Case Study in Renal Failure - Facts Terms & Concepts

Questions test the following terms, facts and concepts:

- Hypovolemia and reduced renal perfusion is associated with ARF via tubular necrosis.
- Renal control of serum electrolytes and acid-base balance.
- Clinical features of ARF; distinction from chronic renal failure.
- Uraemia & the meaning of BUN and creatinine levels
- Definition of oliguria and polyuria.
- The relationship between renal failure and metabolic acidosis.
- Respiratory compensation for metabolic acidosis.
- The relationship between renal failure and pulmonary and peripheral oedema.
- The impact of fluid overload on cardiovascular function.
- Site of action of thiazide diuretics, effects on potassium levels
- Effects of hypokalemia and hyperkalemia.
- Location of sodium re-absorption in the nephron.
- Identify why low-protein diet used in impaired renal function.
- Glomerular filtration rate, normal and abnormal.
- Implication of finding that specific gravity of urine matches SG of blood plasma.
- Renin mechanism.
- Factors governing release of ADH, renin, angiotensin, aldosterone and ANP
- Mechanisms of action of ADH, angiotensin, Aldosterone and ANP.
- Autoregulation, sympathetic regulation and hormonal regulation of kidney function.

Case Study in Renal Failure - Instructions

Part A Notes about THIS case study

Part B How to complete an On-line Quiz

Part C Notes about Assessment

(When a quiz is formally assessed and counts towards your end of year mark).

Part A Notes about THIS case study.

Note 1: Stay on the Subject
This case study is RENAL, not digestive pathology.
Even though the precipitating cause of Mr M.'s renal failure was ulcerative colitis, this quiz is about RENAL pathology. All questions are based on the physiology and pathophysiology of the **renal system**, and the case history contains everything you need to research your answers.
This note is a specific warning not to get sidetracked by digestive pathophysiology, which you have not yet covered in Bioscience. Do not, for example, become sidetracked into searching for elaborate medical knowledge concerning possible relationships between ulcerative colitis and renal functioning.

Part B How to complete an On-line Quiz

Note 1: Questions That Have Only ONE answer
Some questions have only ONE correct or best answer. For these questions, several statements may be correct, but only one statement is the most correct and best from the point of view of THAT question. Understanding the wording of a question and interpreting *what is being asked* is crucial to success with multiple-choice questions
These questions will only allow you to select ONE response. Changing your mind and selecting another response is perfectly possible - your second choice of response then becomes your only answer. You can change your mind as often as you like, but the quiz programme will only permit one response to remain selected.

Note 2: Questions That Have MORE than one answer
These questions allow you to select any number (including all) of the possible responses offered. Marks are gained for each correct response, but full marks are only received if all correct responses are selected, and no incorrect responses are selected.
An example could be a question that asked "Clinical signs and symptoms of hypothermia include" followed by some correct responses and some incorrect responses. Working the quiz on-line, you will be able to remove selected choices and re-apply them as often as you wish, up until the time you press "SUBMIT".

Note 3: Time available before SUBMITTING the quiz
You are permitted to print off the case study and questions before operating the quiz on-line. Although you can log into and operate the quiz at any time after its release, your answers are not submitted until you select the SUBMIT button.

Note 4: Working with others
Working with others is perfectly acceptable, and it is recommended that you discuss and problem solve with other students.
You do however take responsibility for your own quiz. Stating later that you yielded to a group opinion which was wrong cannot change your final mark for the quiz!

Note 5: Researching your answers
It is most unlikely that you will find all the answers in your workbook and lecture notes alone. Additional reading is necessary for this standard of knowledge. Remember also that the Martini texts (*Essentials of Anatomy and Physiology* and *Fundamentals of Anatomy and Physiology*) do not have a specific pathophysiology focus.

You are strongly recommended to consult the prescribed and recommended pathophysiology books. The library has a large number of other suitable books in which the necessary information will be found. Books on pathophysiology are on the shelves in the library at catalogue number 616.

