

Glomerulonephritis and its Therapeutic Approach: A Comprehensive Evaluation

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ABSTRACT

Glomerulonephritis is a group of renal disorders in which the major injury involves the glomerulus rather than the tubules, interstitial tissue, or vasculature. In glomerulonephritis, there is remarkable variation in clinical appearance, disease etiology, management strategy and diagnosis. The prime intention of this review is to provide detail information about Glomerulonephritis; its genesis, etiology, epidemiology, symptoms and diagnostic parameter for identifying acute and chronic glomerulonephritis. This review article focuses on the major treatment which includes Allopathic and Ayurvedic medicine available for treating the conditions of glomerulonephritis. Apart from this it also provides information about precautions and home remedies which are available for the treatment of Glomerulonephritic syndrome.

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1. Introduction

Glomerulonephritis is critically concern with inflammation and cell proliferation in the glomerulus, which is a small tuft of blood capillaries in the kidney, responsible for filtering out waste products. [1] Common clinical findings include hematuria, proteinuria, and decreased glomerular filtration rate, detected as elevation in creatinine, often accompanied with hypertension, edema, and disease-specific findings confirms the abnormal kidney function. [2]

The term glomerulonephritis (GN) ambience a range of immune-mediated disorders that cause inflammation within the glomerulus and other filtering unit of the kidney. [3] This disease group has been described as the most prevalent cause of end stage renal disease (ESRD) in the world. [4] In India about 90% of 7.85 million people suffering from chronic kidney failure, cannot afford the cost of the treatment. According to Kashmir media services report, a survey by medical specialists revealed that about 10 % apparently healthy Indian army personnel were identified with symptoms of chronic kidney disorder. [5]

GN has been listed as the incident of ESRD patients in US over 116,395 patients in 2009 by treatment modality and 17.3% of prevalent dialysis patients wait-listed for a kidney. Deaths caused by ESRD were reported as 90,118 patients and the total Medicare costs of reported ESRD, (US\$) 24,703,978,717 in the year 2009. [6,7] Notably, for every patient with clinically diagnosed with GN, about 5-10 patients have undiagnosed sub-clinically. [8] Therefore it is surprising that, over 50 million individuals worldwide which including 26 million Americans showed the symptoms of CKD. [9,10]

If the situation is not brought under control, chronic GN may lead to pathogenesis of CKD in a significant proportion of this population. CKD increases the risk for the various complications of renal damage; it may further lead to cardiovascular diseases or even death of the patients. [11,12] Every year more than one million

CKD patients develop ESRD. Survival with ESRD requires renal replacement therapy with dialysis or transplantation and expensive medical interventions not available in many developing countries. Hence, effective therapy for GN would have significant impact globally on human health and health care financing. [13,14]

The glomerulonephritis consists of a group of immunological disorders that causes considerable damage to the renal glomerulus, the filtering unit of the kidney. This network of capillaries, feed and drain by the afferent and efferent arterioles, which filters plasma across the fenestrated endothelium, glomerular basement membrane (GBM) and podocyte slit diaphragms to collect in Bowman's space. Filtrate is dramatically modified as it passes through a series of tubules before delivery to the renal pelvis for excretion. [15,16] The approximately 2 million glomeruli in normal adult kidneys filter over 150 liters of plasma per day. With this constant exposure and high filtering capacity, it is perhaps not surprising that the glomerulus is susceptible to injury from immune cells and their soluble products. [17,18]

2. Prevalence

In India, USA and Europe, glomerulonephritis is the third most common cause of end-stage renal disease (USRDS 2009). It is less common than diabetes and hypertension. However, many patients with renal failure attributed to hypertension probably have an underlying glomerulonephritis as the cause, so the numbers quoted for prevalence are probably low. In developing countries, glomerulonephritis is one of the most causes of end-stage renal disease due to effect of various infectious agents like bacteria, virus and parasite. [19,20]

Opportunities for growth of safety profiles for strong pipeline will available till 2017, desires better therapeutics market for renal diseases. It is reported that in-depth analysis of the top four therapeutic indications of renal diseases, which includes

chronic kidney disease, renal anemia, diabetic nephropathy and acute kidney injury and also reported about the global renal disease treatment usage patterns for the covered indications. In addition, research and development pipelines also reported of new management for renal diseases. This analysis shows that in 2010, the overall renal diseases for the four indications (mentioned above) were valued at \$ 50.3 billion.

The market is expected to observe the growth on compound annual growth rate (CAGR) is 5.5% for the forecast period, and will reach about \$ 73 billion in 2017. The introduction of new therapies in global market is expected to increase, which are currently in the regulatory filing stage and in the later stages of development. Drugs like antioxidant, inflammatory modulators and metal-free phosphate binders are likely to improved safety and efficacy in management of nephritic syndrome.^[21,22,23]

3. Epidemiology

Glomerulonephritis is most common in male than in female patients; but lupus nephritis is the major exception in females as the frequency of this is two or more times higher than male population.^[24,25]

Many cases of glomerulonephritis result in mild, asymptomatic illness that is not renowned by the patient due to the lack of medical attention and remains undiagnosed. The occurrence and incidence of these episodes are unknown, but might be considerable.^[26] In several countries like India, Australia, USA, Europe etc., studies have shown that evidence of nephritic syndrome like proteinuria, haematuria, low calculated glomerular filtration rate, or a combination of these features are common in adults as compare to overall population.^[27,28]

