

1.) 21-year-old type I diabetic discontinues insulin because of sore throat and difficulty swallowing. Which of the following is the most likely acid-base disorder to develop?

- a) metabolic acidosis, normal anion gap
- *b) metabolic acidosis, increased anion gap
- c) acute respiratory alkalosis
- d) no acid-base disorder is likely to develop

2.) 24-year-old asthmatic has acute onset of wheezing and non productive cough. Which of the following is the most likely acid-base disorder to develop?

- a) chronic respiratory alkalosis
- b) acute respiratory acidosis
- *c) acute respiratory alkalosis
- d) no acid-base disorder is likely to develop

3.) 22-year-old morbidly obese patient adheres to 600 calorie diet, 2000ml water intake daily for 10 consecutive days. Which of the following is the most likely acid-base disorder to develop?

- a) metabolic acidosis, normal anion gap
- *b) metabolic acidosis, increased anion gap
- c) acute respiratory alkalosis
- d) no acid-base disorder is likely to develop

4.) 57-year-old male with COPD, home oxygen dependence, daily chronic sputum production, is treated with several types of metered dose inhalers. No other medications. He is in his usual state. Which of the following is the most likely acid-base disorder to be present?

- a) chronic respiratory alkalosis
- b) acute respiratory acidosis
- *c) chronic respiratory acidosis
- d) no acid-base disorder is likely to develop

5) The patient described in problem No. 4 develops increasing shortness of breath, purulent sputum production, and increased weakness requiring emergency room visit. He appears to be in moderate respiratory distress with peripheral cyanosis. Which of the following is the most likely acid-base disorder to be present at this time?

- a) chronic respiratory alkalosis
- b) acute respiratory acidosis
- *c) acute respiratory acidosis and chronic respiratory acidosis
- d) acute respiratory alkalosis
- e) no acid-base disorder is likely to develop

6) The patient described in problem No. 5 develops worsening respiratory failure and requires mechanical ventilation. He is placed on a ventilator with tidal volume 800 cc, 100 percent FIO₂, and rate of 12/min. Arterial blood gas is

performed after 30 minutes of these ventilator settings. Which of the following is the most likely acid-base disorder to be present at this time?

- *a) acute respiratory alkalosis and metabolic alkalosis
- b) acute respiratory alkalosis and metabolic acidosis
- c) chronic respiratory acidosis
- c) acute respiratory alkalosis
- d) no acid-base disorder is likely to develop

7) 48-year-old 80 kg male with long-standing slowly progressive chronic renal insufficiency with serum creatinine concentration of 3.1 mg/dl. Urinalysis is positive for one plus protein. His only medication is lisinopril 20 mg daily which has controlled his blood pressure, 130/80. He receives a normal diet with no added salt. Which of the following is the most likely acid-base disorder to be present?

- *a) metabolic acidosis, normal anion gap
- b) metabolic acidosis, increased anion gap
- c) chronic respiratory alkalosis
- d) no acid-base disorder is likely to develop

8) 55-year-old male with ischemic cardiomyopathy, ejection fraction 25 percent receives outpatient treatment including lisinopril, digoxin, low-salt diet, furosemide 80 mg twice daily, and potassium supplement. Blood pressure is 110/70. He has one plus ankle edema. Serum creatinine concentration is 0.9 mg/dl. Which of the following is most likely to be present?

- a) volume contraction metabolic alkalosis
- b) chronic respiratory alkalosis related to impaired cardiac output
- *c) volume expanded and metabolic alkalosis
- d) respiratory alkalosis and metabolic acidosis related to impaired cardiac output

9) When a patient is found to have a metabolic acidosis, you would expect the normal kidney to produce a urine which is:

- A. Acidic and has a normal excretion of titratable acidity (T.A.) and NH_4^+
- *B. Acidic and has a high excretion of T.A. and NH_4^+
- C. Neutral (pH 7.4) and has a high excretion of T.A. and NH_4^+
- D. Alkalotic and high excretion of T.A. and NH_4^+

10) In a patient with a metabolic acidosis (pH: 7.20, renal tubular acidosis), the finding of a plasma (K) of 3.5 mEq/L (normal = 3.5 - 5.2 meq/L) would suggest which of the following?

- A. Normal K balance
- *B. Negative K balance (K depletion)
- C. Positive K balance (K retention)
- D. Serum potassium concentration is unrelated to serum pH

These data refer to Questions 10-12:

Two patients present the following baseline data:

Arterial Values
H⁺ = 61 nmol/L
PCO₂ = 24 mmHg

Patient A

plasma Na = 140 mEq/L
plasma K = 5.0 mEq/L
plasma Cl = 96 mEq/L
plasma HCO₃ = 9 mEq/L

Patient B

plasma Na = 140 mEq/L
plasma K = 5.0 mEq/L
plasma Cl = 121 mEq/L
plasma HCO₃ = 9 mEq/L

11) Based on the data presented for patient A, which one of the following diagnoses would most likely explain the lab findings?

- A. Diarrhea
- B. Respiratory acidosis
- *C. Ketosis

12) Based on the data presented for patient B, which one of the following diagnoses would most likely explain the lab findings?

- *A. Diarrhea
- B. Respiratory acidosis
- C. Ketosis

Urinalysis

	1	2	3	4	5	6	7	8	9	10
Specific gravity	025	1010	1014	1010	1012	1010	1015	1015	1012	1.010
Dipstick:										
Protein	---	2+	3+	1+	1+	1+	4+	1+	2+	Trace
Blood	---	---	3+	1+	2+	3+	---	4+	4+	---
Sediment:	Hyaline casts	Waxy casts	10-15 wbc	0-4 wbc	25-30 wbc	TNTC wbc	No cells	TNTC rbc	50-100 rbc	No cells
	No cells	No cells	TNTC rbc	5-10 rbc	20-30 rbc	50-100 rbc	No casts	rbc casts	0-5 wbc	Waxy casts
			Rbc casts	Granular casts	Granular casts	Wbc casts	+ oval		Gran casts	
			Granular casts	Renal tubular	No bacteria	3+ bacteria	Fat bodies		Rbc casts	
				Epithelial cells						

Match the urinalysis:

- 2 - A) A symptomatic chronic renal failure, glomerular
 1- B) CHF
 7 - C) Membranous glomerulopathy
 3 - D) SLE (diffuse proliferative glomerulonephritis)
 4 - E) Acute tubular necrosis
 6 - F) Acute pyelonephritis
 5 - G) Allergic interstitial nephritis
 10 - H) Asy CKD, tubular origin
 8 - I. IgA
 9 - J. Goodpasturei
- 1 - 1. decompensated CHF
- 2 - 2. 48 yo male with creatinine of 2.8 mg/dl and 15 yr history of "protein" on urinalysis
- 3 - 3. 38 yo BF with arthralgia, rash, thrombocytopenia, + ANA, and lower extremity edema
- 7 - 4. 50 yo WM with pitting edema, cholesterol 400 mg/dl, creatinine 1.0 mg/dl, and albumin 2.3 mg/dl, normal BP

2 - 5. 62 yo BF with 15 yr history of Type II diabetes mellitus

5 - 6. 40 yo male developed rash, arthralgia, creatinine increase from 1.0 mg/dl to 2.7 mg/dl 4 wk after starting Dilantin

1 - 7. UGI bleed

6 - 8. 26 yo female with fever, dysuria, flank pain, nausea, vomiting, wbc count at 20,000 μm^3

4- 9. 50 yo male following emergency surgery for ruptured abdominal aortic aneurysm.

8, 9, 3 - 10. 27 yo male IV drug user with fever, wbc count 18,000 μm^3 and new systolic murmur

9 - 11. 48 yo male with palpable purpura of distal lower extremities, ESR 95, creatinine 3.2 mg/dl

4 - 12. 65 yo male with rise in creatinine from 1.2 mg/dl to 2.1 mg/dl after 2 weeks of Gentamycin

1 - 13. decompensated cirrhosis

10 -14. 80 yo male with chronic bladder outlet obstruction 2° benign prostatic hypertrophy.

MATCH FOLLOWING LABS WITH DIAGNOSIS

	A	B	C	D	E
BUN	100	32	10	32	140
Creatinine	3.7	0.9	0.9	3.0	9.0

- B - Pre-renal with normal renal function.
- A - Pre-renal with impaired renal function.
- D - Intrinsic renal disease, moderate
- E - Intrinsic renal disease, advanced
- C - Normal renal function

MATCH FOLLOWING LABS WITH DIAGNOSIS

	BUN	Creatinine	Descriptive
1 - 10		0.9	Urinalysis: 4 ⁺ protein
2 - 24		0.9	Urinalysis: 1.024 specific gravity negative dipstick
3 - 44		2.7	anuric
9 - 59		4.6	oliguric post-emergency aneurysm repair
5 - 42		3.7	fever, maculopapular rash
6 - 42		3.9	urinalysis—unremarkable asymptomatic

- 5 - A. Allergic interstitial nephritis
- 2 - B. CHF, decompensated
- 3 - C. Obstructive uropathy
- 4 - D. Acute tubular necrosis
- 6 - E. Chronic interstitial renal disease
- 1 - F. Membranous glomerulonephritis

HYPONATREMIA

Match the laboratory data with the disease process

1. 130 | 92 | 10
4 | 24 | 1

2. 130 | 85 | 18
3.5 | 30 | 1

3. 130 | 95 | 20
5.7 | 20 | 1

4. 130 100 80
54 | 20 | 8.0

3 - A. Addison's disease

1 - B. SIADH

2 - C. Protracted N/V

4 - D. Chronic renal failure

5. A 70 kg patient is found to have a plasma (Na) = 125 mM/L, a plasma osmolality (Posm) of 253 mOsm/Kg and a urine osmolality of 550 mOsm/Kg. Based on the above data, which one of the following could be true for this patient?

- A. He is normally a healthy individual, but two hours previously he ingested 4L of water
- B. He has an inability to secrete ADH
- C. He has a renal defect which prevents him from responding to ADH
- * D. He has a severe decrease in his effective arterial blood volume

6. Given a patient with the same lab values as the above patient, and with a normal physical exam (no evidence of hypovolemia or edema) a normal urinalysis (no proteinuria or glucosuria), which of the following would be most likely?

- A. Right heart failure
- B. Left heart failure
- C. Inability to secrete ADH

- *D. Inappropriately high secretion of ADH
- E. Nephrotic syndrome

7. Water output (urine) is influenced by?

- A. Ambient temperature
- B. Plasma osmolality
- C. Sodium intake
- D. Access to water
- *E. All of the above

Volume Regulation

1. A 40-year-old previously healthy female developed protracted nausea and vomiting for 3-4 days. She was unable to keep solid food down at all and minimally able to tolerate liquids. Physical examination revealed a blood pressure of 100/70 and heart rate was 90 beat/min. in supine posture and 90/60 and a heart rate of 116 beats/min. in standing posture. There was no edema. Lab findings include sodium 129 meq/l, potassium 3.9 meq/l, chloride 88meq/l, bicarb 28meq/l, BUN 20 mg%, creatinine 1 mg%, urine osmolality 600 mosm/kg, urine sodium concentration 12 meq/l.

2. A 50 year old male with a dilated cardiomyopathy and longstanding congestive heart failure presented with complaints of increasing fatigue, dyspnea on exertion, and swelling of lower extremities. Physical examination revealed a blood pressure of 100/70, heart rate 96 beats/min. He had marked jugular venous distention, cardiomegaly, and pitting edema to the level of his thighs. Laboratory findings include sodium 129 meq/l, potassium 3.9 meq/l, chloride 88meq/l, bicarb 28 meq/l, BUN 20 mg%, and creatinine 1 mg%, urine osmolality 600 mosm/kg, urine sodium concentration 12 meq/l.

3. A 66 year old male with recently diagnosed oat cell carcinoma of the lung, without apparent central nervous system metastases, comes to the hospital with confusion. There is no history of vomiting and he takes no medicine. Physical examination reveals a blood pressure of 116/80 mmHg, jugular vein pressure 6 cm H₂O, and obtundation without any localizing findings. There is no clinical evidence of extracellular fluid (ECF) depletion. Plasma sodium is 125 meq/l.

4. A 45-year-old female presents complaining of severe weakness which has gradually worsened over the past 3 months. She denies nausea/vomiting and is taking no medications. She also reports darkening of her skin. Physical examination reveals a blood pressure of 98/60 and heart rate of 96 beats/min.

supine. Blood pressure is 84/60 and heart rate is 115 beats/min standing. There is no edema. Cardiac and chest examinations are normal. Plasma sodium is 128 meq/l.

