Manual of Nephrology

Muther, Barry, and Bennett

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Preface

This book was written by two nephrologists and a urologist for non-nephrologists. We thus apologize in advance for being too elementary for some while too esoteric for others.

Our major intent is to present a basic *diagnostic* approach to commonly encountered nephrologic problems. A recent survey of two large community hospitals identified such problems as those necessitating nephrology consultation (see Table). We discuss some of these problems generically (e.g., azotemia, proteinuria, and hematuria). Specific disease categories such as glomerulonephritis and interstitial nephritis are approached separately, even though proteinuria or hematuria may be their primary clinical manifestation.

Our discussion of these nephrologic problems is based on the assumption that most diagnostic failures occur because the clinician does not consider certain diseases or disease categories. In other words, diagnostic failures are the result of "omission, not commission." In order to minimize these failures, we present simplified methods for classifying various problems and diseases. Also presented are several simple diagnostic algorithms we have found useful.

Our method is based on four principles:

1. Once considered, a diagnosis is not difficult to confirm.
2. General categories of disease (e.g., glomerulonephritis or interstitial nephritis) should be considered before specific syndromes.

The Distribution of Clinical Problems Necessitating Nephrologic Consultation in 298 Consecutive Cases

	No. of Cases	*% of Total Consultations*
Azotemia	207	69
Acute	129	43
Postrenal	14	5
Prerenal	25	8
Renal parenchymal	90	30
Chronic	78	26
Interstitial nephritis	34	11
Glomerulonephritis	24	8
Vascular disease	20	7
Hypertension	27	9
Proteinuria	20	7
Electrolyte disturbance	8	3
Urinary tract infection	6	2
Hematuria	5	2
Nephrolithiasis	5	2
Acid-base abnormality	4	1
Other	16	5

3. Five (or fewer) diagnoses account for 95% of most disease categories ("Rule of Fives").
4. Diagnostic failures are minimized by considering the least likely diagnosis first.

In Chapter 1, we review the basic diagnostic tests (clinical, laboratory, and radiographic) that are most useful in assessing renal structure and function. Chapters 2 through 12 discuss the major clinical problems in nephrology.

At the beginning of each chapter, we present cases as unknowns. We encourage the reader to answer the "prechapter" questions and generate a differential diagnosis based on the information provided for each case. A brief review of each topic follows. Although this

review touches upon the pertinent epidemiology, pathophysiology, and therapy for each condition, the major emphasis is on a diagnostic approach distilled from the basic information. Subsequently, each case is reviewed and the prechapter questions answered.

The text is not encyclopedic, nor do we consider the coverage of pathophysiology and therapeutics adequate for clinical practice. In addition, discussions of chronic renal failure and hypertension are omitted. To compensate for this, we refer the reader to several excellent review and reference texts.

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Contents

1 Clinical Evaluation of Renal Structure and Function

- Imaging Techniques for the Genitourinary Tract
- Clinical Evaluation of the Glomerulus
- Clinical Evaluation of the Tubules and Interstitium

This initial chapter is divided into three parts discussing (1) imaging tests, (2) tests used to evaluate the glomerulus, and (3) tests used to evaluate the tubules and interstitium. This is in keeping with our general principle of considering major disease categories (e.g., glomerulonephritis or interstitial nephritis) before considering specific clinical syndromes in the diagnosis of nephrologic problems.

Imaging Techniques for the Genitourinary Tract

Table 1-1 lists commonly used imaging techniques and their relative merits in evaluating renal structure and function. Although the plain *abdominal film* (KUB) provides little specific information, it is commonly available and has benefits that should be emphasized. Renal size and shape are usually evident on KUB, particularly if nephrotomography is used. Ascites and psoas obliteration suggesting abscess, hematoma, or tumor can also be seen on plain

Table 1-1 Relative Merit (0–4+) of Common Imaging Techniques in the Assessment of Renal Structure and Function

	Structure	*Function*	*Comment*
KUB	1+	0	Gross structural change evident. Good for following nephrolithiasis.
IVP with voiding and postvoid films	3+	3+	Best for simultaneous evaluation of structure and function of entire genitourinary tract. Limited by renal function impairment.
Retrograde pyelography	4+	1+	Best for anatomic delineation of ureters, pelvis, and calyces.
Cystography	3+	2+	Best for anatomic delineation of bladder. Voiding urethrogram enhances evaluation of lower urinary tract. May outline ureters if reflux is present.
Ultrasonography	3+	0	Noninvasive, low-risk. Best screening test for structural abnormalities.
CT	4+	2+	Has better resolution than ultrasonography. Can be used without contrast to exclude obstruction. Dynamic study with contrast can yield function information.
Radionuclide scanning ^{131}I-Hippuran ^{99m}Tc-DTPA	1+	3+	Sensitive but nonspecific. Evaluates tubular secretion and renal excretion. Evaluates renal blood flow.

