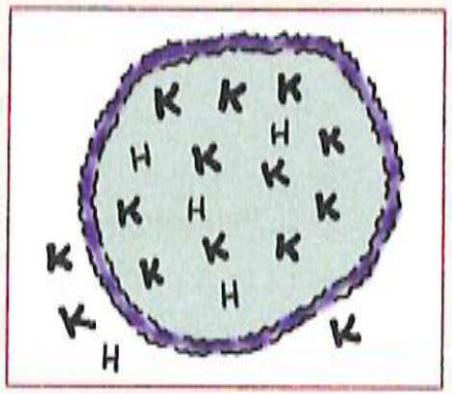
Hypokalemia

POTASSIUM 3.5-5.0 mEq/L

Where is potassium normally found?

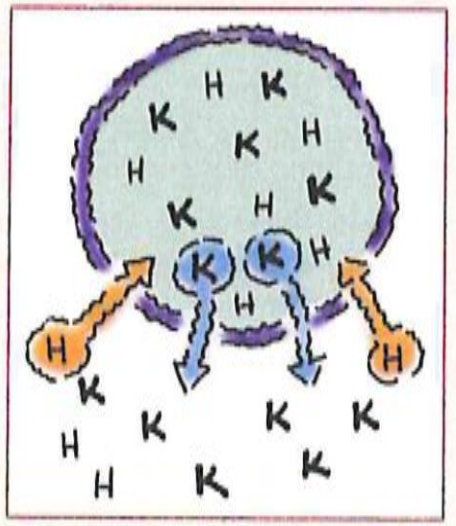


For an average 70 kg adult there is roughly 3500 mmol of potassium in the body. Of this:

- 3150 mmol (90%) is in the intracellular fluid mainly found in muscle. It is the main intracellular cation, and its concentration is around 100 to 120 mmol/L inside cells
- 350 mmol (10%) is in the extracellular fluid. The concentration of extracellular potassium is much lower, around 4 mmol/L, with a range of 3.5 to 5.2 mmol/L. There is also a significant amount of extracellular potassium outside of cells, in bone.

Only about 15 mmol of the body's total 3500 mmol potassium (0.4%) is found in plasma. Consequently, the concentration of potassium in plasma is significantly influenced by transcellular shifts of potassium across cell membranes.

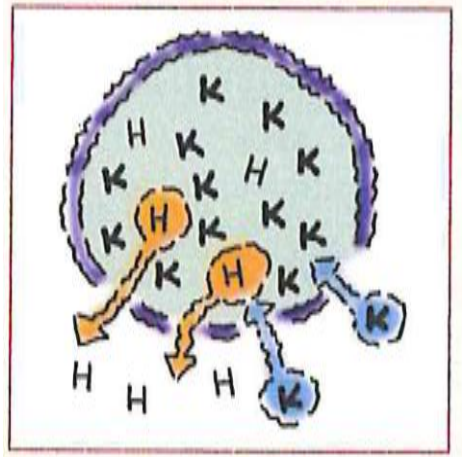
What controls shifts of potassium?



Na/K ATPase pumps potassium into cells in exchange for sodium. Several factors affect the rate of movement of potassium into cells. These are listed in table 1.

Table 1. Factors affecting the rate of movement of potassium into cells

Factors that increase movement of potassium into cells	Factors that reduce movement of potassium into cells
• Insulin • Beta adrenoceptor agonists • Alkalosis • Alpha adrenoceptor antagonists	• Glucagon • Beta blockers • Acidosis • Alpha adrenoceptor agonists • Raised osmolality • Exercise



How does the body handle the overall balance of potassium?

A Western diet contains about 100 mmol of potassium per day.

Excretion of potassium occurs via the following routes [8]:

- Kidneys (90%)
- Colon (10%)
- Skin (negligible in normal circumstances).

How does the body control excretion of potassium by the kidneys?

The kidney is the main organ responsible for homoeostasis of potassium. [8] Factors that affect excretion of potassium by the kidneys are listed in table 2.

