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A practical primary care approach to hematuria in children

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Abstract Although hematuria is a common finding in the unselected population of children, the approach to evaluation is quite variable. Changes in the practice of primary care medicine in the United States mandate an approach to common office problems that is practical and realistic. This review addresses three areas: the current approach to evaluation of hematuria in children, a classification of children with hematuria into four distinct and easily identified clinical categories, and the development of an algorithm for application in the primary care setting. Each category is discussed relative to the more-common etiologies of hematuria, with recommendations for appropriate evaluation as well as suggestions of an appropriate referral to the nephrologist. An algorithm is proposed that provides a practical, systematic approach to the problem without the requirement for a specific diagnosis in every patient. The proposed classification and approach to the evaluation of children with hematuria should help simplify and clarify a potentially complex process.

Key words Hematuria · Algorithm · Practical approach · Primary care

Introduction

An article reviewing the "approach to evaluation" of hematuria in children for a journal oriented toward pediatric nephrologists seems redundant. The subject is already comprehensively addressed in the literature and an additional report might be viewed as only serving to expand, contract, or emphasize a few more disease entities in which hematuria is part of the clinical picture. However, when one considers the significant changes that have occurred in recent years in the practice of primary care medicine, a review of the approach to evaluation of hematuria in children from a *practical* perspective appears justified. From the viewpoint of the authors of this manuscript, the word "practical" implies an approach that is reasonable, effective, time efficient, and applicable in the primary care setting. "Practical" might have a totally different connotation for pediatric nephrologists who most often reside in a world of pre-selected patients, have extensive expertise in complicated cases, and where the availability of sophisticated diagnostic tools allow and may even mandate a different approach. In this article we will attempt to accomplish the former mission by directing our attention to the child with hematuria who presents to the primary care physician.

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The current state of approach to hematuria

From a review of children with hematuria referred to our pediatric nephrology service over the past decade, it is apparent that primary care physicians predominantly fall into one of two groups. One group, immediately following the discovery of hematuria, refers the patient without much further consideration of cause. The other group seems to apply a consistent process to all patients by obtaining the same array of laboratory and radiological evaluations for each case without much attention to the associated clinical features. Also of considerable interest is that, from both groups, many of the initial referrals are to a urologist rather than to the pediatric nephrologist. While these scenarios may or may not represent the norm everywhere, they do serve to highlight the problem of an unrealistic approach to the subject.

One explanation for the seemingly inappropriate approach to the evaluation of hematuria in children lies with our traditional educational system, at least in medical schools in the United States. The student is rarely exposed to the simple or common patient that is seen in the

offices of the primary care physician. Rather, they observe the more-complex causes of hematuria as seen on the in-patient service or in the subspecialty clinic. Adding further to the problem is the fact that the majority of the contact that the student has with patients is with the adult-oriented services of internal medicine and urology. Small wonder that most undifferentiated students finish their basic medical curriculum with the belief that the mere presence of hematuria suggests diagnoses such as lupus erythematosus, renal calculi, or urinary tract cancer. Even those primary care physicians who specialize in pediatrics rarely see more than an occasional patient with simple hematuria during their training. The knowledge that arises from lectures and conferences on the subject does not foster the same perspectives or yield the same confidence as does the observation of real patients over time.

Even if the primary care physician surveys the literature relative to hematuria in children, there are problems with the manner in which many review articles address the evaluation. One strategy seen is to identify the patient who presents with hematuria and, from there, follow an algorithm of specific investigations that, hopefully, will lead to a diagnosis and/or management plan [1–3]. Often, this approach presupposes that the primary care physician has access to certain diagnostic studies and, then, that the physician possesses the necessary skills to interpret the results of the investigations. One example is an algorithm proposed by Travis et al. [3] that recommends the microscopic examination of red blood cell (RBC) morphology in the urine as the first step in evaluation for microscopic hematuria. The utility of phase-contrast microscopy in distinguishing glomerular from non-glomerular hematuria is well documented in the adult and pediatric populations [4–6]. Newer automated techniques are also capable of distinguishing red cell morphology [7, 8]. Despite theses advances, the techniques are not readily available to the community physician and the interpretation of the results is dependent on observer experience. In our referral practice, this investigation is rarely, if ever, performed. Thus, to be able to follow this algorithm, the primary physician is diverted in an early step resulting in an inconsistent and disorganized approach.