Table 1-1 (Continued)

	Structure	*Function*	*Comment*
Indium			When tagged to white blood cells can localize renal infection.
Arteriography	4+	4+	Gold standard. Should be reserved for confirmation of specific lesion.

film. Free peritoneal, retroperitoneal, or intraurinary tract gas can likewise be detected, suggesting viscus perforation or gas-forming bacterial infection. Finally, abnormal calcification of bone (osteodystrophy, lytic or sclerotic lesions), renal parenchyma (nephrocalcinosis), or collecting system (nephrolithiasis, ureterolithiasis, or cystolithiasis) can be assessed by KUB. The latter is particularly useful in the serial evaluation of nephrolithiasis.

The abdominal plain film is greatly enhanced by administering intravenous (IV) contrast material excreted by the kidney. Such an excretory urogram (XU) or *intravenous pyelogram (IVP)* highlights the renal parenchyma, and better delineates renal size and shape. Renal cysts and tumors are thus more easily seen. Concentration of contrast material in the collecting system (5 to 15 minutes after injection) outlines the calyces, renal pelvis, ureters, and bladder (Fig. 1-1) allowing definition of genitourinary tumors, calculi, obstruction, and chronic pyelonephritis. Films taken early (1 minute after injection) can be used to evaluate differential renal perfusion (hypertensive IVP) and are often used as a screening test for renovascular hypertension (see Chapter 2).

Unfortunately, the IVP is limited by potential contrast toxicity in three forms: minor allergic reactions (hives, pruritus), anaphylactic reactions, and nephrotoxicity (see Chapter 3). Renal insufficiency may fail to allow excretion and concentration of contrast material, further limiting the value of the IVP. This latter problem can be minimized by using nephrotomography (Fig. 1-2) and a greater

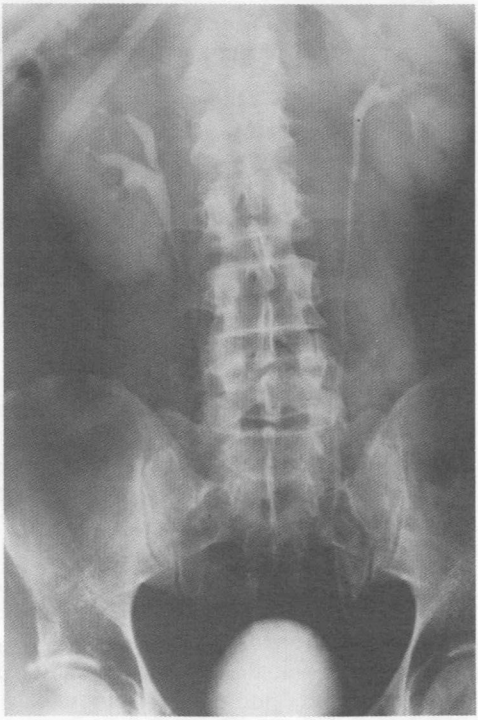


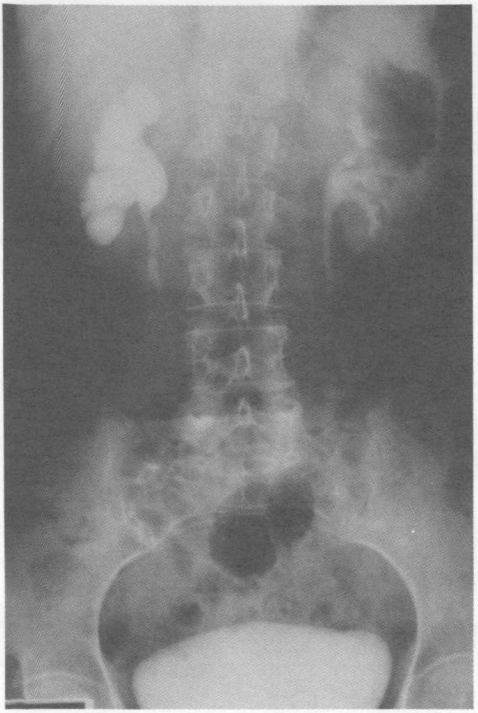
Figure 1-1: *A*, Normal IVP outlining the kidneys, ureters, and bladder.