Table 2. Factors affecting excretion of potassium by the kidneys

Factors that increase excretion of potassium	Factors that decrease excretion of potassium
• Increased luminal flow rate (results in less potassium reabsorption) • Aldosterone • Increased extracellular potassium concentration • Alkalosis	• Reduced luminal flow rate • Aldosterone antagonists (potassium-sparing diuretics) • Reduced extracellular potassium concentration • Acidosis

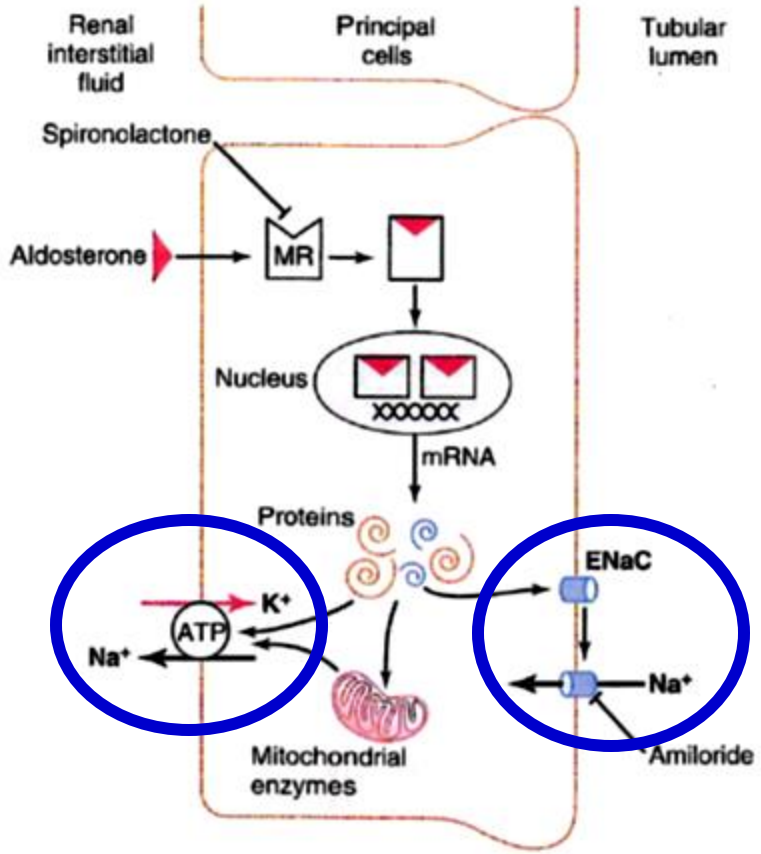
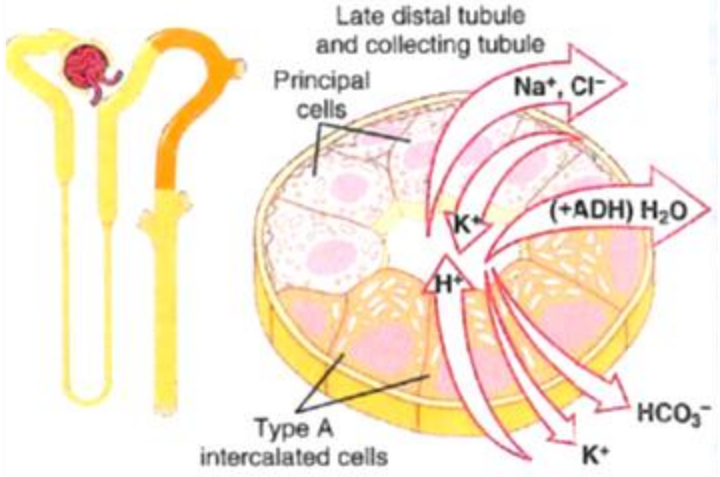
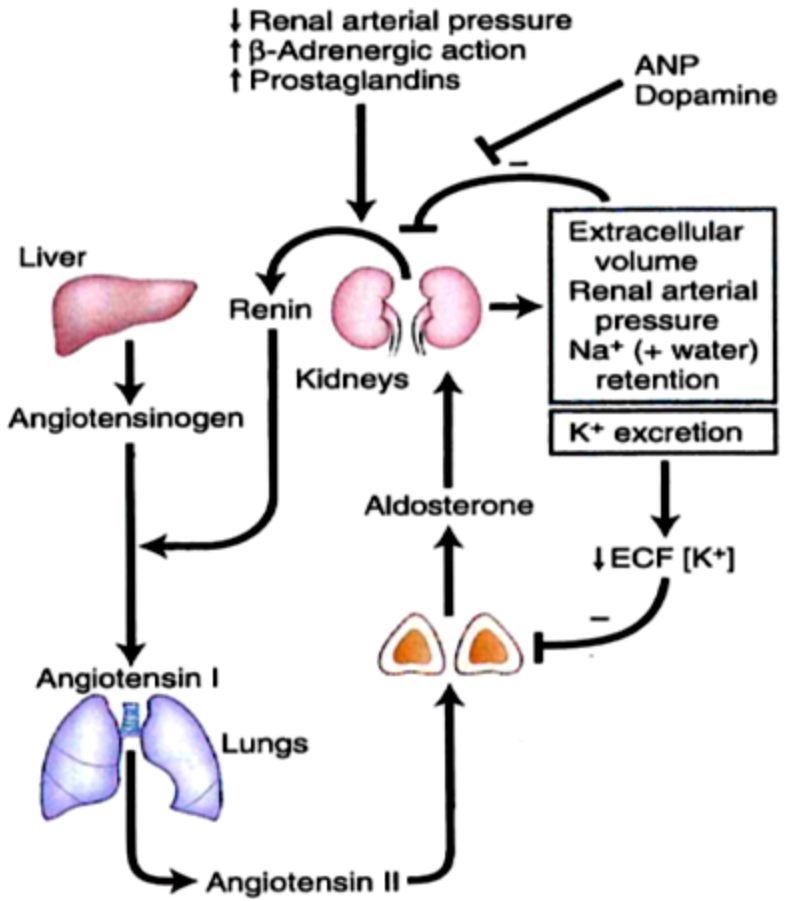