Another tactic utilized in the literature is an attempt to educate or refresh the knowledge of the primary care physician concerning the vast array of diseases where hematuria may be part of the clinical presentation [1–3, 9–11]. While an understanding of the more-common conditions or diseases associated with hematuria seems a reasonable goal, it appears unrealistic for the primary care physician to be sufficiently knowledgeable or to have the requisite experience to deal with the myriad of potential etiologies of hematuria. Cursory knowledge and inadequate experience leads naturally to an unsatisfactory course of investigations and management. It would thus appear that a practical, primary care approach to hematuria should be one that is designed with the patient and type of practice in view. Reasonable goals for the primary care physician are merely to recognize and confirm the finding of hematuria, identify common etiologies, and select those patients that potentially have more-significant urinary system disease that might require further expertise in either diagnosis or management. This review will therefore focus on the unselected population of children presenting with hematuria, either gross or microscopic, and will attempt to design a practical algorithm that is useful to the primary care physician.

Discovery and confirmation of hematuria

Obviously, the initial step in the evaluation is an appropriate identification of the child who has hematuria. Whereas most of the data relative to prevalence of hematuria have come from population-based studies of school children, such routine screening is not generally recommended due to the high cost to benefit ratio [12, 13]. Even routine office screening for urinary abnormalities is no longer recommended in most of the world. Thus, the actual time of onset for microscopic hematuria is often unknown to the practitioner. Children with hematuria come to the attention of the practitioner in one of three ways: (1) onset of gross hematuria, (2) onset of urinary or other symptoms with the incidental finding of microscopic hematuria, or (3) the inadvertent discovery of microscopic hematuria during a visit where a urinalysis is required (i.e., pre-camp or pre-sports physical examination).

The most-common indicator of an abnormality of the urine is a “positive” or abnormal urine strip test for blood. The reagent strip reaction utilizes the pseudoperoxidase activity of hemoglobin (or myoglobin) to catalyze a reaction between hydrogen peroxide and the chromogen tetramethylbenzidine to produce an oxidized chromogen, which has a green-blue color. These strips can detect concentrations of 5–10 intact RBCs/μl, which roughly corresponds to 2–5 RBCs high-power field (HPF) [14]. Improper use of the dip strip, such as delayed reading or cross contamination of urine from other chemically impregnated pads, may result in false-positive results. It is important to briefly dip the strip in the urine, tap off excess urine, and read the strip at the recommended time [15]. High-volume commercial laboratories circumvent this problem by using automated urine analyzers (e.g., Chemstrip Super UA by Boehringer Mannheim). Dip strip analysis is critically important in those patients with “dark” or abnormal appearing urine, since several substances may discolor the urine and give the appearance of hematuria. Some examples include hemoglobin, myoglobin, beets, blackberries, urates, rifampin, and phenazopyridine [16].

Confirmation of the presence of hematuria is indeed the most-important step since false-positive results can occur from both normal and abnormal causes (i.e., hemoglobinuria, myoglobinuria, etc.). This confirmation requires a microscopic examination of the urine for the presence of RBCs. The proper method for reporting

RBCs/HPF requires centrifuging 10 ml of a fresh urine sample at 750 *g* for 5 min, decanting the supernatant, then resuspending the sediment in the remaining 0.5 ml [15]. The sediment is examined by microscopy at ×40, counting RBCs in 20 fields and reporting the average. This process is also automated in most high-volume commercial laboratories. While the presence of hematuria is easily established in the person with macroscopic bleeding, controversy exists with regard to the appropriate criteria for corroborating and defining microscopic hematuria.

