
Thematic chapter: Differential diagnosis of the most common diseases of the urinary tract in children. Emergency care in common emergency conditions

Academic hours: 6
Self-education: 4

1. SIGNIFICANCE

The differential diagnosis of in glomerulonephritis includes many of the causes of hematuria. Acute glomerulonephritis may also follow infection with coagulase-positive and coagulase-negative staphylococci, Streptococcus pneumoniae, and gram-negative bacteria. Bacterial endocarditis may produce a hypocomplementemic glomerulonephritis with renal failure. Acute glomerulonephritis may occur after certain fungal, rickettsial, and viral diseases, particularly influenza. Less common but even more important are the glomerular diseases are IgA nephropathy, membranous glomerulopathy, which become more prevalent in the developed countries due to vigorous antibiotic treatment of streptococcal infection.

Student should also be aware of outbreaks of streptococcal infection in population followed by acute post-streptococcal glomerulonephritis, and recognize symptom and signs relevant to the disease, and institute adequate maintaining therapy for the relatively severe imbalance in homeostasis caused by acute renal insufficiency.

The differential approach to the treatment of glomerulonephritis in children is dictated by a variety of particular forms of the disease, pathogenic pathways, and variable responsiveness to the particular drug. Student should be aware of the contemporary treatment protocols, features of dosing the drugs vs. stage of impairment of renal function, and adverse effects of therapy and their management.

2. PREREQUISITES

The skills listed below will not be taught in this lesson but are necessary to perform physical examination of the patient at nephrology department and the intensive care unit during practical training. Therefore, before beginning this lesson, one has to be sure of the ability to:

- Identify abdominal or flank mass;
- Examine skin for pitting edema;
- Measure blood pressure using a standard technique;
- Percuss and auscultate the heart to recognize arrhythmia or cardiac hypertrophy, stemmed from electrolyte disturbances and systemic hypertension;
- Elicit Pasternatsky sign in older children;
- Perform gross examination of urine;
- Read and comment the results on the routine urinanalysis;
- Read and comment the results on the routine blood biochemistry.

3. EDUCATIONAL OBJECTIVES

Student should know:
- differential diagnosis of post-streptococcal glomerulonephritis, IgA nephropathy, Goodpasture syndrome, idiopathic rapidly progressive glomerulonephritis, and prognosis for these diseases.

Student should be able:
- to recognize symptoms suggestive of post-streptococcal glomerulonephritis, IgA nephropathy, Goodpasture syndrome, idiopathic rapidly progressive glomerulonephritis, collect
them into characteristic pattern to make differential diagnosis, prescribe maintaining treatment and follow-up measures.

4. INTERDISCIPLINARY INTEGRATION

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Student should know</th>
<th>Student should be able to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal anatomy, Physiology</td>
<td>Anatomic and physiologic features of the urinary system in children of different age groups</td>
<td>Use knowledge of anatomic and physiologic features of urinary system in children for evaluation of clinical findings</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>Normal ranges for the routine biochemical blood analysis</td>
<td>Assess blood biochemistry and comment on deviations from normal in a clinical context</td>
</tr>
<tr>
<td>Pathology</td>
<td>Histologic and histochemical presentation of glomerular disease in children</td>
<td>Use knowledge of histologic and histochemical presentation of glomerular disease in children for evaluation of clinical findings</td>
</tr>
<tr>
<td>Pathologic physiology</td>
<td>Pathophysiologic mechanisms of the renal failure</td>
<td>Recognize symptom and signs of renal failure</td>
</tr>
<tr>
<td>Microbiology</td>
<td>Sampling of urine for bacterial cultures</td>
<td>Assess microbiologic findings in clinical context</td>
</tr>
<tr>
<td>Propedeutics of pediatric</td>
<td>Physical examination of urinary system in children</td>
<td>Perform physical examination of the urinary system (gross inspection, palpation, percussion), assess the results of urinary tests</td>
</tr>
<tr>
<td>diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imaging studies</td>
<td>Indications and methods of imaging studies in glomerulonephritis</td>
<td>Assess ultrasound examination of kidney</td>
</tr>
<tr>
<td>Intensive care</td>
<td>Symptoms and signs of renal failure of different stages, its etiology, and principles of intensive care</td>
<td>Recognize renal failure, assess its severity, provide emergency care</td>
</tr>
</tbody>
</table>