Figure 78-4. Aldosterone-responsive epithelial cell signaling pathways. Activation of the mineralocorticoid receptor *(MR)* by aldosterone can be antagonized with spironolactone. Amiloride is a drug that can be used to block epithelial sodium channel proteins *(ENaC)*.



CELLULE PRINCIPALI DEL TUBULO DISTALE e DOTTO COLLETTORE



B **Regulation of aldosterone secretion**

How can we measure excretion of potassium by the kidneys?

In some circumstances it can be helpful to measure renal potassium excretion to help determine the cause of potassium disturbances. There are several ways of examining excretion of potassium by the kidneys.

Table 3. Interpreting urinary potassium excretion test results [1]

Test	High urinary potassium excretion	Low urinary potassium excretion
Spot urine potassium	Greater than 20 mmol/L	Less than 20 mmol/L
24 hour urine potassium	Greater than 10 mmol/24 hours	Less than 10 mmol/24 hours
Urine potassium/creatinine ratio	Greater than 1.5 mmol/mmol	Less than 1.5 mmol/mmol

Several factors can increase urinary excretion of potassium:

- Excess of mineralocorticoids +
- Increased delivery of sodium to the distal nephron +
- Metabolic alkalosis, or chloride depletion, or both +
- Depletion of magnesium +

Cardiac ✓

Neuromuscular >

Gastrointestinal >

Renal >

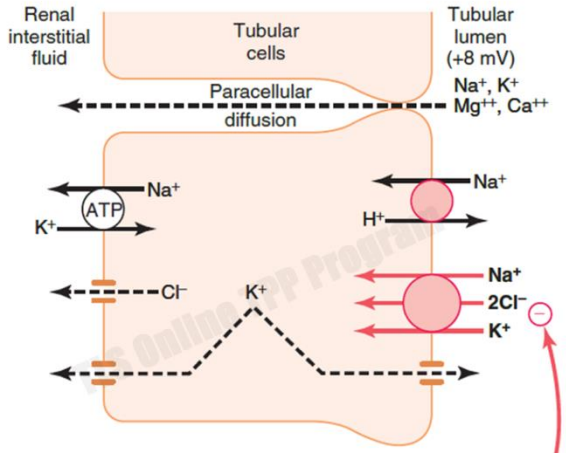
The most serious effects are on the heart. Electrocardiogram (ECG) changes include:

- T wave flattening
- ST depression
- Prominent U waves.

Hypokalaemia can induce ventricular arrhythmias and, in particular, it increases the risk of digoxin toxicity.