There are two important considerations in defining an abnormal number of RBCs in the urine. The definition of hematuria should capture all patients with disease and attempt to exclude patients without disease. Two population-based studies of unselected children used methodologies to identify blood in the urine that are applicable in the community setting and establish criteria for confirming hematuria. Dodge et al. [12] surveyed 12,000 school children in Galveston County and utilized the definition of 5 or more RBCs/HPF in three of three consecutive, fresh, centrifuged urine specimens obtained at least 1 week apart to capture all children who eventually had significant disease. A similar study of Finnish school children, by Vehaskari et al. [17], defined hematuria as 6 or more RBCs/0.9 mm^3 in a fresh uncentrifuged urine sample, and identified all patients with renal disease if the sample was positive twice in a 6-month period. These criteria can be utilized to define microscopic hematuria, which equates to persistence of RBCs in the urine. Thus, a positive dip strip on a single specimen with microscopic confirmation of the presence of >5 RBCs/HPF (centrifuged) or >6 RBCs/0.9 mm^3 (uncentrifuged) should be viewed as an indication for further urine testing until persistence is confirmed. We generally use the criteria of 5 or more RBCs/HPF in three of three fresh urine specimens collected over a few weeks to define microscopic hematuria. We apply the same criteria to the child with asymptomatic microscopic hematuria or microscopic hematuria discovered in the symptomatic child.

Categorizing the patient

An algorithm is defined as a systematic process consisting of an ordered sequence of steps, each step depending on the outcome of the previous one. In clinical medicine, an algorithm is the step-by-step protocol for investigation or management of a health problem. The initial step in the development of an appropriate and workable algorithm is to devise categories that separate the patients into distinct groups for the purpose of applying a standardized approach to each patient. To be of practical use in the community setting, the criteria used for categorizing the patient should have components that are easily identified, preferably during the initial encounter. We propose organizing patients with confirmed hematuria into four distinct groups (Table 1).

Table 1 Categories of hematuria

Gross hematuria
Microscopic hematuria with clinical symptoms
Asymptomatic microscopic (isolated) hematuria
Asymptomatic microscopic hematuria with proteinuria

In the development of our proposed algorithm, each category will be dealt with individually, with a listing of the more-common etiologies as well as recommendations for appropriate evaluations and suggestions of when the patient should be referred to the pediatric nephrologist. The ultimate goal is a simple process that allows a consistent and systematic approach that leads the physician to a specific course of action.

Gross hematuria

Gross hematuria is an uncommon finding in an unselected population of children. The prevalence of gross hematuria was reported as 0.13%, based on a retrospective review of children seen in an emergency walk-in clinic [18]. When this study was analyzed relative to the etiology of the gross hematuria, it was concluded that the majority of such children (56%) have an easily recognizable and apparent cause. The most-common diagnoses assigned were urinary tract infection (26%), perineal irritation (11%), trauma (7%), meatal stenosis with ulceration (7%), coagulation abnormalities (3%), and urinary tract stones (2%). Less than half of the children (44%) had a cause that was either not obvious or required additional and/or more-sophisticated examinations. Among the diagnoses in this group were recurrent gross hematuria (5%), acute nephritis (4%), ureteropelvic junction obstruction (1%) and cystitis cystica, epididymitis, and tumor (each <1%); 23% of the patients were listed as "unproven urinary tract infection," while 9% were categorized as "unknown etiology." If adenoviruses, a known etiology of acute hemorrhagic cystitis in children [19], are considered, then it is plausible that some of the patients in the "unproven urinary tract infection" category could have been assigned this diagnosis. In more-recent years, the common association between gross hematuria and idiopathic hypercalciuria and hyperuricosuria has become more apparent [20–22], and a significant number of the patients in the latter two groups (above) might well have had one of these conditions. These patients present with asymptomatic gross hematuria or symptoms suggestive of a urinary tract infection (i.e., abdominal pain, dysuria, frequency, and urgency). Most of these patients have a positive family history of urolithiasis [23].

Based on this information, the primary physician might be expected to establish a presumptive diagnosis in well over one half of children presenting with gross hematuria with little more than a detailed history (including family history), physical examination, and simple laboratory examination [i.e., urinalysis, urine culture, urinary calcium creatinine ratio (Ca/Cr), complete blood

count (CBC), serum creatinine (S Cr), C3, and renal sonogram]. If the cause of the gross hematuria is not readily apparent from these investigations, the child will undoubtedly benefit from further evaluation and management by a pediatric nephrologist.