Note 6: Suggested Method
Before tackling the quiz on-line:

- *Read the case study*
- *Note down any terms that you do not know, LOOK THEM UP and write down the definitions*
- *Make a list of the clinical signs and symptoms given in the case details and give them names*
- *For example Mr M.'s heart rate on the third day (88 beats per minute) is tachycardia*
- *Read the relevant sections about his condition in your workbook and in the textbook(s)*
- *Make notes from the books about Mr M.' s signs and symptoms as they relate to renal failure*
- *Talk about the case with other students*
- *Working together, you may find it helpful to draw diagrams of altered structure or flowcharts which explain the mechanisms at work in a renal crisis. Textbooks are a good source of flowcharts*
- *Remember that in BioScience, as in many subjects, one good picture can be worth many pages of words*
- *Then look at the quiz.*

Part C Notes about Assessment

Note 1: Time Allowed
When a quiz is a FORMAL PART OF ASSESSMENT, your submitted quiz is marked and counts towards your end of year mark
In these cases, the quiz remains open on WebCT for a set period
During this period, you can operate the quiz at any time, but you can SUBMIT once only
After you have SUMBITTED your answers, the programme will not open for you again
After the closing date, the quiz will be removed from WebCT and will not be accessible
Dates that the quiz is open will be advised in a lecture briefing
Individual results and class averages are generally available on WebCT within a few days.

Note 2: Marking Scheme
Total marks for the On-line Assessment and its percentage of the end of year mark will be advised in a lecture briefing
The marks per question are listed in the quiz
In multi response questions, marks are gained for each correct response, but full marks are only received if all correct responses are selected, and no incorrect responses are selected.

Case Study: Renal Failure

Mr M. is a 49-year-old man who has been treated for ulcerative colitis for the past 11 years. The condition is imperfectly controlled with sulphasalazine and Mr M. is chronically anaemic. He has been hospitalised twice for acute episodes, each time requiring intravenous fluids, complete parenteral nutrition, whole blood and vitamin supplementation.

Two weeks ago, Mr M. was admitted to hospital in a critically ill condition with shock subsequent to a massive colonic bleed. Investigations showed that he had escaped perforation, and frequent blood cultures continued negative for sepsis. The bleeding arrested spontaneously and after vigorous intravenous support, haemodynamic stability was restored. However, between the haemorrhage and the time blood volume was made up, Mr M.'s mean arterial pressure dropped to less than 50 mmHg for over an hour.

24 hours after admission, observations were as follows: Mr M.'s heart rate was 74, blood pressure 134/78, respirations 18. Peripheral pulses were full. Heart and lung sounds were clear. He was nil per mouth, but reported no hunger. His urine output was low, at just 25 mls per hour.

Over the next 24 hours, kidney function dropped to just 10 ml/hr. The urine was a clear yellow, negative for infection. Specific gravity was 1.010, sodium 50 mEqL, blood urea nitrogen 43 mg/dL, creatinine 1.3 mg/dL. An attempt to increase diuresis with drugs that dilate peripheral arteries (dopamine) and diuretics had no effect and was quickly discontinued.

By the third day, Mr M.'s renal function deteriorated further and he was irritable and discouraged. He reported that he felt "very heavy and thirsty"; that he was short of breath and that the bedclothes were itchy. His heart rate was 86, blood pressure 168/92, respirations 26 and laboured. Peripheral pulses were full and bounding and he had an S_3 heart sound. Both ankles and one knee had Grade 3+ pitting oedema and there was a large area of sacral oedema. The ECG showed tall peaked T waves and widening intervals. Epithelial cells and casts appear in the urine and arterial blood assays showed the following: pH 7.20, pO_2 68 mmHg on room air. pCO_2 25 mmHg. Bicarbonate was 10 mEq/L, BUN 180 mg/dL and creatinine 10 mg/dL.

Dialysis was started and effectively resolved both the fluid overload and deranged plasma composition. Kidney function gradually improved and **7 days later**, dialysis was discontinued.