Table 5. Causes of hypokalaemia by frequency

Common	Uncommon	Rare
• Diuretics (for example, furosemide, bendroflumethiazide) • Diarrhoea • Laxative use • Vomiting/metabolic alkalosis	★ Primary hyperaldosteronism (for example, Conn's syndrome) ★ Secondary hyperaldosteronism (for example, renal artery stenosis) • Hypomagnesaemia ★ Drugs: for example, mineralocorticoids, insulin, beta agonists	• Barrter/Gitelman syndromes ★ Liddle's syndrome ★ 11beta hydroxysteroid dehydrogenase deficiency ★ Glucocorticoid remediable aldosteronism • Renal tubular acidosis ★ Severe Cushing's syndrome • Pseudohypokalaemia • Hypokalaemic periodic paralysis

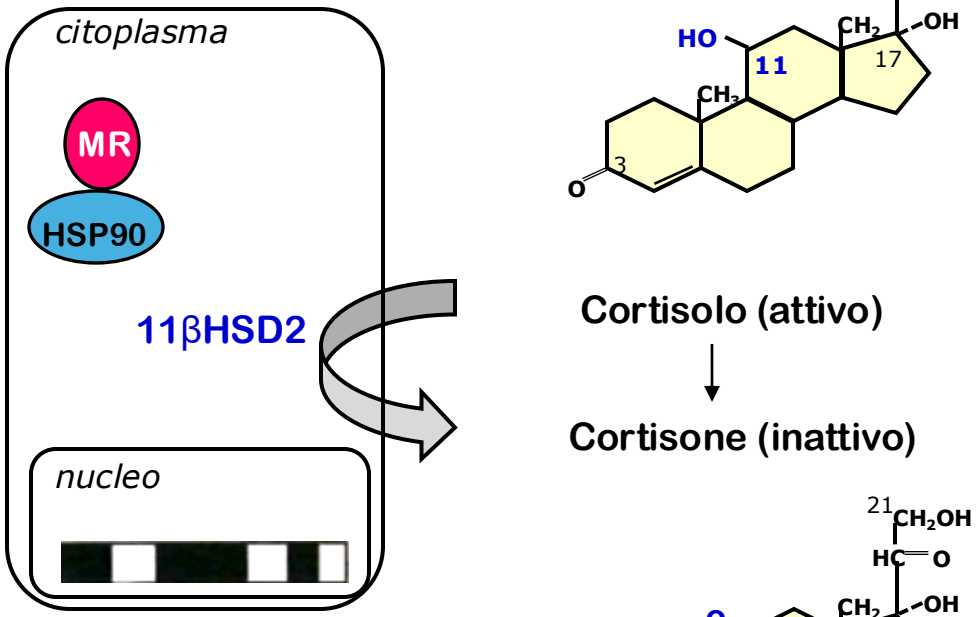


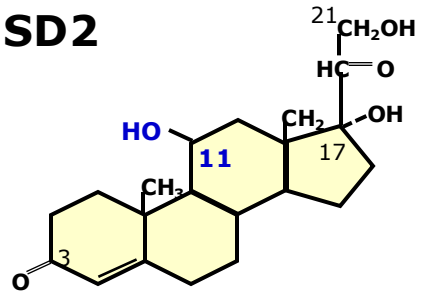
Furosemide

★ PA alta

Pseudoiperaldosteronismo

Difetto 11βHSD2

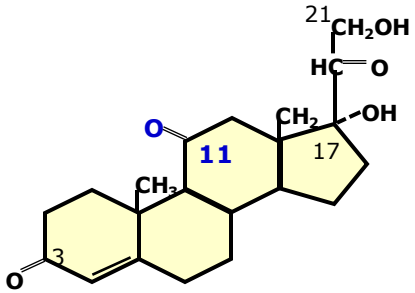




Cortisolo (attivo)