5. ABSTRACT FOR PRE-WORKSHOP SELF-EDUCATION

1. Differential features of the most common glomerular disease

<table>
<thead>
<tr>
<th>DISEASES</th>
<th>PSGN</th>
<th>IgANP</th>
<th>GPS</th>
<th>RPGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age and sex</td>
<td>All ages, mean 7 yr, 2:1 male</td>
<td>10–35 yr, 2:1 male</td>
<td>15–30 yr, 6:1 male</td>
<td>Adults, 2:1 male</td>
</tr>
<tr>
<td>Acute nephritic syndrome</td>
<td>90%</td>
<td>50%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Asymptomatic hematuria</td>
<td>Occasionally</td>
<td>50%</td>
<td>Rare</td>
<td>Rare</td>
</tr>
<tr>
<td>Nephrotic syndrome</td>
<td>10–20%</td>
<td>Rare</td>
<td>Rare</td>
<td>10–20%</td>
</tr>
<tr>
<td>DISEASES</td>
<td>PSGN</td>
<td>IgANP</td>
<td>GPS</td>
<td>RPGN</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>----------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td>Hypertension</td>
<td>70%</td>
<td>30–50%</td>
<td>Rare</td>
<td>25%</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>50% (transient)</td>
<td>Very rare</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Other</td>
<td>Latent period of 1–3 wk</td>
<td>Follows viral syndromes</td>
<td>Pulmonary hemorrhage; iron deficiency anemia</td>
<td>None</td>
</tr>
<tr>
<td>Laboratory findings</td>
<td>↑ ASO titers (70%)</td>
<td>↑ Serum IgA (50%)</td>
<td>Positive anti-GBM antibody</td>
<td>Positive ANCA in some</td>
</tr>
<tr>
<td></td>
<td>↓C3–C9:normal C1, C4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immunogenetics</td>
<td>HLA-B12, D “EN” (9)[*]</td>
<td>HLA-Bw 35, DR4 (4)[*]</td>
<td>HLA-DR2 (16)[*]</td>
<td>None established</td>
</tr>
</tbody>
</table>

**Renal pathology**

<table>
<thead>
<tr>
<th>Light microscopy</th>
<th>Diffuse proliferation</th>
<th>Focal proliferation</th>
<th>Focal diffuse proliferation with crescents</th>
<th>Crescentic GN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunofluorescence</td>
<td>Granular IgG, C3</td>
<td>Diffuse mesangial IgA</td>
<td>Linear IgG, C3</td>
<td>No immune deposits</td>
</tr>
<tr>
<td>Electron microscopy</td>
<td>Subepithelial humps</td>
<td>Mesangial deposits</td>
<td>No deposits</td>
<td>No deposits</td>
</tr>
<tr>
<td>Prognosis</td>
<td>95% resolve spontaneously</td>
<td>Slow progression in 25–50%</td>
<td>75% stabilize or improve if treated early</td>
<td>75% stabilize or improve if treated early</td>
</tr>
<tr>
<td></td>
<td>5% RPGN or slowly progressive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Supportive</td>
<td>Uncertain (options include steroids, fish oil, and ACE inhibitors)</td>
<td>Plasma exchange, steroids, cyclophosphamide</td>
<td>Steroid pulse therapy</td>
</tr>
</tbody>
</table>

*Post-streptococcal glomerulonephritis (PSGN); IgA nephropathy (IgANP); Goodpasture syndrome (GPS); Idiopathic rapidly progressive glomerulonephritis (RPGN); ACE, angiotensin-converting enzyme; ANCA, antineutrophil cytoplasmic antibody; ASO, anti-streptolysin O; GBM, glomerular basement membrane; GN, glomerulonephritis; HLA, human leukocyte antigen, Ig, immunoglobulin. From Kliegman RM, Greenbaum LA, Lye PS: *Practical*
2. Post-streptococcal glomerulonephritis.

The most common form of glomerular disease in childhood. Acute onset of hematuria, oliguria, edema, hypertension, and azotemia. Antecedent infection with beta-hemolytic streptococcal pharyngitis or impetigo. Immunologically mediated with hypocomplementemia and glomerular deposits of C3 and IgG.