Although in diabetic and hypertensive nephropathic patients, glomerulonephritis is likely to be the main cause in a considerable proportion. Between 1995 and 1997, a clinical survey was conducted, which showed about 21.5 % of people from Australia underwent renal biopsies suffering with GN and found to be most common in adults diagnosed with IgA nephropathy, focal and segmental glomerulosclerosis and vasculitis. Most patients suffering from chronic kidney disease enhances the risks of premature cardiovascular disease and progressive kidney failure.^[29,30]

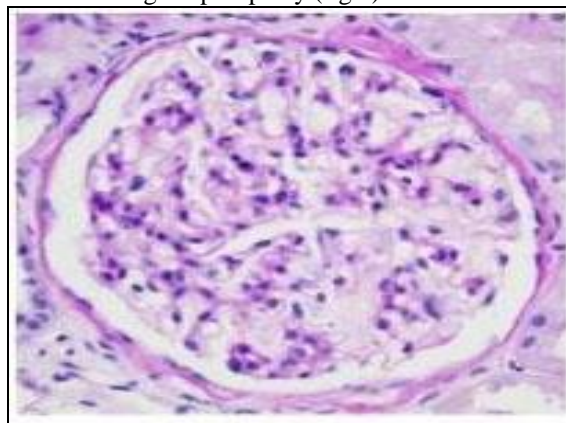
Glomerulonephritis is most clinically evident for contribution to end-stage renal disease, which essentially requires dialysis or transplantation of kidney and recognized as the second commonest cause of end-stage renal disease globally. In Australia, glomerulonephritis is the most common cause of renal failure, leading to 27% of cases in 2001 and becomes third rank among the most common disease in the USA.^[31] The susceptibility varies for each type of glomerulonephritis that causes end-stage renal disease, but the majority of these types are identified during renal biopsy resulting to renal diseases.^[32]

3.1 Subtypes of glomerulonephritis

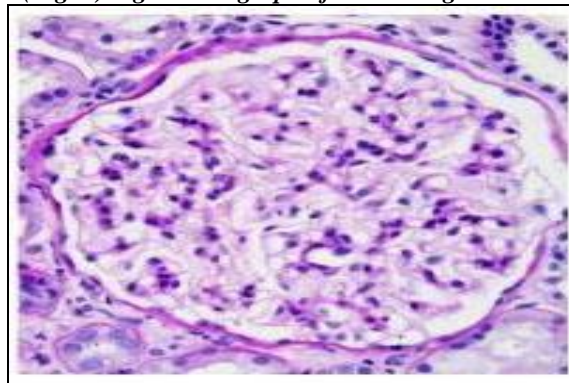
Glomerulonephritis is classified as primary or secondary disease based on abnormality within the glomerulus, where as the aetiology of secondary causes is well-defined. Mostly, appearance, treatment and markers of good prognosis are the most common cause of primary glomerular diseases as mentioned below;

- Minimal-change nephropathy
- Focal segmental glomerulosclerosis
- Membranous nephropathy
- IgA nephropathy
- Mesangiocapillary glomerulonephritis
- Focal necrotizing glomerulonephritis

(i) **Minimal-change nephropathy (MCN):** Mostly children suffering from MCN recognized by nephritic syndrome; about 80% of children (< 10 years) diagnosed from primary nephritic syndrome, which commonly observed in developing countries, where as about 20% of adult also diagnosed. It is very frequently associated with hypertension, cellular casts in urine or persistent impairment of excretory renal function. MCN is also associated with long term use of drugs (particularly NSAIDs) or drugs used in malignancy (particularly Hodgkin's disease and other lymphomas) as a secondary cause leading to nephritic syndrome. MCN is also observed by histopathology supported by light micrograph, a normal glomerulus (fig.1) and electron microscopy with minimal-change nephropathy (fig.2).^[33]

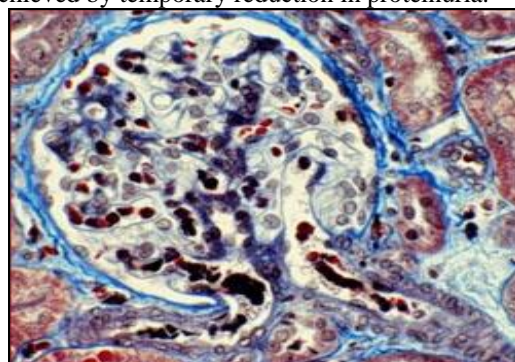


(Fig. 1) Light micrograph of a normal glomerulus

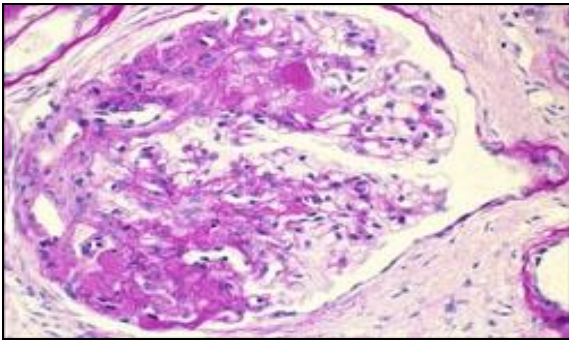


(Fig. 2) Electron microscopy of a glomerulus with minimal-change nephropathy

(ii) **Focal segmental glomerulo-sclerosis (FSGS):** It is mostly associated with asymptomatic proteinuria or nephrotic syndrome. As similar to MCN, also associated with hypertension, microscopic haematuria, impaired excretory renal function and/or corticosteroid resistance. Primary, FSGS tends to recur after renal transplantation and suggested that a circulating permeability factor achieved by temporary reduction in proteinuria.



