Electrolyte Disturbance in Tube Feeding

Interhospital Geriatrics Meeting

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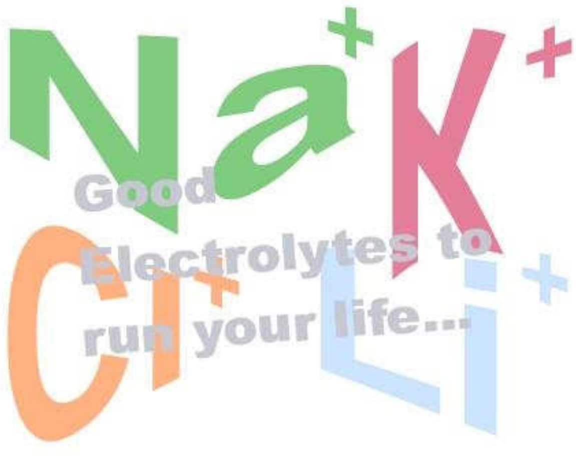
29 Jul 2011



Case

- F/84
- Old aged home resident
- Bedbound, non-communicable
- History of CVA, depression
- Medication:

1. Mirtazapine
2. Clonazepam

- Admitted on 23-29/12/2010 for chest infection
- Oropharyngeal dysphagia with high risk of aspiration.

Nutritional status of this patient

- Alb 29 (low)
- Lymphocyte 1.9 (within normal range)
- BW 27.6kg
- Height 1.45m (by bone-length model)
- BMI 13kg/m2

Patient is undernutrition!

- Put on RT feeding

2 months after last admission

- Decrease in consciousness
- Vomiting once of undigested milk
- Cough and sputum
- No diarrhea
- No fever

Physical examination

- Euvolemic
- Temp 34.9ºC — Mild hypothermia
- BP 104/36 P 68 — Hypotension
- SpO2 100% 2L/min NC
- Chest - crepitations over RLZ
- CVS – HS dual. No murmur
- Abd soft, non-tender, no guarding/ rigidity

Initial investigation results

- CXR - Right lower zone hazziness
- ECG: Sinus rhythm. Peaked T waves in precordial leads

Initial investigation results

WBC	10.50		10^9/L	pH	7.51	H	
Neutrophil	9.8	H	10^9/L	pCO2	4.48	L	kPa
HGB	9.1	L	g/dL	pO2	17.97		kPa
				Base Excess	3.3		mmol/L
PLT	87	L	10^9/L	Bicarbonate	25.9		mmol/L

Initial investigation result

Sodium	95	L	mmol/L	Bilirubin, Total	7		umol/L
Potassium	6.3	H	mmol/L	ALP	136		U/L
Urea	7.1	H	mmol/L	ALT	28		U/L
Creatitine	21	L	umol/L	Calcium	1.85	L	mmol/L
Protein, Total	53	L	g/L	Calcium, alb-adj	2.06	L	mmol/L
Albumin	30	L	g/L	Phosphate	1.03		mmol/L
Globulin	23		g/L	Glucose, spot	5.2		mmol/L

Initial provisional diagnosis

- Chest infection with sepsis
- Hypothermia + Hypotension + Hyponatremia + Hyperkalemia

→Adrenal crisis cannot be excluded

(Normal glucose level)

Immediate treatment

- NPO
- NS Q8H/pint
- Space blanket
- Intravenous Hydrocortisone 100mg Q8H
- Intravenous Augmentin
- Dextrose-Insulin drip, Resonium C, Calcium gluconate
- Stop Mirtazapine and Clonazepam

More Investigations Results

Cortisol (spot)	1443 H nmol/L	Serum Osmolality	188 L mOsm/kg
TSH	0.82 mIU/L	Urine Osmolality	336 mOsm/kg
TTKG	7.0	Ur. Sodium	11 mmol/L
<3 indicates decrease >7 indicates increase		Ur. Creatinine	1.5 mmol/L

Why did she have severe hyponatremia?

Causes of hyponatremia

Hypovolemia	GI loss eg. diarrhea, vomiting Renal loss eg. thiazide
Normovolemia	Adrenal insufficiency Hypothyroidism SIADH Primary polydipsia Low dietary solute intake
Hypervolemia	Heart failure Cirrhosis

Cause of hyponatremia in this patient

Euvolemic

- X Primary polydipsia (solely tube feeding)
- X Hypothyroidism (TSH 0.82 N)
- X Adrenal insufficiency (cortisol 1443 H)
- Not likely SIADH
  (serum/urine osmo 188/336, spot urine Na 11 L)

Reason is Low Dietary Solute Intake ?