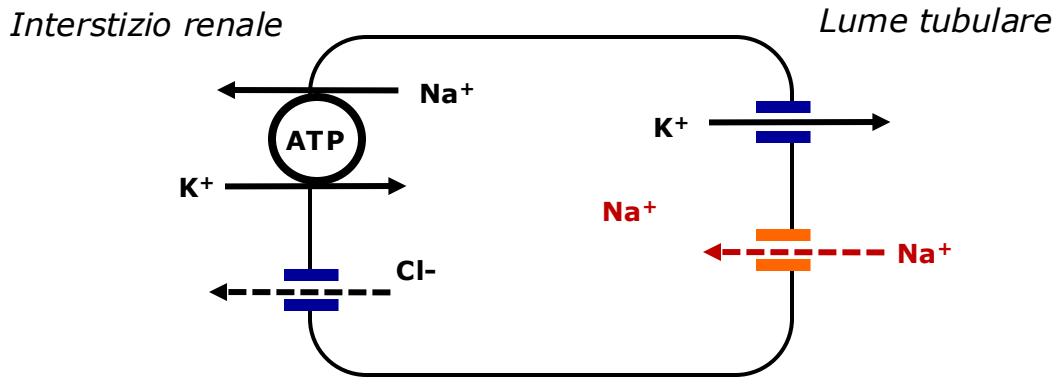
↓

Cortisone (inattivo)



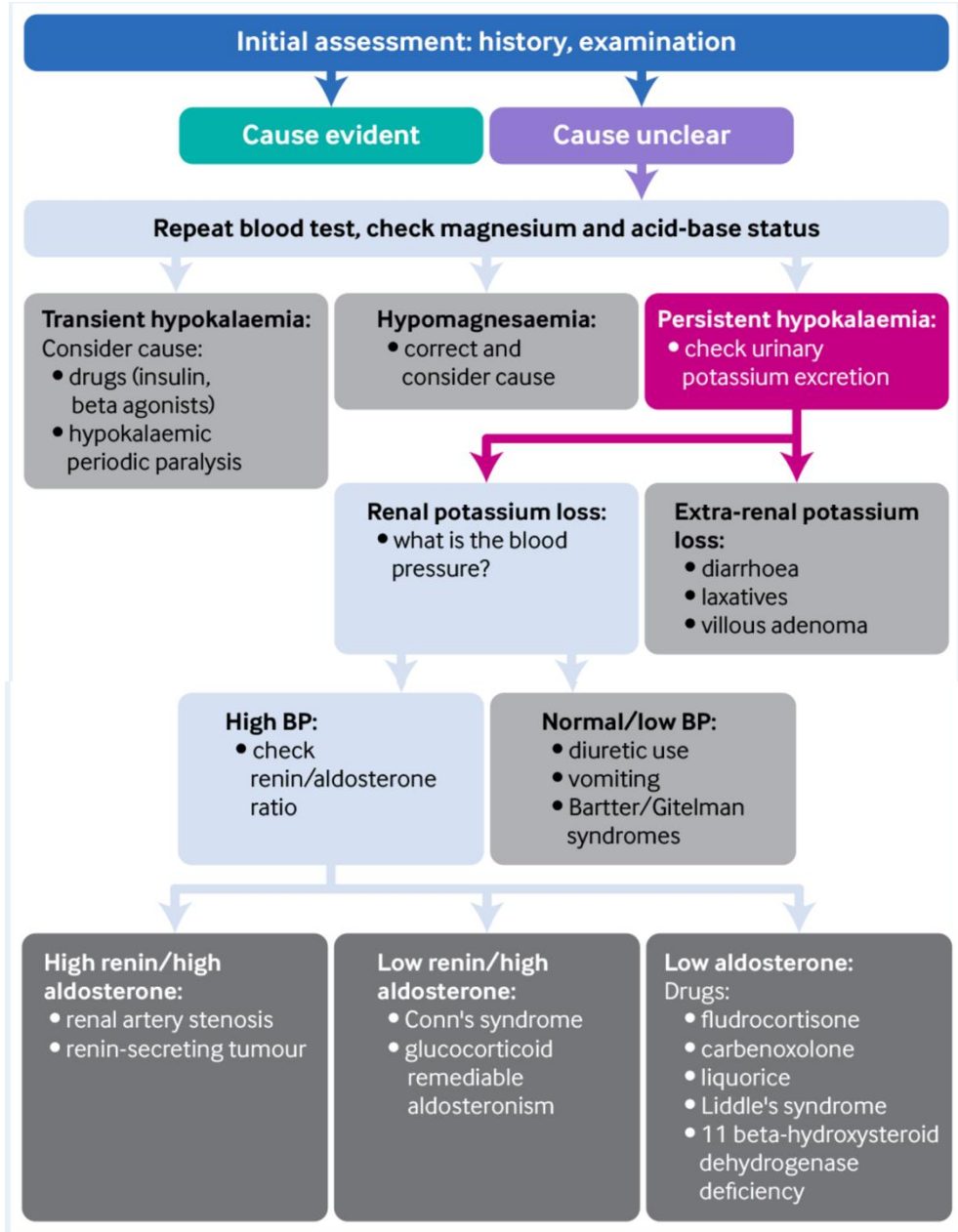
Se genetica - AR
Acquisita - liquirizia
Considerare se aumento cortisoluria e rapporto **cortisolo/cortisone urine 10x**

