Respiratory & Renal/Urinary Systems

United States Medical Licensing Examination (USMLE) Step 1

11 to 15% of Step 1 · 9 sections · content outline and specifications

This system joins the lungs and the kidneys, because both control gas balance and acid-base balance. Step 1 questions test physiology first: ventilation, perfusion, gas exchange, acid-base, glomerular filtration and nephron transport. Many items give an arterial blood gas, pulmonary function results or urine studies and ask you to name the disorder or its mechanism. Pathology questions cover infections, obstructive and restrictive lung disease, lung cancer, and glomerular and tubular kidney disease. Pharmacology focuses on how diuretics and respiratory drugs work and which drugs harm the lungs or kidneys.

You should be able to: After this guide you should be able to read a blood gas and urine study, name the lung or kidney disorder, and explain its mechanism.

Every section: the key point and the trap

1 Ventilation, perfusion and gas exchange

Alveolar oxygen pressure (PAO2) = FiO2 x (760 - 47) - PaCO2/0.8. On room air at sea level this is about 150 - PaCO2/0.8.

Trap: A low PaO2 does not always mean lung disease. Always calculate the A-a gradient before you choose V/Q mismatch.

2 Acid-base balance and arterial blood gases

Step 1: look at the pH. Below 7.35 is acidemia; above 7.45 is alkalemia.

Trap: Compensation never brings the pH fully back to normal or past normal. If it does, look for a second primary disorder.

3 Respiratory infections, upper and lower airways

Croup (parainfluenza virus): barking cough, stridor, subglottic narrowing (steeple sign).

Trap: Do not choose an organism from the setting alone. Join the setting with the Gram stain and one key clue (low sodium, cold agglutinins, CD4 count).

4 Obstructive and restrictive lung disease

Obstructive disease: FEV1/FVC is low, total lung capacity is normal or high (air trapping).

Trap: A low FEV1 alone does not mean obstruction. Restrictive disease also lowers FEV1, but FVC falls as much or more, so the ratio stays normal.

5 Lung cancer, pleura and pulmonary vascular disorders

Squamous cell carcinoma: central, smoking, keratin pearls, hypercalcemia from PTH-related protein.

Trap: Do not confuse small cell and squamous cell syndromes. Calcium points to squamous cell; low sodium, Cushing features or weakness that improves with use point to small cell.

6 Renal physiology: filtration, clearance and transport

Clearance = (urine concentration x urine flow) / plasma concentration. Inulin clearance equals GFR; creatinine clearance slightly overestimates it.

Trap: When a question changes one arteriole, think about both GFR and plasma flow. The filtration fraction (GFR/RPF) changes in the direction of GFR when plasma flow falls.

7 Diuretics and drugs that harm the kidney

Acetazolamide: carbonic anhydrase in the proximal tubule; normal anion gap metabolic acidosis, alkaline urine.

Trap: Loop diuretics and thiazides both cause low potassium and alkalosis. Only calcium separates them: loops lose calcium in urine, thiazides keep it.

8 Glomerular disease: nephritic and nephrotic

Nephritic: hematuria with red cell casts, hypertension, mild proteinuria. Nephrotic: protein above 3.5 g/day, low albumin, edema, high lipids.

Trap: Timing separates IgA nephropathy from poststreptococcal disease. IgA: hematuria within days of the infection. Poststreptococcal: 1 to 3 weeks later.

9 Tubules, interstitium, vessels, stones, cysts and the urinary tract

Acute tubular necrosis: muddy brown granular casts, FENa above 2%. Prerenal azotemia: FENa below 1%, BUN/creatinine above 20.

Trap: Do not read a high BUN as prerenal by itself. Use the FENa and the casts: ischemia that lasts long enough turns prerenal azotemia into tubular necrosis.

Key terms

A-a gradient: The difference between oxygen pressure in the alveoli and in arterial blood.

V/Q ratio: The ratio of air flow (ventilation) to blood flow (perfusion) in a lung region.

DLCO: A test of how easily gas moves from the alveoli into the blood.

Anion gap: Sodium minus chloride and bicarbonate; it rises when an unmeasured acid is added.

FENa: The fraction of filtered sodium that leaves in the urine.

Clearance: The volume of plasma cleared of a substance by the kidneys each minute.

Nephrotic syndrome: Heavy protein loss in urine with low albumin, edema and high lipids.

Nephritic syndrome: Glomerular inflammation with blood in urine, red cell casts and high blood pressure.

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