Epidemiology.
- Incidence is decreasing.
- Peak ages 5–15 y.
- Occurs mainly in winter, spring.

Symptoms and signs.
- Hematuria: painless, cola-colored.
- Fatigue: general malaise, abdominal pain.
- Edema: mainly periorbital.
- Hypertension: mild to severe.
- Ascites and/or pleural effusions.
- Urine: output decreased or normal.

Investigations.
- Urinalysis: crenated erythrocytes, erythrocyte casts.
- Urine dipstick: positive for blood and protein.
- Serum creatinine and BUN: increased.
- Serum albumin: may be decreased.
- Serum potassium: may reach life-threatening levels.
- Hemoglobin: slightly decreased.
- Throat culture for alpha-hemolytic Streptococcus.
- Positive Streptozyme test.
- Positive antistreptolysin O titer (ASOT).
- Complement (C3): markedly decreased.
- Renal biopsy: indicated if atypical presentation or course; or if C3 is low after 8 weeks.
- Renal imaging studies: not routinely indicated.

Complications.
- Acute renal failure.
- Hypertension: can be severe.
- Seizures.
- Chronic renal failure: almost never occurs in acute post-streptococcal glomerulonephritis.

Differential diagnosis.
- IgA nephropathy: negative serologies for antecedent streptococcal infection; normal C3 concentration.
- Henoch-Schönlein purpura: typical purpuric urticarial rash on extensor surfaces; arthritis; abdominal pain, melena; testicular swelling; normal C3 concentration.
- Antineutrophil cytoplasmic antibody (ANCA) – positive glomerulonephritis: rapidly progressive course; may have pulmonary infiltrates, sinusitis, arthritis; ANCA positive; normal C3; kidney biopsy indicated.
- Goodpasture syndrome (antiglomerular basement membrane [GBM] antibody disease): extremely uncommon in children; rapidly progressive course; hemoptysis; pulmonary infiltrates; normal C3; positive serum anti-GBM antibodies; kidney biopsy indicated.
- Membranoproliferative glomerulonephritis (MPGN): usually insidious onset; nephrotic syndrome with nephritic components; low C3; serum nephritic factors; kidney biopsy indicated.
Systemic lupus: can occasionally present with acute nephritic symptoms and signs (usually butterfly rash, arthritis, fever, anemia, thrombocytopenia, leukopenia, serositis); low C3, positive antineutrophil antibodies, DNA binding; kidney biopsy indicated if there is proteinuria.

Postinfectious glomerulonephritis: causes include hepatitis B, C; infective endocarditis; *Mycoplasma pneumoniae*.

Alport syndrome: onset rarely acute; positive family history; sensorineural hearing deficit; X-linked inheritance.

Diet and lifestyle.
- Bed rest as needed by the patient.
- Restrict salt (1 g/d) to reduce edema and hypertension.
- Restrict potassium intake.
- Treat hyperkalemia.
- Dialysis if oligoanuric, hyperkalemic, fluid overloaded.

Pharmacologic treatment.
- Hyperkalemia: exchange resin, insulin plus glucose.
- Diuretics: fluid overload - furosemide if mild; dialysis if severe.
- Hypertension: furosemide if not oliguric; hydralazine or nifedipine.
- Antibiotics: not indicated for renal disease.

Course.
- Onset of diuresis in a week.
- C3 normalizes in 6–8 weeks.
- Gross hematuria rapidly resolves.
- Proteinuria may persist for months.
- Microscopic hematuria may persist for up to 2 years.

Prognosis.
- Excellent outcome.
- Relapses are rare.

Follow-up and management.
- Most patients can be treated at home.

Indications for admission to hospital:
- Oliguria
- Hypertension
- Hyperkalemia
- Elevated serum creatinine

3. Notes on risks and treatments of specific glomerular disease.

Membranous glomerulopathy.
The clinical course of membranous glomerulopathy is variable. Children presenting with asymptomatic low-grade proteinuria may achieve a spontaneous remission. Follow-up studies of 1–14 yr suggest that 20% of children progress to chronic renal failure, whereas 40% continue with active disease. The nephrotic state is best controlled with salt restriction and diuretic agents. Proteinuria may be decreased by angiotensin-converting enzyme inhibitors or angiotensin II receptor antagonists (alone or in combination).

