Acute Renal Failure

Case #10

Our kidneys are incredible organs that get rid of toxins, retain substances needed by our bodies, and maintain the right balance of electrolytes, minerals, and water. Find out what happens to this 27-year-old when toxins accumulate in her kidneys leading to acute renal failure.

Case Objectives

1) Use your text and the following links to define the basic mechanisms of kidney function as it pertains to the elimination of waste products from the bloodstream. The following terms should be included:

    a. Reabsorption
    b. Secretion
    c. Excretion

Additional basic renal function link

2) Define the following terms:

    a. Azotemia
    b. Hypervolemia
    c. Uremia
    d. Metabolic acidosis
    e. Edema
    f. Oliguria

3) Define the function of the glomerulus and tubules.

4) Briefly define the three types of acute renal failure and which one of the three is the most probable type for the patient in this case study. See *acute renal failure.* Include in your definition factors that may lead to the three types of acute renal failure.

5) Discuss the tests listed below in terms of information each provides for a physician in making a diagnosis of acute renal failure.

    a. Urinalysis
    b. Creatinine
    c. blood urea nitrogen
    d. glomerular filtration rate
    e. electrolyte values

6) Identify the key symptoms of a patient in renal failure and provide a physiological reason for the symptoms.

7) Discuss cause and potential effect in ATN patient's of:

   a. Elevated serum K+ levels
   b. Elevated serum Na+ levels
   c. Elevated H+ ion concentrations
   d. Elevated waste products such as urea and Creatinine

8) Outline the roles of the following health care professionals in the diagnosis, management and treatment of a patient with acute renal failure.

   a. Nephrologist
   b. specialized nursing care
   c. laboratory personnel
   d. dialysis technicians and technologists
   e. health information technicians and technologists

9) Compare, in general terms, the two main types of kidney dialysis to include advantages and disadvantages of the two methods.

10) Summarize possible approaches to treating a patient with early renal failure and a patient with advanced renal failure.

11) Summarize the prognosis of a patient in renal failure (see case summary).

A 27 year old female was seen by medical personnel at an after hours clinic. She complained of nausea and weakness. Physical examination showed the patient had some edema. Since the patient's medical record showed a history of diabetes, her family physician was notified.
Further patient history revealed the patient had been treated 2 weeks prior for a recurring urinary tract infection with two types of antibiotics. However, over the past week, the patient's urine output began to decrease markedly. Alarmed by this information, the family's physician ordered several series of blood tests STAT and asked the patient's husband to transport her to the hospital for admission and further evaluation.

The following tests were ordered:

Complete blood chemistry
CBC
Urinalysis (Be sure to view the photos of the cells and casts at this site.) urine clearance test

Instructor's Notes:
At this point the student should review the following 2 links that review kidney physiology.

Kidney function
The kidney

1) *What is the glomerulus?*
2) *What substances are filtered through the capillaries?*
3) *What substances do not pass through the filters of the kidney?*
4) *How does the kidney maintain the proper pH balance and the proper balance of water in the body?*
5) *What does the term reabsorption refer to?*
6) *What does the term secretion refer to?*
7) *What ion, secreted in the tubules, is important in maintaining control of the acid/base balance (ph) of the blood?*
8) *If the pH of the blood is dropping, how do the kidneys maintain the proper pH?*
9) *What does the term excretion refer to?*

This patient's symptoms may well indicate the serious and life-threatening condition know as acute renal failure. The broad definition certainly means the loss of kidney function to some degree and is usually of sudden onset. At the kidney level, this means a loss in the glomerular filtration rate. The link above presents a good overview of the key points of renal failure and links to basic kidney function. In this case study, we will focus on acute tubular necrosis (ATN) as a toxic side-effect of the antibiotics administered previously.

10) *Acute tubular necrosis can be defined as.....?*
11) *What are the risk factors for ATN?*

Initial Significant Laboratory Blood Chemistry Results

Initial Chemistry Values

Blood Chemistry Value	Normal Range	Patient Value
Glucose	90-120 mg/dl	165 mg/dl
BUN (Blood Urea Nitrogen)	7-24 mg/dl	53 mg/dl
Creatinine	0.7-1.4 mg/dl	3.8 mg/dl
Calcium	8.5-10.5 mg/dl	7.3 mg/dl
Sodium	134-143 mEq/L	152 mEq/L
Potassium	3.5-4.5 mEq/L	5.0 mEq/L
Chloride	95-108 mEq/L	119 mEq/L
CO2	20-30 mEq/L	14.0 mEq/L
Blood pH	7.38-7.42	7. 33

Instructor's Note:

As we see from these results, tests that reflect the ability of the kidney to excrete wastes are quite elevated: notably the blood urea nitrogen (BUN) and creatinine tests. Creatinine excretion is relatively constant, and even slightly elevated serum levels are a significant indicator of renal insufficiency. Note also the electrolyte values show a diminished capacity of her kidneys to regulate acid-base balance. Here, we see results indicating

the beginning of metabolic acidosis. As you recall from the diabetes case , acidosis occurs when the blood pH falls below 7.38. The early acidosis we see here is due to the kidney's inability to secrete excess hydrogen ions and conserve bicarbonate, the body's key buffering substance. Another concern the physician will have is the patient's potassium level is above normal. As hydrogen ions increase, intracellular potassium (K+) moves to the extracellular fluid and serum K levels rise. This condition is called hyperkalemia and poses a danger of disrupting the heart's conduction system. Hypernatremia, which is the retention of sodium (Na+), is a major factor in the fluid retention seen in this patient.