Microscopic hematuria with clinical symptoms

In our proposed schema, a child who presents with either symptoms of an illness or a physical abnormality and is, at the same time, discovered to have microscopic hematuria, should be placed in this category. The clinical manifestations may be *general* (i.e., fever, malaise, abdominal pain, hypertension, edema, etc.), *non-urinary tract specific* (i.e., rash, purpura, arthritis, jaundice, respiratory, gastrointestinal, etc.), or *urinary tract specific* (i.e., dysuria, stranguria, frequency, enuresis, edema, hypertension, etc.) [16]. The likelihood of making a renal system diagnosis for these groups of children is dependent upon the primary care physician recognizing and appreciating the relationship between the presenting complaint and the microscopic hematuria. Since this process involves an awareness of an extensive list of diseases and conditions, it is consequently the most-difficult category of patients with which the practitioner must deal. The disorders responsible for such an association can include infections, both generalized and renal, rheumatological or immunological conditions, glomerular and interstitial disease, lower urinary tract disease, stones, tumors, vascular disease, acute abdominal conditions, hematological disorders, drugs or medications, and a host of others [1–3, 9, 10, 16].

In a number of these conditions, the hematuria is directly related to the primary (non-urinary tract) disorder and will disappear once the primary disease resolves. It is obviously difficult and probably inappropriate to even suggest a specific battery of studies that should be performed in this varied group of patients. The evaluation should be directed toward the clinical manifestations where the microscopic hematuria is but one of these. Some of the clinical conditions with associated renal involvement that may be recognized by the primary physician are acute glomerulonephritis, urinary tract infections, familial hematuria (both benign recurrent and progressive hereditary nephritis), Henoch-Schönlein purpura, systemic lupus erythematosus, hypertension, hypercalciuria, and urolithiasis. It is our recommendation that, unless the patient falls into a clear category of illness that is easily identified, an early consultation be obtained with the pediatric nephrologist, since most others will require additional expertise in either delineation or management.

Asymptomatic microscopic (isolated) hematuria

Asymptomatic microscopic hematuria is common in unselected populations of children, with a prevalence that ranges from 0.4% to 4.1% depending on the criteria used to define hematuria [12, 17]. There are a few population studies that provide important information concerning the occurrence of asymptomatic microscopic hematuria, and these suggest a reasonable approach to the evaluation of such patients. In the Galveston County epidemiology study, approximately 4.0% of school-age children had microscopic hematuria (defined as 5–10 RBCs/HPF) in one of the three samples tested. When the criteria for "persistent" hematuria was the presence of blood in two of three consecutive samples, the prevalence decreased to approximately 1%. When the standards were altered so that all three samples must be positive, the prevalence decreased to <0.5%. These figures are similar to those found in other screening programs [17, 24]. Utilizing these data as a guide, it appears obvious that the discovery of hematuria alone in an asymptomatic child is merely an indication for repeat testing on one or more occasions. Further investigations should be pursued only after persistence is established over a period of 2–3 weeks.

The next lesson learned from the Galveston County epidemiology study was that of those children who had three of three consecutive urines demonstrating hematuria, only 37% had hematuria 1 year later. Thus, the cause for the asymptomatic hematuria had apparently resolved in 63% of the children over the course of a single year. Similarly, a study of 8,954 Finnish children found persistence of hematuria in only 32% after 4–6 months [17]. In our experience with patient referrals, most such children would already have undergone extensive investigations by the end of 1 year. That *simple* hematuria in the asymptomatic child is usually a benign process is further supported by the fact that only 7.6% of the children in the Galveston County study continued to have hematuria at the end of 5 years. In both the Galveston County and Finnish studies, significant renal disease was almost non-existent in those where hematuria was the only abnormality found.

These studies suggest that school-aged children falling into this category should be observed for a prolonged time, probably in excess of 2 years, before more-extensive testing is undertaken. During this period of observation, careful reiteration of the patient history for new clinical signs, with special emphasis on the family background, and periodic assessment of physical status seems appropriate. Additionally, regular examination of an early morning urine with microscopic analysis is essential. If, at any stage, the hematuria becomes macroscopic or there is development of proteinuria or pyuria, the condition of *isolated, asymptomatic hematuria* no longer exists and other studies should be performed.

