

Blood in the Urine (Hematuria) in Children — Symptoms and Treatment

[See online here](#)

Hematuria is a common clinical presentation of a number of conditions in children. The etiology of microscopic and gross hematuria is different. A detailed history, physical examination, and focused investigations can help identify the cause of hematuria. Management and prognosis are determined by its etiology. In this article, etiology, pathophysiology, clinical features, diagnosis, differential diagnosis, and management of pediatric hematuria are described.



Definition

The presence of > 5 red blood cells (RBCs)/high-power field (HPF) on microscopic examination of centrifuged urine is called microscopic hematuria. A diagnosis usually requires the demonstration of > 5 RBCs/HPF in 3 consecutive urine specimens obtained 1 week apart. Hematuria that is visible to the naked eye is called macroscopic or gross hematuria.

Epidemiology of Hematuria

The prevalence of hematuria among school-aged children is 0.5–2%. Microscopic hematuria is more common than macroscopic hematuria.

Etiology of Hematuria

Hematuria from the upper urinary tract (glomeruli, convoluted tubules, collecting tubules, interstitium) has a number of causes, including the following:

- Isolated renal diseases—IgA nephropathy (Berger’s disease), Alport syndrome, post-streptococcal glomerulonephritis (PSGN), focal segmental glomerulosclerosis (FSGS), rapidly progressive glomerulonephritis (RPGN), membranous nephropathy, [membranoproliferative glomerulonephritis \(MPGN\)](#), thin glomerular basement membrane (GBM) disease.
- Systemic diseases—[pediatric systemic lupus erythematosus \(SLE\)](#), [Henoch-Schonlein purpura \(HSP\)](#), [Goodpasture syndrome](#), Wegener’s granulomatosis, [hemolytic uremic syndrome \(HUS\)](#), sickle cell glomerulopathy, HIV nephropathy.
- Tubulointerstitial diseases—[pyelonephritis](#), [interstitial nephritis](#), acute tubular necrosis, papillary necrosis.
- Vascular diseases—[arterial or venous thrombosis](#), [vascular malformations](#).
- Renal anatomic diseases—hydronephrosis, [pediatric polycystic kidney disease](#), multicystic renal dysplasia, renal tumors, renal trauma.

Hematuria from the lower urinary tract (pelvicalyceal system, ureter, urinary bladder, urethra) can be caused by:

- Urolithiasis
- Hypercalciuria (hyperparathyroidism, excess of vitamin D, prolonged immobilization, idiopathic hypercalciuria)
- Trauma (including child abuse)
- Tumors
- Inflammation ([cystitis](#), [urethritis](#))
- Structural abnormalities

Non-renal causes of hematuria include:

- High fever
- Heavy exercise
- [Menstruation](#)
- Recent instrumentation such as catheterization

Common causes of gross hematuria in children include:

- [Urinary tract infection](#) (bacterial UTI is the most common cause of gross hematuria in children)
- Urolithiasis
- Meatal stenosis
- Trauma to urinary tract
- Tumors of urinary tract
- Hypercalciuria
- [Coagulopathies](#)

- Glomerular causes—PSGN, HSP nephritis, IgA nephropathy, Alport syndrome, thin GBM disease, SLE nephritis

Common causes of asymptomatic isolated microscopic hematuria in children include:

- Benign familial hematuria (thin GBM disease)
- Idiopathic hypercalciuria
- IgA nephropathy
- [Sickle cell trait or anemia](#)
- Following renal transplant
- Idiopathic

Pathophysiology of Hematuria

The origin of hematuria may be traced back to the kidneys (glomeruli, convoluted tubules, collecting tubules, interstitium) or the urinary tract (the collecting system, ureter, urinary bladder, and urethra).

When RBCs are of glomerular origin, they enter the capillary lumen after crossing the glomerular endothelial-epithelial barrier; hence, glomerular hematuria is accompanied by deformed RBCs (acanthocytes), RBC casts, and proteinuria. The presence of leukocytes in urine and renal tubular epithelial casts suggests that the hematuria originated within convoluted tubules or collecting tubules.

Possible explanations for hematuria in hypercalciuria are irritation of uroepithelium by micro calculi and microscopic nephrocalcinosis.

Non-renal conditions such as high fever and heavy physical exercise can produce transient hematuria by altering renal hemodynamics.

