Approach to Glomerular Disease

NEPHROLOGY
PHRAMONGKUTKLAO HOSPITAL

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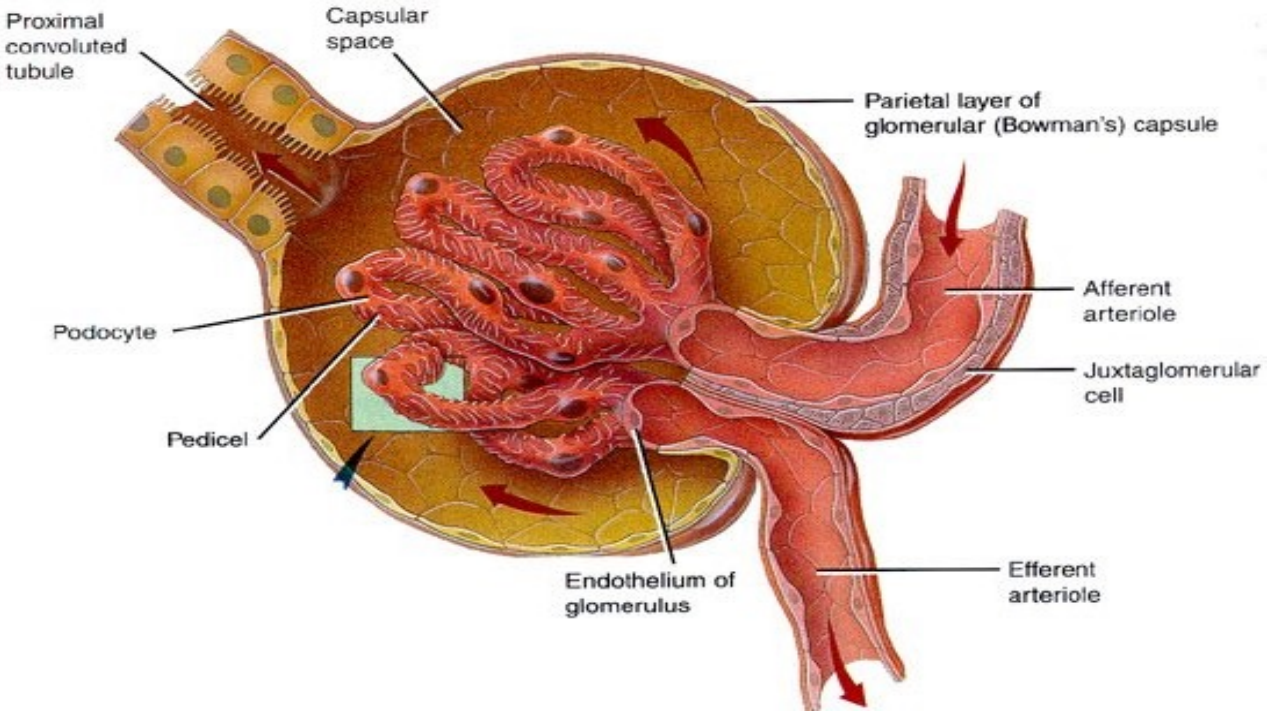
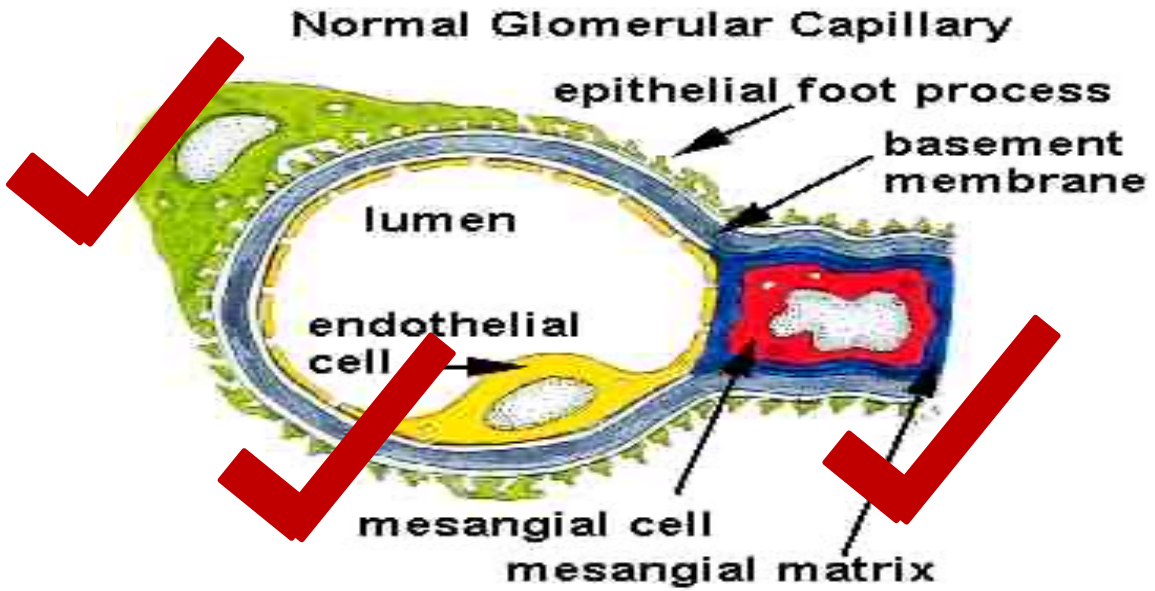
Outlines

- Introduction to glomerular syndrome
- Approach to glomerular disease
- Management of glomerular disease

Glomerular Structure





Normal: Total urine protein
< 30-150 mg/day (Albumin: 20-40%)

Abnormal urine protein:
- **Urine protein > 150 mg/day**
- **UPCI > 0.15**

Modified from UpToDate 2024.

Overview Cause of Protein

Intermittent (transient) proteinuria

1. Functional proteinuria:

- Increase intra-glomerular pressure
- Exercise, CHF, fever, stress, acute illness
- Typical protein < 1-2 g, no active urine sediment, normal GFR

2. Orthostatic proteinuria:

- Abnormal proteinuria: Upright
- Normal urine protein: Supine position
- Common age <30 years old
- Typical: protein < 1-2 g, no active urine sediment, and normal GFR
- Urine protein (23.00-7.00) < 50 mg/8 hours
- Benign and self limited

Persistent proteinuria

1. Tubular proteinuria:

- Loss tubular reabsorption ability
- Protein < 2 gram/day
- Combine with abnormal PTC function

- Bicarbonaturia
- Glycosuria
- Amino aciduria
- hyperuricosuria
- hyperphosphaturia

Overview Cause of Protein

Intermittent (transient) proteinuria

Persistent proteinuria

1. Tubular proteinuria:
- ❖ Loss tubular reabsorption ability
- ❖ Protein < 2 gram/day
- ❖ Combine with abnormal PTC function

Proteinuria in Multiple myeloma

UA disproportion with UPCI

Normal SCr

Overflow proteinuria

↑SCr ± Fanconi syndrome

Myeloma cast nephropathy

UA proportion with UPCI

Deposition diseases:
- ❖ AL amyloidosis
- ❖ MIDD

2. Overflow proteinuria: Multiple myeloma or
- ❖ LMW protein >Tubular reabsorption ability
- ❖ Urine dipstick disproportion to urine 24 h
- ❖ Urine dipstick negative: SSA positive

Overview Cause of Protein

Intermittent (transient) proteinuria

Persistent proteinuria

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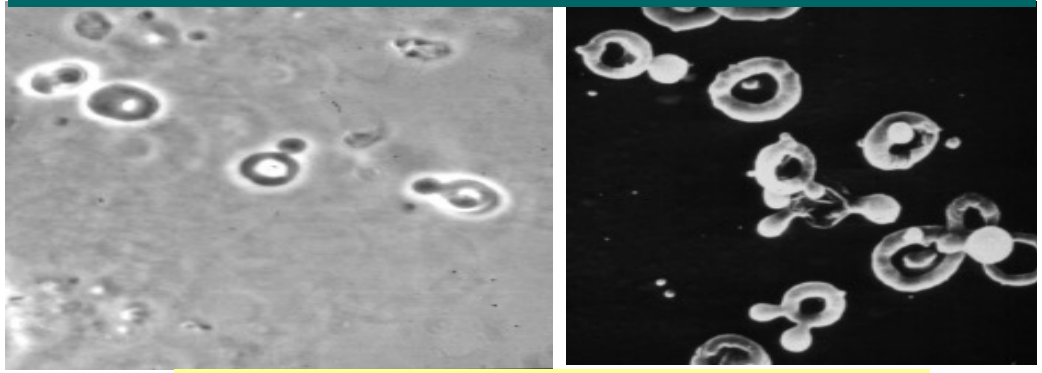
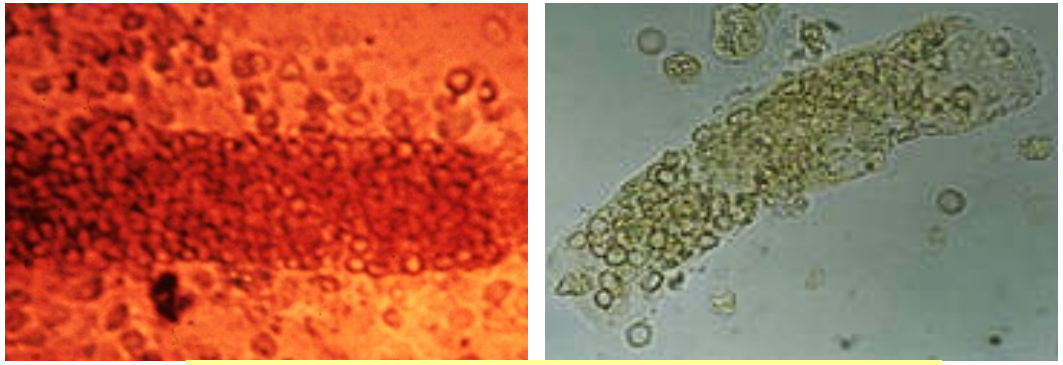
- ❖ Urine dipstick negative: SSA positive

3. Glomerular proteinuria:
- ❖ Glomerular structural abnormality
- ❖ Vary urine protein (> 2-3 g/day suggestive)
- ❖ Clinical and sign: Glomerular syndrome
- ❖ Dysmorphic RBC or RBC cast

Glomerular hematuria



Dysmorphism of RBC in urine



RBC casts

Outlines

- Introduction to glomerular syndrome
- **Approach to glomerular disease**
- Management of glomerular disease

Long Case: Approach to glomerular disease

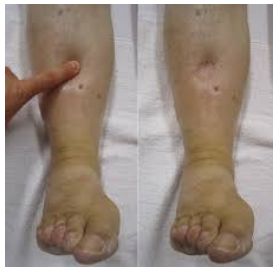
Part 1: (30 minutes)

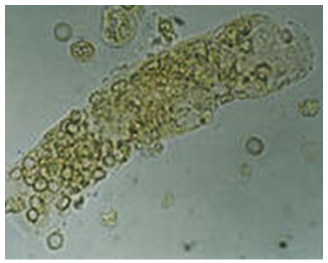
- **History taking**
- **Physical examination: Affected part of glomerular disease**

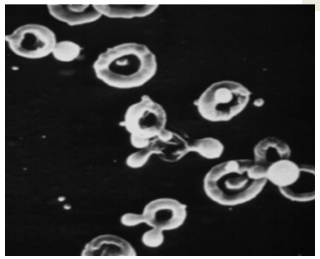
Clinical Presentation of Glomerular Disease

Cardinal Manifestation

1. Salt-water retention	❖ Generalized edema ❖ Hypertension
2. Proteinuria	❖ Foamy urine ❖ > 2-3 gram/day
3. Glomerular hematuria	❖ Dysmorphic RBC ❖ Acanthocyte ❖ RBC cast
4. Decreased GFR	❖ Azotemia (Acute/Chronic) ❖ Oliguria







Systemic /Secondary cause symptom

1. Constitutional symptom
2. Multiorgan involvement (renal)
3. Autoimmune symptom
4. Prolonged fever, infection
5. Significant weight loss, anorexia
6. Malignancy: Solid, hematologic
7. Drug/toxin/vaccine
8. Genetic
9. Other secondary glomerular
10. Pulmonary-renal syndrome
11. Underlying diseases

Clinical Syndrome of Glomerular Diseases

1. Asymtomatic Hematuria/Proteinuria

- Proteinuria 150 mg to 3 g/day
- Hematuria >2 RBC/HPF in spun urine (RBC usually dysmorphic)

2. Nephrotic syndrome

- Generalized edema
- Proteinuria > 3.5 g/day
- Hypoalbuminemia < 3.0-3.5 g/dL)
- Hyperlipidemia
- Lipiduria: Oval fat body, fatty cast

3. Nephritic Syndrome

- Hematuria: Dysmorphic, RBC casts
- Proteinuria: Usually <3 g/day
- Hypertension: Abrupt/recent onset
- Oliguria/Azotemia
- Edema

Macroscopic hematuria Brown/red painless hematuria (no clots)

4. Rapidly Progressive Glomerulonephritis (RPGN)

- BUN/Cr rising over days/weeks
- Active urine sediment: Dysmorphic RBC, RBC cast
- Hypertension
- Proteinuria: usually < 3 g/day
- Oliguria
- Edema

1. Pauci-immune (ANCA)
2. Immune complex-mediated injury
3. Anti-GBM
4. Idiopathic

5. Chronic Glomerulonephritis (CGN)

- BUN/Cr rising
- Hypertension
- Shrunken smooth kidney, small size kidney
- Proteinuria/Glomerular hematuria

Nephritonephrotic

Nephrotic Syndrome/Nephritis Syndrome/RPGN

Primary glomerular disease

Diseases	Nephrotic syndrome	Nephritic syndrome
MCD	4+	-
MN	4+	+
FSGS	3+	2+
IgAN	2+	3+
MPGN	2+	3+
PSGN	1+	4+
RPGN	1+	4+

Correct cause: Secondary glomerular disease

1. Metabolic disease (DN)
2. Connective tissue disease (SLE, RA)
3. Infection-related GN: HBV, HCV, HIV, Bacteria, parasite
4. Malignancy
5. Paraproteinemia (MM, Amyloidosis)
6. Drug
7. Genetic disorder
8. Other
   - Systemic vasculitis
   - Pre-eclampsia
   - Obesity
   - Reflux nephropathy
   - Radiation nephropathy
9. Vasculitis, RPGN, pulmonary-renal syndrome

Approach to Nephrotic Syndrome

1. **Clinical signs/symptoms/lab of possible secondary causes**
2. **Demographic: Age, Race**
3. **Clinical signs/symptoms of nephrotic/nephritis**
4. **Initial Lab: Urine sediments, Azotemia (BUN/cr)**
5. **Lab investigation: Complement, ANA**
6. **Response to treatment**
7. **Family history**

1. Metabolic disease (DN)
2. Connective tissue disease (SLE, RA)
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7. Genetic disorder
8. Other
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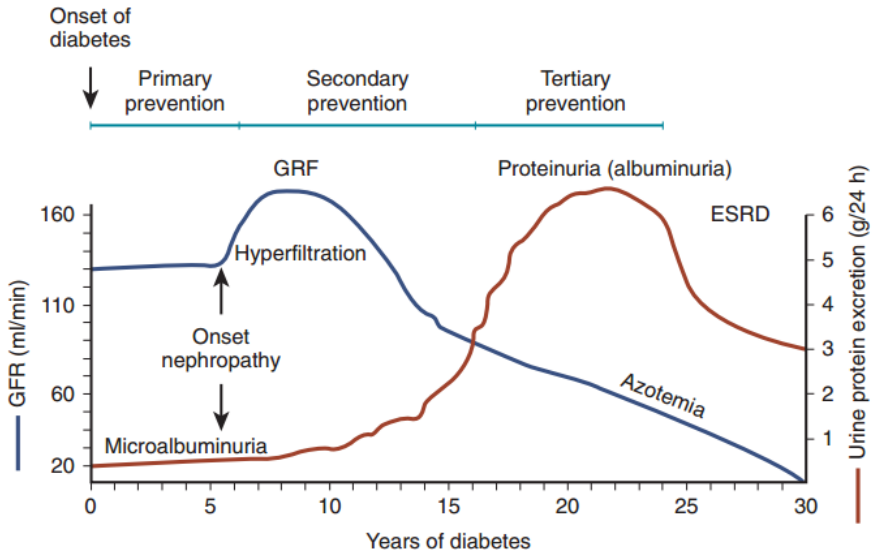
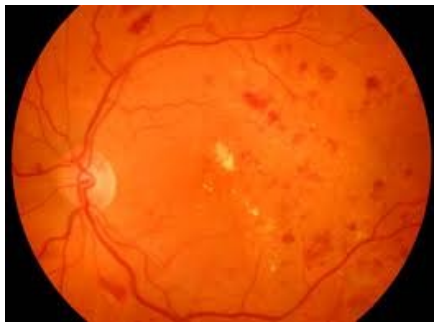
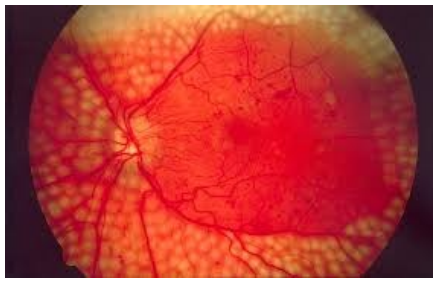
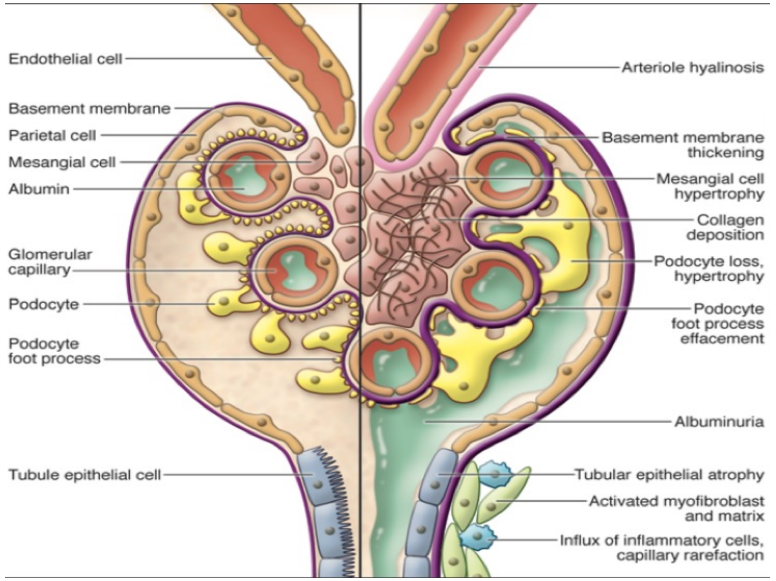
   - Pre-eclampsia
   - Obesity
   - Reflux nephropathy
   - Radiation nephropathy

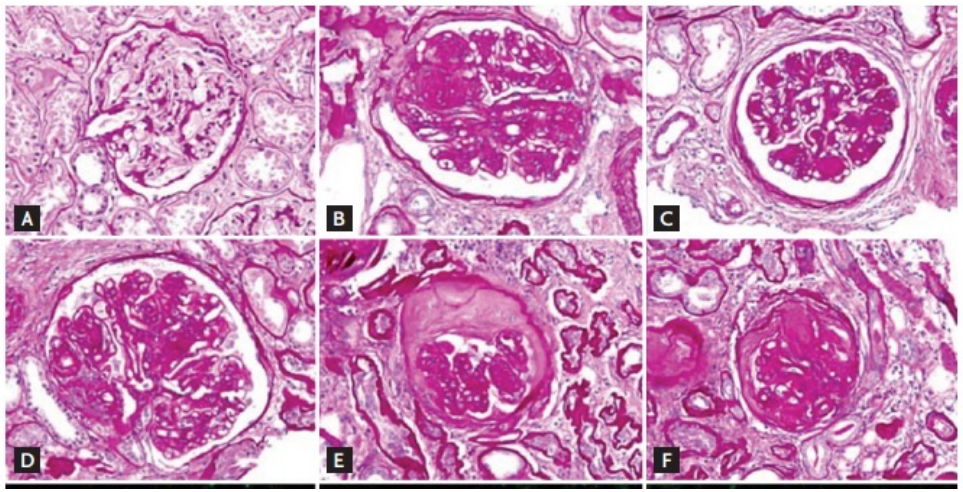
Secondary Cause of Nephrotic Syndrome: Diabetic nephropathy (DN): DKD











When to considered for Other causes of CKD in Diabetes Patient

- ❖Absence of diabetic retinopathy
- ❖Low or rapidly decreasing GFR
- ❖Rapidly increasing proteinuria or nephrotic syndrome
- ❖Refractory hypertension
- ❖Presence of active urinary sediment
- ❖Signs/symptoms of other systemic disease
- ❖>30% reduction in GFR within 2-3 months after initiation of an ACE inhibitor or ARB

Adapted from Ready K, et al. J Clin Invest. 2014;124(6):2333–2340

NKF KDOQI GUIDELINES for Diabetes and Chronic Kidney Disease 2007

Lupus nephritis biopsy ISN/RPS 2013 Classification

Class I	Minimal mesangial lupus nephritis
Class II	Mesangial proliferative lupus nephritis
Class III	Focal lupus nephritis[a]
Class IV	Diffuse segmental (IV-S) or global (IV-G) lupus nephritis[b]
Class V	Membranous lupus nephritis[c]
Class VI	Advanced sclerosing lupus nephritis

Indicate and grade (mild, moderate, severe) tubular atrophy, interstitial inflammation and fibrosis, severity of arteriosclerosis or other vascular lesions.