A

dose of IV contrast, although this will increase the potential for nephrotoxicity.

Although the IVP is neither the most sensitive nor the most specific renal imaging study, it has the advantage of providing both structural and functional information on the entire urinary tract and is therefore an excellent screening test.

When renal insufficiency is severe enough to limit the IVP, a *retrograde pyelogram* or *cystogram* is used to evaluate the renal pelvis, ureters, or bladder. A retrograde pyelogram can definitively exclude obstruction and evaluate filling defects (Fig. 1-3). A cystogram allows specific definition of bladder outlet obstruction, vesicoureteral reflux, trauma, diverticula, or fistula (Fig. 1-4). When



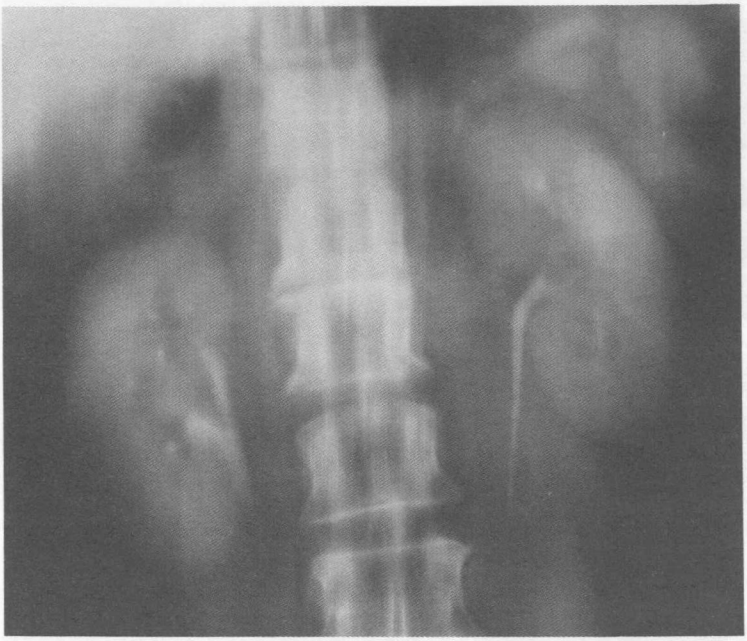
B

Figure 1-1: *B,* IVP showing right ureteral obstruction.

used with a voiding study (*cystourethrogram*), urethral strictures, urethral diverticula, posterior urethral valves, and bladder-emptying are also defined.

The renal *ultrasonogram* offers a noninvasive and relatively low-cost way of evaluating the kidney without the risk of IV contrast (Fig. 1-5). Renal size, cysts, tumors, hydronephrosis, and stones are all well defined by sonography. Its accuracy in determining renal size and excluding obstruction makes it the initial screening test for evaluation of azotemia.

Computed tomography (CT) offers better resolution than ultrasonography and enables one to make a definitive diagnosis of a renal mass, often eliminating the need for cyst puncture and/or arte-