On the 14th hospital day, Mr M. was feeling better and taking a high calorie, low-protein diet. Weight and fluid intake/output were still carefully monitored. The oedema resolved and serum electrolytes, BUN and creatinine levels all moved back to safer levels. His urine output increased dramatically to between 2400 and 3600 ml/day. This expected polyuria resolved after 3 days and he was discharged to continue recovering at home. He was advised that surgical intervention for the colitis may be appropriate later, when his kidneys had fully recovered and his general health was optimal. Periodic measurements of serum electrolyte levels, blood urea nitrogen and creatinine were made to monitor this progress. Seven months later, his blood urea nitrogen plateaued at 27 mg/dL and his creatinine at 1.4 mg/dL. Mr M. had finally recovered from renal failure.

Case Study: Renal Failure - Questions and Answers

Tests: Functions of the renal system

Which of the following are functions of the renal system?

Assisting in the regulation of blood pressure by adjustments to fluid status

Assisting with the regulation of the ionic composition of blood plasma

Assisting with the homeostasis of blood pH

Enhancement of erthyrocyte manufacture

Conservation of nutrients and excretion of wastes

Tests: Control of renal function

Renal function is governed exclusively by the sympathetic nervous system.

True False

Tests: Clinical features of ARF

Acute renal failure is usually associated with:

Separate anuric, oliguric, polyuric and diuretic stages

Renal osteodystrophy and uraemia

Abnormalities of fluid volume, acid-base status and electrolyes

Bilateral urethral obstruction

Tests: Renal responses to ischaemia

The normal renal response to systemic ischaemia from blood loss is:

Increase in sodium reabsorption and fluid conservation

Increase in the permeability of the distal convoluted tubule

Increase in the production and release of EPO

Production of urine with a higher specific gravity

Tests: Renin Mechanism

In response to shock, Mr M.'s renin mechanism was activated. This mechanism attempted to compensate for hypovolemia by:

Starting a cascade reaction through the renin-angiotensin-ADH pathway

Causing vasodilatation and decreasing sodium re-absorption in the renal tubules

Causing excretion of dilute urine

Causing vasoconstriction, increasing sodium and water re-absorption and concentrating the urine

Tests: Relationship between reduced renal perfusion and renal failure

The most probable reason for his oliguria in the first hours was:

Systemic acidosis

Lack of renal perfusion

Rapid transfusions

Formation of an antibody-antigen complex blocking the filtration membrane

Tests: Filtration pressures

Filtration processes in the nephron are driven by the interplay of pressures. Glomerular net filtration pressure is best defined as:

The difference between blood hydrostatic pressure and the opposing capsular and osmotic pressures

The sum of the blood hydrostatic pressure and the capsular and osmotic pressures

The sum of the blood hydrostatic pressure and the capsular pressure minus the osmotic pressure

The difference between intra-glomerular pressure and peritubular pressure

Tests: Capsular pressures

In the normal kidney, the net filtration pressure in the glomerulus is high compared to other capillary beds in the body. This higher filtration pressure is due to:

High capillary colloidal pressure

High blood hydrostatic pressure

High interstitial pressure

High Bowmans capsule pressure

Tests: Relationship between BUN and GFR

Mr M.'s elevated blood urea nitrogen levels reflect the increase in his glomerular filtration rate.

True

False

Tests: Categories of Renal Failure by Pre, Intra and Post

On day three of his crisis, Mr M's condition can be described as:

Clinical progression from intra-renal failure caused by shock to post-renal failure caused by obstruction

Clinical progression from acute renal failure caused by shock to chronic failure caused by loss of functioning nephrons

Clinical progression from pre-renal failure caused by shock to intra-renal failure from renal tubular cell damage

Tests: Impact of renal failure on pulmonary function

When Mr M's lung sounds change from transitory rales that clear on coughing to persistent crackles, it indicates:

Hyperventilation due to increased sympathetic stimulation

Dyspnoea secondary to recumbent position

Pulmonary oedema secondary to fluid overload

Tests: Normal GFR

At the most acute point of Mr M's renal faiure, his GFR was less than 10 mls per hour. This compares to a normal GFR of:

100 mls/min

125 mls/min

150 mls/min

175 mls/min

Tests: Blood indicators of metabolic acidosis

As his condition worsened, Mr M's arterial blood values changed. His blood pH was 7.20; the partial pressure of oxygen was 68 mmHg; the partial pressure of carbon dioxide was 25 mmHg, and his bicarbonate levels were 10 mEq/L. These findings represent:

Respiratory acidosis related to dyspnoea

Metabolic alkalosis related to hypoxia

Metabolic acidosis related to renal impairment

Respiratory alkalosis related to inefficient breathing pattern

Tests: Clinical findings of acute tubular necrosis

As Mr M's conditon deteriorated, his urine changed from clear yellow to cloudy and microscopic analysis revealed tubular casts and sloughed epithelial cell debris. This finding is

Not diagnostically significant as there is always some degree of epithelial sloughing in the urinary system

A dangerous side effect of the diuretic treatment

Compatible with acute tubular necrosis, secondary to acute renal ischaemia

An expected result of his fluid overload

Tests: Relationship of hydrogen and bicarbonate ions to acidosis

If the renal system can neither excrete sufficient hydrogen ions, nor recover sufficient bicarbonate ions, the result must be acidosis.

True

False

Tests: Respiratory compensation for metabolic acidosis

The cause of Mr M's laboured and slightly rapid respirations on the third day of his renal crisis is best described as:

An expected effect of night sedation

A respiratory response to on-going sympathetic stimulation of the adrenal cortex

A respiratory compensation response to increased hydrogen ions in the plasma

Impending respiratory collapse due to oedema and hypertension

Tests: Effects of hyperkalemia on excitable cells

The peaked T waves on Mr M.'s ECG are compatible with his elevated potassium levels. Hyperkalemia is associated with:

The closure of all ion-gated channels

A change in the resting membrane potential of heart muscle cells

A risk of cardiac arrhythmias and cardiac standstill

Tests: Signs and symptoms of hyperkalemia

Apart from the ECG changes, which of his other signs and symptoms are attributable to the hyperkalemis?

Pruritis, S_3 heart sounds, and pitting oedema

Weakness, dyspnoea, restlessness and irritability

Thirst, hypertension, oliguria and weight gain

Irritability, pruritis, and acidosis

Tests: Significance of matching specific gravity, urine and plasma

For several days, Mr M's urine specific gravity is fixed at 1.010. This specific gravity is an exact match to the specific gravity of blood plasma. The implication of this is:

The composition of his plasma and his urine are temporality identical

Secretion and reabsorption processes are unable to correctly transport solutes

Blood urea nitrogen is equally distributed in the tubular and peritubular fluid

Tests: Impact of oedema on cardiovascular system

Prior to dialysis, Mr M.has widespread oedema. The impact of this oedema on his cardiovascular system is:

Increased venous return, increased cardiac output, increased blood pressure, increased renal perfusion

A risk for heart failure from pulmonary venous congestion

Premature closure of pre-capillary sphincters

Tests: Implications of polyuria

Although the return of urine production on day 14 of Mr M's treatment appears to be an excellent development, a potential hazard still exists in that:

His renal tubules are still not functioning normally and he is at risk for pulmonary collapse from oedema

His renal tubules are still not functioning normally and he is at risk for hypokalemia and hypovolemia

His renal tubules are still not functioning normally and he is at risk for azotemia

His renal tubules are still not functioning normally and he is at risk for hypertension

Tests: Rationale for high carbohydrate, low protein diet in ARF

Whilst Mr M.is recovering, his protein intake is restricted. The rationale for this is:

Mr M.has a high metabolic rate due to his illness and has more need of carbohydrates than protein

Mr M's ability to excrete nitrogenous waste products is impaired

Mr M. is unable to metabolise proteins

Tests: Distinction between chronic and acute renal failure

Despite the dialysis correcting Mr M.'s blood toxicity and deranged electrolytes, his acute renal failure will precipitate chronic renal failure.

True

False