[a]Indicate the proportion of glomeruli with active and with sclerotic lesions.

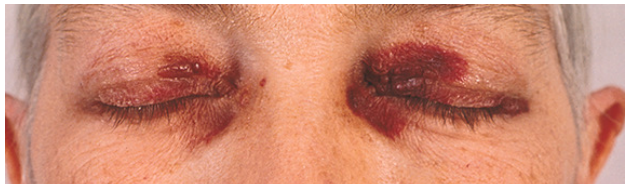
[b]Indicate the proportion of glomeruli with fibrinoid necrosis and cellular crescents.

[c]Class V may occur in combination with class III or IV, in which case both will be diagnosed.

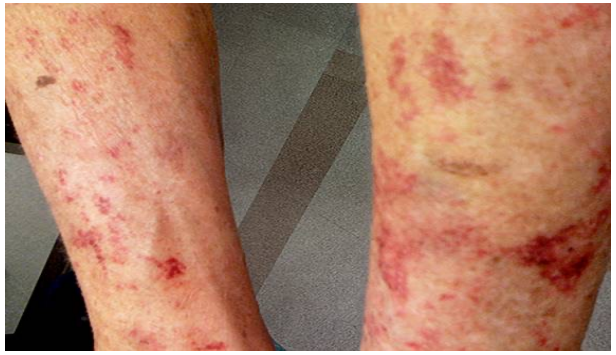
Weening JJ, et al. Kidney Int, 2004: 65: 521–530.

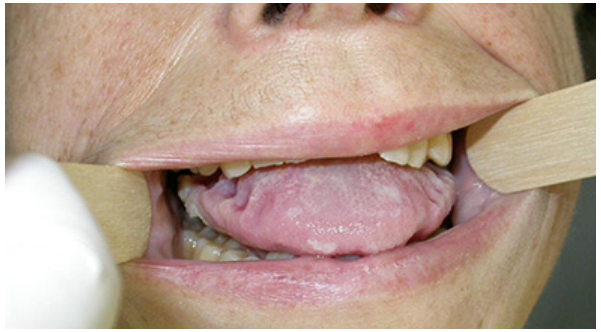
Secondary Cause of Nephrotic Syndrome: Amyloidosis

- ↑Age
- Organomegaly: Hepatomegaly
- Anemia
- Urine protein, Cr
- Urine Bence Jones protein



Periorbital purpura

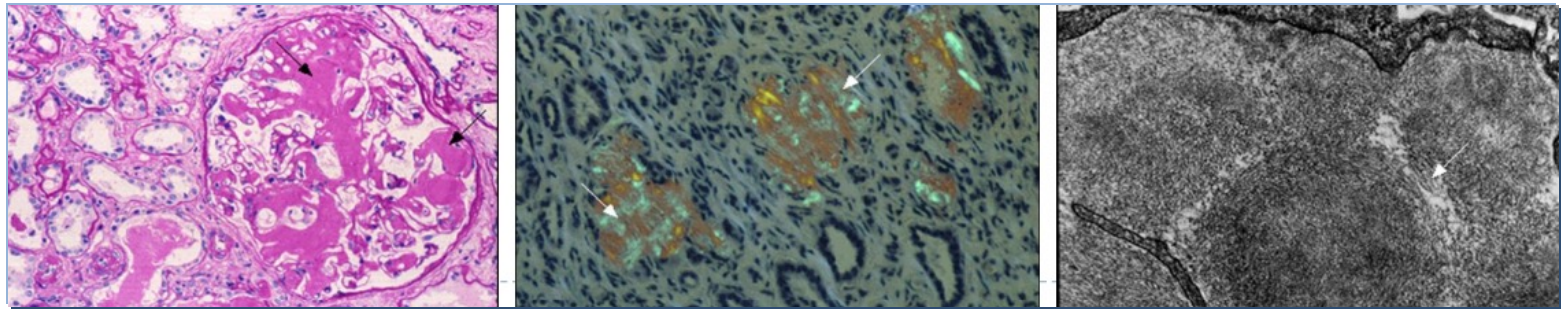




Initial symptoms	
Fatigue	62%
Weight loss	52%
Purpura	15%
Pain	5%
Gross bleeding	3%

Physical examination finding	
Palpable liver	24%
Macroglossia	9%
Palpable spleen	5%
Lymphadenopathy	3%

Laboratory findings	
Increase plasma cell(BM> 6%)	56%
Anemia (Hb< 10 g/dL)	11%
Serum creatinine> 1.3 mg/dL	45%
Elevated alkaline phosphatase	26%
Hypercalcemia(>11 mg/dL)	2%
Proteinuria(> 1 g/24 hr)	55%
Urine light chain	73%
Ќ chain	23%
ɹchain	50%



Secondary Cause of Nephrotic Syndrome/Nephrotic range proteinuria

Etiology of secondary cause of Membranous Nephropathy (MN)

1. Immunologic disorder
   - SLE (LN), MCTD, RA, Sjogren, autoimmune thyroiditis
2. Malignancy: Solid malignancy (colon, breast, lung)
3. Infection: Viral hepatitis, syphilis, and leprosy
4. Drugs: Penicillamine, gold, NSAIDS, and captopril

Etiology of secondary cause of MCD:

1. Drug: NSAID (AIN + MCD)
   Lithium
   Interferon
2. Malignancy: Hodgkin's disease
   Malignant thymoma
3. Atopic disease: Eczema, dermatitis
4. Post vaccination
5. Bee string, snake bite

Etiology of secondary cause of FSGS

1. Reduced nephron numbers: Unilateral renal agenesis, Reflux-interstitial nephritis, Post-focal cortical necrosis
2. Glomerulomegaly: Obesity, Sickle cell disease, Cyanotic congenital heart disease, Hypoxic pulmonary disease
3. Virus-ascociation FSGS: HIV-associated nephropathy, Parvovirus B19, CMV, EBV
3. Drug toxicity: Heroin nephropathy, Pamidronate, Lithium, Interferon-α, CNI, mTor
4. Familial FSGS

Approach to Nephrotic Syndrome

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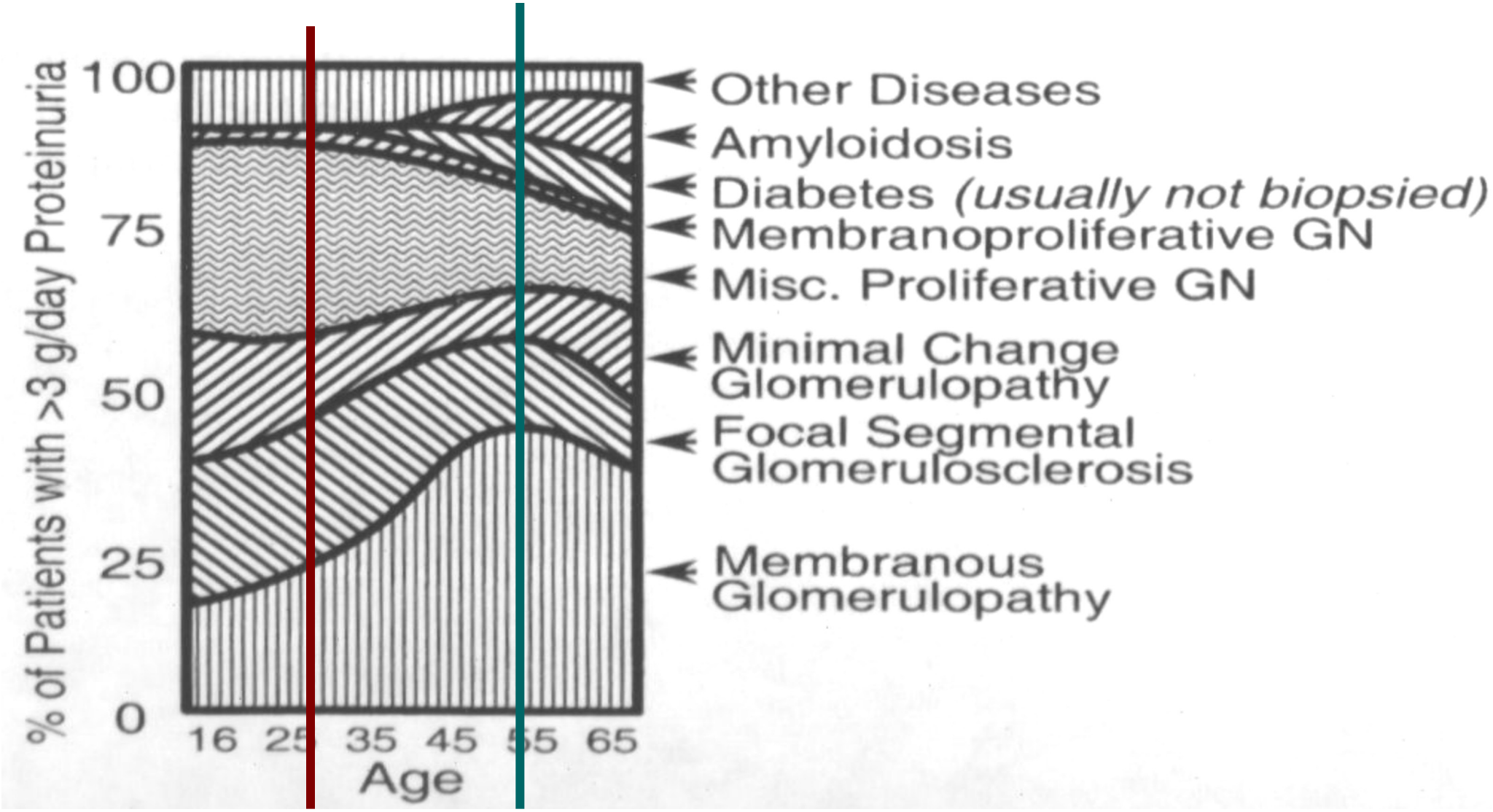
Nephrotic Syndrome and Age Group



Falk. The Kidney (Brenner 2000;p 1271)

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Differentiation Between Nephrotic Syndrome and Nephritic Syndrome

Typical Features	Nephrotic	Nephritic
Onset	Insidious	Abrupt
Edema	++++	++
Blood pressure	Normal	Raised
Jugular venous pressure	Normal/low	Raised
Proteinuria	++++	++
Hematuria	May/may not occur	+++
Red blood cell casts	Absent	Present
Serum albumin	Low	Normal/slightly reduced

Jürgen Floege, John Feehally. Comprehesive clinical nephrology. 2019

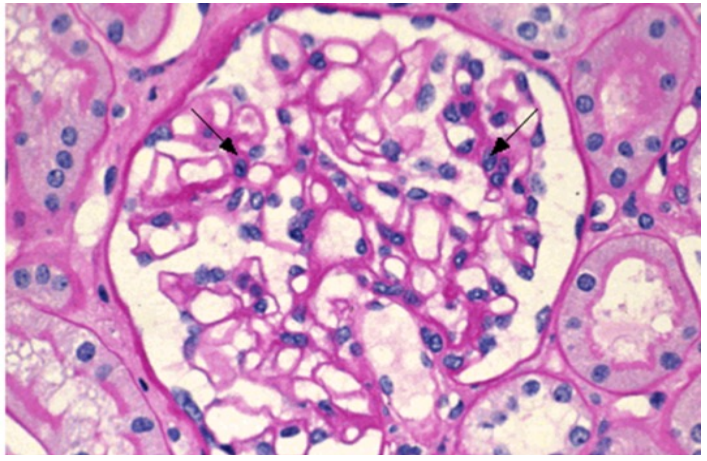
Manifestation of Nephrotic and Nephritic Feature

Diseases	Nephrotic (↑proteinuria , hypoalbuminemia, edema)	Nephritic (dysmorphic RBC, HT, ↑Cr)
MCD	4+	-
MN	4+	+
FSGS	3+	2+
MPGN	2+	3+
IgAN	2+	3+
PSGN	1+	4+
RPGN	1+	4+

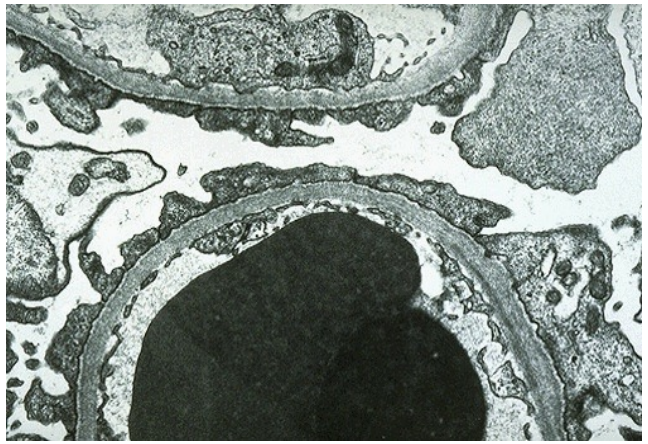
Minimal Change Disease (MCD)

Typical case: NS in young group patients:

- Podocytopathy: T-cell dysregulation driving the podocytopathy
- Full borne nephrotic syndrome (edema, hypoalbuminemia, ↑ lipid, heavy proteinuria)
- Abrupt onset edema and proteinuria
- No HT, no hematuria, normal GFR, rare cause ESRD
- Adults/elderly: 35% atypical presentation（HT, ↑ SCr, microscopic hematuria)
- Etiology: Primary (idiopathic) MCD, secondary cause



LM shows no glomerular lesions or only minimal mesangial prominence



EM shows podocyte foot process effecement.

Etiology of secondary cause:

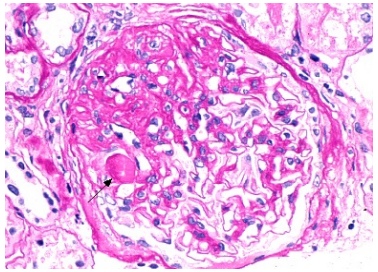
1. Drug: NSAID (AIN + MCD)
   Lithium, interferon
2. Malignancy: Hodgkin's disease (0.01%)
   Malignant thymoma
3. Atopic disease: Eczema, dermatitis
4. Post vaccination
5. Bee string, snake bite

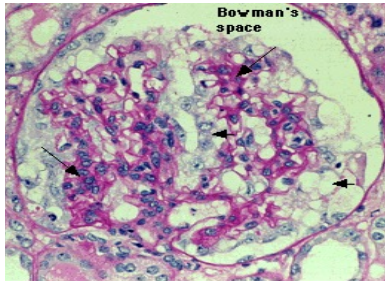
Focal Segmental Glomerulosclerosis (FSGS)

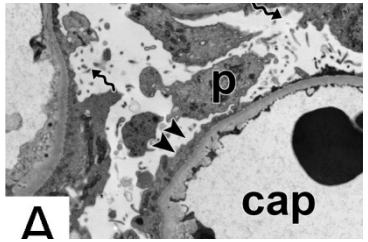
Classic case (60-75%):
- Full borne nephrotic syndrome
- Typical case: Acute onset
- Some case: Subacute, insidious onset
- Child, adolescent, young adult
- Vary: Hematuria: 30-50%,
  Hypertension: 45-65%, ↑SCr: 25-50%

Etiology: Primary (idiopathic) and secondary FSGS

Secondary FSGS:
- Asymptomatic proteinuria/hematuria
- Most case: Subnephrotic range proteinuria
- Some case: Nephrotic range)
- Normal/slightly normal serum albumin







Etiology of Secondary FSGS:

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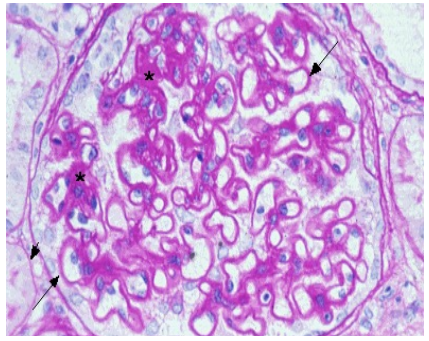
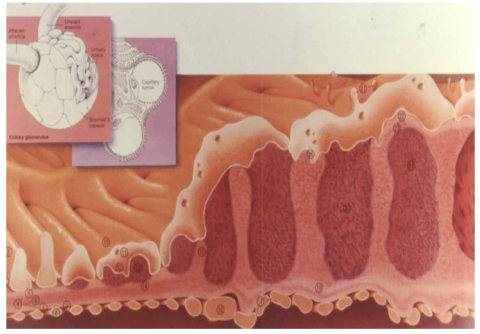
Membranous Nephropathy (MN)

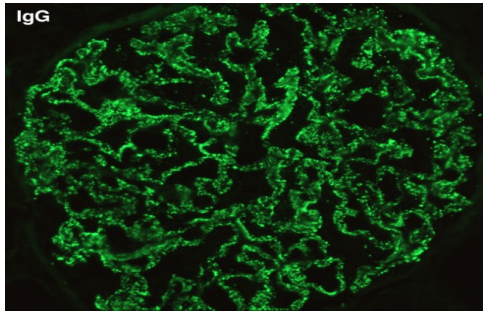
- Typical case: Age > 40 years
- Insidious onset
- Heavy Proteinuria
- Hematuria 15-30%
- Hypertension < 30%
- Acute rising Cr < 20%

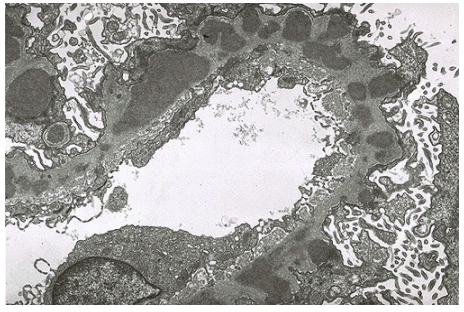
Clinical and natural history:

- Spontaneous remission (30%)
- Persistent proteinuria without progression(30%)
- Persistent proteinuria with progression loss of GFR (30%)
- Dead other cause (10%)









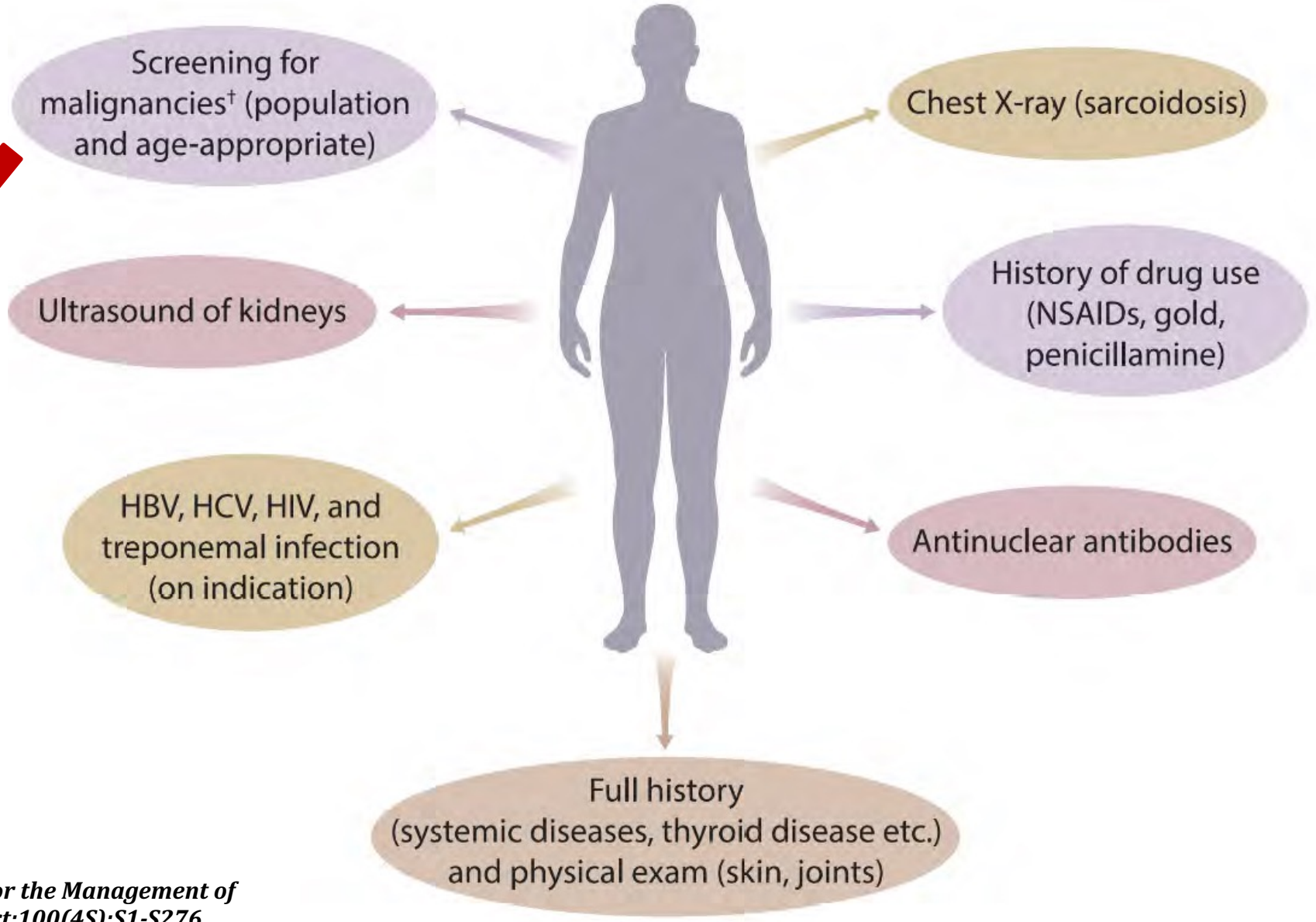
Etiology of Membranous Nephropathy (MN):

