

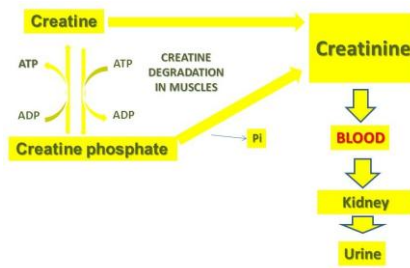
## Biochemical Investigations in Renal Disease

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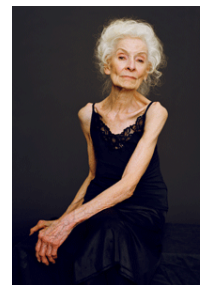
## Why Test Renal Function?

- To identify renal dysfunction.
- To diagnose renal disease.
- To monitor disease progress.
- To monitor response to treatment.
- To assess changes in function that may impact on therapy.

## Creatine and Creatinine



## Creatinine & muscle mass



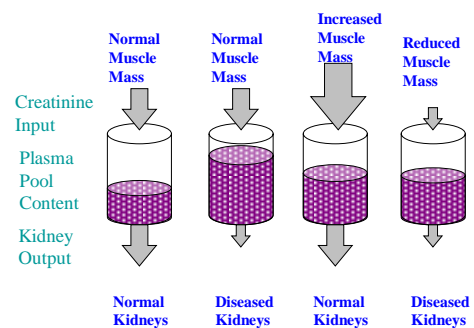
## Creatinine

### Increase

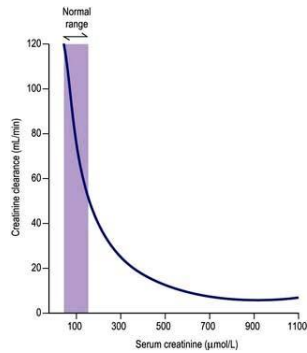
- Male
- Muscular body type
- Meat in diet
- Cimetidine

### Decrease

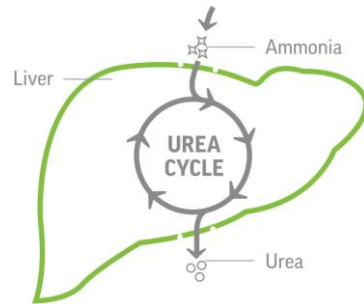
- Age
- Female
- Malnutrition
- Muscle wasting
- Amputation



## Serum creatinine vs GFR

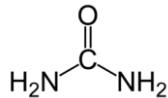


## Blood urea



## Blood urea

- Is it sensitive?
- Urea:Creatinine Ratio
- BUN vs BU



Test	US US units	Other SI Units
Urea	<b>BUN</b> (mg/dL)	<b>U</b> (mmol/L)
	7-30 mg/dL	2.5-10.7 mmol/L

## Blood urea

### Low urea

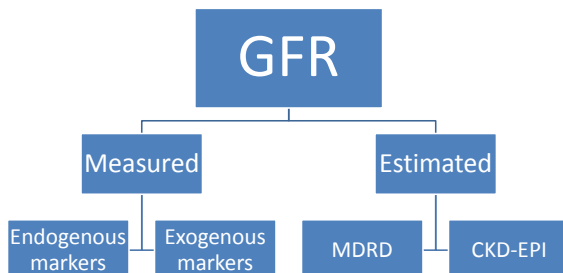
- Pregnancy
- Starvation
- Chronic liver disease

### High urea

- Renal failure
- High protein diet
- Dehydration
- Gastrointestinal bleed

## Filtration markers

- Creatinine
- Inulin
- Iothalamate

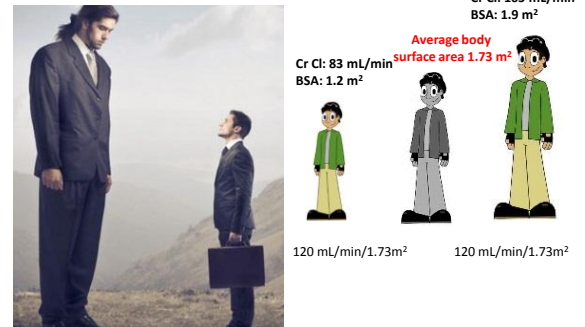


## Performing a creatinine clearance

- 24 hr collection of urine
- Creatinine measured on both serum and urine
- Urine volume noted

$$\text{Cr Cl} = \frac{\text{Creatinine}_{\text{urine}}}{\text{Creatinine}_{\text{serum}}} \times \frac{\text{Volume}_{\text{urine}}(\text{mL})}{\text{Time}(\text{hours}) \times 60}$$

## Body surface area



## Problems of creatinine clearance

- Overestimates GFR
- Creatinine method problems
- Inconvenience of 24 hour urine collection
- Collection errors