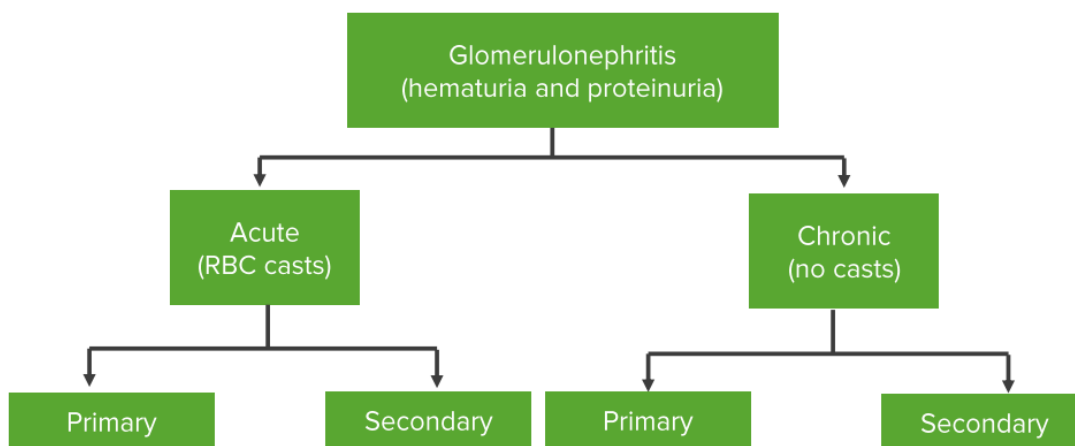


Image: by Lecturio

Chronic (no casts)	
Primary	Secondary
<ul style="list-style-type: none"> • MPGN • Membranous nephropathy • Focal glomerulosclerosis • Mesangial proliferative nephritis 	Same as acute secondary causes: <ul style="list-style-type: none"> • HSP • SLE • Polyarteritis Nodosa • Hemolytic uremic syndrome (HUS) <ul style="list-style-type: none"> • Subacute endocarditis • Goodpasture syndrome

Acute (RBS Casts)	
Primary	Secondary
<ul style="list-style-type: none"> • PSGN • Infectious GN • IgA nephropathy (Berger's disease) • MPGN 	<ul style="list-style-type: none"> • HSP • SLE • Polyarteritis Nodosa • Hemolytic uremic syndrome (HUS) • Subacute endocarditis • Goodpasture syndrome

Symptoms of Hematuria

- Hematuria of the upper urinary tract origin: brown, cola-, or tea-colored urine or burgundy urine
- Hematuria of the lower urinary tract origin: bright-red or pink-colored urine
- Hematuria of the lower urinary tract origin: terminal hematuria, blood clots, normal morphology of urinary RBCs, and absent or minimal proteinuria

Acute nephritic syndrome is characterized by tea- or cola-colored urine, facial edema (periorbital edema) or anasarca, hypertension, and oliguria. Symptoms of significant [hypertension](#) may be present ([headache](#), altered sensorium, diplopia, epistaxis, [heart failure](#)).

Postinfectious glomerulonephritis is characterized by acute nephritic syndrome that appears 7–21 days after a group A β -hemolytic streptococcal pharyngitis or a skin infection. RPGN also presents with acute nephritic syndrome but has a more aggressive course.

In children with IgA nephropathy, episodes of gross hematuria may follow upper respiratory infections or gastrointestinal infections. Other features include mild proteinuria and mild-to-moderate hypertension.

Clinical features of urinary tract infection include

- Fever
- Frequency of urine
- Urgency of urination
- Burning micturition
- [Vomiting](#)
- Flank pain
- Hematuria
- Costovertebral tenderness

Clinical features of urolithiasis include

- Episodes of renal colic
- Flank pain
- Hematuria
- Frequency of urination depending upon location of the stone

Clinical features of nephrocalcinosis include

- Dysuria
- Urinary incontinence
- [Abdominal pain](#)
- [Urinary tract infection](#)
- **In addition to hematuria, dysuria, renal colic, or suprapubic pain may**

be present in children with calciuria

HSP is a small vessel vasculitis characterized by purpuric rash, joint pain, and abdominal pain. Renal involvement is seen in approximately half of patients. The condition resolves spontaneously. HUS is characterized by uremia, microangiopathic hemolytic anemia, and [thrombocytopenia](#), mostly following infection with *Escherichia coli* O157:H7.