- **Primary MN or Idiopathic MN (80%)**
  - Anti-phospholipase A2 receptor

- **Secondary MN (20%)**
  1. Immunologic disorder
     - SLE, MCTD, Rheumatoid arthritis, Sjogren, autoimmune thyroiditis
  2. Malignancy: 7-8% (~22% in age >60 years)
     (colon, breast, lung) 60% with CA, 40% before CA)
  3. Infection: Viral hepatitis, syphilis, and leprosy
  4. Drugs: Penicillamine, gold, NSAIDS, and captopril

Evaluation of patients with MN for associated conditions

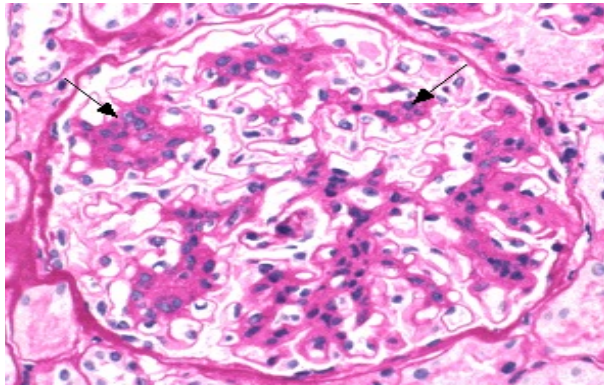
***Patient with MN should be evaluated for associated conditions, independent of the presence or absence of PLA2Rab or TSHD7Aab**
†Varies per country; the yield of cancer screening is not very h… especially in younger patients. Many centers will perform chest X-ray or CT scan, look for iron deficiency, and require the patients to have to participate in the national screening program for breast and colon cancer;
a PSA test is done in adult males >50-60 years.



KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021 Oct;100(4S):S1-S276.

IgM Nephropathy

- All age
- Nephrotic syndrome , asymptomatic hematuria, proteinuria
- Hypertension 32%
- Rising Cr 20%
- **Treatment: Like MCD**
- **Respond to steroid (CR+PR : 60-80%)**



IgA nephropathy (Berger’ s disease)

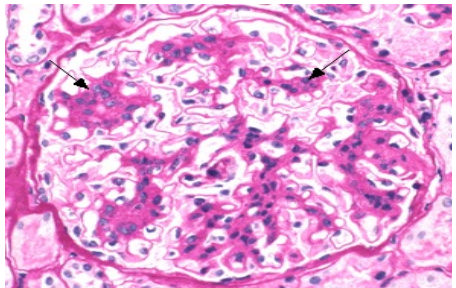
- ❖ Most common cause of primary glomerular disease
- ❖ All ages
- ❖ Male > female

Clinical presentation:

1. Gross hematuria follow immediately URI (Synpharyngitic glomerulonephritis)
2. Chronic glomerulonephritis (CGN)
3. Asymptomatic hematuria /proteinuria
4. Pure nephrotic syndrome (minimal change variant)
5. RPGN

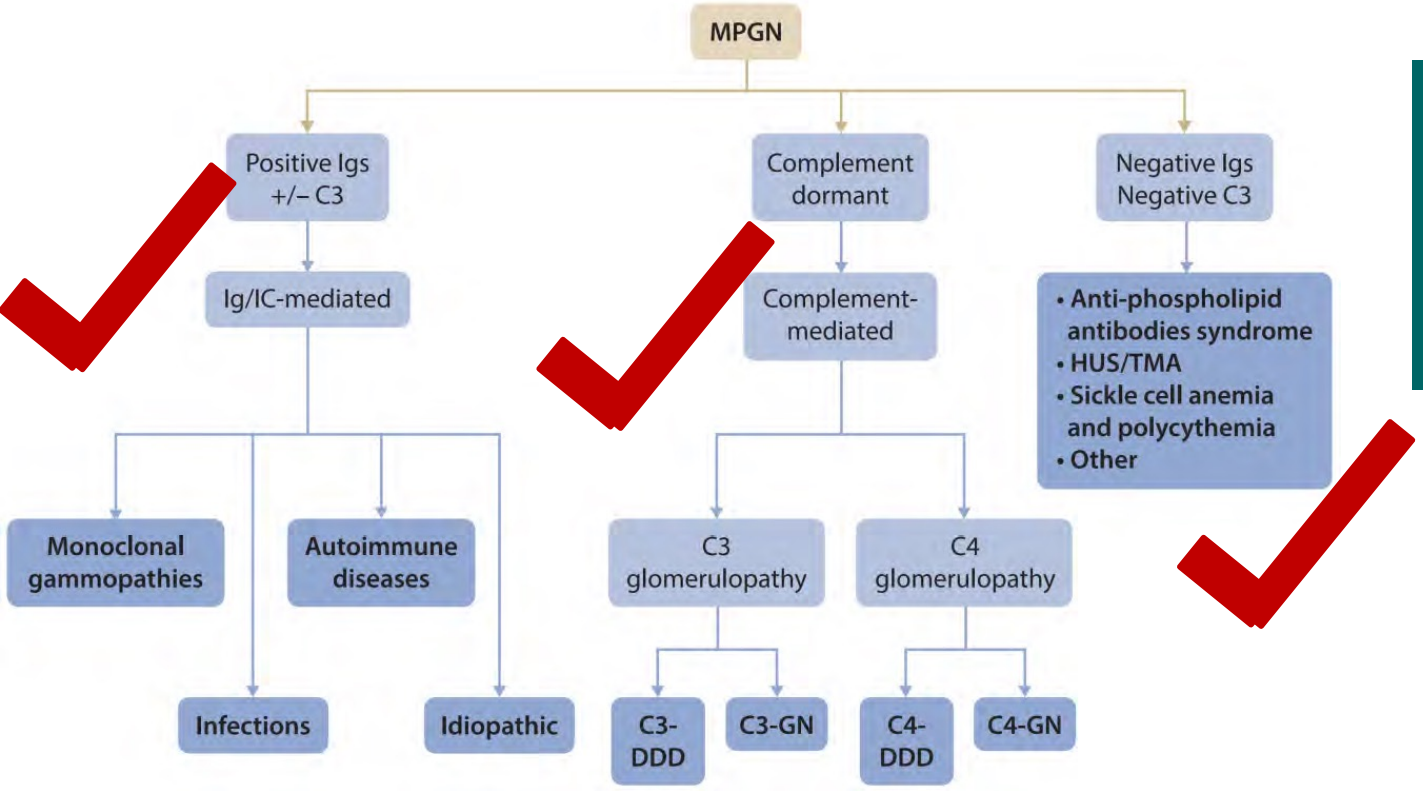
Nephritonephrotic

IgA-vasculitis

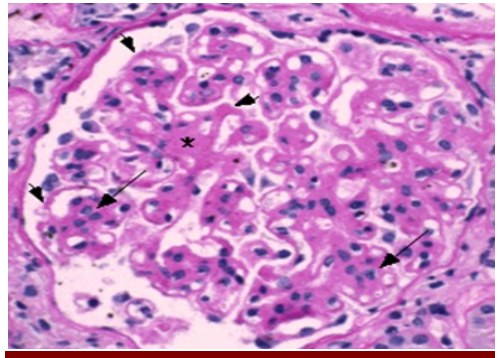


Modified from UpToDate 20224; KDIGO 2021 Kidney Int. 2021 Oct;100(4S):S1-S276.

Membranoproliferative Glomerulonephritis (MPGN)



LAB: Low complement
: Hepatitis C,B, cryoglobulinemia
: Malignancy, RA, SLE
: Kidney biopsy



Nephritonephrotic

Adapted from Public Review Draft: KDIGO Clinical Practice Guideline on Glomerular diseases, June 2020

Causes of a membranoproliferative (MPGN) pattern of injury

Practice Point 8.1.1: Evaluate patients with immune complex–mediated GN (ICGN) for underlying disease

Immunoglobulin-/ immune complex-mediated	**Deposition of antigen–antibody immune complexes as a result of an infection:** • Viral: hepatitis C (including HCV-associated mixed cryoglobulinemia), hepatitis B • Bacterial: endocarditis, infected ventriculo-atrial shunt, visceral abscesses, leprosy, meningococcal meningitis • Protozoa/other infections: malaria, schistosomiasis, mycoplasma, leishmaniasis, filariasis, histoplasmosis **Deposition of immune complexes as a result of an autoimmune disease:** • SLE • Sjögren's syndrome • Rheumatoid arthritis • Mixed connective tissue disease **Deposition of monoclonal Ig as a result of a monoclonal gammopathy due to a plasma cell or B cell disorder** **Fibrillary glomerulonephritis** **Idiopathic** • None of the conditions above are present
Complement-mediated	**C3 glomerulonephritis and C3 DDD:** • Mutations in complement regulatory proteins: CFH, CFI, CFHR5 • Mutations in complement factors: C3 • Antibodies to complement factors: C3, C4, and C5 nephritic factors • Antibodies to complement regulatory proteins: CFH, CFI, CFB **C4 glomerulonephritis and C4 DDD**
Membranoproliferative pattern without immune complexes or complement	• Healing phase of HUS/TTP • Antiphospholipid (anticardiolipin) antibody syndrome • POEMS syndrome • Radiation nephritis • Nephropathy associated with bone marrow transplantation • Drug-associated thrombotic microangiopathies • Sickle cell anemia and polycythemia • Dysfibrinogenemia and other pro-thrombotic states • Antitrypsin deficiency

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Approach Nephrotic Syndrome

1. Clinical signs/symptoms/lab of possible secondary causes
2. Demographic: Age, Race
3. Clinical signs/symptoms of nephrotic/nephritis
4. **Initial Lab: Urine sediments, Azotemia (BUN/cr)**
5. **Lab investigation: Complement, ANA, special lab**
6. Response to treatment
7. Family history

LAB:

1. **Confirm diagnosis glomerular disease**
2. **Lab for findout cause**
3. **Severity/underlying**

Confirm Diagnosis Nephrotic/nephritis Syndrome

Criteria diagnosis of Nephrotic syndrome

1. Generalized edema
2. Proteinuria > 3.5 g/day or
   urine albumin > 2.2 g/day
3. Hypoalbuminemia
   (serum albumin < 3.0 (3.5) g/dL)
4. Hyperlipidemia
5. Lipiduria: Urine oval fat body,
   Urine fatty cast

Nephritis/RPGN: Azotemia, urine: RBC, high BP

Clinical: Foamy urine, urine volume
- : Edema, congestion, BP
- : Underlying disease
- : Systemic symptom
- : Drug
- : Previous lab and treatment

Lab: UA (urine protein, urine specimen)
- : UPCI, 24 h urine protein
- : Serum albumin
- : Lipid profile
- : BUN/Cr

Screening for Proteinuria

- Urine dipstick testing:
  - Semi-quantitative
  - Detects albumin
- Urine specimen:
  - Fresh, clean voided
  - Midstream urine specimen

0 = 0 mg/dL,
TR = 15-30 mg/dL
1+ = 30-100 mg/dL
2+ = 100-300 mg/dL
3+ = 300-1000 mg/dL
4+ = >1000 mg/dL

Urine Protein: Quantitative

24 hours

- Urine Cr ~ 1 gram/day
  - Female15-20 mg/kg/day
  - Male 20-25 mg/kg/day

UPCI or UPCR

- UPCR
  = Urine protein /Urine Cr
- ↑ UPCR > 24 hours :
  - Acute medical illness
  - Exercise
  - Advanced stage AKI
- Early morning urine

Spot urine protein to Cr Ratio (UPCR)

Definition of "nephrotic syndrome," "nephrotic-range proteinuria," and "non-nephrotic-range proteinuria

Nephrotic syndrome	Nephrotic-range proteinuria	Non-nephrotic-range proteinuria
Proteinuria (adults)* • ≥3.5 g per 24 h • PCR ≥3000 mg/g (≥300 mg/mmol)	Proteinuria (adults) • ≥3.5 g per 24 h • PCR ≥3000 mg/g (≥300 mg/mmol)	Variable levels of proteinuria • 0.3–3.4 g per 24 h • PCR <300 mg/g (<30 mg/mmol)
Proteinuria (children)* • ≥40 mg/m²/h • ≥300 mg/dl • 3+ on urine dipstick • PCR ≥2000 mg/g (≥200 mg/mmol)	Proteinuria (children) • ≥40 mg/m²/h • ≥300 mg/dl • 3+ on urine dipstick • PCR ≥2000 mg/g (≥200 mg/mmol)	• Serum albumin normal • No clinical symptoms
• Hypoalbuminemia† • Edema‡ • Hyperlipidemia‡	• Serum albumin usually normal • Edema is usually absent or mino • Serum lipids usually normal or only mildly elevated	

Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Summary: Cause of BUN/Cr rising in Nephrotic Syndrome

1. Progression of disease:
   Severe disease (proliferation↑)

2. RPGN

3. Vasculopathy: TMA, APS, vasculitis

Other cause:

1. Pre-renal (low intake)
2. Over diuresis
3. NSAID
4. ACEI or ARB
5. ATN
6. AIN (drug)
7. Nephrosacar
8. Renal vein thrombosis (MN)
9. Other

Urinalysis in Primary Glomerular Disease

Nephrotic without RBC
No HT, normal SCr

- MCD (classic case)
- FSGS
- MN

Nephrotic with RBC
SCr normal

- FSGS
- MN (15-30% พบ RBC ได้)
- MCD (non-classic case)
- IgM
- IgA

Nephritonephotic/Nephritis
Urine RBC, HT, SCr↑

- IgA
- MPGN
- RPGN
- FSGS (predominate with nephrotic range proteinuria)
- PSGN (History suggest), infection-related GN
- Vasculitis

ใช้ข้อมูลเหล่านี้ในการเรียงอันดับก่อนหลัง:
1. Age 2. HT 3. Rising SCr 4. Onset , clinical course, respond to treatment

Hypocomplementemia in Glomerular Disease

Pathways Affected	Complement Changes	Glomerular Disease	Nonglomerular Disease
Classical pathway activation	C3 ↓, C4 ↓, CH50 ↓	Lupus nephritis (especially Class IV) Cryoglobulinemia Membranoproliferative GN type 1	
Alternative pathway activation	C3 ↓, C4 normal, CH50 ↓	Poststreptococcal GN GN associated with other infection* (e.g., endocarditis, shunt nephritis) HUS	Atheroembolic renal disease
	plus C3 nephritic factor	Dense deposit disease	
Reduced complement synthesis	Acquired		Hepatic disease Malnutrition
	Hereditary C2 or C4 deficiency Factor H deficiency	Lupus nephritis Familial HUS Dense deposit disease	

Low complement:

1. **SLE: Active/severe LN (↓ C3, ↓ C4)**
2. **Cryoglobulinemia (↓ C3, ↓ C4)**
3. **MPGN**
4. **PSGN (↓ C3, Normal C4)**
5. **SBE (↓ C3, Normal C4)**
6. **Shunt nephritis (↓ C3, Normal C4)**

***Glomerulonephritis (GN) with visceral abscesses is generally associated with normal or increased complement (elevations occur because complement components are acute-phase reactants). CH50, 50% hemolyzing dose of complement; HUS, hemolytic uremic syndrome.**

Comprehesive clinical nephrology. Ed 7th.

Common Glomerular Diseases Presenting as Nephrotic Syndrome in Adults

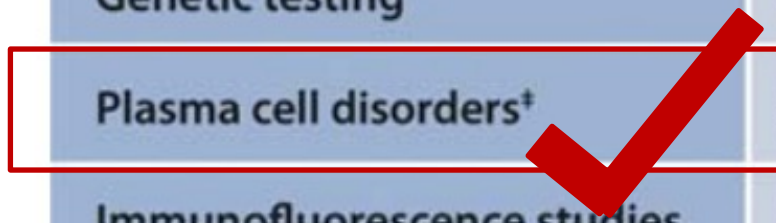
Disease	Associations	Serologic Tests
Minimal change disease (MCD)	Allergy, atopy, NSAIDs, Hodgkin disease	None
Focal segmental glomerulosclerosis (FSGS)	African Americans	—
	HIV infection	HIV antibody
	Heroin, pamidronate	—
Membranous nephropathy (MN)	Idiopathic drugs: Gold, penicillamine, NSAIDs	Anti-PLA_2R antibody
	Infections: Hepatitis B and C; malaria	Hepatitis B surface antigen, anti–hepatitis C virus antibody
	Lupus nephritis	Anti-DNA antibody
	Malignancy: Breast, lung, gastrointestinal tract	—
Membranoproliferative glomerulonephritis (MPGN) type I	C4 nephritic factor	C3 ↓, C4 ↓
Dense deposit disease	C3 nephritic factor	C3 ↓, C4 normal
Cryoglobulinemic MPGN	Hepatitis C	Anti–hepatitis C virus antibody, rheumatoid factor, C3 ↓, C4 ↓, CH50 ↓
Amyloid disease	Myeloma	Plasma free light chains
	Rheumatoid arthritis, bronchiectasis, Crohn disease (and other chronic inflammatory conditions), familial Mediterranean fever	Serum protein electrophoresis, urine immunoelectrophoresis
		C-reactive protein
Diabetic nephropathy	Other diabetic microangiopathy	None

HIV, Human immunodeficiency virus; *NSAIDs,* nonsteroidal antiinflammatory drugs; *PLA_2R,* phospholipase A_2 receptor.

Jürgen Floege, John Feehally. Comprehesive clinical nephrology. 2019

Practice Point 8.1.2: Evaluate patients with GN and monoclonal immunoglobulin deposits for a hematologic malignancy. Practice Point 8.1.3: If no underlying etiology is found for ICGN after extensive workup, evaluate for both complement dysregulation and drivers of complement dysregulation (Figure 70).

