**The Nephrotic Syndrome**

Glomerular Disease associated with heavy albuminuria (> 3-3.5 g/day)

- Hypoalbuminemia
- Edema
- Hyperlipidemia
- Thrombotic tendency

**Objectives – Nephrotic Syndrome**

- Define the nephrotic syndrome.
- Review the mechanism of proteinuria.
- Discuss the mechanisms of the major manifestations of the NS – edema, hyperlipidemia, thrombotic tendency
- Discuss the clinical features and pathology of major clinical forms of the NS.

**Genesis of Hypoalbuminemia**

Glomerular Disease → Increased albumin catabolism → Hypoalbuminemia
Pathogenesis of Nephrotic Edema

- Hypoalbuminemia:
  - Low oncotic pressure

- Na and Water retention:
  - High hydrostatic pressure

Pathogenesis of Edema

Therapy of Edema in NS

- Put pt on low Na+ diet
- Use oral loop diuretics
- Sart w low dose - double doses
  - add zaroxolyn
  - +/- high BID doses
- IV diuretics and colloid rarely needed
- Goal is 1-2 # edema loss/day

Lipiduria and Oval Fat Bodies
Total Cholesterol Levels in 100 Consecutive Nephrotic Synd. Pts

LDL Cholesterol Levels in 100 Consecutive Nephrotic Synd. Pts

Treatment of Hyperlipidemia of the Nephrotic Syndrome

- Select high risk pt (high LDL, low HDL, unlikely to rapidly remit)
- Attempt to induce a remission of the proteinuria (ACEi/ARBs, specific immunosuppressives, etc.)
- Dietary Therapy
- Medical Therapy (statins +)

Treatment Principles

- Treatment of Primary Disease—Often immune modulating medications

- Symptomatic Treatment – Diuretics, statins, diet, in some anticoagulation

- Reduction of Proteinuria/Slowing Progression
Reduction of Proteinuria and Slowing Progression

- Blood pressure reduction
- Inhibition of the renin-angiotensin-aldosterone axis

Meta Analysis: Lower Mean BP Results in Slower Rates of Decline in GFR in Diabetics and Non-Diabetics

ACE-I Is More Renoprotective than Conventional Therapy in Type 1 Diabetes

The Effect of ACE-I on Diabetic Nephropathy: The Collaborative Study Group

Case 1 – 8 year old child

Case 1

- An 8 year old child presents with swelling of his eyes and ankles. He has 4+ proteinuria on urine dipstick
- Other labs:
  - BUN 8 mg/dl
  - Creatinine 0.5 mg/dl
  - Albumin 2.2 g/dL, serum cholesterol 400 mg/dL
  - 24 hour urine protein 6.0 g/day (normal <150 mg)
- Serologic tests are negative or normal
Synonyms
- Minimal Change Disease
- Nil Disease
- Lipoid Nephrosis
- Childhood Nephrosis

Evidence for Immunologic Derangements in Nil Disease
- Viral infections may precede onset or recrudescences.
- May follow recent immunizations.
- Altered in vitro response to mitogens.
- Circulating lymphocytotoxins.
- Altered lymphocyte subpopulations.
- ↑ HLA B-12
- Association with Hodgkin’s Disease and other lymphoproliferative disease

Puromycin Aminonucleoside Nephrosis
Minimal Change Disease

- 5-10% Adults with NS, >85% children
- Usually sudden onset, heavy proteinuria, and edema
- HBP 30%, Microhem 30 %, +/- Low GFR (volume depletion)
- Pathology: LM-NL, IF-Neg, EM-FFP
- Course: Respond to Strds, Relapse, No RF

Case 1: Treatment and Course

- Prednisone 1mg/kg was started
- Furosemide was prescribed for edema
- 3 weeks later the patient was edema-free.
- Urine dipstick tests for protein were negative.
- Prednisone was tapered and stopped by the third month

Case 2

- A 19 year old female college student gains 12 pounds and has lower extremity edema. Her physician finds 4+ albuminuria.
- Labs:
  - Creatinine 1.0 mg/dl
  - Albumin 2.0 g/dl
  - Cholesterol 425 mg/dl
  - 18g proteinuria/day
  - Serologic tests are negative
- Corticosteroid treatment is without improvement.
MCD and FSGS

- Separate or related entities?