If the microscopic hematuria persists unchanged for more than 1–2 years, a few additional studies may be indicated. One possible entity responsible for such an asymptomatic persistence of hematuria is *idiopathic hypercalciuria* and, while there is often a family history of urolithiasis, this is not invariably present. Thus, analysis of a random urine for calcium and creatinine would seem appropriate. If there is a family history of urolithiasis, a personal history of excessive dietary calcium intake, or a

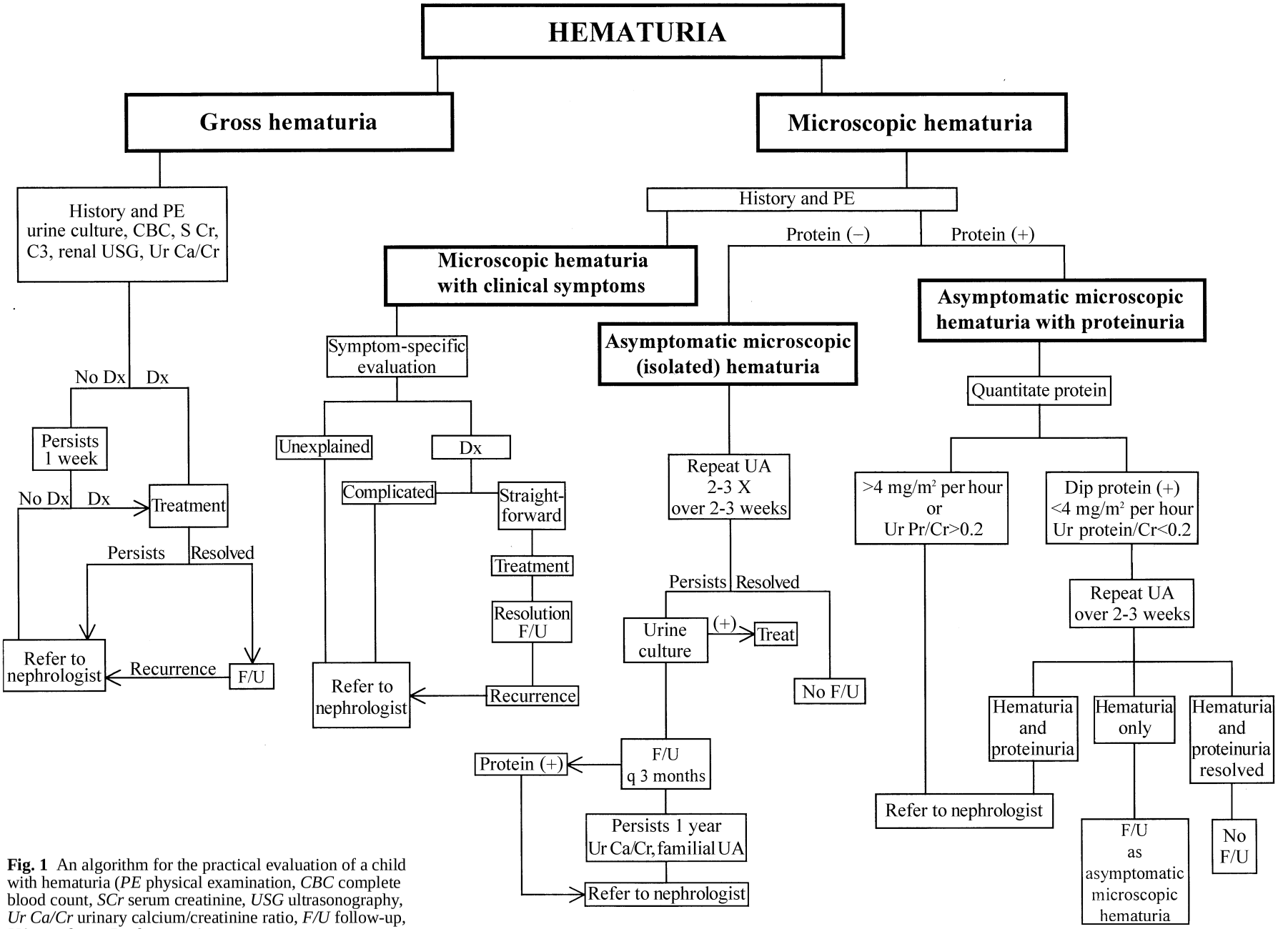

Fig. 1 An algorithm for the practical evaluation of a child with hematuria (*PE* physical examination, *CBC* complete blood count, *SCr* serum creatinine, *USG* ultrasonography, *Ur Ca/Cr* urinary calcium/creatinine ratio, *F/U* follow-up, *UA* urinalysis, *Dx* diagnosis)