Functional assays	CH50, AP50, FH function
Quantification of complement components and regulators	C3, C4, FI, FH, FB, Properdin
Measurement of complement activation	C3d, Bb, sMAC
Autoantibodies	Anti-FH, anti-FB, nephritic factors (C3, C4, C5)
Genetic testing	C3, CFH, CFI, CFB, and CFHR1-5 MLPA
Plasma cell disorders[‡]	Serum free light chains, serum and urine electrophoresis, and immunofixation[†]
Immunofluorescence studies on kidney biopsy specimen	IgA, IgG, IgM, C1q, C3, fibrinogen, kappa, lambda, C4d (usually bright C3, negative or minimal Ig, negative C4d)



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Approach to Nephrotic Syndrome

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2. Demographic: Age, Race
3. Clinical signs/symptoms of nephrotic/nephritis
4. Initial Lab: Urine sediments, Azotemia (BUN/cr)
5. Lab investigation: Complement, ANA, special lab
6. **Response to treatment**
7. **Family history**

Response to treatment

Primary glomerular disease

- ❖ Minimal change nephrotic syndrome (MCD)
- ❖ Focal segmental glomerulosclerosis (FSGS)
- ❖ Membranous nephropathy (MN)
- ❖ IgM nephropathy

- ❖ IgA nephropathy
- ❖ Membranoproliferative GN (MPGN)

Secondary glomerular disease

1. Metabolic disease (DN)
2. Connective tissue disease (SLE, RA)
3. Infection-related GN: HBV, HCV, HIV, Bacteria, parasite
4. Malignancy
5. Paraproteinemia (MM, Amyloidosis)
6. Drug
7. Genetic disorder
8. Other
   - Systemic vasculitis
   - Pre-eclampsia
   - Obesity
   - Reflux nephropathy
   - Radiation nephropathy

1. Specific treatment: Correct cause, medication/intervention
2. Supportive treatment
3. Treatment other underlying disease

Definition of Remission, Relapse, Resistance and Dependence for MCD

1. **Complete remission (CR)**
   - Reduction of proteinuria < 0.3 g/day or UPCR <300 mg/g
   - Stable serum Cr and serum albumin > 3.5 g/dL

2. **Partial remission (PR)**
   - Decrease up to 50% of baseline and 0.3- <3.5 g/day (UPCR 300-3500 mg/g)

3. **Steroid-resistance MCD**
   - Persistent proteinuria > 3.5 g/day with <50% reduction from baseline despite prednisolone 1 MKD or 2 MKAD ≥ 16 weeks

4. **Steroid-dependence MCD**
   - Relapse occurring during, or 2 week of completing corticosteroid therapy

5. **Relapse**
   - Proteinuria >3.5 g/day or UPCR >3500 mg/g after complete remission

6. **Frequently relapsing MCD**
   - ≥2 relapse per 6 months or ≥4 relapse per 12 months

MCD: Respond to steroid

Child: CR > 95%
(50% at 4 weeks: 91% at 8 weeks)

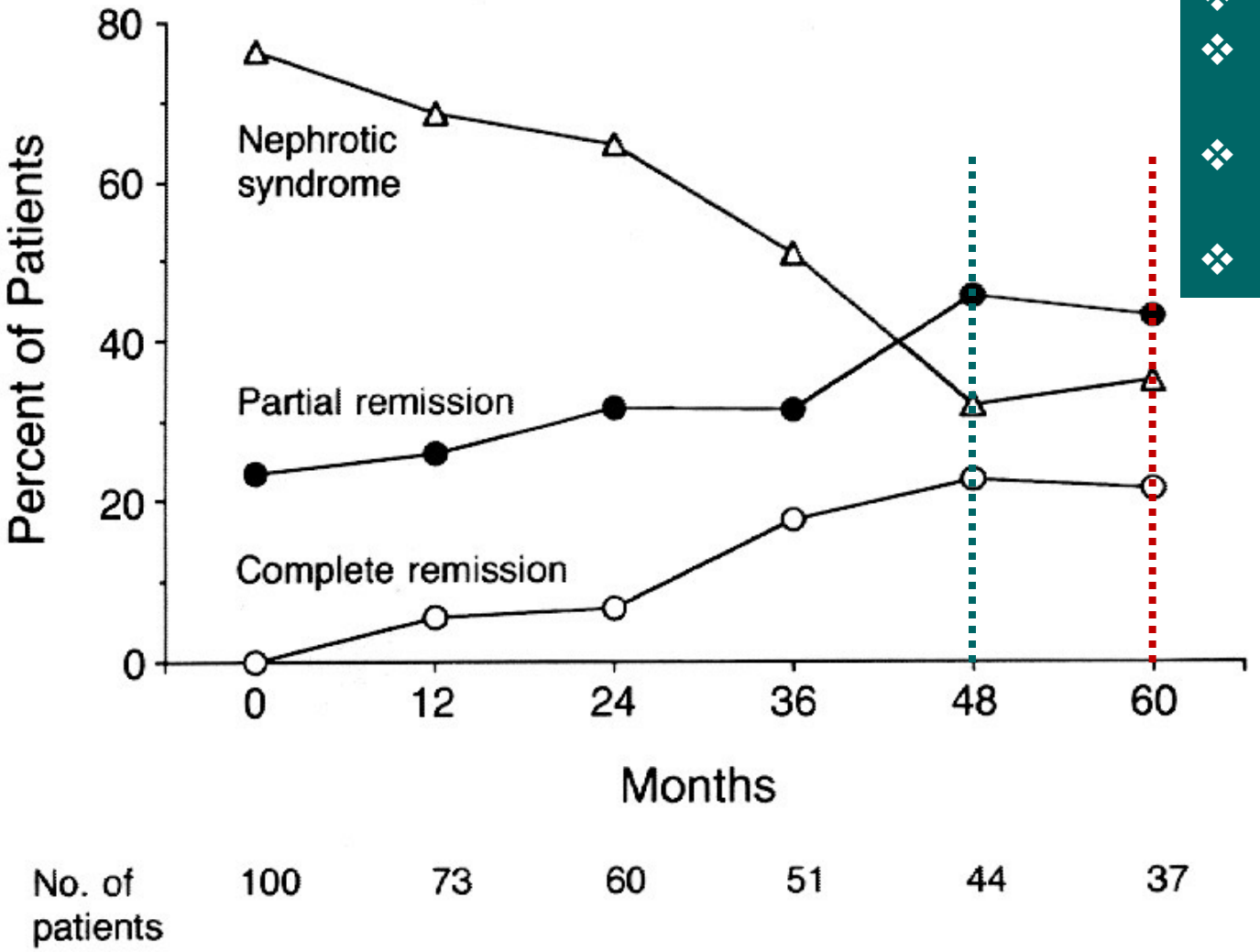
Adult: - CR+PR >80-90% ,
- CR 70-80%
(48 % at 4 week : 75% at 8 weeks)
- Relapse rate
(25% at 1 years, 37% at 4 years)

FSGS: Respond to steroid

CR+PR: 25-60% (CR 20-50%, PR 5-10%)

KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Prognosis of Untreated Patients with Idiopathic Membranous Nephropathy



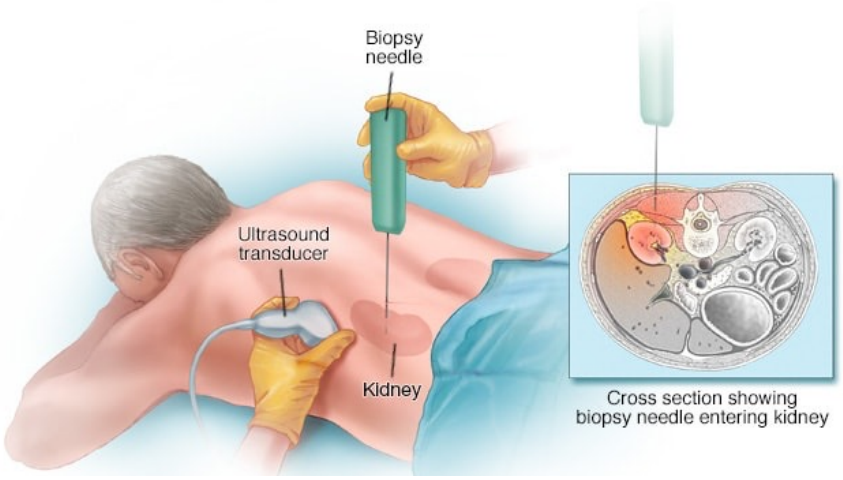
Clinical and natural history:

- **Spontaneous remission (30%)**
- **Persistent proteinuria without progression(30%)**
- **Persistent proteinuria with progression loss of GFR (30%)**
- **Dead other cause (10%)**

Schieppati A, et al. N Engl J Med. 1993 Jul 8;329(2):85-9.

Kidney Biopsy in Patients with Proteinuria/Glomerular hematuria

❖ **Practice Point 1.1.1: The kidney biopsy is the "gold standard" for the diagnostic evaluation of glomerular diseases. However, under some circumstances, treatment may proceed without a kidney biopsy confirmation of diagnosis**



Decision tree for the consideration of a kidney biopsy in patients with proteinuria and/or glomerular hematuria

Patients classically treated without kidney biopsy diagnosis

Children:
- Steroid-sensitive nephrotic syndrome <12 yrs old
- Poststreptococcal GN

The kidney biopsy is the gold standard for diagnostic evaluation of glomerular diseases

Biopsy should be performed if the biopsy result is expected to modify treatment and/or if additional prognostic information is needed

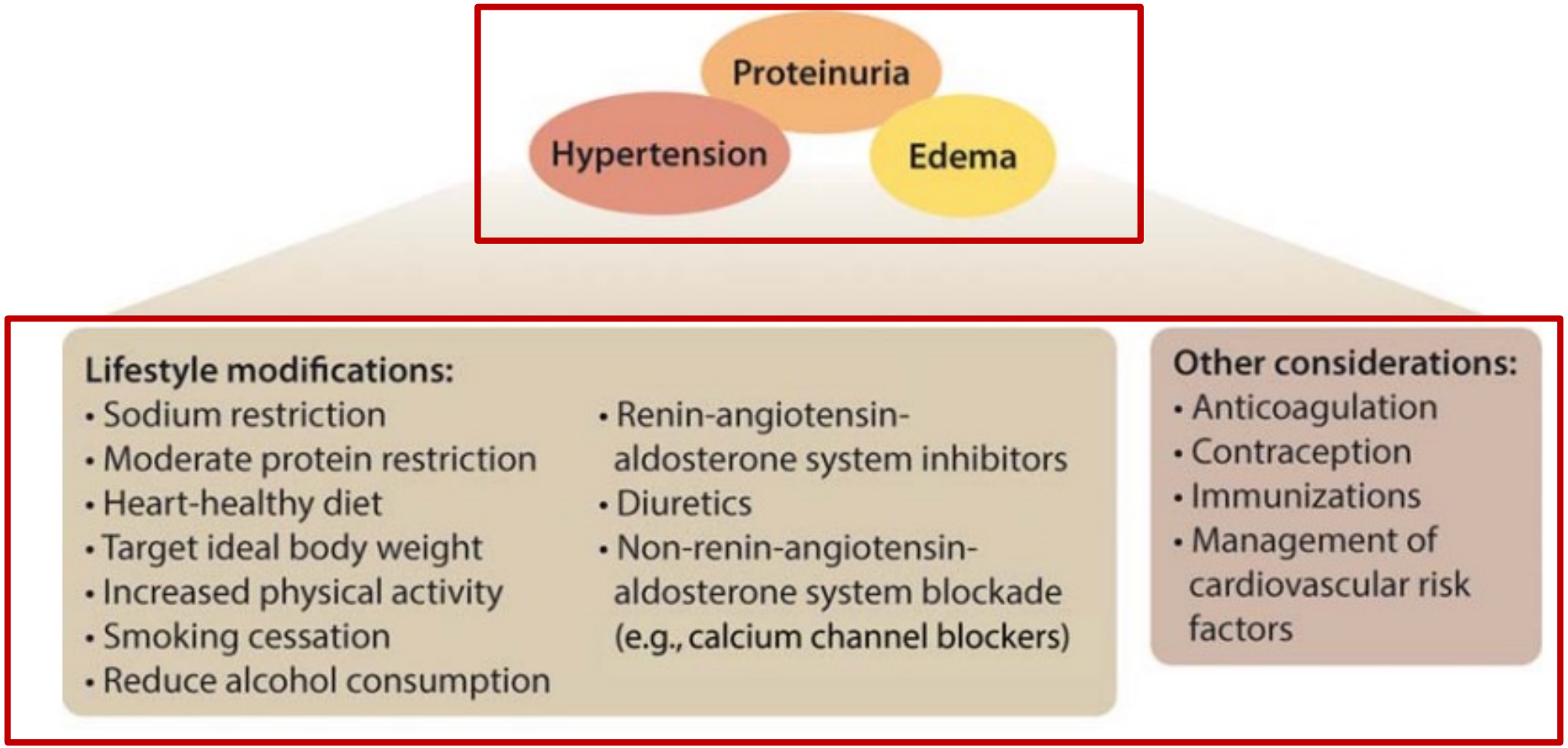
Examples of clinical conditions for which treatment may be considered without diagnostic confirmation by kidney biopsy:
- PLA2Rab+ membranous (especially with normal eGFR)
- MPO+ or PR3+ ANCA vasculitis
- Anti-glomerular basement membrane disease
- Alport disease
- Fabry disease
- Familial focal and segmental glomerulosclerosis in families with well-characterized mutations
- Biopsy contraindicated as judged by a synthesis of history, physical exam, and laboratory testing
- Systemic lupus erythematosus

Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Outlines

- Introduction to glomerular syndrome
- Approach to glomerular disease
- **Management of glomerular disease**

Summary of supportive management of glomerular disease-1



Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Edema management in nephrotic syndrome

Practice Point 1.4.1. Use loop diuretics as first-line therapy for treatment of edema in the nephrotic syndrome	• Twice daily dosing preferred over once daily dosing; daily dosing may be acceptable for reduced GFR • Increase dose of loop diuretic to cause clinically significant diuresis or until maximally effective dose has been reached • Switch to longer acting loop diuretic such as bumetanide or torsemide/torasemide if concerned about treatment failure with furosemide, or if concerned about oral drug bioavailability
Practice Point 1.4.2. Restrict dietary sodium intake	• Restrict dietary sodium to <2.0 g/d (<90 mmol/d)
Practice Point 1.4.3. Use loop diuretics with other mechanistically different diuretics as synergistic treatment of resistant edema in the nephrotic syndrome	• All thiazide-like diuretics in high doses are equally effective. None is preferred. • Thiazide diuretics, administered with an oral or i.v. loop diuretic, will impair distal sodium reabsorption and improve diuretic response • Amiloride may provide improvement in edema/hypertension, and counter hypokalemia from loop or thiazide diuretics • Acetazolamide may be helpful for the metabolic alkalosis of diuresis • Spironolactone may provide improvement in edema/hypertension, and counter hypokalemia from loop or thiazide diuretics
Practice Point 1.4.4. Monitor for adverse effects of diuretics	• Hyponatremia with thiazide diuretics • Hypokalemia with thiazide and loop diuretics • Impaired GFR • Volume depletion, especially in pediatric/elderly patients • Hyperkalemia with spironolactone and eplerenone especially if combined with RAS blockade
Practice Point 1.4.5. Strategies for diuretic-resistant patient	• Amiloride • Acetazolamide • i.v. loop diuretics (bolus or infusion) alone • i.v. loop diuretics in combination with i.v. albumin • Ultrafiltration • Hemodialysis • Amiloride may reduce potassium loss and improve diuresis. Acetazolamide may help to treat metabolic alkalosis but is a weak diuretic

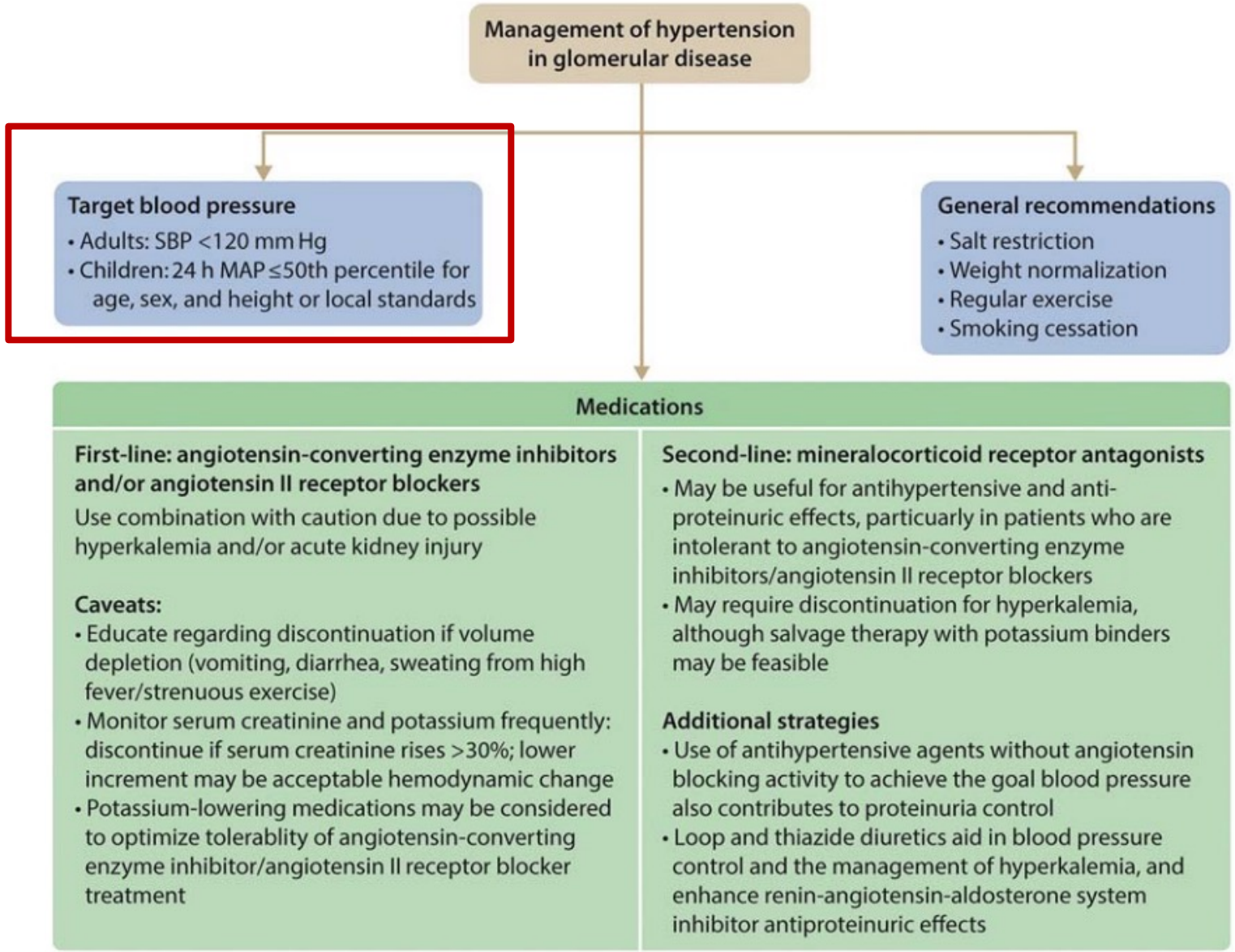
Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Management of hypertension and proteinuria in glomerular disease

Practice Point 1.5.1.	Use an ACEi or ARB to maximally tolerated or allowed dose as first-line therapy in treating patients with both hypertension and proteinuria	• Do not stop ACEi or ARB with modest and stable increase in serum creatinine (up to 30%) • Stop ACEi or ARB if kidney function continues to worsen, and/or refractory hyperkalemia • Combinations of ACEi and ARB may be used in young adults without diabetes or cardiovascular disease, but benefits and safety are uncertain Caveat: do not start ACEi/ARB in patients who present with abrupt onset of NS. These drugs can cause AKI especially in patients with MCD
Practice Point 1.5.2.	Target systolic blood pressure in most adult patients is <120 mm Hg using standardized office BP measurement. Target 24 h mean arterial pressure in children is ≤50th percentile for age, sex, and height by ambulatory blood pressure monitoring	• Refer to KDIGO BP Guideline (https://kdigo.org/guidelines/blood-pressure-in-ckd/) • Formally speaking, SBP <120 mm Hg has not been validated in GN. In practicality, we are able to achieve an SBP of 120–130 mm Hg in most patients with glomerular disease
Practice Point 1.5.3.	Uptitrate an ACEi or ARB to maximally tolerated or allowed daily dose as first-line therapy in treating patients with GN and proteinuria alone	• Indicated for persistent proteinuria despite treatment of primary GN with immunosuppression (where indicated) • Avoid use of an ACEi or ARB if kidney function is rapidly changing
Practice Point 1.5.4.	Proteinuria goal is variable depending on primary disease process; typically, <1 g/d	• It may be reasonable to delay initiation of ACEi or ARB for patients without hypertension with podocytopathy (MCD, SSNS, or primary FSGS) expected to be rapidly responsive to immunosuppression • Proteinuria goal is disease-specific in adults with GN
Practice Point 1.5.5.	Monitor labs frequently if on ACEi or ARB	• Titration of ACEi or ARB may cause acute kidney injury or hyperkalemia

Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Management of hypertension in glomerular disease