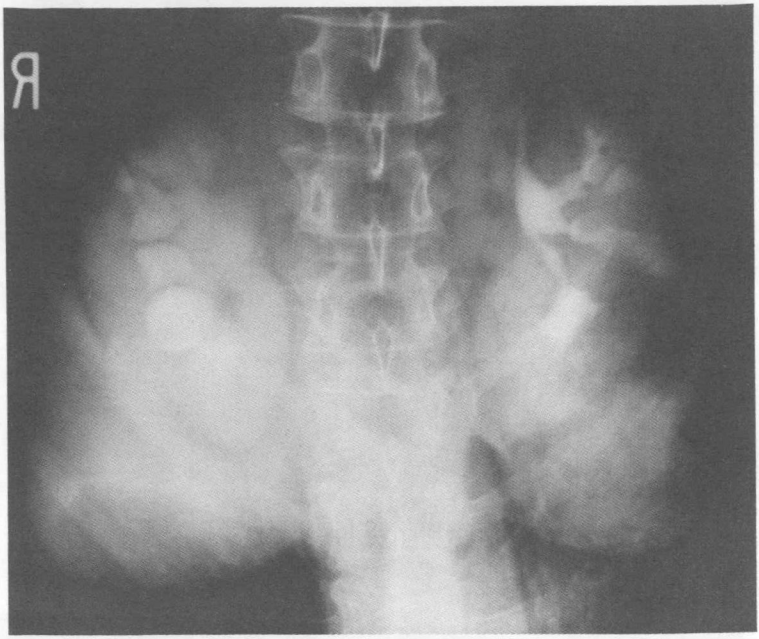


A

Figure 1-2: *A,* Accentuation of renal cortex and calyces by the use of nephrotomography with the IVP.

riography (Fig. 1-6). It can also be used without IV contrast to exclude obstruction in the azotemic patient and to define retroperitoneal, adrenal, and perirenal architecture. Yet despite these advantages, CT is more cumbersome and costly than ultrasonography and therefore usually assumes a secondary role in diagnosis.

Several radionucleotide scans offer information on renal function. *Hippuran* is secreted by renal tubular cells, and when it is tagged with radioactive ^{131}I, one can evaluate renal tubular function and excretion through the lower urinary tract. It is used primarily as a predictor of renal tubular recuperation after acute tubular necrosis or as a means of defining the relative contribution of each kidney to



B

Figure 1-2: *B*, Nephrotomography in a patient with right ureteral obstruction.

total renal function. *Technetium-99m* (^{99m}Tc)-tagged diethylenetriamine penta-acetic acid (DTPA) offers a sensitive estimate of renal blood flow. Unfortunately, both of these studies lack specificity, so that an IVP, CT, or ultrasonogram is usually necessary for evaluating morphology, and arteriography is usually necessary for definitive assessment of the renal circulation in patients with focal or unilateral perfusion defects by scan.

An indium-tagged white blood cell (WBC) study may often localize an occult infection process in the kidney. It offers equal sensitivity but greater specificity than gallium-67 which is not specific for infection.

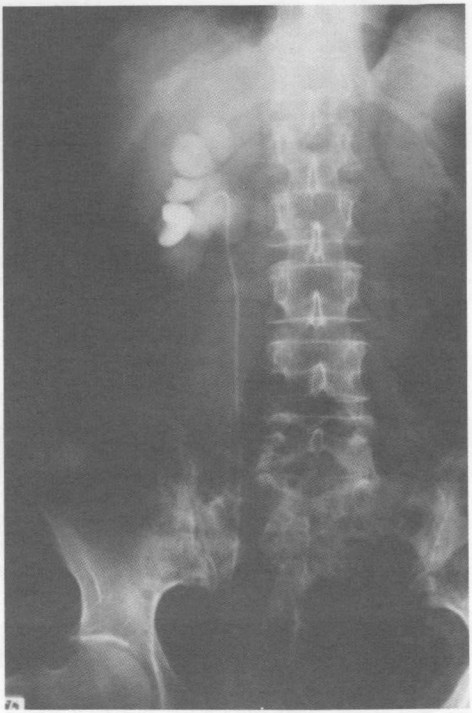


Figure 1-3: Right retrograde pyelogram in a patient with ureteropelvic junction obstruction.

Renal *arteriography* is the most sensitive and specific test to evaluate renal vascular structure (Figs. 1-7A and B). It is the definitive test for evaluating renal vascular lesions and the renal mass. It can also be used for specific therapeutic intervention such as balloon angioplasty for renal artery stenosis or renal ablation by embolization or thrombosis (Fig. 1-7C). Risks include those of arterial puncture, those incurred by IV contrast, and the possibility of traumatizing an atherosclerotic aorta or renal artery, causing distal atheroemboli.