urine Ca/Cr greater than 0.20 [25], a 24-h urine collection for calcium is appropriate (normal <4 mg/kg per 24 h) [22, 25]. At the same time, urinary uric acid values (normal <0.57 mg/dl glomerular filtrate in a 24-h urine sample) may be indicated [25]. Familial or hereditary hematuria, either benign, non-progressive (i.e., "thin basement membrane disease") or progressive (i.e., Alport syndrome or one of its variants) is another condition where, early in the course, hematuria may be found in the absence of proteinuria. For this reason, we usually recommend the assessment of urines from family members for the presence of hematuria by dip strip and, if positive, the presence of RBCs confirmed by microscopic examination.

Asymptomatic microscopic hematuria with proteinuria

In the asymptomatic child, simultaneous microscopic hematuria and proteinuria (≥50 mg/dl) in three of three consecutive urine samples is unusual, and occurred in the Galveston study with a prevalence of 64/100,000 school children (approximately 0.06%). All of the children in this survey who were thought to have significant renal disease were included in this group. Despite the obvious concern attendant to this combined finding, almost 50% of the children discovered to have both hematuria and proteinuria had spontaneous resolution of both findings during the course of the 5-year follow-up. In the Finnish study, 16% of the patients with hematuria also had proteinuria (e.g., ≥25 ug/ml, or ≥1+Albustix, or ≥6 mg/h per m^2) in at least one sample with an overall prevalence of 0.7% [17]. Interestingly, during a 1-week follow-up home testing, the protein excretion was intermittent in each patient. Only 35% or 6 of the 17 patients with hematuria and proteinuria had hematuria 4–6 months later. In these 6 patients, renal histology was evaluated, demonstrating definite glomerular disease in only 2. The amount of proteinuria seen in repeated samples is negatively correlated with its spontaneous disappearance and positively correlated with the potential for a significant renal disorder. The presence of proteinuria strongly suggests a renal glomerular origin for the hematuria, even though some persons with tubulointerstitial disease will also demonstrate both hematuria and proteinuria. The amount of protein excreted is usually assessed by either determination of the ratio of protein to creatinine in a random sample of urine or by the quantitation of such in timed urine collections. The significance of the renal involvement is, in most cases, correlated directly with the quantity of protein being excreted.

Thus the combination of asymptomatic microscopic hematuria and proteinuria seems to select those patients more likely to have significant renal disease. It is in this group of referral patients where we have observed the highest tendency among primary care practitioners for over-utilization of the laboratory. At the other end of the spectrum, we have seen a lack of investigation by physicians who attribute the presence of protein (dip strip ≥1+) to microscopic amounts of RBCs in the urine, despite the fact that microscopic hematuria does not result in proteinuria [26]. Our general suggestion is that asymptomatic patients who are found to have both hematuria and proteinuria in several samples collected over a few weeks be referred to a pediatric nephrologist for further evaluation and recommendations.

An algorithm for *practical* evaluation

The focus of this review has provided the foundation for the development of an algorithm for evaluation of children with hematuria using the four major clinical categories discussed. The goal of the proposed algorithm (Fig. 1) is to provide a practical systematic approach to the problem for the primary care physician. The program is designed to segregate the patient during the initial or subsequent encounter and then utilize the basic knowledge, skills, and laboratory studies available to the practitioner to proceed to an end point. This algorithm encourages the physician to select those patients who are appropriately managed in the office setting, are likely to have significant risk of urinary system disease, or who require expertise in further evaluation and management, without the need for a diagnosis in each patient. The algorithm also recommends the pediatric nephrologist as the initial referral source, since he/she has the expertise to determine the minority of conditions that will require cystoscopy or urological evaluation [27]. Another goal of the design is to discourage the random and often unnecessary use of laboratory investigations in each child with hematuria.