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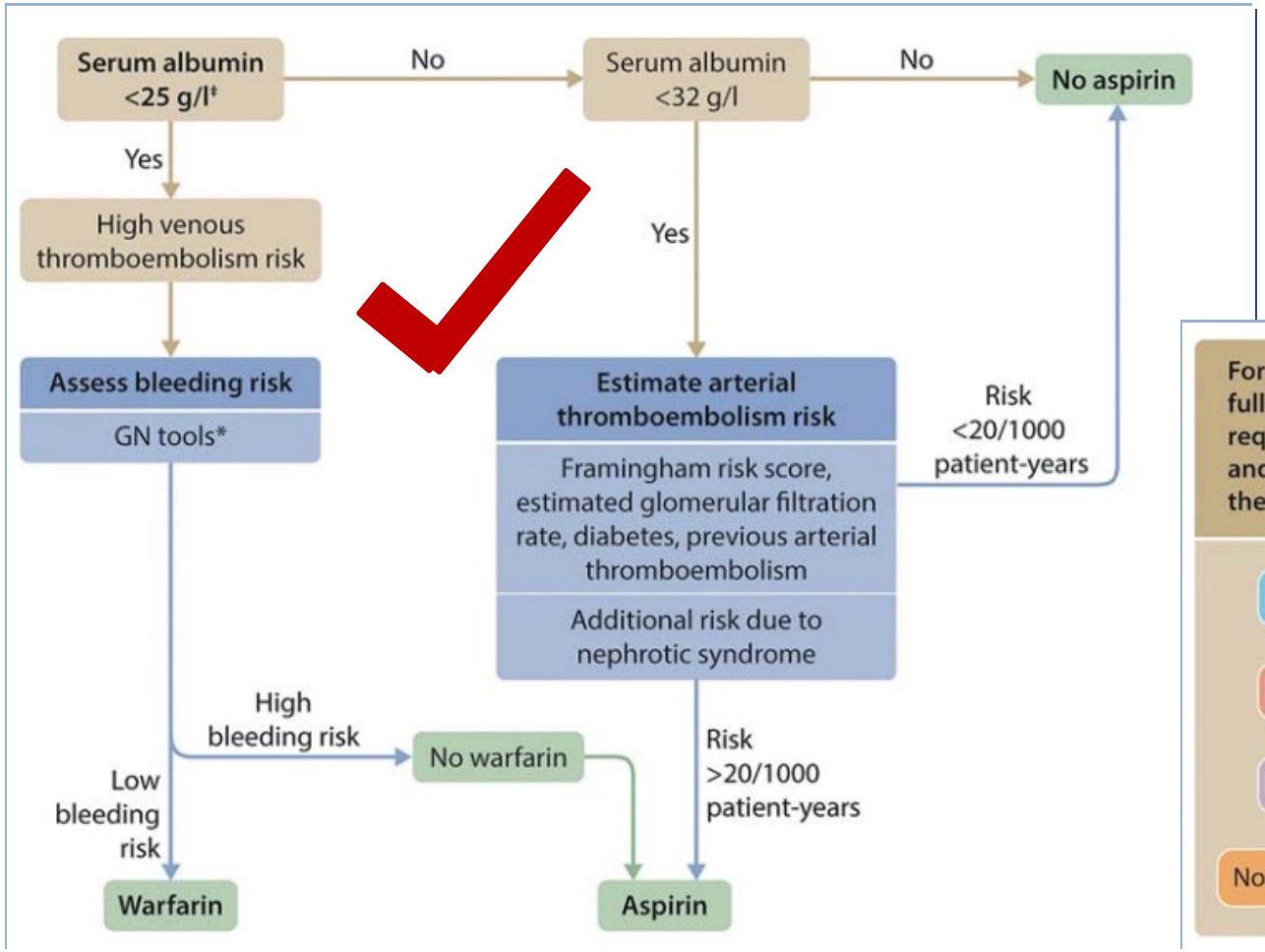
Management of hyperlipidemia in glomerular disease-1

Practice Point 1.6.1.	Treatment of hyperlipidemia may be considered in patients with the nephrotic syndrome, particularly for patients with other cardiovascular risk factors, including hypertension and diabetes	High quality data are lacking to guide treatment in these patients
Practice Point 1.6.2.	Use lifestyle modifications in all patients with persistent hyperlipidemia and glomerular disease: • Heart-healthy diet • Increased physical activity • Weight reduction • Smoking cessation	• Not well studied as primary means of reducing lipids in nephrotic syndrome • Can be used as primary therapy in low-risk individuals with mild to moderate hyperlipidemia • Additive to pharmacologic treatment of hyperlipidemia • Considered first-line treatment of hyperlipidemia in children • Consider a plant-based diet • Avoid red meat
Practice Point 1.6.3.	Consider starting a statin drug as first-line therapy for persistent hyperlipidemia in patients with glomerular disease: • Assess ASCVD risk based on LDL-C, Apo B, triglyceride and Lp (a) levels, age group, and ASCVD 'risk enhancers' • Align statin dosage intensity to ASCVD risk • Statins can be initiated in children aged > 8 years with concerning family history, extremely elevated LDL-C or Lp(a), in the context of informed shared decision-making and counselling with patient and family	• Reduced eGFR (<60 ml/min/1.73 m^2 not on dialysis) and albuminuria (ACR >30 mg/g) are independently associated with an elevated risk of ASCVD • ASCVD risk enhancers include chronic inflammatory conditions such as systemic lupus erythematosus, rheumatoid arthritis, history of preeclampsia, early menopause, South Asian ancestry, chronic kidney disease and human immunodeficiency virus/AIDS (accuracy of ASCVD risk estimators have not been well validated for adults with chronic inflammatory disorders or human immunodeficiency virus) • Adherence to changes in lifestyle and effects of LDL-C lowering medication should be assessed by measurement of fasting lipids and appropriate safety indicators 4–12 weeks after statin initiation/dose adjustment or inflammatory disease-modifying therapy/antiretroviral therapy, and every 3–12 months thereafter based on need to assess adherence or safety

Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Hypercoagulability and thrombosis

- **Practice Point 1.7.1: Full anticoagulation is indicated for patients with thromboembolic events occurring in the context of nephrotic syndrome. Prophylactic anticoagulation should be employed in patients with nephrotic syndrome when the risk of thromboembolism exceeds the estimated patient-specific risks of an anticoagulation-induced serious bleeding event**



For thromboembolic events, full-dose anticoagulation is required for 6–12 months and/or for the duration of the nephrotic syndrome

- Venous thrombosis
- Arterial thrombosis
- Pulmonary embolus
- Nonvalvular atrial fibrillation

Prophylactic full-dose anticoagulation should be considered if:*

Serum albumin <20–25 g/l and any of the following:

- Proteinuria >10 g/d
- Body mass index >35 kg/m²
- Genetic disposition for thromboembolism
- Heart failure New York Heart Association class III or IV
- Recent orthopedic or abdominal surgery
- Prolonged immobilization

Relative or absolute contraindications to prophylactic anticoagulation

- Patient preference/ability to adhere
- Bleeding diathesis
- Central nervous system lesion prone to hemorrhage
- Genetic mutations influencing warfarin metabolism/efficacy
- Frailty (falls)
- Prior gastrointestinal bleed

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Dietary suggestions in glomerular disease

Practice Point 1.14.1.	Restrict dietary sodium to reduce edema, control blood pressure, and control proteinuria	• Dietary sodium <2.0 g/d (<90 mmol/d)
Practice Point 1.14.2.	Restrict dietary protein based on degree of proteinuria	• Nephrotic-range proteinuria: 0.8–1 g/kg/d protein intake* • Add 1 g per g of protein losses (up to 5 g/d) • The safety of protein restriction in GN has not been established in children • Plant-based diets may be preferred
Practice Point 1.14.3.	**Restrict dietary protein based on kidney function**	• Estimated glomerular filtration rate <60 ml/min/1.73 m^2 with nephrotic-range proteinuria • Limit or target intake to 0.8 g/kg/d • Avoid <0.6 g/kg/d due to safety concerns and risk of malnutrition • Emphasis on vegetable (plant) sources of protein is appropriate
Practice Point 1.14.4.	Restrict caloric intake to achieve normal body mass index and limit central adiposity in order to reduce chronic kidney disease progression, development of kidney failure, cardiovascular events, and mortality	• Target caloric intake 35 kcal/kg/d • Estimated glomerular filtration rate <60 ml/min/1.73 m^2: 30–35 kcal/kg/d
Practice Point 1.14.5.	Restrict dietary fats in patients with elevated serum cholesterol to prevent cardiovascular complications	• Heart-healthy diet • Dietary fat <30% of total calories • Mono- or polyunsaturated fat 7%–10% of total calories

Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Management of Nephrotic Syndrome

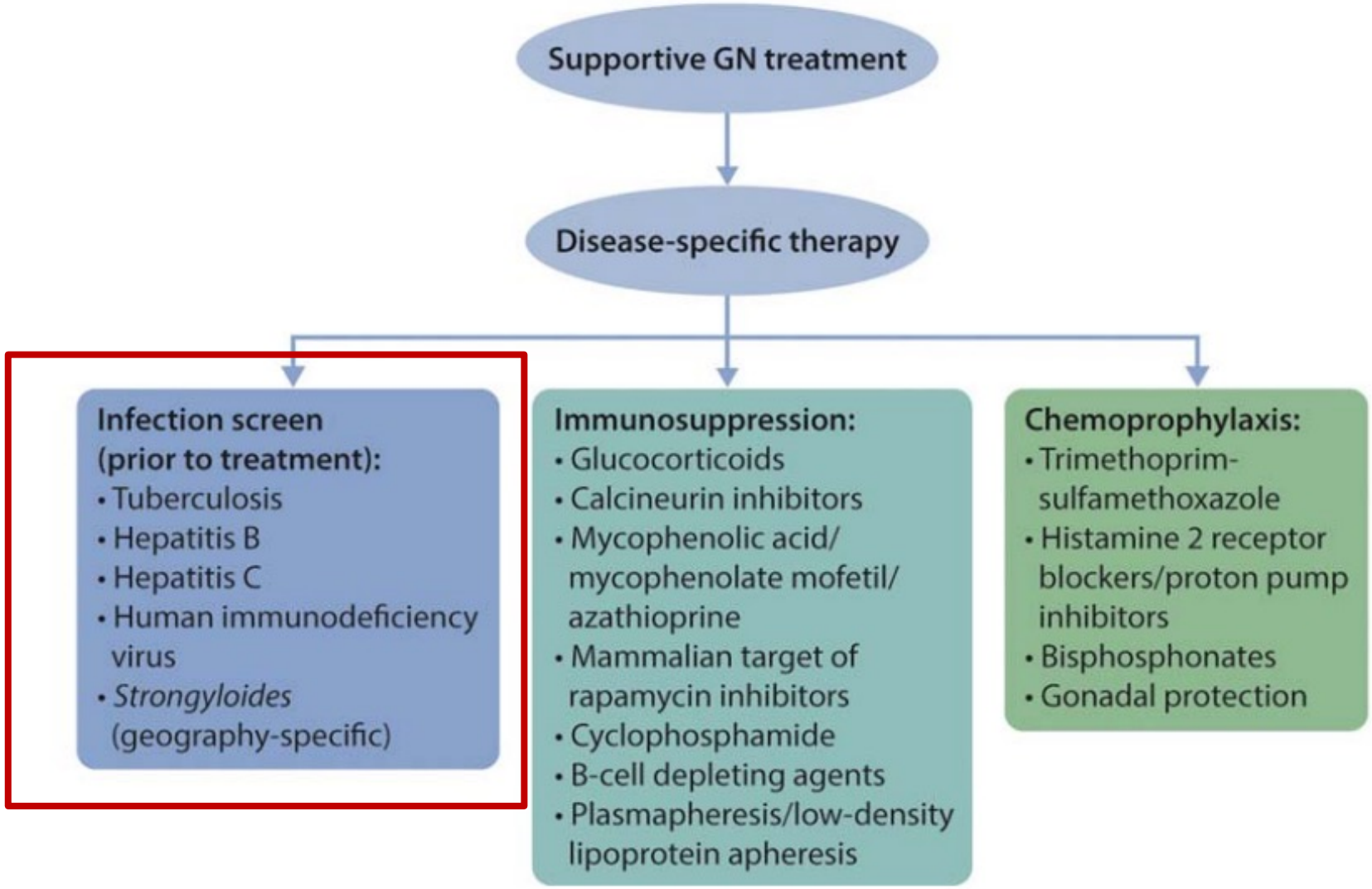
Immunosuppressive

1. Infection: Low serum level of Ig, defect in CMIR and opsonization
2. Thromboembolic complication
3. Alteration in lipid: Increase cholesterol, triglyceride, LDL, VLDL
4. Loss of transport proteins in the urine:
   - Thyroid blinding protein: Low T4 , normal TSH
   - Loss vitamin D-blinding protein: ↓ Calcium
   - Erythropoietin, transferrin
5. Protein malnutrition

General management

1. Low salt diet (Na^+ < 2 g/d)
2. Protein intake 0.8-1 g/kg/d
3. Control SBP <120-130 mmHg
4. ACEI or ARB
5. Stop smoking
6. Diuretic: Volume over load/HT/edema
7. Statin
8. F/U, compliance, complication of NS
9. Prevent infection, vaccination
10. Side effect of treatment

Summary of supportive management of glomerular disease-2



Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Screening/prophylaxis for all patients with glomerular disease on immunosuppression

Assessment	Measures
Peptic ulcer disease	H_2 blockers Proton pump inhibitors
Bone health and protection	Individual fracture risk assessment/bone mineral density Calcium and vitamin D supplementation Bisphosphonates Growth hormone (pediatric population)
Infection risk	Assess medical history of herpes zoster infection Screening for hepatitis B virus, hepatitis C virus, human immunodeficiency virus Hepatitis B virus vaccination Zoster vaccination Screening for tuberculosis Screening for strongyloides Pneumocystis prophylaxis Influenza and pneumococcal vaccination* Meningococcal vaccination (if C5 antagonists are used) Monitor gammaglobulin levels and white blood cells levels (rituximab, cyclophosphamide)
Ultraviolet light protection	Limit ultraviolet exposure Broad-spectrum sunscreen
Fertility protection	Gonadotropin receptor hormone agonists (i.e., leuprolide) in cyclophosphamide Sperm/oocyte cryopreservation in cyclophosphamide
Effective contraception	Individual evaluation (preference, thrombosis risk, age)
Cancer screening	Evaluate individual risk factors for malignancy Age-specific malignancy screening Annual dermatology exam Bladder cancer (cyclophosphamide cumulative dose >36 g)

Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Specific Treatment of Nephrotic Syndrome

Specific Treatment of Nephrotic Syndrome

Primary glomerular disease

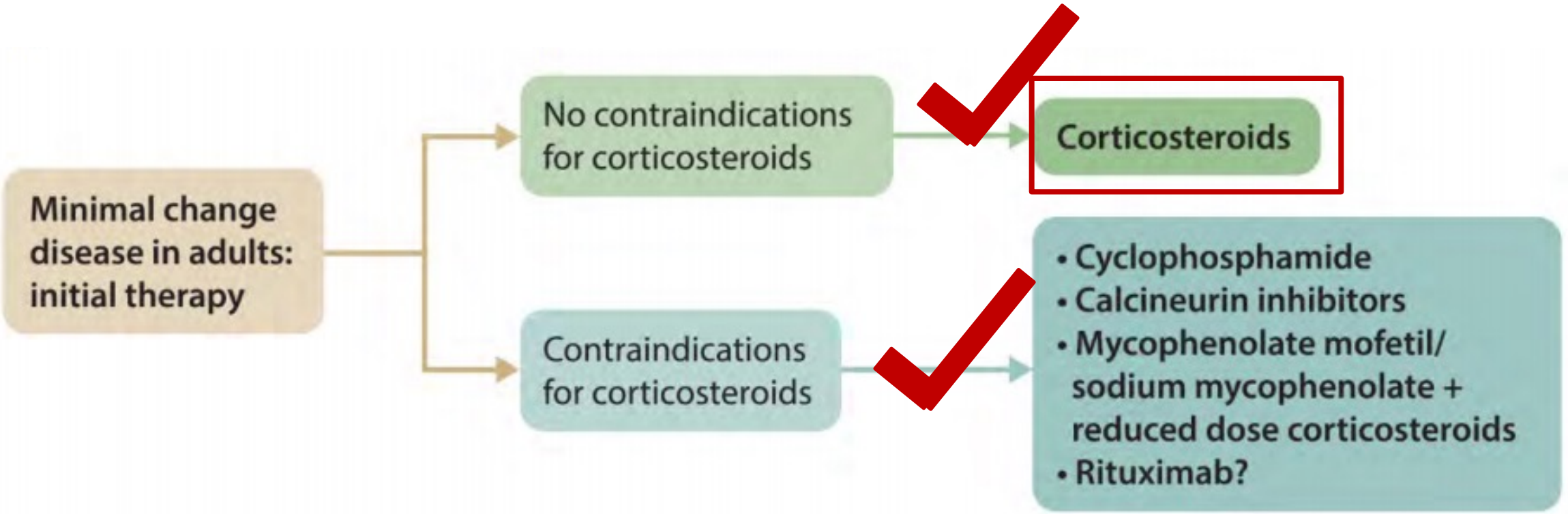
Diseases	Nephrotic syndrome	Nephritic syndrome
MCD	4+	-
MN	4+	+
FSGS	3+	2+
IgAN	2+	3+
MPGN	2+	3+
PSGN	1+	4+
RPGN	1+	4+

Correct cause: Secondary glomerular disease

1. Metabolic disease (DN)
2. Connective tissue disease (SLE, RA)
3. Infection-related GN: HBV, HCV, HIV, Bacteria, parasite
4. Malignancy
5. Paraproteinemia (MM, Amyloidosis)
6. Drug
7. Genetic disorder
8. Other
   - Systemic vasculitis
   - Pre-eclampsia
   - Obesity
   - Reflux nephropathy
   - Radiation nephropathy

Treatment of MCD in Adults

Initial Treatment of MCD in Adults



5.3.1. We recommend high-dose oral corticosteroids for initial treatment of MCD (1C)

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Treatment of MCD

Immunosuppressive

(Stool for parasite, CXR)
(Dental caries examination)

1. Prednisolone 1 mg/kg/d (max 80 mg/d) X after complete remission ≥ 2 weeks (maximum 16 weeks)

2. Begin tapering of glucocorticoids 2 weeks after complete remission

3. No studies comparing a rapid versus a slower glucocorticoid taper in adults. Based on case series, glucocorticoids are usually tapered by 5–10 mg/week after remission has been achieved for a total period of glucocorticoid exposure of approximately 24 weeks

General care

MCD respond to steroid:

Adult: - CR+PR > 80-90%
- CR 70-80% (48 % at 4 week : 75% at 8 weeks)
- Relapse rate (F/U: 25% at 1 years, 37% at 4 years)

Child: CR > 95% (50% at 4 weeks: 91% at 8 weeks)

Definition of Remission, Relapse, Resistance and Dependence for MCD

1. Complete remission (CR)
   - Reduction of proteinuria < 0.3 g/day or UPCR <300 mg/g
   - Stable serum Cr and serum albumin > 3.5 g/dL

2. Partial remission (PR)
   - Decrease up to 50% of baseline and 0.3- <3.5 g/day (UPCR 300-3500 mg/g)

3. Steroid-resistance MCD
   - Persistent proteinuria > 3.5 g/day with <50% reduction from baseline despite prednisolone 1 MKD or 2 MKAD ≥ 16 weeks

4. Steroid-dependence MCD
   - Relapse occurring during, or 2 week of completing corticosteroid therapy

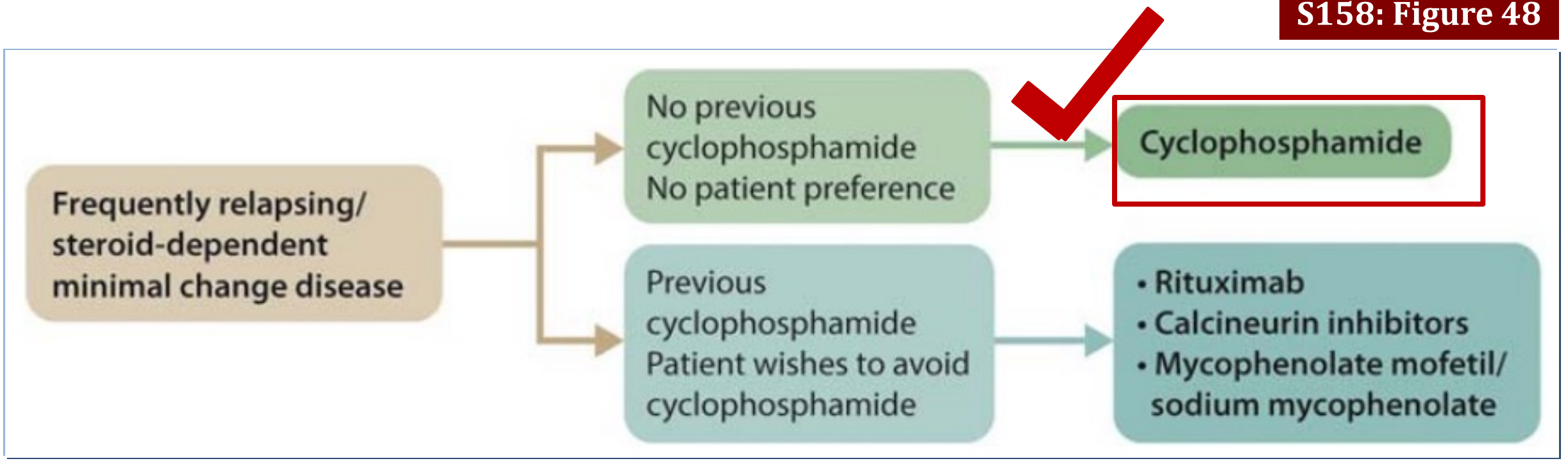
5. Relapse
   - Proteinuria >3.5 g/day or UPCR >3500 mg/g after complete remission

6. Frequently relapsing MCD
   - ≥2 relapse per 6 months or ≥4 relapse per 12 months

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Treatment Frequently relapsing/Steroid-dependent of MCD in Adults

S158: Figure 48



5.3.1.1: We recommend cyclophosphamide, rituximab, CNIs, or mycophenolic acid analogs (MPAA) for the treatment of frequently relapsing/steroid-dependent MCD, rather than prednisone alone or no treatment (1C).