5. A 50-year-old asymptomatic female with mild hypertension who has received long-term treatment with thiazide diuretics with no potassium supplements. Physical examination is completely normal.

For each patients listed in the cases above, state whether the following patients are decreased, normal, or increased:

	1	2	3	4	5
1. Total body sodium	↓↓	↑	WNL	↓	WNL
2. Total body water	↓	↑↑	↑	↓	WNL
3. Urinary sodium concentration	↓	↓	WNL>20mEq/L	↑>20mEq/L	>20mEq/L
4. Urine osmolality	↑	↑	↑	↑	Var(>100mosm/kg)
5. Plasma osmolality	↓	↓	↓	↓	WNL
6. Plasma vasopressin concentration	↑	↑	↑	↑	Var
7. Arterial pH	↑	↑	WNL	WNL or ↓	WNL to ↑
8. Creatinine clearance	NSC or ↓	NSC to ↓	WNL	WNL or ↓	WNL
9. Urea clearance	↓	↓	↑	↓	WNL to ↓
10. Plasma uric acid	↑	↑	↓	↑	↑

6. In the normal individual, the daily excretion of sodium in the urine is determined mainly by which of the following?

- A. The urine volume
- B. Atrial natriuretic hormone
- *C. The amount of sodium in the diet
- D. The serum sodium concentration

Hypernatremia

Seventy-six year old man presents with severe obtundation, dry mucous membranes, decreased skin turgor, fever, tachypnea, and blood pressure of 140/80 without orthostatic changes. The serum sodium concentration is 168 mEq per liter the body weight is 68 kg.

Which of the following can best describe the patient?

- Hypovolemic hypernatremia
- hypervolemic hypernatremia
- *euvolemic hypernatremia

Which of the following can best describe the patient's losses?

- *Primarily water loss with minimal solute loss
- isotonic losses of sodium and water
- Losses of both sodium and water, water > sodium

The patient estimated total body water is which of the following?

- *34 liters
- 30 liters
- 40.8 l

The patient's water deficit came primarily from which of the following compartments?

- Extracellular fluid volume
- Interstitial fluid volume
- Plasma volume
- *Intra cellular volume

Which of the following is true concerning intra cellular osmolality?

- *It is increased and identical to extracellular osmolality
- it is increased and is greater than extracellular osmolality
- it is increased and is less than extracellular osmolality

Which of the following intravenous fluids would be most appropriate to replace his deficits?

- Lactated ringer's
- 0.9 percent saline
- 0.45 percent saline
- *5 percent dextrose in water

How much should serum sodium concentration change during therapy over the first 24 hours?

- 5 mEq per liter
- *10 mEq per liter
- 15 mEq per liter
- 20 mEq per liter

Assuming that 5 percent dextrose in water is chosen as the replacement fluid, what IV rate is needed to result in the change in serum sodium concentration of about 10 mEq per liter over the next 24 hours. Assume ongoing insensible losses to be 1.5 liters per day.

100 ML per hour *150 ML per hour
200 ML per hour 250 ml per hour

62 year old man with advanced cirrhosis is treated with lactulose for hepatic encephalopathy. On physical examination he is confused and has asterixis. Blood pressure is 100/60 while the patient is supine and the pulse is 110 beats per minute. There is no peripheral edema, but ascites is detected. Serum sodium concentration is 160 mEq per liter and potassium is 2.6 mEq per liter. The body weight is 64 kg.

This patient hypernatremia can be best described by which of the following?
Excessive insensible losses, primarily of water (euvolemic hypernatremia)
hypotonic losses of sodium and potassium and water (hypovolemic hypernatremia)
*hypervolemic hypernatremia

The etiology of the patient losses is primarily related to which of the following?
*Lactulose therapy
Poor oral intake
Development of ascites

Treatment should include which of the following? (True or False)
T - Replacement of water
F - Replacement of sodium chloride
T - Replacement of potassium
T - Discontinuing lactulose
F - All the above

Our goal with therapy will be to decrease serum sodium concentration about 10 mEq per liter over the next 24 hours. Assuming ongoing losses to be 1.5 liters, which IV fluids would be most appropriate?

Quarter normal saline with 5 percent dextrose in water
*Quarter normal saline with 5 percent dextrose in water with 30 mEq per liter of potassium chloride
Half normal saline
Half normal saline with 30 mEq per liter of potassium chloride

If the infusion used for therapy is quarter normal saline and 5 percent dextrose with 30 mEq KCL added, what IV fluid rate will be needed to reach our treatment goal?

150 ML per hour *220 ml per hour

300 ml per hour 320 ml per hour

A patient is found to have a plasma Na of 160 mEq/L and a plasma osmolality of 323 mOsm. Regardless of the cause of this finding what can you conclude about his intracellular compartment (IC)? (Assume normal cell function).

- A. IC volume is increased, IC osmolality = 285 mOsm
- B. IC volume is increased, IC osmolality = 323 mOsm
- C. IC volume is decreased, IC osmolality = 285 mOsm
- *D. IC volume is decreased, IC osmolality = 323 mOsm
- E. IC volume is normal, IC osmolality = 323 mOsm

If you could reduce his (above patient) plasma sodium from 160 mEq/L to 140 mEq/L by selectively causing the loss of NaCl from the body, i.e., keep total body water content constant, what would happen to his intracellular (IC) and extracellular (EC) volumes?

- A. IC volume increased, EC volume increased
- B. IC volume decreased, EC volume decreased
- *C. IC volume increased, EC volume decreased
- D. IC volume decreased, EC volume increased
- F. Would depend on the cause of the initial increase in plasma Na

Polyuria and increased serum sodium concentration are characteristic features of which of the following?

- A. Compulsive water drinking
- *B. Diabetes insipidus
- C. Chronic renal failure
- D. High salt diet

Water intake is influenced by which of the following?

- A. Ambient temperature
- B. Serum sodium concentration
- C. Sodium intake
- D. Access to water
- *E. All of the above

A 40 year old white male alcoholic was admitted to the hospital because of severe head injury sustained in falling down a flight of stairs. He remained comatose, and over a period of three days his serum sodium concentration increased from 145 mEq/L to 170 mEq/L. Urine output was not accurately measured, but specific gravity in a random specimen was 1.004. What is the probable cause of the hypernatremia?