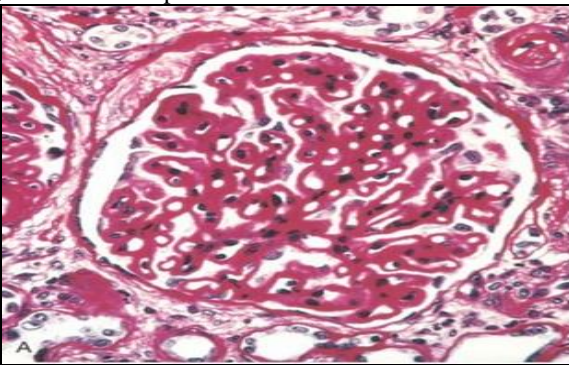
(Fig. 3) Immunofluorescence micrograph of a normal glomerulus



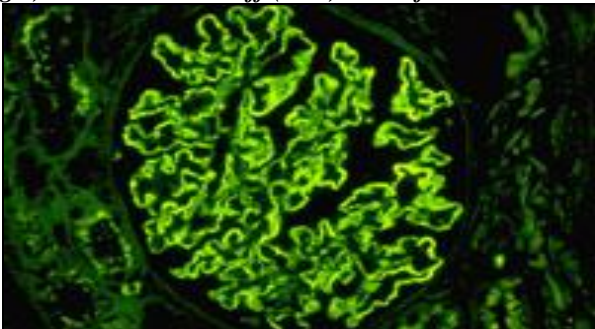
(Fig. 4) Light microscopy of a glomerulus with Focal segmental glomerulosclerosis

It is diagnosed under kidney biopsy and shows focal segmental glomerulosclerosis observed by immunofluorescence micrograph (Fig. 3) and light microscopy of glomerulus (Fig. 4), shows some sclerotic changes which are focal and segmental glomerulus carried under histopathological studies.^[34,35]

(iii) **Membranous nephropathy (MN):** It is a nephritic syndrome occurs during the microscopic haematuria, hypertension and/or impaired excretory renal function associated with proteinuria, which is asymptomatic or sufficiently severe to cause nephrotic syndrome linked with prognostic signs. MN is carried out under secondary phase glomerular nephritis due to the long term uses of drugs like NSAIDs, gold, penicillamine and occurs in tumours particularly carcinoma of the bronchus, colon or breast and/or by infection (particularly HBV, HCV). About 20% Membranous nephropathy are mostly seen in patients over the age of 60 years, observed by screening investigations (suggestive signs or symptoms) including chest X-ray, mammography, colonoscopy, occult blood in stool and prostate specific antigen. Histological studies also supported that Periodic acid-Schiff (PAS) stain of Membranous GN (fig.5) and Immunofluorescence microscopy of Membranous nephropathy (fig.6) altered as compared to the normal Glomerulus.^[36,37]

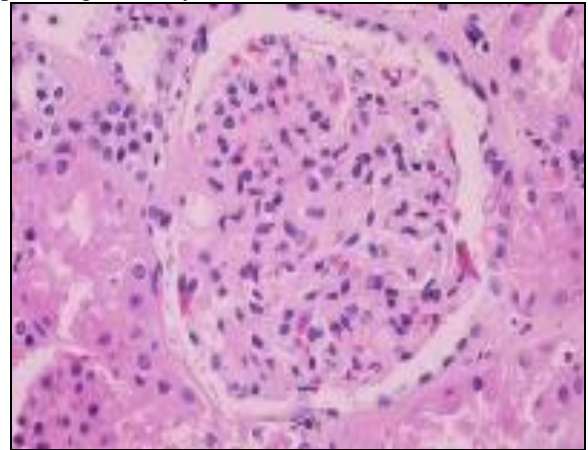


(fig.5) Periodic acid-Schiff (PAS) stain of Membranous GN

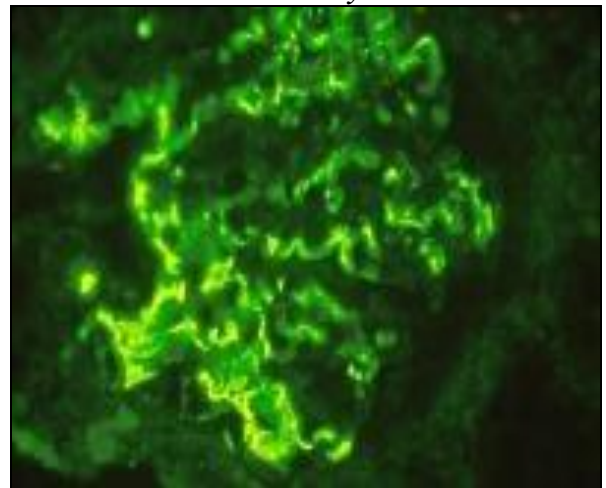


(fig.6) Immunofluorescence microscopy of Membranous nephropathy

(iv) **IgA nephropathy (IgAN, Berger's disease):** It is the most common glomerulonephritis associated with microscopic hematuria and acute kidney failure due to chronic renal disease in patients showing glomerular lesions with prominent mesangial proliferation due to high deposition of IgA. The elevation of different IgA serum concentration among 50% of patients observed due to the alteration IgA level with carbohydrate moieties. Light microscopy of glomerulus from a patient with IgA nephropathy due to increased mesangial matrix with cellularity (Fig.7) and Immunofluorescence microscopy indicating large mesangial IgA deposition (Fig.8) is supported by histopathological study.^[38]

