NEPHROLOGY
TERMINOLOGY

• RENAL INSUFFICIENCY
• CKD (CHRONIC KIDNEY DISEASE)
• ESRD (ENDSTAGE RENAL DISEASE)
• GLOMERULONEPHRITIS
• UREMIA
• PROTEINURIA
• NEPHROTIC SYNDROME
• HEMATURIA
ANATOMY AND PHYSIOLOGY

OF THE

KIDNEY
ANATOMY

Front View of Urinary Tract

- Kidney
- Ureter
- Bladder
- Sphincter
- Urethra
- Kidney
- Ureter
RIGHT KIDNEY SECTIONED IN SEVERAL PLANES, EXPOSING PARENCHYMA AND RENAL SINUS
225,000-900,000 NEPHRONS IN EACH KIDNEY. BASED ON URETERIC BUD MORPHOGENESIS

ULTIMATELY DETERMINES HOW WELL THE KIDNEY Responds TO PHYSIOLOGIC DEMANDS
Filtration permeability factor \times \left( \begin{array}{c} \text{Intra-capsular hydrostatic pressure} \\ \text{Intra-capillary hydrostatic pressure} \end{array} \right) = \text{Colloid osmotic pressure of plasma proteins} = \text{Glomerular filtration rate (GFR)}

\text{Plasma inulin concentration} \times \text{Glomerular filtration rate} = \text{Urine inulin concentration} \times \text{Urine volume/min.}

\frac{U_{in}}{P_{in}} = \frac{U_{in} \times V}{P_{in}}
FUNCTIONS OF THE KIDNEY

EXCRETORY

ELIMINATES METABOLIC WASTES AND TOXINS

SECRETORY

PRODUCES HORMONES WHICH AFFECT OTHER ORGANS

ERYTHROPOIETIN
1,25 VITAMIN D
RENIN
PROSTAGLANDINS
HOW TO EVALUATE KIDNEY FUNCTION

• SYMPTOMS AND PHYSICAL FINDINGS
• BLOOD TESTS
• URINE TESTS
• IMAGING STUDIES
SYMPTOMS ARE VARIABLE AND MOST OFTEN SILENT

PHYSICAL FINDINGS ARE COMMONLY EDEMA AND HYPERTENSION
BLOOD TESTS

• BUN (BLOOD UREA NITROGEN)

• CREATININE

• eGFR (ESTIMATED GLOMERULAR FILTRATION RATE)

• ANTI-DNA, C3, C4, CH50
URINE TESTS

• URINALYSIS

• URINE MICROALBUMIN/CREATININE RATIO

• URINE PROTEIN/CREATININE RATIO

• 24 HOUR URINE FOR CREATININE CLEARANCE AND TOTAL PROTEIN
PROTEINURIA

<150 mg/24 hours- normal
<1000 mg/24 hours- mild
1000- 3000 mg/24 hours- moderate
>3500 mg/24 hours- nephrotic

edema
hypoalbuminemia
hyperlipidemia
IMAGING STUDIES

• RENAL ULTRASOUND
• CT SCAN
• NUCLEAR SCAN
• MRI
• ARTERIOGRAM
NUCLEAR SCAN

7740  Posterior  09/26/99

L   R

INJECTION  6 SEC  9 SEC  12 SEC  15 SEC  18 SEC

21 SEC  24 SEC  27 SEC  30 SEC  33 SEC  36 SEC

39 SEC  42 SEC  45 SEC  48 SEC  51 SEC  54 SEC

RENNAL FLOW

3 SECOND IMAGES

60 SEC
PATIENT'S NAME: XXXXXXXXXXXXXX
PATIENT'S ID: 7740
STUDY DATE: 09/28/1999

RENAL SCAN/FLOW STUDY
P.B.G.MED.CENTER.

FLOW

REFERENCE CURVES:
- AORTA
- LT KIDNEY
- RT KIDNEY

RENOMGRAM

REFERENCE CURVES:
- BLADDER
- LT KIDNEY
- RT KIDNEY

RESULT:
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<tr>
<th>Measure</th>
<th>Left</th>
<th>Right</th>
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<tbody>
<tr>
<td>Peak Time (sec)</td>
<td>210</td>
<td>270</td>
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<tr>
<td>1/2 Peak Time</td>
<td>780</td>
<td>960</td>
</tr>
<tr>
<td>Diff Perfusion</td>
<td>55%</td>
<td>45%</td>
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BIOPSY
BIOPSY
KIDNEY DISEASE MAY BE

ACUTE (AKI)

SUBACUTE OR

CHRONIC (CKD)

> 3 MONTHS DURATION
ETIOLOGIES OF CKD

- DIABETES MELLITUS 33.8%
- HYPERTENSION 28.3%
- GN 12.0%
- CYSTIC DISEASE 3.0%
- INTERSTITIAL NEPHRITIS 3.0%
- OBSTRUCTIVE DISEASE 2.0%
- ISCHEMIC RENAL DISEASE
- ATHEROEMBOLIC DISEASE
- ETC.
CKD RISKS