### Circulating Factors in MCD and FSGS:

<table>
<thead>
<tr>
<th>Ref</th>
<th>Source</th>
<th>Biologic Activity</th>
<th>Biochemical Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker 1985</td>
<td>Serum or mononuclear cells of MCD</td>
<td>Increases vasc. permeability</td>
<td>~ 120 Kd Kallikrein-like</td>
</tr>
<tr>
<td>Koyama 1991</td>
<td>T cell hybridoma from MCD</td>
<td>Causes proteinuria and foot process fusion in rats</td>
<td>60-160 Kd Not an Ig</td>
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<tr>
<td>Sevin 1999</td>
<td>Serum or plasma of FSGS (initial, collapsing, recurrent) and steroid-resistant MCD</td>
<td>Increases glom permeability in vitro</td>
<td>50 Kd Binds protein A Not Ig Not Cationic</td>
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<tr>
<td>Dattal 1994</td>
<td>Plasma of recurrent FSGS in bop</td>
<td>Causes proteinuria and foot process fusion in rats</td>
<td>&lt; 100,000 Kd Binds protein A Not Ig</td>
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</tbody>
</table>
Secondary FSGS due to Adaptive Responses

- Reflux nephropathy
- Renal agenesis (solitary functioning kidney)
- Any Chronic Renal Disease
- Obesity

Obesity-Glomerular “Stress”
Focal Segmental Glomerulosclerosis

- Increased frequency > 20% NS - Blacks!
- In adults onset 2/3 NS, 1/3 proteinuria
- HBP > 30%, Microhematuria >30%, renal dysfunction 50%
- Predictors of ESRD: hvy prot., Blks, high creatinine, on BX – int fibrosis & Collapse
- Strds >50% respond, cytoxan, cyA, MMF
- Recurs 1/3 Txps-

Case 3

- A 67 year old Caucasian Male develops ankle edema and weight gain.
- Labs:
  - 12 g proteinuria/day
  - GFR normal (creatinine 1.1 mg/dl)
  - Albumin of 1.4 g/dl
  - Cholesterol 635 mg/dl
Conditions Associated with Membranous Glomerulopathy

- Infections
  - Hepatitis B, Hepatitis C, secondary and congenital syphilis, malaria, schistosomiasis
- Drugs
  - Gold, penicillamine, captopril
- Collagen vascular disease
  - SLE, Hashimoto's thyroiditis, Rheumatoid Arthritis
- Neoplasia
  - Carcinoma (lung, breast, colon, stomach)

Membranous Nephropathy

- The most common etiology of idiopathic nephrotic syndrome in white adults
- Course variable
- Renal survival at 10 y: 65%-85%
- Renal survival at 15 y: 60%
- Spontaneous remission rate: 20%-30%
Treatment of Membranous Nephropathy

- Conservative Therapy
- Corticosteroids
- Alternating Steroids –Cytotoxics
- Cyclosporine
- Mycophenolate
- Anti C5 Ab, Rituximab

Case 3: Post Biopsy Course

- All serologic tests are normal
- Normal Colonoscopy and CT abdomen/chest
- 3 days after admission, he develops a dull back ache and then becomes acutely short of breath.
- Chest X-ray is normal
- ABG: pH=7.45, pCO2=30, pO2=60 on room air
- CT angiogram is requested

CT angiogram: Abdomen

CT angiogram: Chest

Thrombotic Abnormalities in the Nephrotic Syndrome

- Increased coagulation tendency (plat. hyperaggregability, high fibrinogen and fibrinogen-fibrin transfer, decreased fibrinolysis, low anti-thrombin III)
- DVT, RVT, pulmonary emboli
- Membranous NS greatest risk (up to 35%)
- Most RVT asymptomatic, but flank pain, microhematuria, low GFR
Case 4

- A 38 year AA female has had Type 1 diabetes since the age of 19.
- She has severe retinopathy and multiple admissions for labile blood sugars.
- Her internist refers her for proteinuria which has gone up from 200mg/day to 3.2 grams. Her serum creatinine is 1.5mg/dL.
- She has experienced a 22 pound weight gain and pitting edema to her thighs.
- She is on twice/daily insulin and Diltiazem.