- A. Inappropriate normal saline administration
- *B. Diabetes insipidus due to head trauma
- C. Insufficient water intake alone
- D. Acute renal failure

The patient weighed 60 kg on admission but was not weighed thereafter. What was the magnitude of change in total body water (assuming negligible changes in total body sodium)?

- A. 5.3 liter reduction
- B. 2.5 liter reduction
- C. 11.7 liter reduction
- *D. 8.8 liter reduction

Hypokalemia

MATCH (match the lab data with clinical condition)

1) 145 | 104 Ucl 50 mEq/L
2.8 | 29

2) 135 | 85Ucl 10 mEq/L
2.8 | 35

3) 140 | 118 UpH 6.0
2.9 | 15 Urine Na 20
 Urine K 30
 Urine Cl 40

4) 140 | 118 UpH 5.4
2.9 | 15 Urine Na 18
 Urine K 15
 Urine Cl 35

5) 140 | 100
5.5 | 15

6) 135 | 105
4 | 19

- 1 - A) Adrenal adenoma
- 2 - B) Prolonged nasogastric suction
- 3 - C) Distal RTA
- 4 - D) Diarrhea
- 5 - E) DKA
- 6 - F) Pregnancy

MATCH LABS WITH DIAGNOSIS

138	84	Uk 40 mEq/L	(A)
3.1	36		

140	114	Uk 10 mEq/L	(B)
3.1	18		

145	105	Uk 55 mEq/L	(C)
2.9	29		

140	105	Uk 40 mEq/L	(D)
2.9	29	plasma Calcium	6.7 mg/dl

132	102	Uk 15 mEq/L	(E)
5.8	18		

140	115	Uk 35	(F)
3.1	15	UNa 30	
		UCI 55	

140	105	Uk 20	(G)
5.9	18	UNa 30	
		UCI 40	

140	104	Uk 25	(H)
3.6	25		

- F - 1. Classic distal RTA
- G - 2. Hyperkalemic RTA
- A - 3. Metabolic Alkalosis (vomiting)
- C - 4. Primary hyperaldosteronism
- E - 5. Addison's disease
- D - 6. Hypomagnesemia
- B - 7. Diarrhea

H - 8. HCTZ for hypertension

Medications: Nephrology issues

1. A patient with diabetes mellitus has hypertension, a creatinine of 2.8 mg/dl and a plasma potassium concentration that ranges from 5.5 to 5.9 meq/l. Which of the following would be the most appropriate antihypertensive agent?

- A. Converting enzyme inhibitor
- B. Angiotensin II receptor blocker
- C. Propanolol
- * D. Furosemide
- E. Amiloride

2. Hypernatremia is seen with all of the following drugs?

- A. Chlorpropramide
- B. Vincristine
- C. Phenothiazine
- D. Thiazides
- * E. Lithium

3. Hyponatremia is seen with all of the following drugs?

- * A. Thiazides
- B. Lithium
- C. Democycline
- D. Heavy glycosuria

4. Hyperkalemia can be seen as a complication of which of the following conditions?

- A. Glycosuria
- B. Thiazides
- * C. Metolazone
- D. Angiotensin II receptor blockers

5. Which of the following would be expected to lead to an enhanced ability to excrete a potassium load:

- A. Amiloride
- B. Spironolactone
- C. Converting enzyme inhibitors
- * D. Acetazolamide
- E. Triamterene

6. Which of the following decreases urinary magnesium excretion?

- A. Thiazides
- B. Furosemides
- * C. Amiloride
- D. Ethanol
- E. Cis-platinum

7. Which of the following is **least likely** to be associated with development of chronic tubulointerstitial disease?

- A. Lithium
- B. Cyclosporin A
- C. Chronic analgesic use
- * D. Azathioprine

8. Which of the following drugs is **least likely** to be associated with allergic interstitial nephritis:

- A. Cephalosporin
- B. Septra
- C. Dilantin
- D. Allopurinol
- * E. Captopril

9. Which of the following drugs is **least likely** to be associated with an acute decrease in GFR:

- A. Non-steroidal anti-inflammatory drugs
- B. Aminoglycosides
- C. Cyclosporin A
- * D. Nifedipine

10. Hypochloremia may be seen in which of the following conditions?

- A. Diarrhea
- B. Acetazolamide use
- C. Hyporeninemic/hypoaldosteronism
- * D. Cushing's disease
- E. Chronic respiratory alkalosis

11. Which of the following conditions can result in hypochloremia?:

- A. Diarrhea
- B. Acetazolamide therapy
- C. Congenital chloride wasting diarrhea
- * D. Chronic respiratory alkalosis

12. Which of the following drugs can be associated with neutropenia?

- A. Cyclosporin A
- B. Glucocorticoids
- C. Digoxin
- * D. Azothioprine

13. Which of the following drugs is most likely to produce increased renal vascular resistance?

- A. Converting enzyme inhibitor
- B. Hydralazine
- *C. Cyclosporin A
- D. Diltiazem

14. Which of the following drugs is most likely to produce decreased renal vascular resistance?

- A. Cyclosporin A
- B. Contrast media
- C. Nonsteroidal anti-inflammatory drugs
- *D. Converting enzyme inhibitor

15. Prerenal azotemia may occur as a complication of :

- A. Furosemide
- B. Converting enzyme inhibitor
- C. Minoxidil
- D. Non-steroidal anti-inflammatory drugs
- *E. All of the above

16. Metabolic alkalosis can occur as a complication of all of the following EXCEPT:

- A. Metolazone
- B. Fluorinef
- C. Excess licorice ingestion
- *D. Amiloride

17. Respiratory acidosis can occur with all of the following EXCEPT:

- A. Opiates
- *B. Furosemide
- C. Phenobarbital
- D. Benzodiazepines

18. Respiratory alkalosis can be seen in all of the following EXCEPT:

- A. Salicylates
- *B. Phenobarbital
- C. Pregnancy
- D. Pain
- E. Hypoxemia

19. An elderly patient with a creatinine of 2 mg/dl reports a decreased PO intake. He has no edema. Serum potassium concentration is 6.2 meq/l. Which of the following measures would be likely to achieve negative external potassium balance?