Immunosuppressive therapy with prednisone in conjunction with chlorambucil or cyclophosphamide may be beneficial in adults in slowing the rate of progressive renal disease, particularly in patients with severe or prolonged proteinuria, renal insufficiency, or hypertension.

Rituximab, a monoclonal antibody to the B-cell CD20 antigen, has been effective therapy in a small number of adult patients.

Membranoproliferative glomerulo-nephritis (MPGN).
Approximately 50% of patients with MPGN progress to end-stage renal disease 10 yr after their initial presentation. Factors associated with a poor prognosis include: nephrotic syndrome at time of presentation, histologic presence of type II MPGN, decreased glomerular filtration rate 1 yr following the initial presentation.

Recurrence of MPGN in the allograft following kidney transplantation occurs in approximately 30% of patients with type I and 90% of patients with type II MPGN, suggesting the presence of a systemic disorder.

No definitive therapy exists, although stabilization of the clinical course has been reported in many patients receiving 3–7 yr of alternate-day prednisone therapy.

**Glomerulonephritis associated with systemic lupus erythematosus (SLE).**

Children with SLE should be treated by pediatric specialists in medical centers, where both medical and psychological support can be given to both patients and their families. Immunosuppressive therapy in lupus nephritis is aimed at establishing a clinical and serologic remission, defined as normalization of anti-DNA, C3, and C4 levels.

Therapy is initiated in all patients with prednisone at a dose of 1–2 mg/kg/day divided into 2 or 3 doses followed by a slow steroid taper over 4–6 mo beginning 4–6 wk after achieving a serologic remission.

For patients having more severe forms of nephritis (WHO classes III and IV), 6 consecutive monthly intravenous infusions of cyclophosphamide at a dose of 500–1,000 mg/m2 followed by dosing every 3 mo for 18 mo appears to reduce the risk of progressive renal dysfunction.

Azathioprine at a single daily dose of 1.5–2.0 mg/kg may be used as a steroid-sparing agent in patients with WHO class I or II lupus nephritis.

Single-center case reports also suggest the potential benefit of mycophenolate mofetil in patients with mild lupus nephritis.

Rituximab, a chimeric monoclonal antibody specific for human CD20, may be effective in patients with WHO type IV lupus nephritis resistant to conventional immunosuppressive therapies.

**Henoch-schönlein purpura (hsp) nephritis.**

The prognosis in HSP nephritis is generally favorable, although the risk of chronic kidney disease is 2–5%. Presentation with isolated microscopic hematuria alone carries the best prognosis. Presentation with acute nephritic and/or nephrotic syndrome carries the highest risk of developing hypertension, pregnancy-induced hypertension, hematuria, or chronic renal failure. There is no controlled data demonstrating that steroids, cytotoxic agents, or anticoagulants alter the course of HSP nephritis.

Uncontrolled studies suggest the potential value of high-dose corticosteroid and cytotoxic therapy with cyclophosphamide or azathioprine in patients with crescentic glomerulonephritis or significant proteinuria.

Addition of dipyridamole and/or heparin/warfarin may provide additional benefit in patients with severe forms of nephritis.

Some studies suggest that short courses of low-dose prednisone initiated at diagnosis reduce the subsequent risk of developing any clinical signs of nephritis.

There is no controlled data suggesting that any therapy reduces the risk of progression to severe renal disease.

Tonsillectomy does not appear to alter the course of HSP nephritis.

Children with more severe forms of HSP nephritis remain at risk of chronic kidney disease into adulthood.

Children with a rapidly progressive course associated with post-streptococcal GN usually recover spontaneously. Excellent therapeutic response using a combination of corticosteroids and cytotoxic therapy with cyclophosphamide often occurs in patients with systemic lupus erythematosus, IgA nephropathy, and Henoch-Schönlein purpura nephritis. Renal outcomes in
other diseases causing rapidly progressive GN are less favorable, with end-stage renal disease occurring within 2–3 yr. Therapy combining pulse methylprednisolone and oral cyclophosphamide may be effective, particularly in patients with Wegener granulomatosis. Plasmapheresis or lymphocytapheresis has been effective in case reports.