The algorithm begins by defining the child with confirmed (presence of RBCs by microscopy) hematuria as either gross or microscopic. The child with *gross hematuria* is usually identified during the first visit, since bloody or dark urine is often the reason they presented to the physician. The appropriate categorization of the child with microscopic hematuria may occur during the first visit, particularly if symptoms prompt the physician to obtain a urinalysis, or it may be delayed to the follow-up visit in the child with inadvertently discovered hematuria. A thorough history, physical examination, and dip strip test for protein is essential in categorizing the child with microscopic hematuria. The child with symptoms of an illness or a physical abnormality is categorized as *microscopic hematuria with clinical symptoms*. The child with asymptomatic microscopic hematuria is categorized as either *asymptomatic microscopic (isolated) hematuria* or *asymptomatic microscopic hematuria with proteinuria*, based on the presence or absence of protein.

The first step in the child with *gross hematuria* is to obtain a thorough history and physical examination. The following laboratory evaluations should be performed as part of this first step: urine culture, CBC, S Cr, urine Ca/Cr, C3, and renal ultrasonography, unless the history or physical examination suggests a more-directed evaluation (e.g., terminal hematuria). Based on the initial

evaluation, the majority of the patients should have an easily recognizable or definable cause for their gross hematuria. If a diagnosis or presumptive diagnosis is made then the appropriate therapy and follow-up is provided. If the hematuria resolves then repeat follow-up evaluations are necessary to insure that the patient does not develop recurrence of gross hematuria or the original disease, or persistent microscopic hematuria. If hematuria persists, despite therapy, then other diagnoses should be considered and a nephrologist is best equipped to pursue the evaluation. If no cause for the hematuria is determined at the initial visit or after 1 week and the hematuria persists (gross or microscopic), then the patient should be referred to the nephrologist. If the primary physician is unfamiliar with a particular diagnosis or its management then consultation for confirmation and assistance with management is necessary.

It is important to reiterate that the child with *microscopic hematuria* associated *with clinical symptoms* may have a vast number of diseases or conditions, which makes this a difficult category to suggest specific evaluation. The first step in this category is to direct the evaluation based on the symptoms or physical examination. The extent and thoroughness of the evaluation will depend on the knowledge and experience of the physician. The child with a complicated diagnosis or unexplained cause for the hematuria should be referred to the nephrologist or in some cases to the appropriate sub-specialist. If a diagnosis is straightforward then the appropriate therapy or follow-up is administered. If the child has recurrence of the symptoms and associated hematuria, or if the hematuria is persistent, then referral to the nephrologist is recommended.

The most-common finding in the child categorized as *asymptomatic microscopic (isolated) hematuria* is transient hematuria. A single examination will yield hematuria in approximately 4% of school-age children, but with repeat testing (2–3 samples over 2–3 weeks) less than 0.5% will have hematuria. If the hematuria is transient or has resolved then no further follow-up, with respect to the hematuria, is recommended. If the child has persistent hematuria over 2–3 weeks then a urine culture is appropriate, particularly in the younger child where symptoms of a urinary tract infection may not be apparent. The next step is to follow the patient quarterly with particular attention to the development of proteinuria, pyuria, or symptoms that may be associated with hematuria. If the hematuria persists for 1 year then a random urine Ca/Cr should be obtained as well as urinalysis of family members. These studies are warranted at an earlier step if there is a family history of urolithiasis or familial forms of hematuria. In the final step it is recommended that the nephrologist participate in directing the further evaluation of the child with asymptomatic hematuria persisting for more than 1 year.

The discovery of *asymptomatic microscopic hematuria with proteinuria* in the unselected population of school-age children is rare, yet the combination selects those children most likely to have a significant renal disease. Even so, a significant number of these children will have resolution of their proteinuria or both hematuria and proteinuria over a few weeks. The first step in this category is to quantitate the urine protein at the initial or follow-up visit. If the child has significant proteinuria (i.e., >4 mg/m^2 per hour or urine protein/Cr >0.2), they should be referred to the nephrologist for further evaluation. The child with a positive dip strip for protein and less than a significant quantitative protein study should have repeat testing of the urine for protein and blood over 2–3 weeks. If both have resolved no further testing is recommended. If hematuria is the only finding after repeat testing then the child should be re-categorized as *asymptomatic microscopic (isolated) hematuria*. If the hematuria and proteinuria remain after repeat testing then we recommend the nephrologist direct further evaluation of that child.

