Louisiana State University Health Sciences Center
Renal Physiology Problem Set for Medical Physiology
Lecture 3 – Renal Clearance and Glomerular Filtration Rate
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II. Starling Forces

1. At the afferent arteriolar end of a glomerular capillary, P_{GC} is 45 mmHg, P_{BS} is 10 mmHg, and π_{GC} is 27 mmHg.

What are the value and direction of the net ultrafiltration pressure?

III. Renal Clearance, Renal Blood Flow, Glomerular Filtration Rate

2. To measure GFR:

Infuse inulin intravenously until P_{IN} is stable. Measure urine volume produced in a known period of time (urine flow). Measure P_{IN} and U_{IN}.

Given the following:
P_{IN} = 0.5 mg/ml
U_{IN} = 60 mg/ml
Urine flow = 1.0 ml/min

Calculate GFR?

3. To estimate Renal Plasma Flow (RPF):

Infuse PAH. Obtain a timed, complete urine collection and a blood sample. Measure P_{PAH}, U_{PAH}, and urine flow.

Given the following:
P_{PAH} = 0.05 mg/ml
U_{PAH} = 29.5 mg/ml
Urine flow = 1.0 ml/min

Calculate C_{PAH}?

4. Calculation of Renal Blood Flow (RBF): RBF = RPF ÷ (1–HCT)

Given the following:
Hematocrit = 0.45
RPF calculated in problem #3

What is RBF = ?

5. Calculation of Filtration Fraction (FF): Fraction (%) of renal plasma flow that is filtered (moves across the glomerular capillary walls into the Bowman's space) as blood traverses the kidney. FF = GFR ÷ RPF

Given the GFR and RPF calculated in problems #2 and #3
What is FF = ?

6. Fractional Excretion (FE_Q) is the fraction (%) of filtered substance (Q) that is excreted in the final urine. FE_Q = Amount excreted/min ÷ Amount filtered/min = $U_QV \div (P_Q \times GFR)$ = $Clearance_Q \div GFR$

Given the following:
$Clearance_{Na}$ = 0.9 ml plasma/min
GFR from problem #2

What is FE_{Na} = ?

7. Fractional Reabsorption (FR) is the fraction (%) of filtered substance that is reabsorbed by the tubules. $FR_Q = 1 - FE_Q$

Given the FE_{Na} calculated in problem #6
What is FR_{Na} = ?

8. Creatinine is a substance that is excreted primarily by filtration and is produced by the body at a fairly constant rate. Thus, it can be used to estimate glomerular filtration rate (GFR).

Given the following data:
24 hour urine volume = 1.2 liters
U_{Cr} = 144 mg/100 ml
P_{Cr} = 2 mg/100 ml

8A. Calculate the GFR.

8B. Is this value below normal, normal, or above normal?

9. In many experimental studies, inulin is used to measure GFR because it is easily measured and only filtered. Also, PAH is used to estimate the plasma flow because the kidney extracts it from plasma very efficiently.

Given the following data:

urine flow = 3 ml/min
P_{IN} = 0.22 mg/ml
U_{IN} = 9.5 mg/ml
P_{PAH} = 0.08 mg/ml
U_{PAH} = 20 mg/ml

9A. Calculate the GFR and PAH clearances.

9B. Calculate the filtration fraction.

9C. If the hematocrit is 0.40, what is the total renal blood flow?

10. You are given the following information:

Urine flow = 1.0 ml/min
U_{IN} = 60 mg/ml
U_{urea} = 0.240 mmol/ml
P_{IN} = 0.5 mg/ml
P_{urea} = 0.005 mmol/ml

Calculate the following:

10A. Filtered Load of Urea (mmol/min)

10B. Excreted Load of Urea (mmol/min)

10C. Reabsorbed Load Urea (mmol/min)

10D. FE_{urea} (%)

10E. FR_{urea} (%)