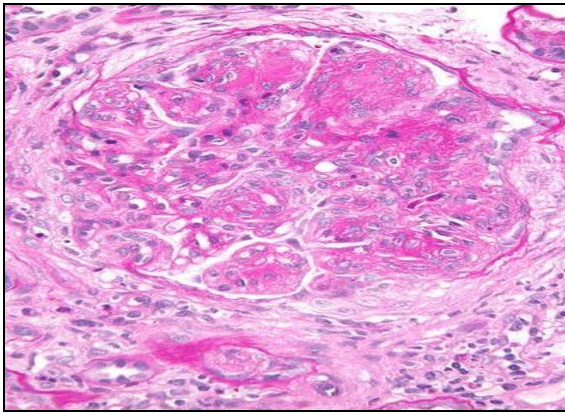


(Fig.7) Light microscopy of a glomerulus from a patient with IgA nephropathy showing increased mesangial matrix & cellularity

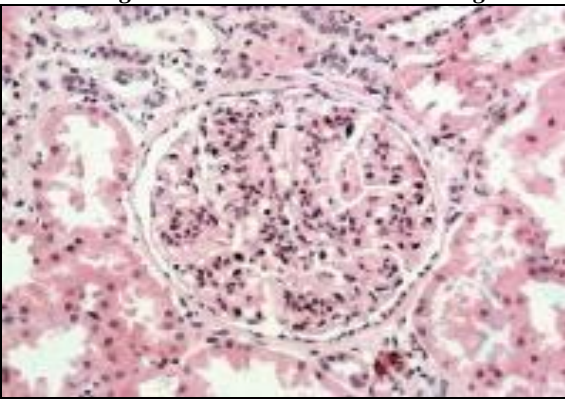


(Fig.8) Immunofluorescence microscopy demonstrating large mesangial IgA deposits diagnostic of IgA nephropathy

(v) **Mesangiocapillary GN (MCGN, also known as membranoproliferative GN, MPGN):** It is a classical nephropathy associated with activation of the complement cascade, involving various pathways depends upon the types of MCGN. Type I MCGN occurs at low C4 and C3, type II MCGN is the alternative pathway occurs at low C3 & normal C4 leading to partial lipodystrophy, where as type III MCGN associated with terminal pathway. Partial lipodystrophy is a selective loss of fat cells in the face and upper trunk characterized by cadaveric appearance in patients. Type II MCGN also associated with abnormalities in the eye, especially with prominent presence of drusen (deposits within Bruch's membrane).



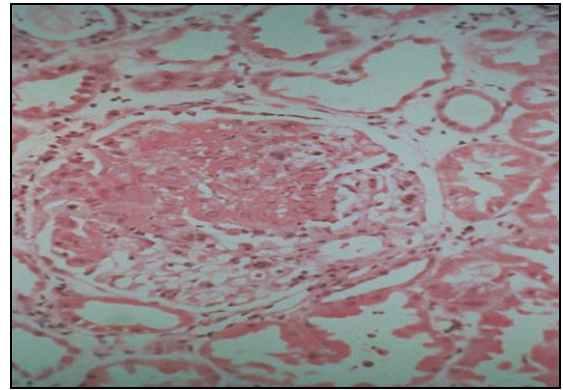
(Fig.9) Membranoproliferative glomerulonephritis with increased mesangial matrix and increased mesangial cellularity



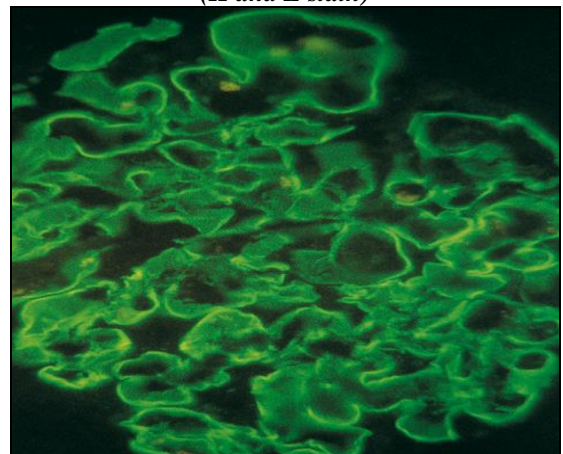
(Fig.10) Mesangiocapillary with proliferation of mesangial and endothelial cells and expansion of the mesangial matrix

Recent observations provide a unifying explanation and involved in the regulation of alternative pathway of complement. Recently, it is reported that the variations in the gene-encoding factor H, which is a regulator of the alternative complement pathway. Histological studies showed a membranoproliferative glomerulonephritis with increased mesangial matrix and increased mesangial cellularity (Fig.9) associated with mesangiocapillary proliferation of mesangial and endothelial cells linked with the expansion of the mesangial matrix (Fig.10).^[39,40,41]

(vi) **Focal necrotizing GN (FNGN):** It is an acute nephritic syndrome linked with haematuria, proteinuria and cellular casts in the urine associated with pulmonary haemorrhage, leading to pulmonary renal syndrome or Goodpasture's syndrome. The most common cause of this syndrome is small vessel vasculitis (microscopic polyangiitis, Wegener's granulomatosis), which is usually associated with the presence of anti-neutrophil cytoplasmic antibodies (ANCA). Other syndrome includes systemic lupus erythematosus (SLE) and cryoglobulinaemia. It is also associated with renal lesion typically clinical syndrome of rapidly progressive glomerulonephritis (RPGN) leading to the medical emergency among patients. If untreated, FNGN causes renal insufficiency and severe damage. ANCA is closely associated with systemic vasculitis and pauci-immune FNGN which is probably a formation of small vessel vasculitis restricted to the kidney (Figure11) and about 80% of patients suffering from FNGN exhibited circulating ANCA.^[42,43]



(Fig.11) Antineutrophil cytoplasm antibody associated FNGN (H and E stain)