Case 4: Physical Exam

BP: 160/102

Case 4: Ophthalmologic Exam
Types of Diabetes Mellitus

- **Type I - Insulin Dependent**  
  (hypoinsulinemic, ketotic, juvenile onset)
- **Type II - Non-Insulin Dependent**  
  (Normoinsulinemic, non-ketotic, maturity onset)

Basement Membrane Thickening in Diabetes Mellitus

**Vascular BM**
- Glomerular Capillaries
- Muscle Capillaries
- Retinal Capillaries
- Arterioles

**Other BM**
- Renal Tubules
- Mammary Ducts
- Schwann Cells

Diabetic Nephropathy

- Nonenzymatic Glycation Glom BM
- Proteinuria
- Glomerular thickening

Diabetic Neuropathy

- Diabetic Retinopathy
- Diabetic Ketoacidosis
- Diabetic Foot Ulceration
**Stages of Diabetic Renal Disease**

**Type 1 Diabetes**

- **Stage 1**
  - Hyperfiltration

- **Stage 2**
  - Clinically silent

- **Stage 3** (AER: 20-200ug/min)
  - Incipient Nephropathy

- **Stage 4**
  - Overt Nephropathy

- **Stage 5**
  - ESRD

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**Progression of Diabetic Nephropathy**

- Microalbuminuria
- Proteinuria
- ESRD

**Current Strategies to Limit Renal Injury in Diabetic Nephropathy**

- Blood pressure reduction
- Inhibition of the renin-angiotensin-aldosterone axis
- Blood sugar control
- Metabolic manipulation

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**Blood Pressure Targets**

<table>
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<th>Clinical Status</th>
<th>BP Goal</th>
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<tbody>
<tr>
<td>Hypertension (no diabetes or renal disease)</td>
<td>$&lt; 140/90$ mmHg (JNC 7)</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>$&lt; 130/80$ mmHg (ADA, JNC 7)</td>
</tr>
<tr>
<td>Renal Disease with proteinuria &gt;1 gram/day or diabetic kidney disease</td>
<td>$&lt; 130/80$ mmHg $&lt; 125/75$ mmHg (NKF)</td>
</tr>
</tbody>
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**Case 4: Follow up**

- Symptomatic
  - Furosemide 80mg + Metolazone 5mg
  - Pravastatin 40mg
- Reduction of Proteinuria
  - Ramipril 10mg + Candesartan 16mg/day
- Edema improved and proteinuria decreased to 200mg/day
- Her GFR however gradually deteriorated over 6 years and she is on hemodialysis awaiting a kidney transplant.
Case 5

- A 66 y o housewife with severe rheumatoid arthritis for 22 years develops edema. She is currently taking no medications.

- Labs:
  - 9 g proteinuria/day
  - Serum creatinine 1.2 mg/day
  - Serologic tests are negative
  - Creatinine clearance of 100 cc/min

Rheumatoid Hands
**Amyloid**
- **LM:** A homogenous, hyaline eosinophilic proteinaceous substance.
- **Special Stains:**
  - Congo Red
  - Methyl Violet
  - Thioflavin T
- **EM:**
  - Fibrillar Constituent
    - Random arrays of non-branching fibrils, 80-100Å in width, beading with 55Å periodicity
  - Non-Fibrillar Constituents
    - Pentameric discs (AP protein)
  - X-ray Diffraction: beta pleated sheet

**Amyloidosis**

<table>
<thead>
<tr>
<th>Cause</th>
<th>Type</th>
<th>Precursor Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Diseases</td>
<td>Primary</td>
<td>Light Chain</td>
</tr>
<tr>
<td>Associated with “AA”</td>
<td>Secondary</td>
<td>SAA protein (acute phase reactant)</td>
</tr>
</tbody>
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**Chronic Diseases Associated with “AA” Amyloidosis**
- Tuberculosis
- Leprosy
- Chronic Osteomyelitis
- Paraplegia
- Chronic bronchiectasis
- Cystic Fibrosis
- Chronic Heroin Addiction
- Rheumatoid Arthritis
- Psoriasis
- Familial Mediterranean Fever
Case 5: follow up

- Symptomatic treatment
  - HCTZ 25mg qd
- Reduction of proteinuria
  - Lisinopril 10mg/day
- Rheumatoid Arthritis
  - Anti TNF therapy

Conclusions

- Glomerular disease due to the Nephrotic Syndrome (nephrosis) is a common cause of renal disease.
- A renal biopsy and good nephropathologist are essential in diagnosis
- Treatment includes BP control, use of ACE-inhibitors in addition to specific and symptomatic therapy.

The End
(Et Cetera!)