Sindrome di Liddle



AD
Alterazione canale luminale per riassorbimento sodio
Considerare in pazienti in cui esclusione di tutte le altre forme di eccesso mineralocorticoidi e **risposta all'amiloride**

William, Endocrine Reviews, 2017


Initial assessment: history, examination
Cause evident
Cause unclear
Repeat blood test, check magnesium and acid-base status
Transient hypokalaemia:
Consider cause:
• drugs (insulin, beta agonists)
• hypokalaemic periodic paralysis
Hypomagnesaemia:
• correct and consider cause
Persistent hypokalaemia:
• check urinary potassium excretion
Renal potassium loss:
• what is the blood pressure?
Extra-renal potassium loss:
• diarrhoea
• laxatives
• villous adenoma
High BP:
• check renin/aldosterone ratio
Normal/low BP:
• diuretic use
• vomiting
• Bartter/Gitelman syndromes
High renin/high aldosterone:
• renal artery stenosis
• renin-secreting tumour
Low renin/high aldosterone:
• Conn's syndrome
• glucocorticoid remediable aldosteronism
Low aldosterone:
Drugs:
• fludrocortisone
• carbenoxolone
• liquorice
• Liddle's syndrome
• 11 beta-hydroxysteroid dehydrogenase deficiency

Indications for emergency treatment include:

- Ventricular arrhythmias (especially in the context of myocardial ischaemia)
- Paralysis
- Digoxin toxicity.

In this context you can use intravenous potassium chloride. Concentrations of up to 40 mmol/L at a rate of up to 10 to 20 mmol/hour may be given peripherally (continuous cardiac monitoring is recommended at faster rates). [5] Higher concentrations should be given via a central line.

NON SUPERARE 200 mEq/24 ore

A slow oral replacement of potassium is effective in most situations. The options include:

- Potassium chloride salts
- Potassium bicarbonate
- Potassium sparing diuretics (such as amiloride or spironolactone).

Potassium chloride is used for patients with normal blood pressure and when potassium sparing diuretics are contraindicated. Doses equivalent to 30 to 60 mmol potassium per day are effective for preventing hypokalaemia, although higher doses are needed for treatment. Effervescent preparations are preferable, although modified release tablets may be used if effervescent preparations aren't tolerated.

Potassium bicarbonate is indicated for patients with hypokalaemia and a hyperchloraemic metabolic acidosis (for example, proximal renal tubular acidosis or villous adenoma). You should also treat any magnesium deficiency. Where possible, you should correct the underlying cause.

Potassium sparing diuretics are often appropriate to treat or prevent hypokalaemia in patients with hypertension and in patients on diuretic therapy.

Testo quesito :
Valutazione paziente con ipokalemia

Anamnesi :
Consulenza endocrinologica redatta visionando i referti su G2 e dopo contatto telefonico per: ipokaliemia. Paziente al 3° trimetre di gravidanza. Non patologie di rilievo in anamnesi, appendicentomia, endometriosi. Al momento ricoverata per ipokaliemia dopo episodi di vomito.

Ricognizione farmacologica :
Infusione di potassio

Esame obiettivo :
Riferita normotesa

Esame di laboratorio

- Riferita alcalosi
- Esami 13/05/2025 Potassio 2.17 mEq/L; Sodio 132 mEq/L; Magnesio1.54 mEq/L; Cloro 88 mEq/L Creatinina 0.60 mEq/L, Albumina 2.97 g/dL
- Esami 14/05/2025 (in corso di correzione di potassio) Potassio 3.04 mEq/L, Potassio urine 24 ore 37 mmol/24 ore, Cloro urine <15 mEq/L - non calcolabile

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Diagnosi o ipotesi diagnostica :
Verosimile ipokaliemia associata a vomito (alcalosi metabolica e ipocloremia)