. Mistakes in interpretation may also arise if the observer does not read the meniscus at eye level. Other observer errors may arise from poor hearing and bias in terms of digit preference. Periodic retraining of the individuals recording the blood pressure by the standard auscultation technique will improve accuracy.

DIAGNOSIS

The following schema presents an approach to the diagnosis of hypertension utilizing information from the history and physical examination, followed by routine laboratory tests. A stepwise selective approach to laboratory studies is presented in this section so that simple and inexpensive tests precede complicated ones that generally require hospitalization. Even though many patients present with several abnormalities suggestive of a particular diagnosis, few manifest all characteristic findings. This entire outline is intended only as a guide, which is not all inclusive. Selected references are included at the end of the section.

Although the majority of children and adolescents are hypertensive secondary to renal causes, additional etiologic factors must be considered as part of the differential diagnosis; these have been included. Essential hypertension is often a diagnosis of exclusion. However, in children and adolescents who have a positive family history and are obese, mesomorphic or both, the diagnosis of essential hypertension is likely. In prepubertal children, published, well-documented case reports of essential hypertension are a rarity, and systematic diagnostic investigation is recommended. In postpubertal individuals, the extent of the diagnostic workup rests with the bias of the physician. At this time, recommendations as to the completeness of workup await publication of detailed studies. It would seem prudent, however, to obtain routine noninvasive studies in this group of patients and then, depending on the course of their hypertension, to obtain additional studies as warranted.

I. History
  A. Family history (parents and siblings)
    Hypertension: myocardial infarction, cerebrovascular accident, uremia
    Renal diseases: polycystic disease, cystinuria, hydronephrosis, cystinosis, familial nephritis, calculi, renovascular anomalies
    Adrenal hyperplasia; diabetes mellitus
    von Recklinghausen's disease with or without renal artery stenosis or pheochromocytoma
    Disseminated systemic lupus erythematosus and collagen disorders
    Hemophilia; sickle cell disease
    Obesity: hypercholesterolemia

B. Past history
Trauma to the abdomen
Urinary tract infection
Radiation to the abdomen
Poor growth rate
Renal vein thrombosis as newborn or infant
Meningitis or central nervous system disease
Rubella syndrome

C. Present history
Polyuria and polydipsia with either weight loss or poor weight gain
Sudden weight gain, polyphagia, hirsutism, striae
Symptoms of acute renal disease, e.g., nephritis
Abrupt onset of severe symptoms of hypertension: epistaxis, seizures, palpitations, sweating, flushing, fever
Drug ingestion: amphetamines, oral contraceptives, corticosteroids, sympathomimetics, methysergide
Excessive licorice ingestion
Abdominal mass or masses
Recent emotional stress or significant stress associated with visiting physicians
Gastrointestinal symptoms: vomiting and diarrhea
Hemarthroses and evidence of bleeding

II. Physical examination
A. Findings—other than hypertension and its secondary effects
Fever: pyelonephritis, systemic lupus erythematosus, renal artery stenosis
Cafe-au-lait spots and abdominal bruit: von Recklinghausen's disease (neurofibromatosis)
Buffalo hump, ruddy cheeks, truncal obesity, striae, hirsutism: hypercorticism (iatrogenic or endogenous, Cushing's disease)
Virilization, increased muscle mass, increased scrotal pigmentation: congenital adrenal hyperplasia
Sweatiness, tachycardia, weight loss, exophthalmos, jitteriness: hyperthyroidism
Differences in blood pressure between arms, decreased pressure in legs and decreased femoral pulses: coarctation of the aorta
Short stature, widely spaced nipples, wide carrying angles, delayed onset of secondary sexual characteristics: gonadal dysgenesis (Turner's syndrome)
Edema: acute and chronic renal disease
Bilateral abdominal masses: infantile polycystic disease, hydronephrosis, bilateral Wilms' tumors, neuroblastoma
Hepatosplenomegaly: congenital hepatic fibrosis, neuroblastoma
Continuous abdominal bruit: renal artery stenosis (with or without findings of rubella syndrome, neurofibromatosis, pheochromocytoma)
Small stature with or without evidence of chronic malnutrition: chronic renal disease
Obesity: false-positive blood pressure elevation; essential hypertension
Rash, fever, alopecia, arthritis, lymphadenopathy, serous effusions: systemic lupus erythematosus