- A. Calcium gluconate
- B. Dextrose and insulin
- C. Inhaled beta 2 agonist
- * D. Isotonic saline infusion

20. A patient is receiving converting enzyme inhibitor and amiloride is added to his treatment regimen. He reports with weakness, serum potassium concentration is noted to be 7.9 meq/l and there are striking EKG changes of peaked T waves. The most immediate treatment should be :

- A. Dextrose and insulin
- B. Sodium bicarbonate
- C. Hemodialysis
- * D. Calcium gluconate

21. Which of the following drugs can decrease the antihypertensive effect of converting enzyme inhibitors?

- A. Thiazides
- B. Digoxin
- * C. Nonsteroidal anti-inflammatory drugs
- D. Furosemide

22. Which of the following drugs or conditions is likely to lead to impaired renal potassium excretion?

- A. Fluorinef
- B. Metolazone
- C. Piperacillin
- *D. Nonsteroidal anti-inflammatory drugs

E. Hypomagnesemia

23. An increased plasma bicarbonate concentration is most likely to occur in which of the following conditions?

- A. Chronic renal insufficiency
- B. Pregnancy
- C. Advanced cirrhosis
- *D. Primary hyperaldosteronism
- E. Salicylate ingestion

24. An decrease in plasma bicarbonate concentration is most likely to be seen in which of the following conditions?

- A. COPD
- B. Bilateral adrenal hyperplasia
- C. Furosemide therapy
- *D. Acetazolamide therapy

25. Which of the following acid-base disorders is least likely to be present in a patient with sepsis?

- A. Metabolic acidosis
- B. Respiratory alkalosis
- C. Mixed metabolic acidosis and respiratory alkalosis
- *D. Respiratory acidosis

26. Hydrochlorothiazide can be associated with all of the following EXCEPT:

- A. Renal potassium wasting
- *B. Renal bicarbonate wasting
- C. Decreased total body sodium content
- D. Decreased total body water content

27. All of the following statements concerning hydrochlorothiazide are true EXCEPT:

- A. Leads to impaired diluting capacity
- B. Leads to decreased total body water
- *C. Leads to impaired urinary concentrating ability
- D. Is the most common diuretic associated with hyponatremia

28. Which of the following effects would be expected to be present in a patient receiving furosemide therapy?

- A. impaired diluting ability
- B. impaired calcium excretion
- * C. decreased magnesium excretion
- D. decreased PRA

29. Which of the following diuretic combinations would be most likely to result in metabolic alkalosis?

- A. Acetazolamide and furosemide
- B. Hydrochlorothiazide and amiloride
- C. Metolazone and furosemide
- * D. Acetazolamide and hydrochlorothiazide

30. Which of the following would be the most likely cause of an increased anion gap metabolic acidosis?

- A. Mild chronic renal insufficiency
- * B. Salicylate toxicity
- C. Diarrhea
- D. NG suction
- E. Acetazolamide

31. Normal anion gap metabolic acidosis can be seen with which of the following?

- A. Mild chronic renal insufficiency
- B. DKA
- C. Massive isotonic saline infusion
- D. Acetazolamide
- * E. All of the above

32. A 70-year-old black female has a blood pressure of 186/80. She ingests no alcohol and is on no medications. Physical examination is normal. Urinalysis is normal and serum creatinine concentration is 1 mg/dl. Which of the following statements concerning this patient is most correct?

- A. She has essential hypertension
- B. No treatment is indicated
- C. Treatment should include hydrochlorothiazide 50 mg daily
- * D. The patient has increased risk of CVA

33. A 35 year old male with a negative past medical history and normal physical examination urinalysis, and serum creatinine concentration presents with a consistent blood pressure of 160/98 over three different readings. He is not

obese and is a non-smoker and does not drink alcohol. Which of the following is the most reasonable treatment option?

- A. No treatment is necessary
- * B. Low dose thiazides
- C. Low dose furosemide
- D. Low dose hydralazine

34. Which of the following statements concerning hyponatremia seen in association with hydrochlorothiazide is correct?

- A. Is most often associated with overt hypovolemia
- B. More common in patients with renal insufficiency
- * C. Is contributed to by impaired urinary diluting ability
- D. More common in males

35. All of the following statements concerning renal vascular hypertension due to unilateral renal artery stenosis in adults is true EXCEPT:

- A. Is most commonly due to fibromuscular dysplasia
- B. Is more common in females
- C. Is usually associated with other peripheral vascular disease
- * D. Usually presents with edema

Renovascular Hypertension

36. Which of the following represents a significant risk factor for the presence of unilateral renal artery stenosis?

- A. Acute renal failure with converting enzyme inhibitor therapy
- * B. Onset of hypertension after age 55
- C. Suppressed PRA
- D. Edema

37. Which of the following clinical factors is unlikely to be present in patients with bilateral renal artery stenosis?

- A. Acute renal failure with converting enzyme inhibitor therapy
- B. Proteinuria
- * C. Absence of edema
- D. Flash pulmonary edema

38. Which of the following screening tests for renal vascular hypertension has the best sensitivity and specificity?

- A. An increased random PRA
- B. Persistent hypokalemia
- C. Positive captopril nuclear medicine renal scan
- D. Increased serum creatinine concentration

39. All of the following statements concerning unilateral renal artery stenosis are true EXCEPT:

- A. Results in decreased kidney size in the non-stenotic kidney
- * B. Leads to salt retention by the stenotic kidney
- C. Leads to salt retention by the non-stenotic kidney
- D. Leads to enhanced renin output by the non-stenotic kidney

40. Which of the following statements is true concerning the contralateral kidney in unilateral renal artery stenosis?

- A. Has increased renal renin secretion
- B. Has avid renal sodium retention
- * C. May develop hypertensive nephrosclerosis
- D. Has a reduced GFR

41. Which of the following statements is true concerning converting enzyme inhibitor therapy of unilateral renal artery stenosis:

- A. Frequently results in acute renal failure
- B. Increases GFR to the stenotic kidney
- * C. Is effective antihypertensive therapy
- D. Leads to decreased plasma renin activity

42. Which of the following statements concerning converting enzyme inhibitor therapy of unilateral renal artery stenosis is correct?

- A. Would decrease the difference between renal vein renin levels between the stenotic and unaffected kidney
- B. Would increase the GFR in the stenotic kidney
- * C. Will increase the sensitivity of nuclear medicine renal scan in identifying the presence of renal artery stenosis
- D. Will decrease the GFR in the non-stenotic kidney

43. In the general population the most common secondary cause of hypertensive is:

- A. Primary hyperaldosteronism
- B. Renal vascular hypertension secondary to atherosclerosis
- C. Pheochromocytoma
- *D. Chronic renal insufficiency

Chronic Kidney Disease

1. Which one of the following types of clinico-pathologic problems is least likely to cause progressive irreversible damage to the kidney?