**Glomerulonephritis in Goodpasture disease.**

Patients who survive pulmonary hemorrhage commonly progress to end-stage renal failure. Rates of survival and recovery of renal function have improved with pulse methylprednisolone, oral cyclophosphamide, and plasmapheresis therapy, though controlled data are not available.

Supportive care with meticulous attention to fluid and electrolytes, control of hypertension, aggressive nutrition, and early institution of dialysis has been responsible for a decrease in the mortality from this disease from 80% to less than 10% over the past 30 yr.

**Hemolytic uremic syndrome (HUS).**

Antibiotics should be avoided in patients with acute enteritis presumed secondary to *E. coli* 0157: H7 as they may increase the risk of developing HUS. Nephroprotection in the early phase of HUS may be possible by prevention of dehydration with intravenous fluids. Antithrombotic therapy has no proven therapeutic benefit in HUS. Prospective controlled studies assessing the value of plasmapheresis in HUS with a diarrheal prodrome are not available.

However, plasmapheresis or administration of fresh frozen plasma may be beneficial in thrombotic thrombocytopenic purpura or HUS that is not associated with a diarrheal prodrome or in children with familial recurrent HUS or with severe central nervous system involvement. Plasmapheresis or administration of fresh frozen plasma may exacerbate HUS caused by *S. pneumoniae* and should be avoided when this infection is present.

Peritoneal dialysis controls fluid and electrolyte abnormalities, maintains a normal intravascular volume, and provides the opportunity for aggressive nutritional support. Peritoneal dialysis may contribute to the dissolution of vascular thrombi by removing fibrinolytic inhibitors and circulating plasminogen activating inhibitor-1, thereby activating normal endogenous fibrinolytic pathways.

Shiga toxin–binding resin was ineffective in diminishing the prevalence of death or serious extra-renal events. *In vitro* studies using more potent multivalent synthetic inhibitors of Shiga toxin or genetically engineered bacteria that neutralize large amounts of the Shiga toxin show promise in reducing the incidence of diarrhea-associated HUS.

With aggressive management of acute renal failure, more than 90% of patients survive the acute phase of HUS with a diarrheal prodrome. Death or end-stage renal disease affects 12% (0–30% of patients in various studies). Hypertension, proteinuria, or low glomerular filtration rates (<80 mL/min/1.73 m2) affects 25%.

The overall prognosis of HUS is associated with negative long-term renal outcomes when central nervous symptoms (coma, stroke, seizures) are present during the acute illness and dialysis is required.

Other predictive factors for acute or chronic severity include a white blood cell count >20,000, ischemic colitis, and hypertension. Patients recovering from the acute phase of HUS require long-term follow-up because complications such as hypertension, chronic renal insufficiency, and proteinuria may not be apparent for up to 20 yr. Kidney transplantations in patients with HUS can be successful, although there may be disease recurrence, particularly in familial or non–diarrhea-associated cases. Combined liver and renal transplantation may be an option for those familial cases associated with complement factor H mutations.

### 6. MATERIALS FOR METHODOLOGICAL BACKGROUND OF THE WORKSHOP

**6.1. Quiz**

1. What is the most common etiology for acute glomerulonephritis?
2. What is epidemiology of an acute post-streptococcal glomerulonephritis?

3. Define acute post-streptococcal glomerulonephritis?

4. List symptoms and signs of an acute post-streptococcal glomerulonephritis.

5. What are investigations in acute post-streptococcal glomerulonephritis?

6. When is renal biopsy indicated in acute post-streptococcal glomerulonephritis?

7. What are complications of acute post-streptococcal glomerulonephritis?

8. What are the distinctive features of IgA nephropathy versus acute post-streptococcal glomerulonephritis?

9. What are the distinctive features of Henoch-Schonlein purpura versus acute post-streptococcal glomerulonephritis?

10. What are the distinctive features of Goodpasture syndrome versus acute post-streptococcal glomerulonephritis?

11. What are the distinctive features of membranoproliferative glomerulonephritis versus acute post-streptococcal glomerulonephritis?

12. What are the distinctive features of systemic lupus erythematosus versus acute post-streptococcal glomerulonephritis?

13. What are the distinctive features of post-infectious glomerulonephritis versus acute post-streptococcal glomerulonephritis?