Summary

Hematuria in the pediatric patient can represent a process that is simple and benign or complex and life threatening. It is our desire that this discussion and algorithm is of practical help in the daily practice of our primary care colleagues. We propose a categorization and approach to the pediatric patient with hematuria that we believe will help simply and clarify a potentially complex evaluation process.

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LITERATURE ABSTRACTS

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Renal transplantation in end-stage sickle cell nephropathy

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Background The role of renal transplantation as treatment for end-stage sickle cell nephropathy (SCN) has not been well established.
Methods We performed a comparative investigation of patient and allograft outcomes among age-matched African-American kidney transplant recipients with ESRD as a result of SCN (*n*=82) and all other causes (Other-ESRD, *n*=22,565).
Results The incidence of delayed graft function and predischarge acute rejection in SCN group (24% and 26%) was similar to that observed in the Other-ESRD group (29% and 27%). The mean discharge serum creatinine (SCr) was 2.7 (+/–2.5) mg/dl in the SCN recipients compared to 3.0 (+/–2.5) mg/dl in the Other-ESRD recipients (*P*=0.42). There was no difference in the 1-year cadaveric graft survival (SCN: 78% vs. Other-ESRD: 77%), and the multivariable adjusted 1-year risk of graft loss indicated no significant effect of SCN (relative risk [RR]=1.39, *P*=0.149). However, the 3-year cadaveric graft survival tended to be lower in the SCN group (48% vs. 60%, *P*=0.055) and their adjusted 3-year risk of graft loss was significantly greater (RR=1.60, *P*=0.003). There was a trend toward improved survival in the SCN transplant recipients compared to their dialysis-treated, wait-listed counterparts (RR=0.14, *P*=0.056). In comparison to the Other-ESRD (RR=1.00), the adjusted mortality risk in the SCN group was higher both at 1 year (RR=2.95, *P*=0.001) and at 3 years (RR=2.82, *P*=0.0001) after renal transplantation.
Conclusions The short-term renal allograft result in recipients with end-stage SCN was similar to that obtained in other causes of ESRD, but the long-term outcome was comparatively diminished. There was a trend toward better patient survival with renal transplantation relative to dialysis in end-stage SCN.

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Clinical course after total parathyroidectomy without autotransplantation in patients with end-stage renal failure

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In patients with chronic renal failure, hyperparathyroidism is a common problem and surgical parathyroidectomy (PTX) is frequently required. The three different surgical approaches are subtotal PTX, total PTX with autotransplantation, and total PTX without autotransplantation. Recurrence of hyperparathyroidism varies from 5% to 80% in different studies for the first two surgical approaches. To minimize the risk for recurrence, and because we fear severe relapses with calciphylaxia, we perform total PTX without autotransplantation. From October 1993 to October 1997, 20 patients (9 men and 11 women) underwent total PTX without autotransplantation (median age, 52 years; range, 23 to 74 years; median dialysis time before PTX, 6.5 years; range, 1 to 22 years). All patients were supplemented with vitamin D analogues postoperatively. Patients were followed up for 1 to 48 months (median, 20 months). Bone pain, when present, disappeared within the first week after total PTX. Postoperatively, most patients had temporary hypocalcemia. In the long term, five patients had asymptomatic hypocalcemia. One patient, however, repeatedly had hypocalcemic seizures. Five patients developed asymptomatic hypercalcemia when supplemented with calcitriol. At the end of the individual's observation time, parathyroid hormone (PTH) levels were less than normal in six patients, normal in seven patients, and increased in seven patients despite total PTX. We conclude that total PTX should be reconsidered an option for the treatment of hyperparathyroidism secondary to renal failure. There was no evidence of clinical bone disease after total PTX. Apparently, remaining ectopic parathyroid tissue accounts for PTH levels after total PTX.