12) *What 2 blood chemistry values are reflective of the kidneys ability to excrete waste?*
13) *Why are these values elevated in this patient?*
14) *What blood chemistry values indicate the patient is in metabolic acidosis?*
15) *What are the dangers of a high K+ level?*
16) *Why is the patient experiencing edema?*

Urinalysis results also show kidney malfunction. Protein and glucose are normally filtered by the kidneys and should not be present in the urine. White and red blood cells are indicative of damage to the kidneys, as are casts in the urine. The student may wish to review the urinalysis site found earlier in the case.

Key Urinalysis Values

Urinalysis Results

Urinalysis Value	Patient Values	Normal Values
Protein	2 gm/dl	absent
Specific Gravity	1.005	1.005-1.030
pH	5.0	5.5-6.5 (avg. range)
Glucose	present (3plus)	absent
Blood (hemoglobin)	2 plus	absent
Casts	granular and epithelial cells 3-5 per low power field	absent or rare
White Blood Cells	5-10 per high power field (p/hpf)	0-1 p/hpf
Red Blood Cells	5 -10 p/hpf	rare
Epithelial Cells (renal)	25-50 p/hpf	0-3 p/hpf

17) *Does the presence of glucose and protein in this urine sample indicate the patient may also be diabetic? Why or why not?*
18) *The presence of casts in the urine are indicative of....?*
19) *What results from the urinalysis point to acute renal failure?*

20) *Which health care professional is responsible for testing the blood and urine sample?*

The patient was admitted to the hospital by the patient's family practice physician. In the meantime, he contacted a nephrologist, an internal medicine physician specializing in disorders of the kidney. In addition, a registered nurse with special skills in caring for patients with renal disease was assigned to oversee the patient's nursing care.

Initial care and assessment consisted of:

a) Stabilizing the patient's acid-base balance and **hypervolemic** state through **diuresis** (using diuretic drugs).

b) Carefully monitoring the patient's **urine output** and renal clearance tests (i.e. creatinine clearance tests) that measure the kidney's filtering capacity.

c) Assuring proper nutrition, but restricting excessive protein intake.

21) *What are the effects of diuresis in treating a patient with kidney disease?*
22) *Why is protein restricted in the diet?*

***Instructor's Note**:*

Since this patient's renal failure was determined early, a relatively conservative approach to her care was indicated. However, if the serum creatinine level had exceeded 8-10 mg/dl., prophylactic renal dialysis would have been indicated. Stabilizing her hypervolemia through controlled diuresis was the clinical approach of choice.

23) *What is renal dialysis?*
24) *What are the 2 different options for a patient facing renal dialysis? How do these 2 methods differ? List advantages and disadvantages of each.*

After several days of treatment and monitoring vital indicators such as urine output, blood creatinine levels, and urine clearance tests, the patient was discharged from the hospital.

Answers to Case Questions

Question 1
The filtering unit of the kidney.

Question 2
Minerals, wastes, and water.

Question 3
Red blood cells, proteins, large molecules.

Question 4
Through absorption or secretion of acids such as potassium, bases such as sodium chloride, and water.

Question 5
The reclaiming by the body of needed molecules such as glucose, salts, and amino acids, that have been filtered by the kidneys. Reabsorption occurs from the tubules.

Question 6
The cells of the tubules remove certain molecules and ions from the blood and deposit these into the fluid within the tubules. Example: Both hydrogen ions (H+) and potassium ions (K+) are secreted directly into the fluid within the distal tubules.

Question 7
H+

Question 8
By secreting H+ ions. This removes excess H+ ions from the blood and raises the pH.

Question 9
The elimination by the kidneys of wastes and the removal of normal components of the blood that are present in greater-than-normal concentrations.

Question 10
Abrupt and progressive decline in tubular and glomerular function.

Question 11
Use of drugs in older patients that are toxic to the kidneys including certain antibiotics. Also prolonged prerenal factors such as burns, hypertension, shock, and congestive heart failure.

Question 12
BUN and Creatinine.

Question 13
The patient is unable to filter the waste products from the blood because of damage to the tubules of the kidneys.

Question 14
pH, CO_2, and electrolytes (Na^+, K^+, CL^-).

Question 15
Can disrupt the heart's rhythm.

Question 16
Elevated Na^+ in the extracellular fluid.

Question 17
The patient could be diabetic but the glucose in the urine could also be from the inability of the kidneys to properly filter the blood glucose.

Question 18
Damage to the tubules of the kidney.

Question 19
The presence of protein, cells, and casts in the urine.

Question 20
Clinical laboratory scientist.

Question 21
Diuresis reduces the blood volume which is increased due to edema. The increased blood volume causes an increased circulatory load which can lead to heart failure. The diuretic also dilutes the elevated sodium level in the blood.

Question 22
The damaged kidneys are unable to filter protein from the blood. Decreasing protein intake decreases possible further damage to the kidneys.

Question 23
Renal dialysis filters waste products from the blood that are not effectively filtered when the kidneys are malfunctioning.

Question 24
Hemodialysis: Blood is pumped from body to a filter where it is purified and returned to the body. Advantages: No patient training is required. Disadvantages: Dialysis graft failure, cannot be performed at home-lack of freedom

Peritoneal dialysis: Bodies peritoneal membrane is used as a filter. Fluid is drained in and out of abdomen.

Advantages: It can be done at home--more freedom.
Disadvantages: Patient training, possible peritonitis and membrane failure.

Health Professionals Introduced in this Case

Physician specializing in Nephrology
Health Information Technology*
Clinical Laboratory Scientist
Dialysis Technologists and Technicians
Nursing

Instructor's Note: Since the patient medical record is such an integral part of patient care, we have included the roles of the health care professionals responsible for maintaining the patient's medical record

Additional links of Interest

AHIMA (American Health Information Management Association) is a website for students wishing to learn more regarding careers in health information management and health administration (HIM/HAS)
WSU Program Information

WebMD This site has an excellent overview of topics discussed in this case.