- A. Chronic glomerulonephritis in an 18 year old male
- B. Analgesic nephropathy in a 45 year old female
- C. Diabetic glomerulosclerosis in a juvenile onset diabetic
- *D. Acute pyelonephritis in a 22 year old female

2. Given the following data on a 24 hour urine collection of a 60 kg, 76 year old male, which of the values below represents his GFR (glomerular filtration rate)?

Urine volume per 24 hrs = 1160 cc. Urine creatinine concentration = 56 mgm/dl. Blood urea nitrogen concentration = 16 mgm/dl. Hematocrit (PCV) = 40%. Serum creatinine concentration = 0.9 mgm/dl.

- *A. 50 cc/min
- B. 71 cc/min
- C. 100 cc/min

D. 5 cc/min

3. If a 60 kg, 76 year old patient, such as the one above, is found to have the same serum creatinine as was present at age 25, which one of the following statements is most likely to be true?

A. The glomerular filtration rate is the same at age 76 as it was at age 25

*B. The GFR is likely to be significantly lower despite the absence of a change in the serum creatinine

C. The GFR in this instance would be better estimated by using the values for urea clearance

D. The fact that the hematocrit (Packed Red Blood Cell Volume) has remained normal indicates that no appreciable change in the renal function has occurred

4. Oval fat bodies, fatty casts, and increased urinary protein are found in the following:

A. Obstructive nephropathy

B. Acute tubular necrosis

C. Pyelonephritis

*D. Nephrotic syndrome

5. Waxy casts are:

A. Specific for acute glomerulonephritis

B. Practically never found in the nephrotic syndrome

*C. Practically never found in normal urine

D. Frequently seen in patients with cystitis

6. In clinical states in which there is generalized pitting edema (non-allergic) which of the following is always present?

A. Increased cardiac output

*B. Increased total body sodium

C. Increased blood pressure

D. Hypoalbuminemia

The following case refers to questions 7-12

A 17 year old male with no past medical history of serious illnesses presented to the hospital with a recent development of headache and nausea one week following the onset of a sore throat. On the day of admission he vomited and

passed urine which was coca-cola colored. He was then taken to the hospital emergency room. His blood pressure was 180/100, P-100, R-24, T-99o and weight-70 kg. He had periorbital, facial and pedal edema. He also had a congested circulation with evidence of an increased blood volume (distended jugular veins while sitting up, rales in his lung bases, full pulse waves). In addition he had evidence of a high rather than a low cardiac output (active forceful precordial apical cardiac impulse, warm digits, bounding radial and papable digital pulses).

The initial laboratory findings included the following:

Blood urea nitrogen (BUN) of 86 mgm/dl (normal is 10-18 mgm/dl)
Serum creatinine of 2.8 mgm/dl (normal is 0.5 - 1.2 mgm/dl)
Serum albumin of 3.6 gm/dl

Serum electrolytes:

Na = 132 mEq/L (low)
K = 5.0 mEq/L (high normal)
HCO₃ = 16 mEq/L (low)
Cl = 97 mEq/L (normal)

Arterial Blood Gases:

pH = 7.35 units
pCO₂ = 30 mmHg
H⁺ = 45 nEq/L

The urinalysis revealed a specific gravity of 1.025, 3+ protein, 15 white blood cells per high power field (WBC's/HPF), 50-75 red blood cells per high power field (RBC's/HPF), and red blood cells casts.

His initial hematocrit is 34% with a white blood cell count of 13,500/mm³. A pre-camp physical exam taken 3 months prior to the admission showed normal findings including the physical, hematocrit, urinalysis, BUN, electrolytes and creatinine.

During the first 24 hours the patient passed 150 cc of urine which contained 0.6 grams of protein. A throat culture taken on admission later returned showing the existence of beta hemolytic streptococci.

7. If a renal biopsy is done on this patient, which of the following findings would you expect to be present?

- A. A decrease in the overall number of cells in the glomerulus (glomerular hypercellularity)
- B. Sclerotic glomeruli
- *C. Glomerular immunofluorescent staining for gamma globulin and complement
- D. A decrease of polymorphonuclear leukocytes within the glomeruli

8. Which of the following can be said about this patient's clinical problem?
- A. He probably will not recover renal function
 - B. The pulmonary rales and congested circulation are due to failure of the heart to pump blood to meet the demands of the tissue (congestive heart failure).
 - C. If one looked very closely at his fingernails one would see broad white bands of edema fluid beneath the nail beds
 - *D. He has the nephritic syndrome
9. Which of the following regarding this patient's renal handling of sodium and sodium balance is true?
- *A. The filtered load of sodium is decreased
 - B. The low sodium in the serum is because this patient's nephrons have an inability to reabsorb normally and to retain as much sodium as the patient is ingesting
 - C. The patient more than likely does not have total body excess of sodium
 - D. Because of enhanced proximal sodium reabsorption, the fluid leaving the proximal tubule and entering the loop of Henle is hypotonic
10. Which of the following statements regarding the acid base aspect of this case is/are true?
- A. The electrolyte and arterial blood gas profiles suggest a form of respiratory acidosis
 - B. The plasma anion gap is normal
 - C. The pulmonary edema has added an element of stiffness to the lungs to the extent that respiratory compensation is incomplete
 - *D. This is a metabolic acidosis

The following case refers to questions 13-16

A 19-year-old female presents with a history of the onset of dysuria and urgency six days previously. She had begun to drink extra water, and the symptoms improved over the next two days. She had a return of symptoms following sexual intercourse seventy-two hours prior to admission. Two days prior to admission cramping abdominal pains and diarrhea developed. The day prior to admission she developed bladder spasms, had a shaking chill, followed by protracted nausea and vomiting, and worsening of the diarrhea. She was unable to hold down any food or fluids.

Her past medical history and review of systems was significant for repeated symptoms of dysuria (approximately 10 episodes) over the past 3 years. These had primarily been associated with sexual activity. She denied previous chills or back pain. Neither had she been admitted to a hospital, had a urine culture, nor been treated for urinary tract infections since early childhood. Her mother, however, indicated that she had become ill as a three year old with fever lasting several days.