(Fig.12) Immunofluorescence microscopy of a glomerulus in anti-GBM with deposition of IgG

In GBM, a linear deposition of IgG causes Goodpasture's disease (Figure 12) and in case of RPGN, there is no immunoglobulin in the glomerulus termed as 'pauci immune FNGN' which is a rapid and reliable serological tests available for ANCA and anti-GBM antibodies.^[44,45]

4. Etiology

Glomerulonephritis usually occurs due to the primary glomerular disease (idiopathic) or secondary glomerular disease caused by drugs, infections, tumours or blockages in glomerulus could be isolated or manifested by renal involvement in a systemic disease and diagnosed by subdivision/categories depends on clinical features, laboratory data and histological analysis of subject. Finally, the renal biopsy is carried out for the confirmation of glomerulonephritis.^[46]

Glomerular diseases are classified according to whether primary glomerular defect or secondary to an underlying cause. In initial stage, GN may be a temporary and reversible condition, if the patient left untreated, glomerulonephritis can lead to chronic renal failure, high blood pressure, congestive heart failure, pulmonary edema, and end-stage renal disease.^[47]

4.1 Causes of Glomerulonephritis

(i) **Primary Causes (Idiopathic):** Fibrillary glomerulonephritis, Idiopathic crescentic glomerulonephritis, Focal segmental glomerulosclerosis, Membranoproliferative glomerulonephritis, Mesangiocapillary glomerulonephritis, Focal necrotizing glomerulonephritis, IgA nephropathy.^[48]

(ii) Secondary Causes:

(a) Infectious and Postinfectious Causes

• **Bacterial:** Group A β -streptococcal infection, *Mycoplasma* infection, *Neisseria meningitidis* infection, *Salmonella typhi* infection, Staphylococcal infections (especially bacterial

endocarditis), *Streptococcus pneumoniae* infection, Visceral abscesses (due to *Escherichia coli*, *Pseudomonas*, *Proteus*, *Klebsiella*, or *Clostridium* sp), Sepsis.

- **Parasitic:** Malaria (due to *Plasmodium falciparum* or *P. malariae*), Schistosomiasis (due to *Schistosoma haematobium* or *S. mansoni*), Toxoplasmosis.
- **Viral:** Coxsackievirus infection, Cytomegalovirus infection, Epstein-Barr virus infection, Hepatitis B & C, Herpes zoster, Measles & Mumps, Varicella.
- Fungal infections (due to *Candida albicans* or *Coccidioides immitis*), Rickettsial infection.^[49]

(b) Non-Infectious Causes

- Connective tissue disorders: Henoch-Schönlein purpura, Microscopic polyangiitis, Polyarteritis nodosa, Wegener's granulomatosis, Systemic lupus erythematosus.
- Drug-induced disorders: High-dose Captopril, Gold, Penicillamine, Procainamide, Quinine, Cisplatin, Gemcitabine, Mitomycin, NSAIDs.
- Hematologic dyscrasias: Mixed IgG-IgM cryoglobulinemia, Serum sickness, Thrombotic thrombocytopenic purpura-hemolytic-uremic syndrome.
- Hereditary disorders: Hereditary nephritis (Alport's syndrome) this basement membrane disease.
- Glomerular basement membrane diseases- Goodpasture's syndrome.^[50]

(c) Conditions increase the risk for GN

- Focal segmental glomerulosclerosis
- Anti-glomerular basement membrane antibody disease
- Blood vessel diseases such as vasculitis or polyarteritis
- Toxic chemicals and heavy metals
- Infection of the urinary tract
- Environmental reasons
- Metabolic disorders
- Tumor of the kidney

4.2 Possible Complications

- Nephrotic syndrome
- Acute nephritic syndrome
- Chronic kidney failure
- Pulmonary edema
- End-stage kidney disease
- Malignant Hypertension, CHF
- Chronic or recurrent urinary tract infection
- Increased susceptibility to other infections^[51]

4.3 Symptoms

The symptoms of GN includes; Swelling in any part of the body especially on face, albumin content in urine, blood in urine, foamy urine, nausea and/or vomiting, increase in blood pressure, headache, backache, abdominal pain, increased frequency of urination and burning sensation, excessive urination, fever, diarrhea, cough, Joint aches, muscle aches, loss of appetite and shortness of breath^[52].

5. Diagnostic Tests

Several diagnostic tests are performed for the analysis of glomerular in GN. When there is an abnormal urinalysis during a routine physical or examination for unrelated disorders, the symptoms develop gradually leading to the severe renal diseases. Laboratory tests shows reveal anemia and signs of reduced kidney function indicates GN. A kidney biopsy confirms the diagnosis including swelling (edema), polyneuropathy and signs of fluid overload on heart and lung sounds indicating the signs of chronic kidney failure. Rapidly progressive glomerulonephritis

showed casts (clumps of red blood cells or white blood cells) which is visible in urine sample examine under the microscope.^[53,54]

Kidney biopsy helps to determine the amount of scarring and potential for reversibility of GN, which is also showed by blood tests used to diagnose anemia associated with high number of white blood cells. Kidney biopsy is performed by inserting a needle in one of the kidneys, guided by the ultrasound or computed tomography (CT) to obtain a small amount of kidney tissue and diagnostic test is performed.^[55]

For the analysis of chronic glomerulonephritis, several urine tests are performed for the determination of protein and blood cells in a person who is suffering from GN. Usually, ultrasound, CT scan and magnetic resonance imaging (MRI) scan also helps for determination of GN in patients while kidney biopsy rarely performed under advanced stages where the kidneys are shrunken and scarred for obtaining specific information about the cause.^[56]