Table 1-2 presents a problem-oriented approach to renal imaging techniques used as screening (most sensitive) and confirmatory (most specific) tests. For patients with hematuria, the IVP visualizes

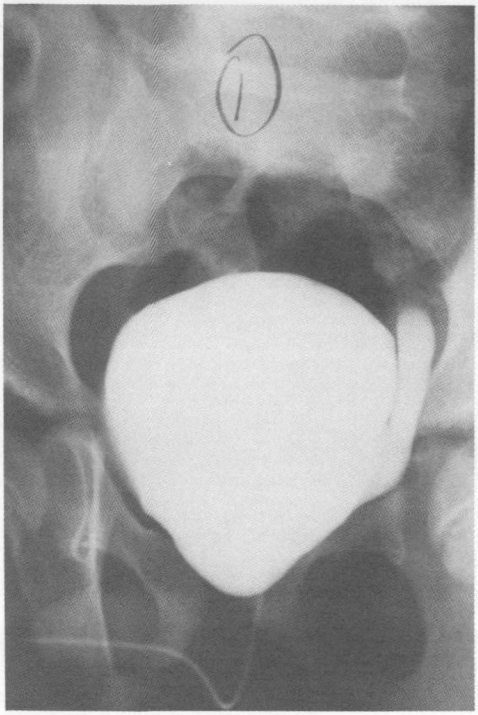
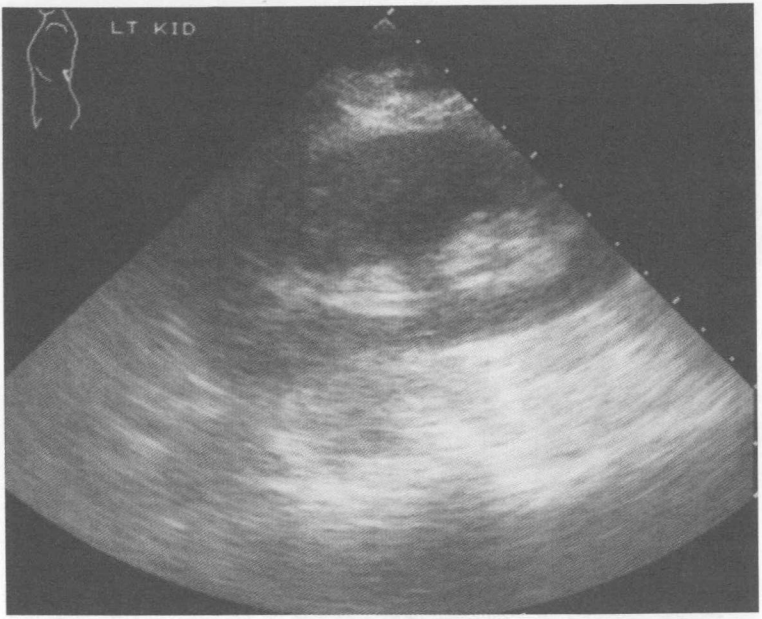


Figure 1-4: Cystogram demonstrating left ureteral reflux.

the entire urinary tract. If the cause of hematuria is not readily apparent, cystoscopy and perhaps retrograde pyelography are indicated. CT or arteriography will be needed to evaluate any renal mass. IVP is also the best screening test to use in patients with nonnephrotic-range proteinuria to evaluate potential parenchymal disease (e.g., vesicoureteral reflux, chronic pyelonephritis, renal tuberculosis, amyloid, and cystic diseases). If the IVP is negative, further radiographic studies are probably not warranted. When using IVP as a screening test in these patients, one must consider the potential for contrast toxicity and define those at high risk (patients with diabetes, myeloma, and/or renal insufficiency).

In the azotemic patient, renal ultrasonography offers clear ad-



A

Figure 1-5: *A*, Normal renal ultrasonography. Note that renal cortex is more lucent than the background. Medulla and papillae are echogenic.

vantages as a screening test. Acutely, a ^{99m}Tc-DTPA nucleotide scan can exclude a gross abnormality of renal perfusion. If there is such an abnormality, an arteriogram may be required for definitive diagnosis. A retrograde pyelogram can similarly specify the cause of any obstruction noted by initial ultrasonography.

Because IVP can evaluate renal perfusion, asymmetric renal size, obstruction, and renal parenchymal disease, it is the procedure of choice when one is screening for renal causes of secondary hypertension. If one is specifically concerned about renovascular hypertension, equal support can be generated for ^{99m}Tc-DTPA nucleotide scanning and venous digital subtraction angiography (DSA) as screening tests. Often, however, screening for renovascular disease