The illness had been diagnosed as a urinary tract infection and treated as an outpatient. The patient stated that she recently had begun to have nocturia approximately 3 times nightly and felt that she passed urine more frequently than her peers. She also said that she often would return to the bathroom within 10 minutes of voiding and pass more than two ounces of urine again.

On physical examination she had a weight of 110 lbs (weight of 115 lbs two weeks prior), a temperature of 104°F, a pulse of 110/min, a blood pressure of 116/76, and respirations of 12/min. She was flushed and had dry mucous membranes. Her pulse rate on sitting up was 120, and the blood pressure was 100/62. The lungs were clear and her heart rhythm was regular. She had exquisite tenderness to "fist percussion" over her costovertebral angles, which was felt to be an indication of tenderness of the kidneys. Examination of the abdomen revealed only mild generalized tenderness; however, deep palpation in the suprapubic region elicited tenderness of the bladder. Pelvic examination revealed signs of bladder tenderness but no extraordinary cervical or adnexal tenderness, thus reassuring the examiner that no pelvic or peritoneal inflammation was likely. A sterile catheter was placed into the bladder through the urethra with ease, and the urine was submitted for urinalysis and culture. The urine culture was later reported showing significant growth of proteus mirabilis.

The CBC was as follows:

Hematocrit = 35%

WBC = 14,800 (high) with increased % of polymorphonuclear leukocytes

The blood chemistries showed:

Na = 134 mEq/L

K = 2.8 mEq/l

Cl = 84 mEq/l

HCO₃ = 34 mEq/L

BUN = 28 mgm/dL

Creatinine = 1.6 mgm/dL

The arterial blood gases were as follows:

pH = 7.51 units
H⁺ = 31 nEq/L
pCO₂ = 44 mmHg

Urinalysis results:

appearance = yellow cloudy
specific gravity = 1.014
protein = 2⁺
glucose = negative
rbc's = 4-8/HPF
wbc's = 25-35/HPF
casts = hyaline, granular, and WBC casts
bacteria = numerous motile rods (with positive gram stain for gram negative bacteria on an unspun specimen)

13. Which of the following statements about this patient's primary diagnosis is/are likely to be true?

- A. The pathogenesis most likely involves infection of the urinary tract through hematogenous spread
- B. An immune complex injury to the glomeruli is likely accounting for the proteinuria
- C. An organism commonly causing this syndrome is mycobacterium tuberculosis
- *D. There is a urinary infection involving both the lower and upper tracts

14. Which of the following underlying conditions would you suspect might be present in such a patient?

- *A. Vesico-ureteral reflux
- B. Normal urinary tract
- C. Chronic glomerulonephritis
- D. Renal tubular acidosis

15. Which of the following statements regarding the acid-base disturbance is/are true?

- A. There is a laboratory error accounting for one or more of the values of either pH, H⁺, pCO₂, or bicarbonate
- B. The patient has a simple appropriately compensated metabolic acidosis
- C. This patient's anion gap elevation is due only to the low potassium

*D. This patient's urine chloride would be low if it had been measured on admission

16. Which of the following statements regarding this patient's fluid and electrolyte abnormality is/are likely to be true?

- A. The total body water is elevated
- B. If this patient's first 24 hr urine creatinine excretion was 1.2 grams/24 hr and her serum creatinine did not change, her creatinine clearance would measure 62.5 cc/min (uncorrected for body surface area)
- *C. The patient has a total body sodium deficit
- D. The patient probably has lost less than 200 mEq of potassium

17. Which one of the following findings is not typically seen with the acute nephritic syndrome?

- A. Red blood cell casts in the urine
- B. Hypertension
- *C. Polyuria due to a defect in renal concentrating ability
- D. Elevation of serum creatinine
- E. Edema

For questions 18-20 mark the single best response

A 54 year old white male presents with a history of chronic renal disease since age 18 and recent easy fatigability. In addition he has nocturia x3, recent anorexia and 5 lb weight loss. Blood pressure = 184/116, pulse = 90, resp. -16, T = 98.4°, weight = 160 lbs. His jugular venous pressure is normal. His chest is clear, and his heart is slightly enlarged with an audible 4th heart sound (consistent with moderate concentric hypertrophy of the left ventricle due to hypertensive heart disease). The abdomen is normal without bruits or organ enlargement (organomegaly). The BUN is 88 mgm/dl and the serum creatinine is 4.0 mgm/dl. Na = 142 mEq/L, Cl = 104 mEq/L, K = 4.8 mEq/L. In evaluating his problem imaging studies are done and show contracted small kidneys consistent with chronic kidney disease with renal insufficiency.

18. Which of the following explanations best fits the current understanding of the most likely mechanism of hypertension in a case such as this?

- A. One kidney is releasing renin under the stimulus of a restricted blood flow to that kidney. The resulting angiotensin II is raising the blood pressure. This suppresses the release of renin from the opposite kidney.

B. The renal insufficiency found in this case causes the release of epinephrine and norepinephrine from the adrenal medulla which in turn are raising the blood pressure.

*C. The renal parenchymal damage in this case results in reduced release of vasodepressor substances and an inability to normally excrete the Na and H₂O at a normal blood pressure. The resulting retention of Na and H₂O causes volume expansion which acts to enhance cardiac output. The Na retention also enhances the response of the smooth muscle to vasoconstrictor substances. These factors together raise the blood pressure.

D. The renal parenchymal disease leads to ischemia of the cortex which causes renin release. This then stimulates the hypothalamus to release vasopressin which acts on the mesangium of the glomeruli to decrease GFR (and enhance Na retention) and on the adrenal medulla (to cause epinephrine release). These latter effects act to raise blood pressure.

19. Sodium restriction to 10 mEq/24 hrs for a number of days to weeks would not be expected to cause which of the following?

- A. Lowering of the blood pressure
- *B. Worsening of the GFR
- C. Reduce fractional sodium restriction to less than 1%
- D. Loss of weight

20. A 27 year old female was seen by her physician because of asymptomatic gross hematuria of 6 days duration and edema of her feet and ankles. Her blood pressure was 160/110. She was noted to have facial puffiness and abdominal swelling. The rest of the physical examination was normal. Significant laboratory findings included: Urinalysis: specific gravity 1.024; RBC 40-50/HPF, 4+ proteinuria, several granular casts, 1 RBC cast, and few hyaline; oval fat bodies; BUN 35 mg/dl; serum creatinine 1.8 mg/dl. How would you best classify her probable glomerular disease from a clinical standpoint?