5.1 Biochemical Parameters

(i) **Creatinine clearance:** Endogenous creatinine is excreted by filtration through the glomerulus and by tubular secretion. Clinically, creatinine clearance (Normal Range: 0.6-1.3 mg/dL) is an acceptable measure of glomerular filtration rate but sometimes overestimates GFR. About 50% reduction in GFR, serum creatinine approximately doubles. The following test helps to provide information on kidney function;

a) **Blood creatinine test:** Creatinine is a breakdown product of creatin, which is an important part of muscle. The normal range of blood creatinine is 0.7 to 1.3 mg/dL for men and 0.6 to 1.1 mg/dL for women. Females usually have a lower creatinine than males, because they usually have less muscle mass. The decreased blood creatinine level reveals the acute or chronic renal failure.

b) **Urine creatinine test:** Creatinine is removed from the body entirely by the kidneys. Urine creatine (normal value: 150 mg/dL) values can range from an alternative to 24 hours urine collection is 500 - 2000 mg/day. Results are highly dependent on patient age and amount of lean body mass. The creatinine clearance test is used to estimate the glomerular filtration rate (GFR).

Note: Normal values ranges may vary slightly among different laboratories.^[57]

(ii) **Total protein:** The plasma protein concentration (normal range is 6–8 g/dL) determines the total amount of two classes of proteins: albumin and globulin. Albumin helps prevent fluid from leaking out of blood vessels. Globulins are an important part of patient immune system. The decreased level of total protein (about 4.4 g/dL) reveals the diagnosis of nephrotic syndrome.^[58]

(iii) **Uric acid in urine:** Uric acid is an end product of nucleoprotein metabolism and is excreted by the kidney. An increase in serum uric acid concentration occurs with increased nucleoprotein synthesis or catabolism or decreased renal excretion (renal failure). The normal range of uric acid 2.4-7.4 mg/dL in male & 1.4-5.8 mg/dL in female. In case of renal failure or chronic glomerulonephritis the levels uric acid in the urine is increased.^[59]

(iv) **Urine concentration test:** A urine concentration test measures the ability of the kidneys to conserve or excrete water appropriately.

a) **Urine osmolality test:** The osmolality urine test confirms the concentration of ion particles (Na^+ , Mg^{2+} , K^+ , Cl^- etc.) in urine. Osmolality (particles/kg water) and osmolarity (particles/liter of solution) are sometimes confused, but for dilute fluids such as urine they are essentially the same. Normal values are as follows: Random specimen: 50 to 1400 milliosmoles per kilogram

(mOsm/kg); 12 to 14 hour fluid restriction: > 850 mOsm/kg. In glomerulonephritis urinary osmolality is higher than that of the plasma.

b) **Urine specific gravity:** Urine specific gravity measures the ability of the kidneys to concentrate urine. Because urine contains electrolytes and other substances, its specific gravity is greater than 1.000. The range of specific gravity in urine is from 1.003 to 1.035. A decreased urine volume and low specific gravity reveals Glomerulonephritis and pyelonephritis.

c) **Urine RBC:** The RBC urine test measures the number of red blood cells in a urine sample. Normal values are 4 red blood cells per high power field (RBC/HPF) or fewer. The greater than normal numbers of red blood cells in the urine may indicate Glomerulonephritis.^[58,59]

(v) **Anti-glomerular basement membrane antibody test:** The glomerular basement membrane is a part of the kidneys that helps filter waste and extra fluid from the blood. Anti-glomerular basement membrane antibodies are antibodies against this membrane. They can lead to kidney damage.^[60]

(vi) **Complement component 3 (C3):** The classic and alternative complement pathways converge at the C3 step in the complement cascade. Low levels indicate activation by one or both pathways. Most diseases (e.g. Glomerulonephritis) will show decreased C3 levels (normal range is 64-166 mg/dL) due to increase catabolism.^[61]

(vii) **BUN:** Blood Urea Nitrogen test can be done to measure the amount of urea & nitrogen in the blood. Normal range is 7 - 20 mg/dL. Several kidney diseases, including glomerulonephritis, pyelonephritis, and acute tubular necrosis may be due to increased level of BUN.^[62]

6. Prevention & Treatment

There is no specific way to prevent most cases of glomerulonephritis. Some cases may be prevented by avoiding or limiting exposure to organic solvents, mercury, and non-steroidal anti-inflammatory drugs (NSAIDs). The treatment varies accordingly on the cause of the disorder, type and severity of symptoms of GN. During the treatment, there is a risk of High blood pressure which is difficult to control and manage.^[13]

6.1 Allopathic system of medication

Blood pressure is the major target for the treatment to control high blood pressure in GN patients controlled by allopathic drugs. Angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers are most commonly prescribed drugs for the control of high blood pressure while treating GN. Corticosteroids and Antineoplastic drugs may relieve the symptoms and immune suppressants for quick relief are usually prescribed (see table 1).³⁴

Plasmapheresis, an extracorporeal therapy generally used to control glomerulonephritis affected by immune-related causes. Under this therapy, the fluid part of the blood containing the antibodies is removed and replaced with intravenous fluids or donated plasma (without antibodies). While removing the antibodies, there is a reduction in kidney inflammation associated by closely watched signs in patients suffering from GN, may lead to the renal failure. In these cases, kidney transplant is required.^[16, 17]

Mycophenolate mofetil (MMF), a novel treatment for kidney transplantation in patients with end stage renal disease. Currently, MMF is widely used in GN therapy as low level of side effects and relatively high levels of efficacy. Mycophenolic acid (MPA) is an active form of MMF, which has specific effects on lymphocytes and white blood cells mediated by glomerulonephritis in the kidney. It has beneficial effects on

blood vessel cells, other inflammatory cells such as monocytes and on scar tissue-forming fibroblasts. Each of these effects predicts MMF might be very effective in treating glomerulonephritis.^[63]

6.2 Follow-Up

(i) Further Inpatient Care

• A follow-up evaluation by a nephrologist is essential for all patients include following as:

- Ensure appropriate evaluation of the etiology.
- Reassess and address the course the illness takes in its progression.
- Provide any intervention or treatment indicated based on the specific etiology and the course it follows in that specific patient.