Microscopic or gross hematuria may follow blunt abdominal trauma. Hematuria after a minor blunt abdominal trauma is highly suggestive of congenital anomalies, especially with > 50 RBCs/HPF in urine.

In a child with hematuria, family history is important vis-a-vis disorders such as Alport syndrome, SLE nephritis, IgA nephropathy, thin glomerular basement membrane disease, [polycystic kidney disease](#), [sickle cell disease](#), and urolithiasis.

Alport's syndrome is an X-linked disorder characterized by renal manifestations (recurrent hematuria, proteinuria, and renal insufficiency), high-frequency sensorineural hearing loss, and ocular manifestations (anterior lenticonus, retinal involvement). Thin GBM disease is characterized by persistent microscopic hematuria in the absence of proteinuria, progressive renal insufficiency, hearing loss, and ocular features.

Abdominal mass may be present in hydronephrosis, polycystic kidney disease, multicystic dysplastic kidney, or tumor. Skin rashes and arthritis suggest the possibility of SLE or HSP.

Loin pain hematuria syndrome is characterized by recurrent episodes of unilateral/bilateral lumbar pain with microscopic or macroscopic hematuria and normal renal function and normal genitourinary tract. Women between the ages of 20 and 40 years are most commonly affected, although the syndrome can also be seen in children. Diagnosis is made after the exclusion of other causes of hematuria. Approximately half of patients have psychological problems.

Idiopathic urethrorrhagia is characterized by terminal urethral hematuria and dysuria in prepubertal boys, due to bulbar urethral inflammation. Spontaneous resolution occurs in > 90% of patients and endoscopy is usually unnecessary for evaluation.

In children with normal blood pressure, normal urine output, and absence of proteinuria, it is unlikely that microscopic hematuria warrants aggressive management, regardless of etiology.

Question	Why
Recent sore throat or skin infection?	Post-strep glomerulonephritis
Associated fever, dysuria or flank pain?	Pyelonephritis
History of high blood pressure?	Nephritic syndrome and renal involvement
Family history of deafness/renal disease?	Alport syndrome
Chronic medical problems?	SLE, sickle cell
History of purpuric rash, abdominal pain?	Henoch-Schönlein purpura
History of trauma?	Bleed in urinary tract

Diagnosis of Hematuria

Commercially available dipsticks can detect hematuria; however, dipsticks can give both false positive (urine pH > 9, contamination with hydrogen peroxide) and false negative (presence of formalin in urine sample or high intake of ascorbic acid) results. Hematuria

diagnosed by dipstick needs to be confirmed by microscopic examination of urine.

To confirm the presence of RBCs in the urine, 10 mL of freshly centrifuged (2000 rpm for 5 minutes) urine should be examined under microscope (400 x magnification).

After confirming the diagnosis of hematuria, appropriate laboratory investigations and imaging should be performed to identify the etiology.

Urine examination

- Presence of proteinuria (> 100 mg/dL) suggests renal disease
- Positive urine nitrites, positive urine leukocyte esterase, and the presence of white blood cells in urine suggests a UTI
- Urine calcium:creatinine ratio > 0.2 mg/mg suggests hypercalciuria

Complete blood counts and peripheral smear

- Anemia is present in [acute renal failure](#) (intravascular dilution due to hypervolemia), chronic renal failure (decreased production of RBCs), hemolysis (HUS or SLE), and blood loss (pulmonary hemorrhage in [Goodpasture syndrome](#) or malena in HSP or HUS).
- It is rare to develop anemia due to blood loss from hematuria.
- Leukocytosis suggests pyelonephritis or [urinary tract infection](#) (leukopenia is a feature of SLE).
- Thrombocytopenia may be present in malignancies such as SLE, HUS, renal vein thrombosis, etc.
- Examination of a peripheral blood smear helps to reveal microangiopathic anemia in HUS.