- A. Rapidly progressive glomerulonephritis
- B. Nephritic syndrome
- C. Nephrotic syndrome
- *D. Nephritic-nephrotic syndrome
- E. Asymptomatic hematuria

Calcium and Phosphorous

2. Kidney stones are comprised of which of the following compounds most frequently?

- A. Calcium phosphate
- B. Cystine
- C. Uric acid
- *D. Calcium oxalate
- E. Magnesium ammonium phosphate

Acute Renal Failure

The following case refers to questions 1-6 (Mark single best response)

A previously healthy 27 year old male was involved in an accident while riding a motorcycle. He sustained a ruptured spleen, bilateral hemopneumothoraces (hemorrhage and air in both pleural spaces), bilateral compound tibial fractures, and multiple lacerations, abrasions and contusions. He arrived in the ER comatose with the above injuries, respirations of 34, a blood pressure of 62/40, temperature of 36.5°C, and pulse of 160, one hour following the accident. He was examined, x-rayed and blood was obtained for appropriate lab studies. He was stabilized with blood and IV fluids and taken immediately to the OR.

The CBC was consistent with severe hemorrhage and stress.
The blood chemistries showed the following:

BUN = 25 mg/dl
Cr = 1.4 mg/dl
Na = 145 mEq/L
K = 5.9 mEq/L
HCO₃ = 15 mEq/L
Cl = 105 mEq/L
CK = 2500 U/L

Arterial blood gases showed the following:

pH = 7.25 units
pCO₂ = 35 mmHg
pO₂ = 49 mmHg

Urinalysis showed the following:

pH = 5.0 units, protein = 2⁺, RBC = 20-30/HPF, WBC = 5-10/HPF, specific gravity = 1.018, many hyaline, granular and broad coarsely granular casts with epithelial cells.

Urine chemistries (on the small amount of urine found in the bladder) were as follows:

Sodium = 48 mEq/L
Creatinine = 18 mg/dl
Potassium = 28 mEq/L

1. Which of the following best describes the acid/base status of this patient?
 - *A. He has a mixed metabolic and respiratory acidosis
 - B. He has an uncomplicated metabolic acidosis
 - C. He has an uncomplicated respiratory acidosis
 - D. He has a mixed metabolic acidosis with a respiratory alkalosis with the acidosis predominating

2. What is the fractional sodium excretion in this case?
 - *A. 2.4%
 - B. 12.8%
 - C. .31%
 - D. .024%

3. The level of urine sodium concentration seen in this patient is most likely due to which of the following?
 - A. Appropriately increased sodium reabsorption due to low peritubular capillary pressure in response to the shock
 - *B. Lack of renal tubular response to stimuli for sodium reabsorption because of ischemic injury
 - C. Increased water reabsorption secondary to vasopressin release
 - D. Increased sodium reabsorption in the ascending limb of the loop of Henle because of ischemic injury

4. What is the most likely pathophysiologic problem causing the oliguria?
 - A. Pre-renal acute renal failure due to hemorrhage
 - *B. Acute renal failure due to probable acute tubular necrosis
 - C. Post-renal acute renal failure due to ureteral obstruction from crystals
 - D. Probable bilateral renal artery thromboses from trauma

5. If the urine output in this patient had been 50 cc per hour and the other findings the same, which of the following statements would be true?

- A. The GFR would be approximately 50 cc/min
- B. The BUN would not rise over the next 72 hours
- C. The diagnosis would be non-oliguric acute renal failure
- D. The patient would likely have a low serum magnesium in 48 hours

6. Which condition is most likely associated with decreased urine output and a fractional excretion of sodium of less than 0.5% (low)?

- A. Acute tubular necrosis
- *B. Severe hypovolemia
- C. Pyelonephritis
- D. Diabetic ketoacidosis

ACID BASE FORMULAE

1. HENDERSON EQUATION

$$[H^+] = K \times [pCO_2] / [HCO_3]; K = 24$$
$$[H^+] = 24 \times pCO_2 \text{ (mmHg)} / HCO_3 \text{ (mEq/L)}$$

2. HENDERSON HASSELBACK EQUATION

$$pH = K^+ + \log [HCO_3] / [H_2CO_3]; K^+ = 6.1$$
$$pH = 6.1 + \log [HCO_3] / [pCO_2 \text{ (mmHg)} \times .03]$$

3. COMPENSATION FORMULAE

- A. Metabolic acidosis - $\Delta pCO_2 = 1.2 \times \Delta HCO_3$
- B. Metabolic Alkalosis - $\Delta pCO_2 = 0.6 \times \Delta HCO_3$ (range 0.4 to 0.8)
- C. Acute Respiratory Acidosis (minimal renal compensation) - $\Delta [H] = 0.8 \times \Delta pCO_2$
- D. Chronic Respiratory Acidosis - (maximal renal compensation) - $\Delta [H] = 0.3 \times \Delta pCO_2$
- E. Acute Respiratory Alaklosis - (minimal renal compensation) - $\Delta [H] = 0.8 \times \Delta pCO_2$
- F. Respiratory Alkalosis - (maximal renal compensation) - $\Delta [H] = 0.17 \times \Delta pCO_2$

ADULT NORMAL LABORATORY VALUES

Serum and plasma chemistries

BUN	10-18 mgm/dl
Creatinine	
child	0.3-0.7 mgm/dl
male	0.6-1.2 mgm/dl
female	0.5-1.1 mgm/dl
Glucose (fasting)	75-105 mgm/dl
Sodium	136-146 mEq/L

Chloride	98-106 mEq/L
Potassium	3.5-5.0 mEq/L
Bicarbonate	22-29 mEq/L
Creatinine Kinase (CK)	12-70 U/L (international Units/Liter)

Arterial Blood Gases

pH	7.33-7.44
Male	35-48 mmHg
Female	32-45 mmHg
pO ₂	83-100 mmHg
Hydrogen ions	36-44 nmol/L (nanomoles/L)

Creatinine Clearance 85-140 ml/min/1.73 m²

Hematologic

Hematocrit (Packed Red Blood Cell Volume)

male	37-53%
female	36-46%

White Blood Cell Count 3,000-11,000 mm³