14. What diet and lifestyle should be followed by patient with acute post-streptococcal glomerulonephritis?

15. List the treatment aims for acute post-streptococcal glomerulonephritis?

16. What is pharmacologic treatment for an acute post-streptococcal glomerulonephritis?

17. What is the normal cause of an acute post-streptococcal glomerulonephritis?

18. What do you know over the prognosis of acute post-streptococcal glomerulonephritis?

19. What are follow-up measures for acute post-streptococcal glomerulonephritis?

20. What glomerular disease do you know?

21. What is the clinical course of membranous glomerulopathy?

22. What are the children that achieve spontaneous remission in membranous glomerulopathy?

23. Which percent of children with membranous glomerulopathy progress end-stage renal failure?

24. Which percent of children with membranous glomerulopathy stay with active disease?

25. How nephritic state in membranous glomerulopathy is best controlled?

26. What is the use of angiotensin-converting enzyme inhibitors or angiotensin II receptor antagonists in membranous glomerulopathy?

27. What are the combinations of prednisone with other drugs in patients with prolonged proteinuria, renal insufficiency, or hypertension.

28. Which percent of children with membranoproliferative glomerulonephritis progress end-stage renal failure after 10 years of initial presentation?

29. What are the factors that associated with a poor prognosis of membranoproliferative glomerulonephritis?

30. In which percent of children have a recurrence of membranoproliferative glomerulonephritis in the allograft following kidney transplantation?

31. What is the aim of immunosuppressive therapy in systemic lupus erythematosus nephritis?

32. What is the initial therapy in systemic lupus erythematosus nephritis?

33. What is the protocol for use of prednisone?

34. What is the treatment of severe forms of systemic lupus erythematosus nephritis (WHO class III and IV)?

35. What is the use of azathioprine in systemic lupus erythematosus nephritis?

36. What is the use of rituximab in systemic lupus erythematosus nephritis?

37. What is the risk for chronic kidney disease in Henoch-Schonlein purpura?
38. In which form of Henoch-Schonlein purpura, there is the best clinical prognosis?
39. What are the risk factors in Henoch-Schonlein purpura?
40. What is the use of antibiotics in hemolytic uremic syndrome?
41. What is the nephroprotection of hemolytic uremic syndrome in early phase?
42. What is the use of antitrombotic therapy in hemolytic uremic syndrome?
43. When FFP is contraindicated in hemolytic uremic syndrome?

6.2. Multi-choice questions
A 17-year old girl comes to hospital with his mother with complaints of pain in loin region, appearance of blood in urine. Her mother tells that he was suffering from viral pharyngitis 2 weeks ago. A physical examination reveals mild edema in lower extremities, blood pressure is 125/75 mm Hg, pallor and slightly lethargic. Laboratory investigations reveals positive antistreptolysin-O titer, urinalysis shows hematuria, proteinuria and leukocytes. Microscopic examination reveals dysmorphic RBCs and RBC casts. What is the diagnosis?
A. Acute post-streptococcal glomerulonephritis*
B. IgA nephropathy
C. Alport disease
D. Hemolytic uremic syndrome
E. Urinary tract infection

6.3. Sample case report
A 8 years old boy 2 weeks ago was admitted to hospital due to palpable purpuric rash, mild periorbital edema and “cola like” color of urine and BP 120/75 mmHg. His GFR was 85 ml/min. In anamnesis: 3 weeks ago appeared rash on posterior surface of legs and buttocks. Today patient complains on severe headache, vomiting, nose bleeding and weakness. On physical examination: patient is pale, has severe periorbital and peripheral edema, BP is 130/90 mmHg. In laboratory investigation: Blood analysis show leucocytosis with mild anemia and elevated ESR. BUN and creatinine levels are markedly elevated. Urinalysis shows modest proteinuria, microscopic hematuria, RBCs, and RBC and WBC casts. GFR is 30 ml/min. A renal biopsy specimens show a diffuse, proliferative, necrotizing glomerulonephritis with crescent formation
1. What is the diagnosis?
2. What is the differential diagnosis?
3. What is the follow-up?

Suggested reading

Additional reading
1. Sahar Fathallah-Shaykh, MD; Chief Editor: Craig B Langman, MD. Pediatric Nephritis http://emedicine.medscape.com/article/982811-overview