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Treatment of FSGS in Adults

Definition of remission, relapse, resistance, and dependence for FSGS

1. **Complete remission (CR)**
   - Reduction of proteinuria < 0.3 g/day or UPCR <300 mg/g
   - Stable serum Cr and serum albumin > 3.5 g/dL

2. Partial remission (PR)
   - Decrease up to 50% of baseline and 0.3- <3.5 g/day (UPCR 300-3500 mg/g)

3. Steroid-resistance FSGS
   - Persistent proteinuria > 3.5 g/day with <50% reduction from baseline despite prednisolone 1 MKD or 2 MKAD ≥ 16 weeks

4. Steroid-dependence FSGS
   - Relapse occurring during, or 2 week of completing corticosteroid therapy

5. Relapse
   - Proteinuria >3.5 g/day or UPCR >3500 mg/g after complete remission

CNI-resistance FSGS:

- Persistent proteinuria > 3.5 g/day with <50% reduction from baseline despite cyclosporine treatment at trough levels of 100-175 ng/mL, or tacrolimus treatment at trough levels 5-10 ng/mL for 4-6 months

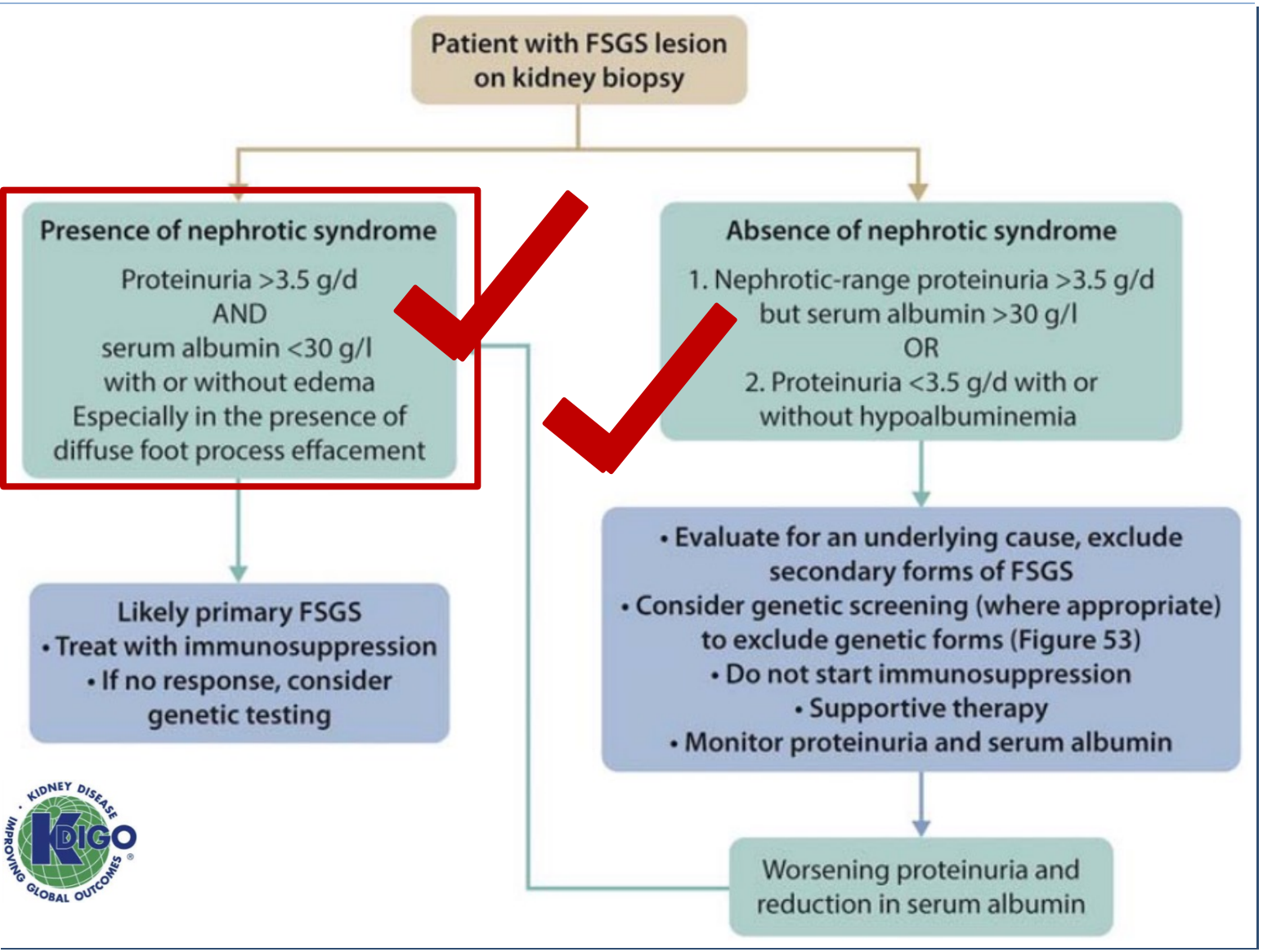
CNI-dependence FSGS:

- Relapse occurring during, or 2 week of completing cyclosporine or tacrolimus therapy for >12 months

CNI; Calcineurin inhibitors

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Evaluation of a patient with FSGS lesion on the kidney biopsy and no evidence of other glomerular pathology



Secondary to alterations of glomerular epithelial cells	
Viral infections	HIV (established) CMV (probably) Parvovirus B19, EBV, HCV (possibly) Hemophagocytic syndrome (possibly) SARS-COV-2 (with *APOL1* risk genotype)
Drug-induced	Direct-acting antiviral therapy mTOR inhibitors, CNIs Anthracyclines Heroin (adulterants) Lithium Interferon Anabolic steroids NSAIDs
Secondary to adaptive changes with glomerular hypertension	
Reduced nephron number	Reflux nephropathy Renal dysplasia Oligomeganephronia Sickle cell disease Age-related FSGS
Normal nephron number	Obesity-related glomerulopathy Primary glomerular diseases Systemic conditions, e.g., diabetic nephropathy, hypertensive nephrosclerosis
Genetic forms of FSGS	
Genetic mutations of podocyte and glomerular basement membrane proteins	• Familial • Sporadic • Syndromic

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

❖ Recommendation 6.2.2.1: We recommend that high dose oral glucocorticoids be used as the first-line immunosuppressive treatment for primary FSGS (1D)

Treatment	Dose and duration
Glucocorticoids	**Starting dose:** • High-dose glucocorticoid therapy with prednisone at daily single dose of 1 mg/kg (maximum 80 mg) or alternate-day dose of 2 mg/kg (maximum 120 mg)
	High-dose glucocorticoid treatment duration: • Continue high-dose glucocorticoid therapy for at least 4 weeks and until complete remission is achieved, or a maximum of 16 weeks, whichever is earlier • Patients who are likely to remit will show some degree of proteinuria reduction before 16 weeks of high-dose treatment • It may not be necessary to persist with high-dose glucocorticoid therapy until 16 weeks if the proteinuria is persistent and unremitting, especially in patients who are experiencing side effects
	Glucocorticoid tapering: • If complete remission is achieved rapidly, continue high-dose glucocorticoid treatment for 2 weeks or after the disappearance of proteinuria, whichever is longer. Reduce prednisone by 5 mg every 1–2 weeks to complete a total duration of 6 months • If partial remission is achieved within 8 to 12 weeks of high-dose glucocorticoid treatment, continue until 16 weeks to ascertain whether further reduction of proteinuria and complete remission may occur. Thereafter, reduce the dose of prednisone by 5 mg every 1–2 weeks to complete a total duration of 6 months • If the patient proves to be steroid-resistant or develops significant toxicities, glucocorticoids should be rapidly tapered as tolerated and treatment with alternative immunosuppression like a CNI should be considered

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

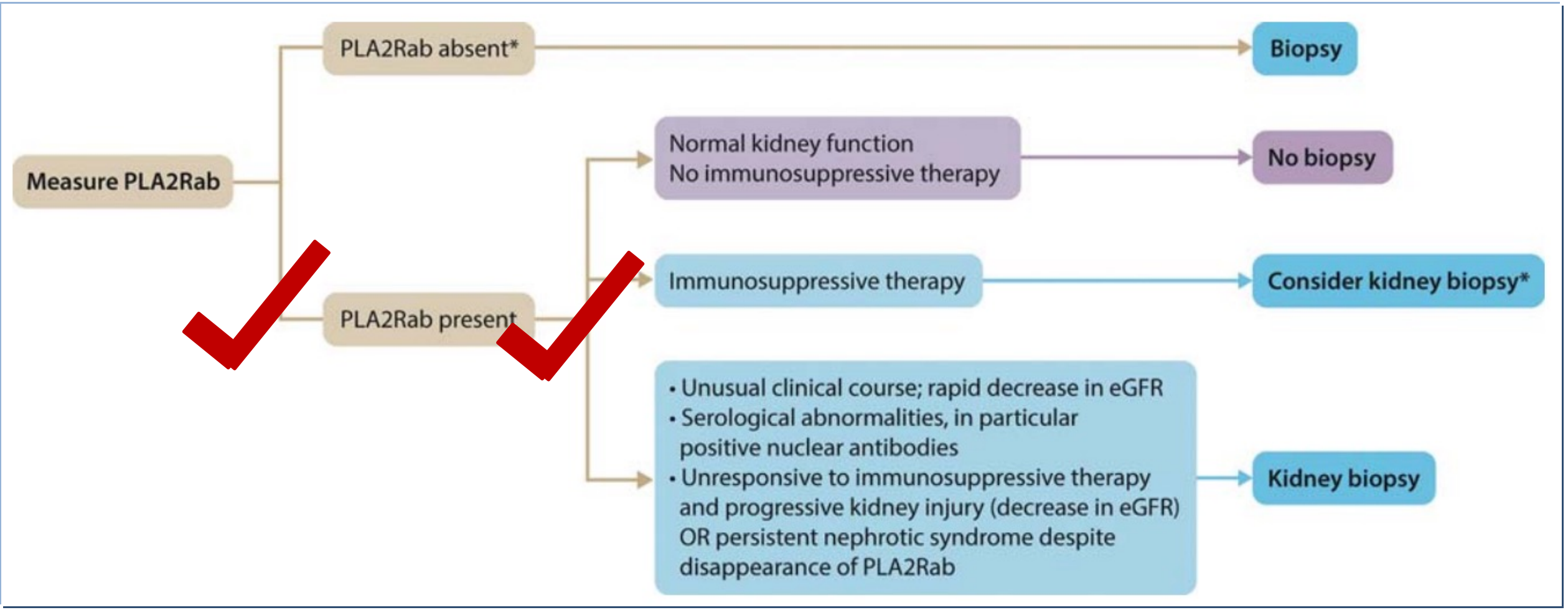
❖ Practice Point 6.2.2.4: In adults with relative contraindications or intolerance to glucocorticoids, alternative immunosuppression with CNIs should be considered as the initial therapy in patients with primary FSGS

Calcineurin inhibitors*	**Starting dose:** • Cyclosporine 3–5 mg/kg/d in 2 divided doses OR tacrolimus 0.05–0.1 mg/kg/d in 2 divided doses • Target trough levels could be measured to minimize nephrotoxicity • Cyclosporine target trough level: 100–175 ng/ml (83–146 nmol/l) • Tacrolimus target trough level: 5–10 ng/ml (6–12 nmol/l)
	Treatment duration for determining CNI efficacy: • Cyclosporine or tacrolimus should be continued at doses achieving target trough level for at least 4–6 months, before considering the patient to be resistant to CNI treatment
	Total CNI treatment duration: • In patients with partial or complete remissions, cyclosporine or tacrolimus should be continued at doses achieving target trough level for at least 12 months to minimize relapses • The dose of cyclosporine or tacrolimus can be slowly tapered over a course of 6–12 months as tolerated

Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Treatment of Primary MN in Adults

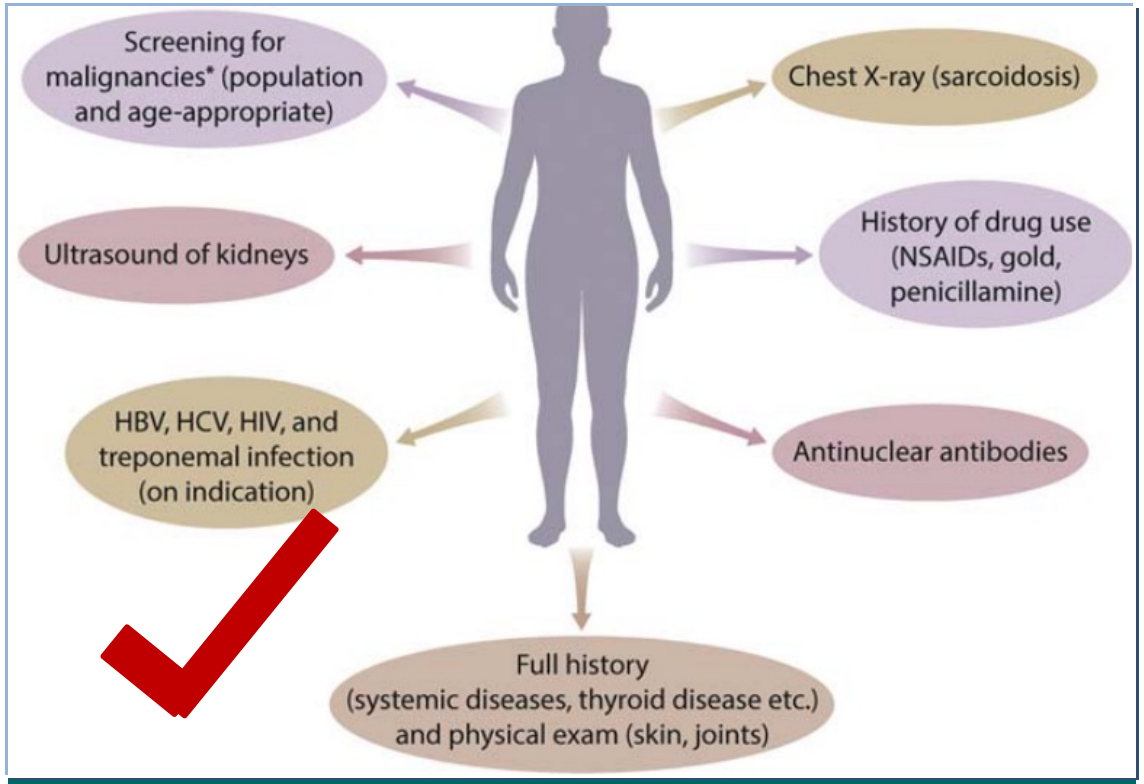
When to consider a kidney biopsy in a patient who is anti-PLA2R antibody-positive



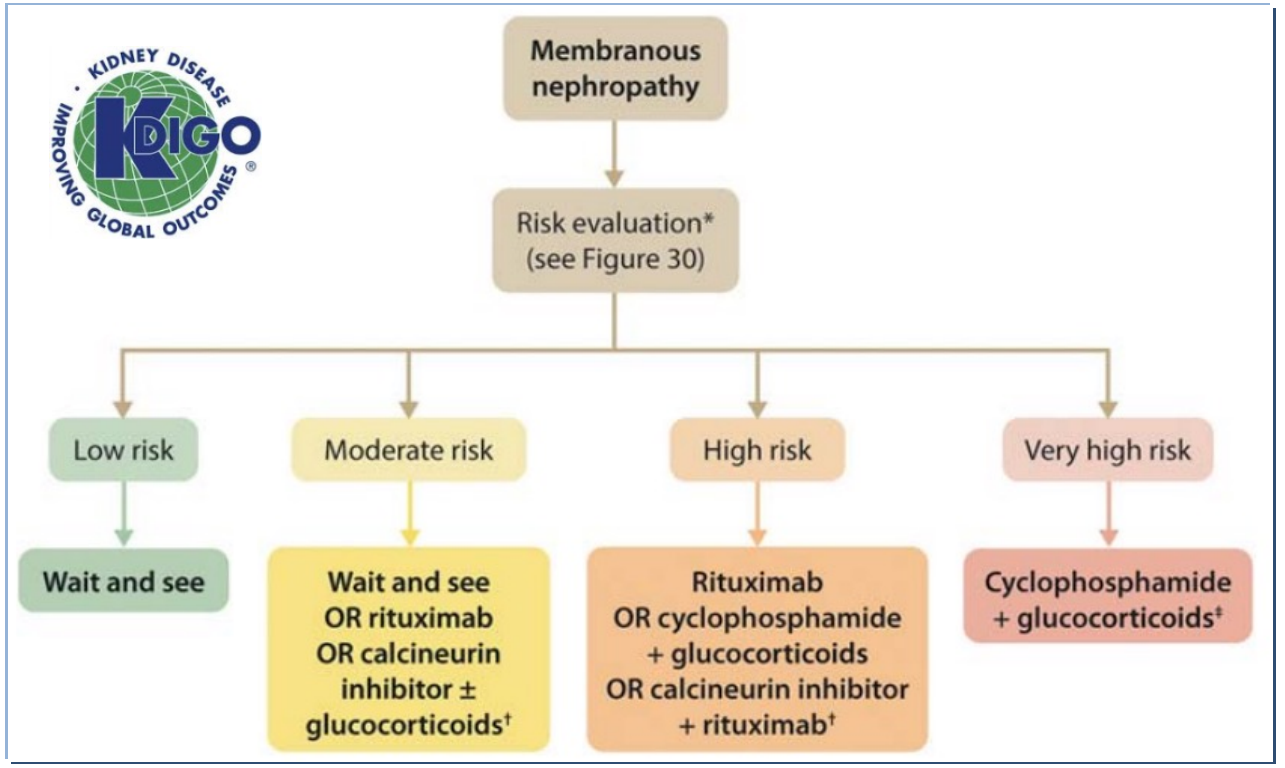
Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Risk-based treatment of MN

❖ **Practice Point 3.3.1: Considerations for treatment of patients with primary MN: All patients with primary MN and proteinuria should receive optimal supportive care. Immunosuppressive therapy should be restricted to patients considered at risk for progressive kidney injury**



Evaluation of patients with MN for associated conditions



Low risk	Moderate risk	High risk	Very high risk
• Normal eGFR, proteinuria <3.5 g/d and serum albumin >30 g/l OR • Normal eGFR, proteinuria <3.5 g/d or a decrease >50% after 6 months of conservative therapy with ACEi/ARB	• Normal eGFR, proteinuria >3.5 g/d and no decrease >50% after 6 months of conservative therapy with ACEi/ARB AND • Not fulfilling high-risk criteria	• eGFR <60 ml/min/1.73 m²* and/or proteinuria >8 g/d for >6 months OR • Normal eGFR, proteinuria >3.5 g/d and no decrease >50% after 6 months of conservative therapy with ACEi/ARB AND at least one of the following: • Serum albumin <25 g/l† • PLA2Rab >50 RU/ml‡ • Urinary α_1 -microglobulin >40 µg/min • Urinary IgG >1 µg/min • Urinary β_2-microglobulin >250 mg/d • Selectivity index >0.20§	• Life-threatening nephrotic syndrome OR • Rapid deterioration of kidney function not otherwise explained