Other laboratory investigations

- Elevated serum creatinine and blood urea suggest renal failure.
- Serum C3 and C4: PSGN, MPGN, or lupus nephritis are associated with hypocomplementemia.
- Serum antistreptolysin O (ASO) and anti-DNase B are useful in the diagnosis of postinfective glomerulonephritis (throat and skin culture can be performed if indicated).
- Serum antinuclear antibody (ANA) and anti-dsDNA antibody are useful in the diagnosis of SLE.
- Sick cell preparation and hemoglobin electrophoresis are useful in the diagnosis of [sickle cell trait or disease](#).
- Urine culture helps to diagnose a [urinary tract infection](#).
- 24-hour urine for calcium, creatinine, uric acid, and oxalate is helpful in the diagnosis of crystalluria, urolithiasis, and nephrocalcinosis.
- Coagulation studies are not helpful in the evaluation of a child with hematuria unless medical history or family history suggests the possibility of a bleeding disorder.
- It is important to remember that a bleeding disorder is an unusual cause of hematuria in children.

Imaging studies

- Renal ultrasonogram is the first modality of imaging in the evaluation of hematuria. It is especially useful in the evaluation of patients presenting with trauma, gross hematuria, abdominal pain, or flank pain.
- Spiral [CT scan](#) is better than ultrasonogram, but ultrasonography is often the first-line imaging modality due to availability, cost, and safety.
- Voiding cystourethrogram is helpful in patients with hydronephrosis, hydroureter, urinary tract infection, renal scarring, and pyelocaliectasis.
- Cystoscopy is indicated in children with bladder mass seen on ultrasonogram, posterior urethral valves, and urethral abnormalities caused by trauma, tumor, or rare true urethral stenosis. In other cases, cystoscopy is unnecessary (it is also costly and carries a risk of anesthesia).
- Indications of renal biopsy are recurrent gross hematuria with hypertension, proteinuria, and/or decreased renal function, as well as some children with persistent microscopic hematuria.

Remember

1. The most important tests for the initial evaluation of a child with microscopic hematuria are tests for proteinuria and microscopic examination of urine for RBCs and RBC casts.
2. The most important tests for the initial evaluation of a child with gross hematuria are a urine culture and renal ultrasonogram.

Differential Diagnoses of Hematuria

The presence of hemoglobin (hemolysis) and myoglobin ([rhabdomyolysis](#)) in urine causes heme-positive red urine. Certain drugs (rifampin, pyridium, deferoxamine, chloroquine, iron sorbitol, metronidazole, etc), dyes (aniline dye), and foods (beets, blackberries, food colors) can produce red, cola-colored or burgundy urine. The presence of abnormal metabolites or pigments (homogentisic acid, melanin, methemoglobin, porphyrin, urate) in urine can also produce red, cola- or dark-colored urine.

Management of Hematuria

As hematuria is a sign and not a disease, its management includes identification of the cause and treatment of the cause. There is no specific treatment of hematuria itself.

Some children have persistent asymptomatic isolated hematuria and normal laboratory evaluation. Parents of such children need reassurance; monitoring of blood pressure and urine examination should be done every 3 months until resolution of the hematuria. Such children should be referred to a pediatric nephrologist if hematuria persists for more than 1 year.

Progression and Prognosis of Hematuria

The prognosis of children with hematuria is determined by the primary etiology of hematuria. In children with isolated microscopic hematuria without the specific medical disorder, the prognosis is good.

Review Questions

1. Which of the following conditions is associated with a normal serum C3 level?

- A. IgA nephropathy
- B. Poststreptococcal glomerulonephritis
- C. Membranoproliferative glomerulonephritis
- D. Lupus nephritis

2. Which of the following is a characteristic ocular finding in children with Alport syndrome?

- A. Keratoconus
- B. Anterior lenticonus
- C. Brushfield spots
- D. Subcapsular cataract
- E. Hypopyon

3. Under which of the following conditions can dipsticks can give false-positive test results for hematuria?

- A. Contamination of urine with formalin
- B. High intake of ascorbic acid
- C. Significantly acidic urine
- D. Significantly alkaline urine

References

Pan CG, Anver ED. Clinical Evaluation of the Child with Hematuria. In: Kliegman RM, Stanton BF, St. Geme III JW, Schor NF, Behrman RE, Editors. Nelson Textbook of Pediatrics, 19th Edition. Elsevier Saunders; 2011: 1778-81.

Meyers KEC. Evaluation of hematuria in children. Urologic Clinics of North America. 2004; 31: 559-73.

[Hematuria](#) via [emedicine.medscape.com](#)

[Evaluation of gross hematuria in children](#) via [uptodate.com](#)

Correct answers: 1A; 2B; 3D

Legal Note: Unless otherwise stated, all rights reserved by Lecturio GmbH. For further legal regulations see our [legal information page](#).