## eGFR

$$\text{GFR} = 186 \times (\text{serum creatinine} [\text{mg/dL}])^{-1.154} \times (\text{age})^{-0.203}$$

( $\times 0.742$  for females)  
( $\times 1.210$  for blacks)

- Results standardised for BSA
- No 24 hour urine collections
- No collection errors
- Just one blood sample

## MDRD eGFR calculator

**MDRD GFR Calculator - (SI Units Version)**  
by Stephen Z. Fadem, M.D., FACP, FASN

Serum creatinine  
☐ mg/dL ☒ μmol/L

☐ Creatinine methods recalibrated to be traceable to IDMS




Age  years

Race ☒ African American ☐ All other races\*

Gender ☒ Male ☐ Female

**GFR Value: 85 mL/min/1.73 m<sup>2</sup>**  
(Age, Race, Gender, Plasma creatinine)

Chronic kidney disease (GFR less than 60 or kidney damage for at least three months) ☐  
\*All ethnic groups other than African American  
NOTE: The estimated GFR values above 60 mL/min/1.73 m<sup>2</sup> should be interpreted as "above 60 mL/min/1.73 m<sup>2</sup>," not an exact number.

THE SAME SERUM CREATININE: VERY DIFFERENT eGFR			
			
	22-YR-OLD BLACK MAN	58-YR-OLD WHITE MAN	88-YR-OLD WHITE WOMAN
Serum creatinine	1.2 mg/dL	1.2 mg/dL	1.2 mg/dL
GFR as estimated by the MDRD equation	98 mL/min/1.73 m <sup>2</sup>	66 mL/min/1.73 m <sup>2</sup>	46 mL/min/1.73 m <sup>2</sup>
Kidney function	Normal GFR or stage 1 CKD if kidney damage is also present	Stage 2 CKD if kidney damage is also present	Stage 3 CKD

## eGFR for anybody? NO!

- Extremes of age
- Pregnant
- Disease of skeletal muscle/amputation
- Extremes of nutritional status (severe malnutrition or obesity, creatine supplements)
- Have rapidly changing kidney function –ARF
- CKD-EPI

## CKD

Stages of Chronic Kidney Disease of all Types		
Stage	Qualitative Description	Renal Function (mL/min/1.73 m <sup>2</sup> )
1	Kidney damage-normal GFR	≥90
2	Kidney damage-mild ↓ GFR	60-89
3	Moderate ↓ GFR	30-59
4	Severe ↓ GFR	15-29
5	End-stage renal disease	<15 (or dialysis)

## Urine protein

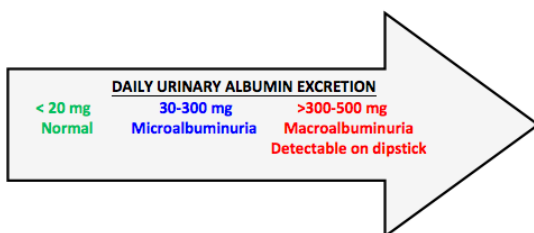
- Normal adults excrete less than 150 mg/d
- Albumin <30 mg/d
- Abnormal urinary protein excretion is a marker of renal disease
- Urine protein concentration : mg/dL
- Protein to creatinine ratio : mg/mmol

## Albuminuria

- Normalalbuminuria : <30mg/d
- “Microalbuminuria”: 30-300mg/d
- Macroalbuminuria : >300mg/d

## Spot urine albumin

- Albumin to creatinine ratio
- Best sample?



## Sample collection cont.

- Recent exercise (within 24 hours before the test)
- Recent sexual intercourse (within 24 hours before the test) in males
- Illness
- UTI
- Menstruation or pregnancy in women

	24-Hour Urine: Urinary Albumin Excretion, mg/24 hours	Urinary Albumin Concentration, mg/L	First Morning Void		
			Sex	Albumin:Creatinine Ratio	
				mg/mmol	mg/g
Normoalbuminuria	<30	<20	Male	<2.5	<20
			Female	<3.5	<30
Microalbuminuria	30–300	20–200	Male	2.5–25	20–200
			Female	3.5–35	30–300
Macroalbuminuria	>300	>200	Male	>25	>200
			Female	>35	>300

Medscape

Source: Am J Epidemiol © 2008 Oxford University Press

## Osmolality

- Osmolality is a count of the number of particles in a fluid sample.
- Measured by osmometer

## Plasma osmolality

- The osmolality of plasma is closely regulated by anti-diuretic hormone (ADH).
- 275–295 mmol/kg
- Usually depends on
  - serum sodium
  - blood glucose
  - blood urea

## Calculated osmolality

- Calculated osmolality=
 
$$2 \times \text{serum sodium} + \text{serum glucose} + \text{serum urea}$$
 (all in mmol/L)

Thank You