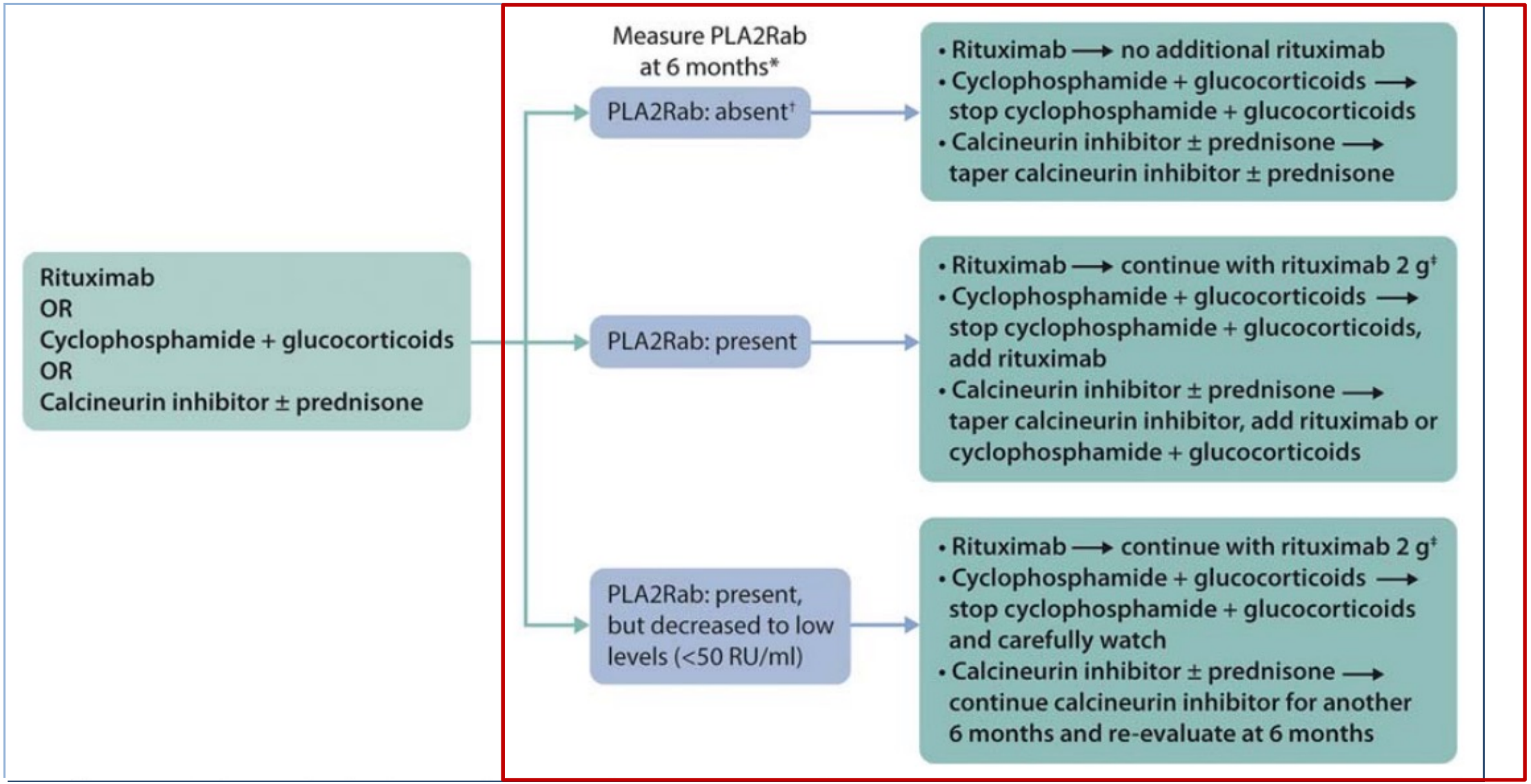
Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

❖ **Recommendation 3.3.1: For patients with MN and at least one risk factor for disease progression, we recommend using rituximab or cyclophosphamide and alternate month glucocorticoids for 6 months, or CNI-based therapy for ‡6 months, with the choice of treatment depending on the risk estimate (Figure 30 and Figure 31) (1B).**

Cyclophosphamide (cyclical)	• Methylprednisolone 1 g i.v. for 3 consecutive days at start of month 1, 3, and 5 • Prednisone 0.5 mg/kg/d in months 1, 3, and 5 • Cyclophosphamide 2.5 mg/kg/d in months 2, 4, and 6‡
Cyclophosphamide (continuous)	• Methylprednisolone 1 g i.v. for 3 consecutive days at start of month 1, 3, and 5 • Prednisone 0.5 mg/kg/d every other day in months 1–6, with taper thereafter • Cyclophosphamide 1.5 mg/kg/d in months 1–6‡
Rituximab	• Rituximab 1 g i.v. administered twice within 2 weeks* • Rituximab 375 mg/m^2 given 1–4 times at weekly intervals
Tacrolimus	• Tacrolimus 0.05–0.1 mg/kg/d, target trough level 3–8 ng/ml (3.7–9.9 nmol/l), duration 12 months†
Cyclosporine	• Cyclosporine 3.5 mg/kg/d, target trough level 125–225 ng/ml (104–187 nmol/l)†

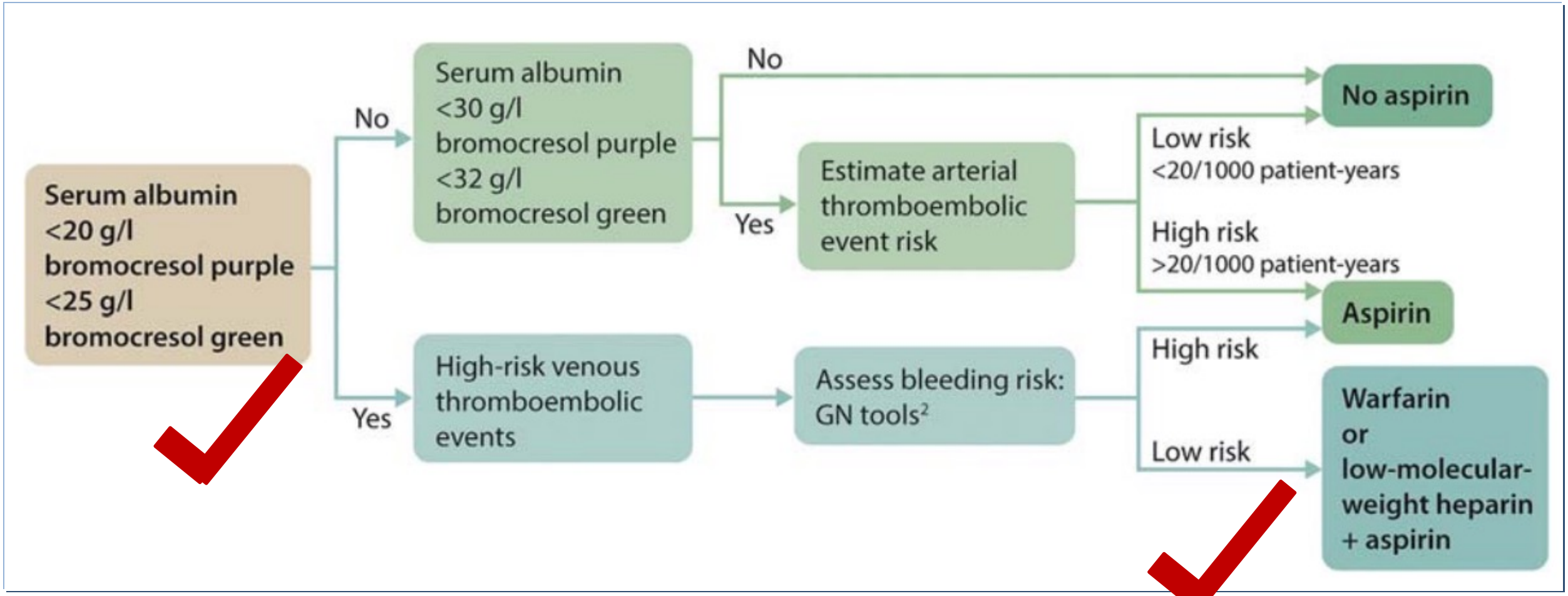
Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Immunologic monitoring in MN after start of therapy



Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Anticoagulant therapy in patients with MN

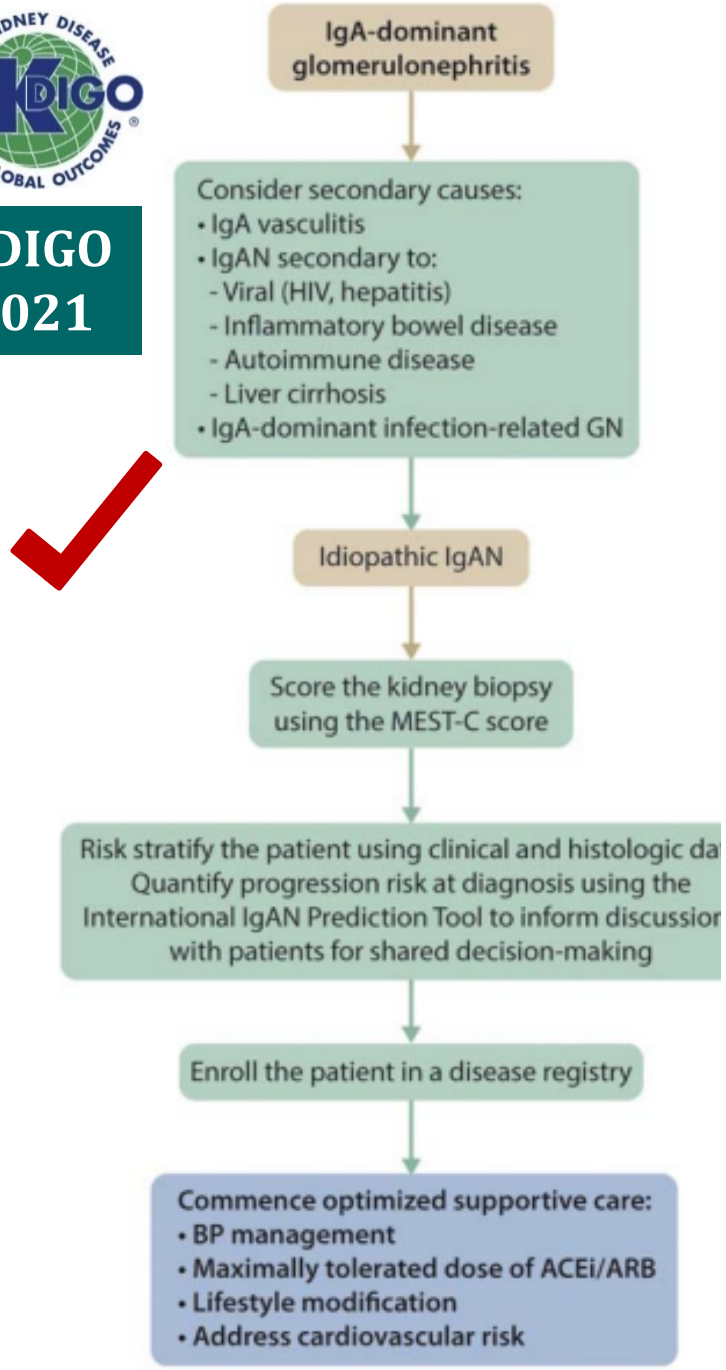


Adapted from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

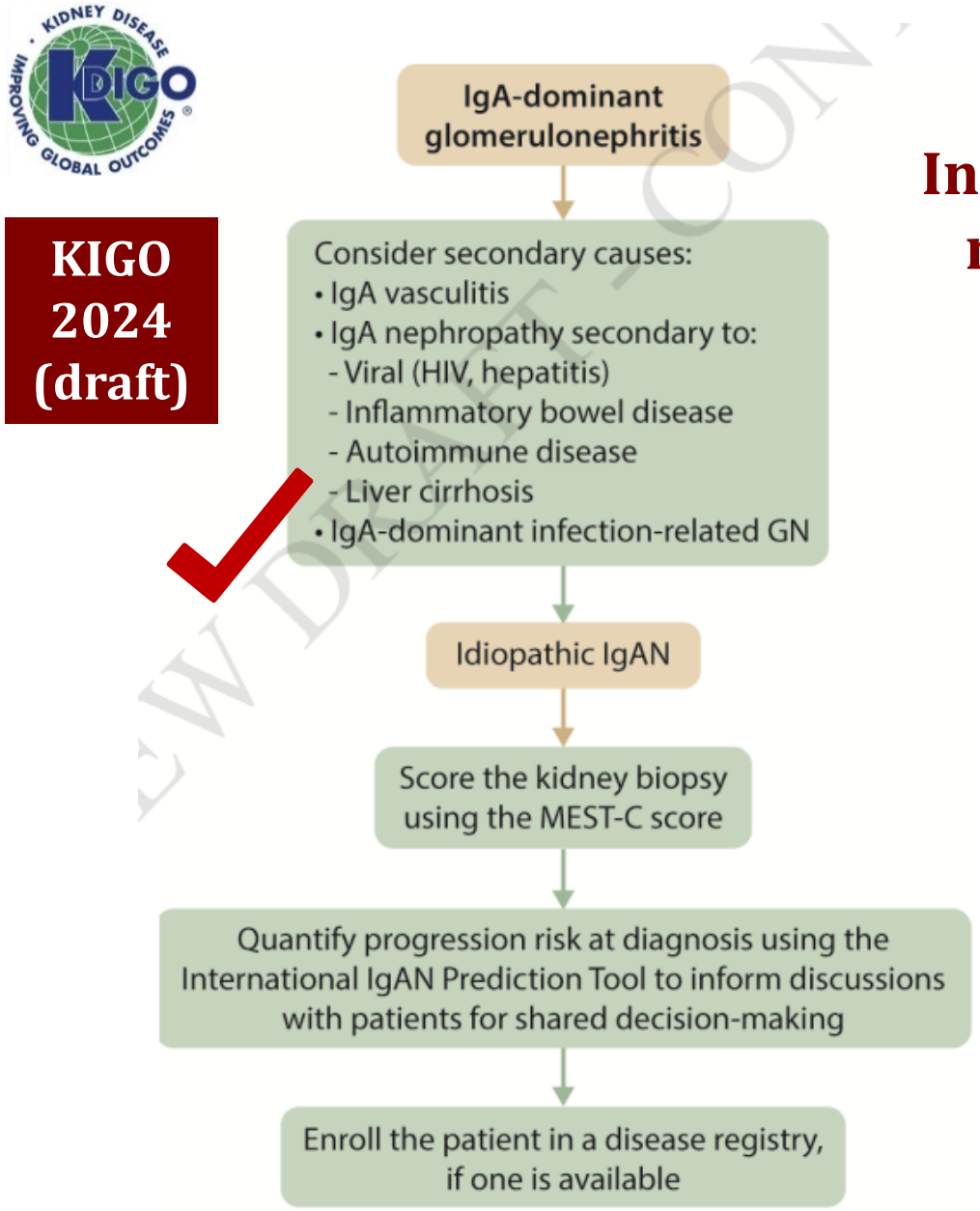
Treatment: IgA

Initial assessment and management of the patient with IgAN

KDIGO 2021



KIGO 2024 (draft)

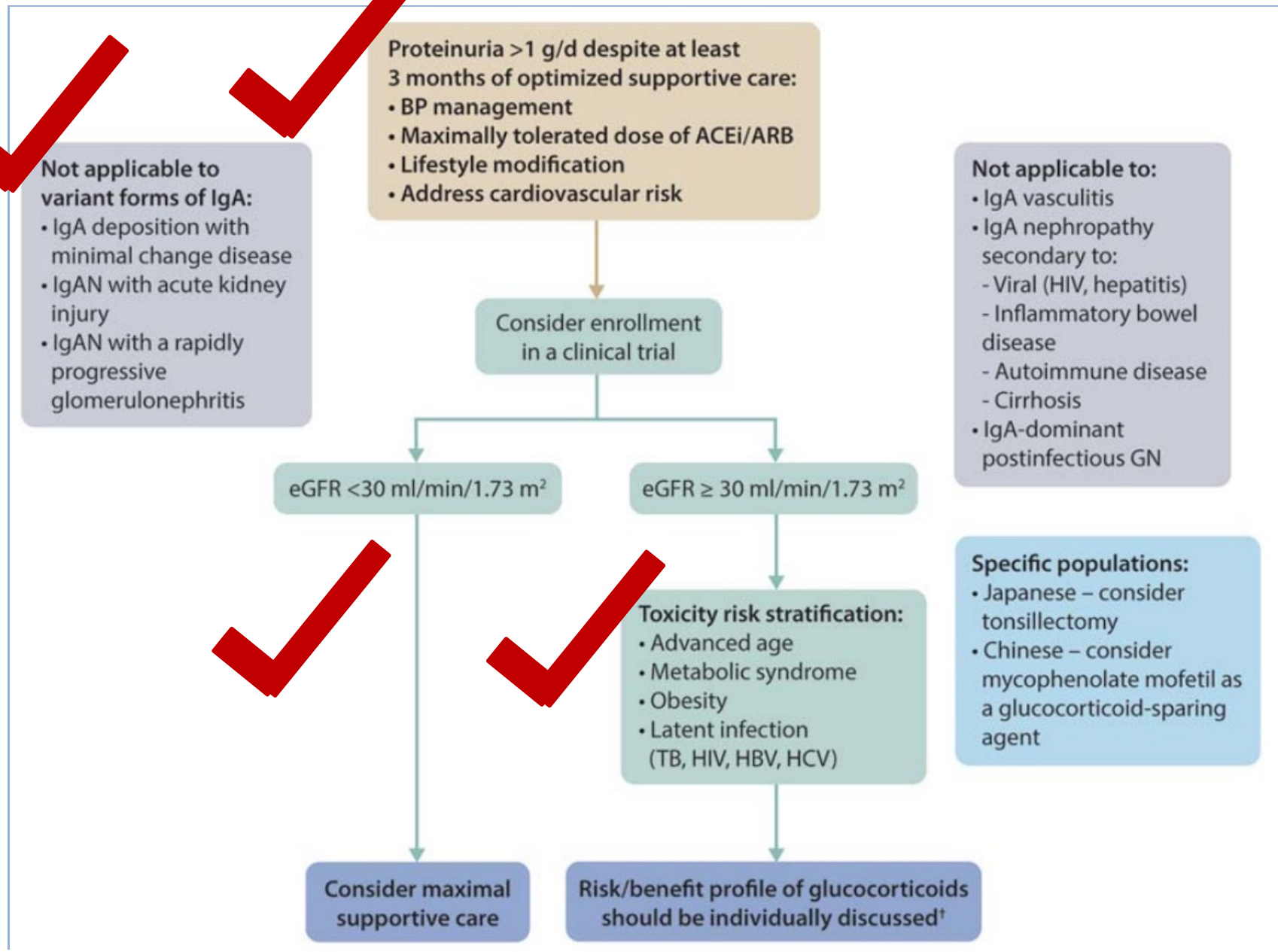


KDIGO 2021; Clinical Practice Guideline on Glomerular diseases, 2021.
KDIGO 2024; Clinical Practice Guideline for management IgAN and IgAV. Public review draft August 2024.