- Atherosclerosis
- End stage renal disease
TREATMENT

TREAT UNDERLYING CAUSE
CONTROL COMORBID CONDITIONS
DIETARY MODIFICATION
DIURETICS
ACE INHIBITORS & ANGIOTENSIN RECEPTOR BLOCKERS
ADJUST DRUG DOSAGES
AVOID NEPHROTOXINS
RENAL REPLACEMENT THERAPY
PROGRESSION OF CKD
ESRD PROGRAM  2008

547,982  PTS ENROLLED IN ESRD PROGRAM
350,617 PTS ON IN-CENTER HD
3,826 PTS  ON HOME HEMODIALYSIS
26,546 PTS ON PERITONEAL DIALYSIS
17,413  NEW KIDNEY TRANSPLANTS

COST $39.46 BILLION
ESRD PROGRAM 2008

INCIDENCE 111,476 NEW BENEFICIARIES

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<tr>
<th>Condition</th>
<th>Count</th>
<th>72.5%</th>
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<td>DIABETES</td>
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<tr>
<td>HYPERTENSION</td>
<td>31,349</td>
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<tr>
<td>GLOMERULONEPHRITIS</td>
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<tr>
<td>CYSTIC KIDNEY DISEASE</td>
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<td>UROLOGIC DISEASE</td>
<td>1,567</td>
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<tr>
<td>OTHER</td>
<td>19,925</td>
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</table>

NKUDIC/NIDDK/NIH 2/15/2012
87,820 pts awaiting kidney transplants

Number of transplants performed per year:

- 2008: 17,413
- 2007: 17,519
- 2006: 18,059
- 2005: 17,450
- 2000: 14,629
- 1990: 10,035
- 1980: 3,786
Paired Donation

Pair 1

Donor 1 → not compatible → Recipient 1

Pair 2

Donor 2 → compatible → Recipient 2

Donor 1 → compatible → Recipient 1

Donor 2 → not compatible → Recipient 2
LUPUS IS ONE OF SEVERAL DISEASES THAT REPRESENT A DYSREGULATION OF AUTOIMMUNITY

THE KIDNEY IS A TARGET ORGAN AND COMMONLY EFFECTED IN SLE
1. Genes

- C1q, C2, C4
- HLA-D2, 3, 8
- MBL
- FcR 2A, 3A, 2B
- IL-10
- MCP-1
- PTPN22

2. Abnormal Immune Response

3. Autoantibodies

3.1 Immune Complexes

4. Inflammation

5. Damage

- Rash
- Nephritis
- Arthritis
- Leukopenia
- CNS dz
- Carditis
- Clotting
- Etc.

- Renal Failure
- Atherosclerosis
- Pulm fibrosis
- Stroke
- Damage from Rx
- Etc.

Environment

- UV light
- Gender
- ?Infection
- ?EBV
- Others

Defective suppressive networks
Virtually all patients will have some degree of renal involvement on biopsy.

ARA criteria: Renal involvement if 500 mg proteinuria/24 hours +/- casts.

Diverse presentation:
- Asymptomatic
- Renal failure

Predisposing factors
Clinical manifestations of Lupus Nephritis

Symptoms

Physical findings

Hypertension

Edema

Rash
WORLD HEALTH ORGANIZATION CLASSIFICATION

ISN CLASSIFICATION

Class I. Normal glomeruli
Class II. Pure mesangial disease
Class III. Focal segmental glomerulonephritis
Class IV. Diffuse proliferative GN
Class V. Membranous GN
Class IV. Advanced sclerosing GN

• Activity/chronicity index
• transformation
TREATMENT

STEROIDS
CYCLOPHOSPHAMIDE
AZATHIOPRINE
MYCOPHENOLATE MOFETIL
TACROLIMUS
CYCLOSPORINE
RITUXIMAB
PLASMAPHERESIS

AGGRESSIVE IMMUNOSUPPRESSION

ACE INHIBITORS
ARB’S
TREATMENT

CLOSE MONITORING FOR EFFECTIVENESS AND TOXICITY

BLOOD COUNT, CHEMISTRIES, URINALYSIS, COMPLEMENT LEVELS, ESR, ANTI-DNA LEVELS

INFECTION
BONE MARROW SUPPRESSION
TOXICITY TO OTHER ORGANS
• 10 – 30% OF PTS PROGRESS TO ESRD WHO HAVE PROLIFERATIVE LUPUS NEPHRITIS OVER TIME

• DISEASE ACTIVITY TENDS TO DECREASE WHEN ESRD DEVELOPS

• SIMILAR SURVIVAL TO OTHER ESRD PATIENTS ON DIALYSIS AND WHO HAVE TRANSPLANTS

• TIMING OF TRANSPLANT : USUALLY ON HD FOR ATLEAST 3 – 6 MONTHS AND ON LESS THAN 10 MG OF PREDNISONE DAILY

• RECURRENCE IN TRANSPLANT PTS IS NOT TYPICAL (2-11%)
PREGNANCY

Pts with disease activity have increased risk of fetal loss and worsening renal function

If proteinuria is present prior to pregnancy it is likely to worsen during pregnancy with subsequent edema and hypertension.

Risk factors for worsening renal function include hypertension, proteinuria and renal insufficiency

Higher incidence of pre-eclampsia and miscarriage with the presence of antiphospholipid antibodies

Better prognosis if: SLE quiescent for 1yr
nl BP
nl GFR