• In-patient care may be necessary, based on the type and/or etiology of acute glomerulonephritis (eg, shunt nephritis), the extent of renal involvement, or the existence of signs and symptoms indicative of potentially serious complications (eg, pulmonary edema, severe hypertension, encephalopathy).^[31,32]

(ii) Further Outpatient Care

- Urinalysis at 2, 4, and 6 weeks and at 4, 6, and 12 months
- Cessation of follow-up care when urinalysis is normal
- Blood pressure monitoring during each visit
- Serum creatinine level monitoring at 2, 6, and 12 months
- Serum complement usually normal by 6 weeks.

(iii) Deterrence/Prevention

Early penicillin therapy does not prevent the development of acute poststreptococcal glomerulonephritis. Although, antibiotic therapy is administered to the patients suffering from streptococcal infection indicating the presence of glomerulonephritis.^[64]

6.3 Ayurvedic system of medication

In ayurvedic system, the treatment with various plant parts or extracts is used to prevent glomerular disease having no significant adverse effects which is very effective system of alternative medication in glomerulonephritis. There are some commonly used medicinal plants (Table 2) and ayurvedic formulation (Table 3) described for the treatment for glomerulonephritis.

6.4 Home Remedies

- 8 - 9 bananas in daily diet for 3 - 4 days can serve as remedies for nephritis.
- Carrot juice acts effective in nephritis when it is taken with honey and fresh lime juice early in the morning.
- Avocados are effective remedies as they contain minerals and protein for nephritis.
- 1 tumbler of radish juice for 2 - 3 times a day can serve as promising diuretic in nephritic conditions.
- Grapes are useful for treating nephritis as it acts as a good diuretic.
- Consuming vegetable juices for 7 - 10 days in nephritic condition causes removal of toxic substance from body.
- Tender coconut water is another excellent remedy for this disease. The water of one green tender coconut can be taken beneficially once or twice a day. It acts as a very effective but safe diuretic in the treatment of nephritis.

6.5 Diet restriction: The patient may suggest reducing salt, fluids, and protein intake. Adequate rest and sound sleep is important. Avoid sour, fried foods and drink lots of water. Remain physically and mentally active with mild exercise or walking.^[65]

Table 1: List of some currently used Allopathic drugs for treatment of GN

Sr. N.	Drug Name	Mechanism of Action	Doses		I) Uses
			Adult	B. Pediatric	
1.	Antibiotics: Penicillin-V	It inhibits enzymes and cell wall receptors, resulting in cell wall synthesis inhibition.	500 mg p.o. every 6 hours	<12 years: 40 mg/kg/d PO divided q4-6h; >12 years: Administer as in adults.	Acute GN of a poststreptococcal group A beta-hemolytic
2.	Nonselective β-Blocker With Cardioselective α1-Blocker: Labetalol	Acts as nonselective beta-antagonist and cardio-selective α 1-antagonist effects.	20 mg iv injection slowly over 2 min; desired BP may be achieved with continued inj. of 40-80 mg at 10min intervals	Suggested dose: 0.4-1 mg/kg/h iv; not to exceed 3 mg/kg/h	Hypertensive encephalopathy and malignant hypertension
3.	Loop Diuretics: Furosemide	It inhibits reabsorption of sodium and water in ascending limb of loop of Henle by interfering with $\text{Na}^+/\text{K}^+/\text{2Cl}^-$ channel.	20-80 mg p.o./iv once initially, followed by once q.d., or once q.o.d. after titrating for optimum efficacy, or by dividing daily dose bid/tid	Initially: 2 mg/kg po/iv once; titrate with additional 1-2 mg/kg q6h	Hypertensive encephalopathy with CNS signs and circulatory congestion or pulmonary edema
4.	Corticosteroids: Methyl-prednisolone	It has potent anti-inflammatory effects in kidney function disorders	Pulse therapy of 30 mg/kg IV over minimum of 30 min	Administer as in adults	Nonstreptococcal etiologies of acute GN, particularly in lupus nephritis and in idiopathic progressive GN
5.	Antineoplastics: Cyclo-phosphamide	Acts as alkylating agent that cross-links strands of DNA and RNA. Other actions include inhibition of protein synthesis, and cholinesterase inhibition.	For long-term therapy, 400-1800 mg/m^2 (30-40 mg/kg) IV in divided doses over 2-5 day	Long-term therapy: Administer as in adults	Treatment of acute GN due to Wegener granulomatosis
6.	Immuno-suppressive Agent Mycophenolate Mofetil (MMF)	Inhibiting proliferation of immune cells involved in GN, specifically B & T lymphocytes; inhibiting adhesion & migration of inflammatory cells to blood vessels and induction of programmed cell death of inflammatory cells	1.0 gm po/iv twice a day (daily dose of 2 gm) is recommended for use in renal transplant patients.	3 months to 18 years: Oral suspension is 600 mg/m^2 administered twice daily (up to a maximum daily dose of 2 g/10 mL oral suspension)	Treatment of GN, IgA Nephropathy