Practice Point 2.3.1.4:
Management of patients with IgAN who remain at high risk for progression after maximal supportive care

Practice Point 2.3.1.3: Use of glucocorticoids in IgAN:
Clinical benefit of glucocorticoids in IgAN is not established and should be given with extreme caution or avoided entirely in situations listed in

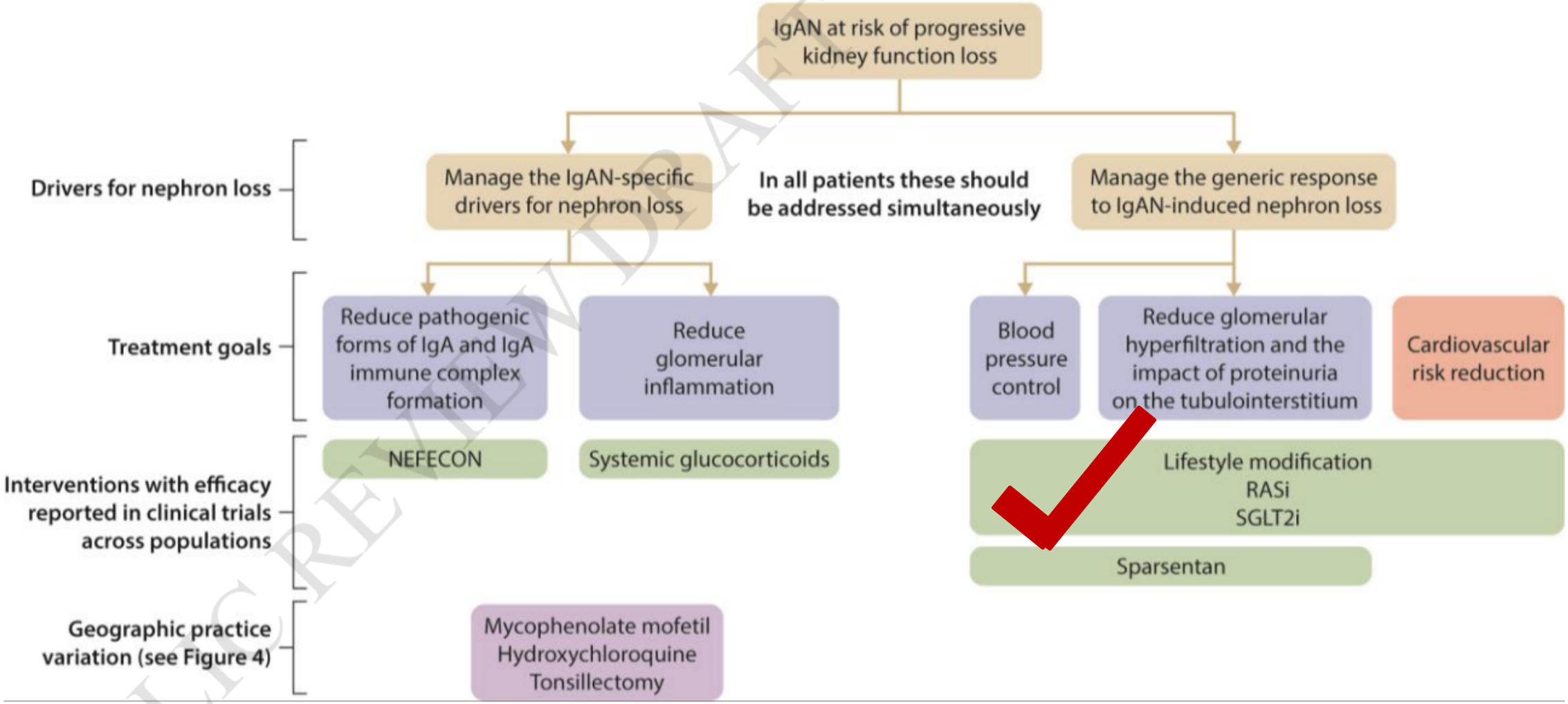
eGFR <30 ml/min/1.73 m²*
Diabetes
Obesity (BMI >30 kg/m²)†
Latent infections (e.g., viral hepatitis, TB)
Secondary disease (e.g., cirrhosis)
Active peptic ulceration
Uncontrolled psychiatric illness
Severe osteoporosis



Proteinuria > 1g/d (ACEI and/or ARB as initial Rx 3-6 mos) (2C):
1. Manno : Prednisolone 0.8-1 MKD X2 mos then 0.2 mkd x 4 mos
2. Pozzi : IVMP 1 g x 3 d (1,3,5 Mo) + prenisolone 0.5 mk/AD x 6 mo

Adapted KDIGO Clinical Practice Guideline on Glomerular diseases, 2021

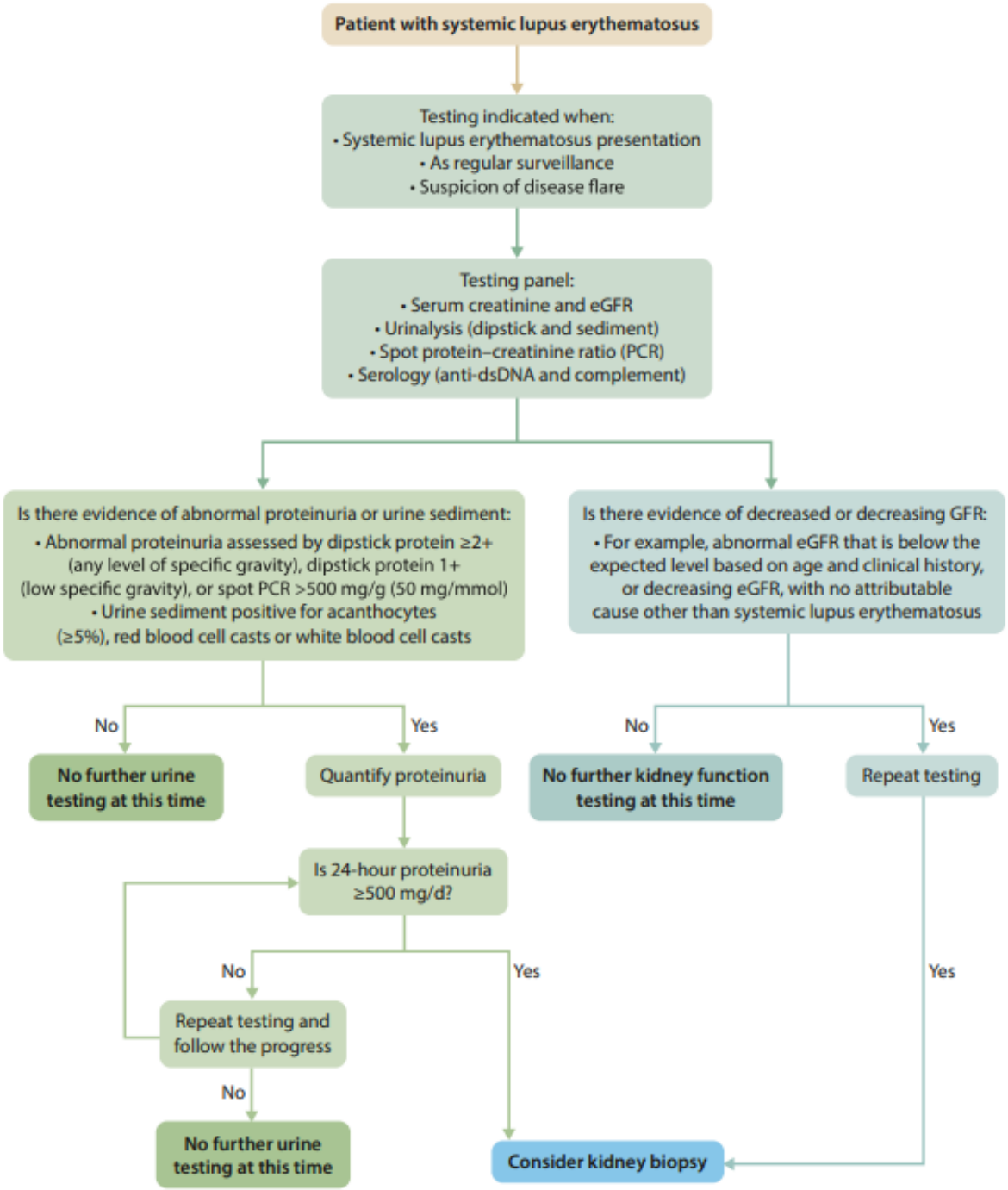
Treatment targets in immunoglobulin A nephropathy (IgAN) and available to-date approved treatment options



KDIGO 2024 Clinical Practice Guideline for management IgAN and IgAV. Public review draft August 2024.

Treatment: LN

Diagnosis of kidney involvement in SLE



KDIGO 2024 Clinical Practice Guideline for the management of LUPUS NEPHRITIS. Kidney Int. 2024 Jan;105(1S):S1-S69.

Lupus nephritis biopsy ISN/RPS 2013 Classification

Class I	Minimal mesangial lupus nephritis
Class II	Mesangial proliferative lupus nephritis
Class III	Focal lupus nephritis[a]
Class IV	Diffuse segmental (IV-S) or global (IV-G) lupus nephritis[b]
Class V	Membranous lupus nephritis[c]
Class VI	Advanced sclerosing lupus nephritis

Indicate and grade (mild, moderate, severe) tubular atrophy, interstitial inflammation and fibrosis, severity of arteriosclerosis or other vascular lesions.

[a]Indicate the proportion of glomeruli with active and with sclerotic lesions.

[b]Indicate the proportion of glomeruli with fibrinoid necrosis and cellular crescents.

[c]Class V may occur in combination with class III or IV, in which case both will be diagnosed.

Weening JJ, et al. Kidney Int, 2004: 65: 521–530.

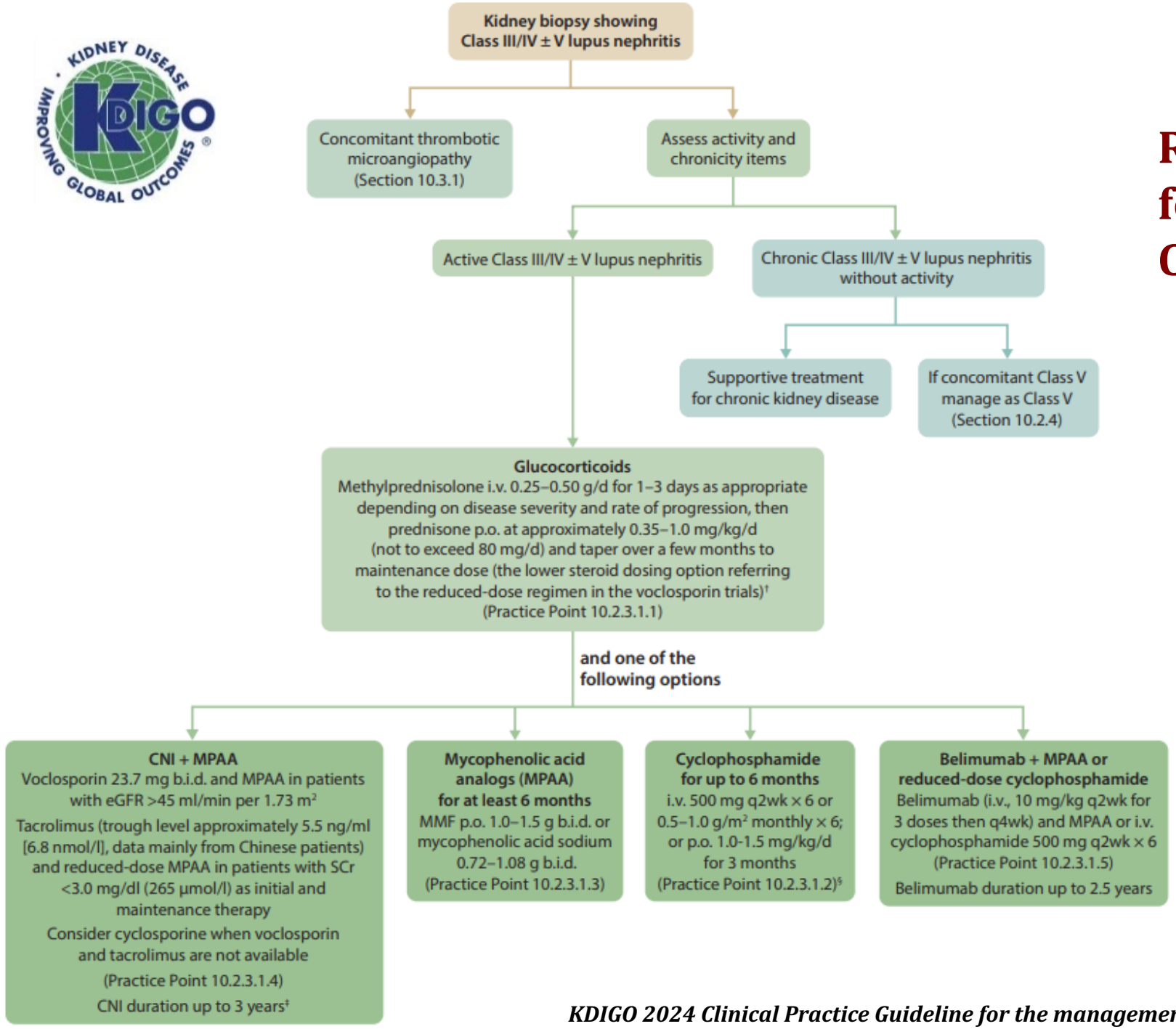
Activity and chronicity items included in lupus nephritis kidney biopsy report

Components of the activity index	Score	Calculating the activity score Extent of lesion	Points
• Endocapillary hypercellularity • Neutrophils and/or karyorrhexis • Fibrinoid necrosis • Hyaline deposits (wire loop and/or hyaline thrombi) • Cellular/fibrocellular crescents • Interstitial inflammation (interstitial leukocytes)	0–3 0–3 (0–3) × 2 0–3 (0–3) × 2 0–3 **Total: 0–24**	Not present Present in <25% Present in 25%–50% Present in >50%	0 1 2 3
Items included into the NIH chronicity score	**Score**	**Calculating the chronicity score** **Extent of lesion**	**Points**
• Total glomerulosclerosis (global + segmental) • Fibrous crescents • Interstitial fibrosis • Tubular atrophy	0–3 0–3 0–3 0–3 **Total: 0–12**	Present in <10% Present in 10%–25% Present in 25%–50% Present in >50%	0 1 2 3
Other histologic findings not included in the activity or chronicity score			
• Foot process effacement (lupus podocytopathy) • Collapsing lupus glomerulopathy • Vascular lesions (arteriosclerosis, non-inflammatory vascular immune complex deposits, thrombotic microangiopathy, non-inflammatory necrotizing vasculitis, true renal vasculitis)			

Figure 2 | Activity and chronicity items included in lupus nephritis kidney biopsy report. NIH, National Institutes of Health, USA.

Adapted from KDIGO 2023 Clinical Practice Guideline for the Management of lupus nephritis (public review draft , March 2023).

Recommended approach for initial therapy of active Class III/IV lupus nephritis



KDIGO 2024 Clinical Practice Guideline for the management of LUPUS NEPHRITIS. Kidney Int. 2024 Jan;105(1S):S1-S69.

Examples of glucocorticoid regimens for lupus nephritis

Practice Point 10.2.3.1.1: A regimen of reduced-dose glucocorticoids following a short course of methylprednisolone pulses may be considered during the initial treatment of active LN when both the kidney and extrarenal disease manifestations show satisfactory improvement (Figure 7).

	High-dose scheme	Moderate-dose scheme	Reduced-dose scheme
Methylprednisolone intravenous pulses	Nil or 0.25–0.5 g/day up to 3 days as initial treatment	0.25–0.5 g/day up to 3 days often included as initial treatment	0.25–0.5 g/day up to 3 days usually included as initial treatment
Oral prednisone equivalent (/day)			
Week 0–2	0.8–1.0 mg/kg (max 80 mg)	0.6–0.7 mg/kg (max 50 mg)	0.5–0.6 mg/kg (max 40 mg)
Week 3–4	0.6–0.7 mg/kg	0.5–0.6 mg/kg	0.3–0.4 mg/kg
Week 5–6	30 mg	20 mg	15 mg
Week 7–8	25 mg	15 mg	10 mg
Week 9–10	20 mg	12.5 mg	7.5 mg
Week 11–12	15 mg	10 mg	5 mg
Week 13–14	12.5 mg	7.5 mg	2.5 mg
Week 15–16	10 mg	7.5 mg	2.5 mg
Week 17–18	7.5 mg	5 mg	2.5 mg
Week 19–20	7.5 mg	5 mg	2.5 mg
Week 21–24	5 mg	<5 mg	2.5 mg
Week >25	<5 mg	<5 mg	<2.5 mg

HQ

KDIGO 2024 Clinical Practice Guideline for the management of LUPUS NEPHRITIS. Kidney Int. 2024 Jan;105(1S):S1-S69.

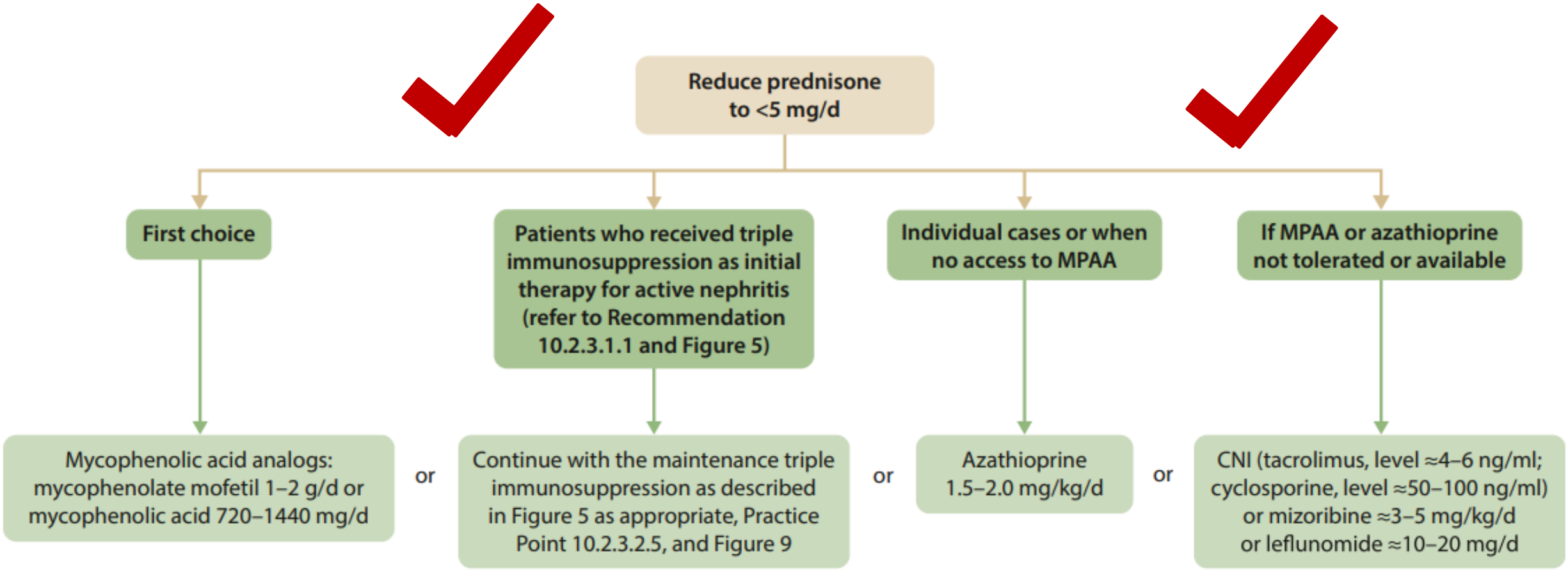
Definitions of response commonly used in clinical trials of lupus nephritis

Criteria	Definition
Complete response*	• Reduction in proteinuria <0.5 g/g (50 mg/mmol) measured as the PCR from a 24-h urine collection • Stabilization or improvement in kidney function (±10%–15% of baseline) • Within 6–12 mo of starting therapy, but could take more than 12 mo
Primary efficacy renal response	• PCR ≤0.7 g/g (70 mg/mmol) • eGFR that was no worse than 20% below the pre-flare value or ≥60 ml/min per 1.73 m^2 • No use of rescue therapy for treatment failure
Partial response	• Reduction in proteinuria by at least 50% and to <3 g/g (300 mg/mmol) measured as the PCR from a 24-h urine collection • Stabilization or improvement in kidney function (±10%–15% of baseline) • Within 6–12 mo of starting therapy
No kidney response	• Failure to achieve a partial or complete response within 6–12 mo of starting therapy

Figure 11 | Definitions of response commonly used in clinical trials of lupus nephritis. *For children <18 years old, complete response is defined as proteinuria <0.5 g/1.73 m^2 per day or <300 mg/m^2 per day based on a 24-hour urine specimen. eGFR, estimated glomerular filtration rate; PCR, protein–creatinine ratio.

KDIGO 2024 Clinical Practice Guideline for the management of LUPUS NEPHRITIS. Kidney Int. 2024 Jan;105(1S):S1-S69.

Recommended maintenance therapy for Class III and Class IV lupus nephritis



KDIGO 2024 Clinical Practice Guideline for the management of LUPUS NEPHRITIS. Kidney Int. 2024 Jan;105(1S):S1-S69.

Pregnancy in patients with lupus nephritis

- Patients with active LN should be counseled to avoid pregnancy while the disease is active or when treatment with potentially teratogenic drugs is ongoing, and for ≥6 months after LN becomes inactive.

- To reduce the risk of pregnancy complications, hydroxychloroquine should be continued during pregnancy, and low-dose aspirin should be started before 16 weeks of gestation.

- Only glucocorticoids, hydroxychloroquine, azathioprine, tacrolimus, and cyclosporin are considered safe immunosuppressive treatments during pregnancy.

KDIGO 2024 Clinical Practice Guideline for the management of LUPUS NEPHRITIS. Kidney Int. 2024 Jan;105(1S):S1-S69.

Coordinated care of pregnant patients with glomerular disease

Prepregnancy	• Discuss timing of contraception • Contraception advice if needed • Fertility assessment if needed	• Assess disease activity with repeat biopsy confirmation if necessary • Optimize blood pressure control	• Change to non-teratogenic medications and provide reassurance about continuation of safe medications in pregnancy	• Explain risk of pregnancy complications and need for heightened surveillance
Antenatal	• Target BP <140/90 mmHg	• Start low dose aspirin • Consider vitamin D and calcium supplements	• Baseline and serial kidney function, proteinuria (albumin–creatinine or protein–creatinine ratios or 24 h collections) and markers of disease activity • Monitoring of calcineurin levels if required	
	• Oral glucose tolerance test (especially important in women taking glucocorticoids or calcineurin inhibitors)	• Frequent fetal monitoring if concerns about fetal well-being • Up to twice weekly BPPs • Up to weekly placental Dopplers • q2 weekly growth scans	• Consider venous thromboembolic event prophylaxis if risk factors, e.g., nephrotic syndrome, previous venous thromboembolic events, high body mass index	
Delivery	• Delivery if presence of fetal or maternal decompensation • NOT at pre-specified gestation • Glucocorticoid administration for fetal lung maturation at least 24 h and up to 7 d prior to anticipated delivery if <34 weeks gestation		• Aim for vaginal delivery if possible • Hydrocortisone stress dosing if required	
Postnatal	• Encourage breast-feeding	• Careful surveillance for active glomerulonephritis • Calcineurin inhibitor level if dose changed in pregnancy	• Continue venous thromboembolic event prophylaxis for at least 6 weeks if necessary	• Emotional support

Modified from KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases. Kidney Int. 2021;100(4S):S1–S276.

Thank You for Your Attention

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