Table 3: List of some herbal formulations for treatment of GN

Plant Name	Preparations	Dose	Uses
Mutra-Krich-Antak Churna	Salacia oblonga, crataeva nurvala, butea monosperma, boerhavia diffusa, tribulus terrestris, P. Santalinus, moringa oleifera, achyranthes aspera, albezzia lebbeck	3 to 6 gm herbs powder (1 tea-spoonful twice daily)	Kidney Failure, Painful Urination, Urethral Strictures, Kidney Stones
Cystone - 120 Tabs	Ginger, Shilapushpa, Pasanabheda, Indian madder, Umbrella's edge, Prickly chaff flower	1 Tablet (120 mg) Twice Daily don't give to children under 14 year old	Treats stones in the urinary tract, and recurrent urinary tract infections.
Suvarna vasanta Malati Rasa	<i>Michelia</i> Murantiaceae <i>Magnoliaceae</i>	Suvarna bhasma, mouktika bhasma, purified hingul (cinnabar), piper nigrum, shuddha kharpar, butter and citrus limon.	250 mg and 500 mg (Two spoonfuls with milk on an empty stomach)
Pellitory-of-the-Wall	<i>Parietaria officinalis</i> (Urticaceae)	The juice of the fresh herb, made into a thin syrup stimulates the kidneys	4 - 5 ml extract 2 -3 times daily

Table 2: List of some medicinal plants used for treatment of GN

Plant Name	Biological Source and Family	Parts Used	Dose	Uses
Punarnava	<i>Boerhavia diffusa</i> (Nyctaginaceae)	Roots	125 mg to 250 mg powder twice daily	Diuretic, Micturition
Sarvato bhadra Vati	<i>Azadiracta indica</i> (Meliaceae)	Leaves	62.5 mg to 125 mg powder twice daily	Glomerulonephritis
Varunadi Vati	<i>Crataeva nurvala</i> (Saxifragaceae)	Bark & root	2 tablets twice daily	Effective in urinary tract and helps in removing the renal stones
Gokhru	<i>Tribulus terrestris</i> (Zygophyllaceae)	Fruits	650 mg – 1.30 g powder daily	Diuretic and herbal tonic for genitor-urinary system
Rakt Chandan	Red Sandalwood <i>Santalum album</i> (Santalaceae)	Heart-wood	5 mg powder mixed into a cup of cold milk	Urinary alkalizer and acts as a natural diuretic
Palaash	<i>Butea monosperma</i> (Fabaceae)	Seeds & Fruits	Capsules- dose of 2.5 gm per day	Urinary alkaliser and also relieves painful micturition
Kaasni	<i>Cichorium intybus</i> (Asteraceae)	Leaf & Seeds	1-2 gm powder with honey or cow's milk/day for 15 days	In acute and chronic kidney failure
Patha, Akanadi	<i>Cissampelos pareira</i> (Menispermaceae)	Root	3-6 g of powder/day	Anti-inflammatory & Diuretic property
Garlic pear tree, Barna	<i>Crataeva adansonii</i> (Capparaceae)	Fruits & Flowers	250 mg capsule/tablet OD for 7 days	Urinary tract infections, pain and burning micturition, renal and vesical calculi
Niruri	<i>Phyllanthus asperulatus</i> (Euphorbiaceae)	Leaf & Fruits	25 gm of powder/ day for 5 day	In Glomerulonephritis
Poplar	<i>Populus Nigra</i> (Salicaceae)	Dried Buds	Extract of dried buds, 2-3 cup/day	Reduce inflammation of kidneys & urinary tract
Woundwort	GOLDENROD <i>Solidago virgaurea</i> (Asteraceae)	Leaf & Flowers	20 drops of fluid extract twice a day	Cleanse or "flush" the kidneys and bladder, either as part of a healing fast, or to treat cystitis
Kulikhara	<i>Asteracantha longifolia</i> (Acanthaceae)	Seeds	Ethanol extract	Haematopoietic activity
Akarkara	<i>Anacyclus pyrethrum</i> DC. (Compositae)	Roots	2 to 3 g powder of dried roots	Good General Diuretic
Suvarna vasanta Malati Rasa	<i>Michelia</i> Murantiaceae Magnoliaceae	Suvarna bhasma, mouktika bhasma, purified hingul (cinnabar), piper nigrum, shuddha kharpar, butter and citrus limon.	250 mg and 500 mg (Two spoonfuls with milk on an empty stomach)	Glomerulonephritis
Pellitory-of- the-Wall	<i>Parietaria officinalis</i> (Urticaceae)	The juice of the fresh herb, made into a thin syrup stimulates the kidneys	4 - 5 ml extract 2 -3 times daily	Diuretics and other urinary complaints

7. Conclusion

GN is a characteristic disorder of kidney, leading to one of the major cause of renal failure. It is generally caused by various bacterial and certain medicated drugs like- Gold, Pamidronate, Penicillamine, Propylthiouracil, Antineoplastics, Allopurinol, etc. The prevention and treatment of GN by various corticosteroids, NSAIDs, Antibiotics and Immunosuppressant are commonly recommended in allopathic system of treatment. These therapies based on specific antigen-antibody responses or dominant effectors cells and/or molecules engaged in individual Glomerulonephritic patient. In ayurvedic systems of treatment, roots & seeds of various plants such as- Varunadi, Punarnava, Palaash, Kaasni, Niruri etc. are widely used and either individual or in the combination form for the treatment of glomerulonephritis. In Future, a variety of therapy will provide sufficient treatment of GN and more susceptible to renal failure,

as cellular immunity, immune tolerance and regulatory networks will grant the foundation for customized individualized therapy.

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