Dietary intake of this patient

Ultracal 237ml X 4/day for 2 weeks

	Enteric feeding provided	Requirement of healthy people	
Water	40	25-30	ml/kg/day
Energy	36	30	kcal/kg/day
Protein	1.5	0.8-1	g/kg/day

Dietary intake of this patient

Post discharge FU 2 weeks later by dietitian

237ml x 4/day

237ml x 5/day for 8 weeks

	Ultracal	Isocal	
Water	40	52	ml/kg/day
Energy	36	45	kcal/kg/day
Protein	1.5	2.8	g/kg/day

Higher calories and higher protein regimen

Investigations

	1 week before	←	Start RT feeding	→	10 weeks later		
Sodium	144		142	→	95	L	mmol/L
Potassium	4.7		4.2	→	6.3	H	mmol/L
Urea	9.3	H	7.3	H	7.1	H	mmol/L
Creatinine	45		48		21	L	umol/L
Protein, total	74		68		53	L	g/L
Albumin	32	L	29	L	30	L	g/L
Globulin	42		39		23		g/L
Calcium	2.15	L	2	L	1.85	L	mmol/L
Calcium, alb-adj	2.32		2.22		2.06	L	mmol/L
Phosphate	0.98		0.71	L	1.03		mmol/L

Types of enteric feeding formula

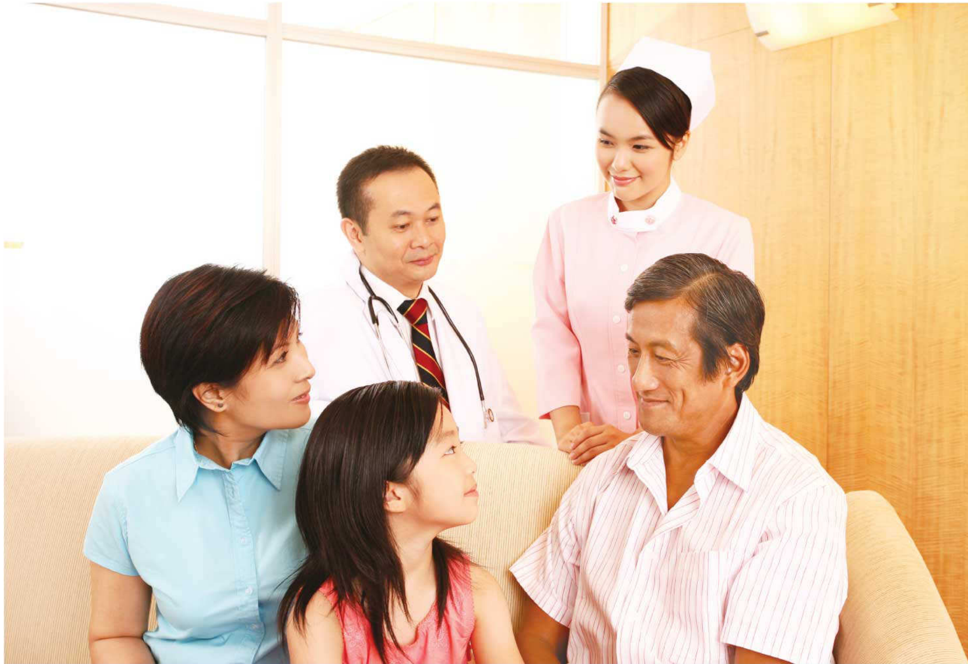
Category	Subcategory	Characteristics	Indications	Examples
Polymeric	Standard	Similar to average diet	Normal digestion	Isocal, Osmolite
	High nitrogen	Protein>15% of total kcal	Catabolism Wound healing	Isocal HN, Osmolite HN
	Caloric dense	2kcal/ml	Fluid restriction Volume intolerance Electrolyte abnormalities	Nutren optimum, Twocal HN
	Fiber-containing	Fiber 5-15g/L	Regulation of bowel function	Jevity

BB有便便喇！

Types of enteric feeding formula

Category	Subcategory	Characteristics	Indications	Examples
Monomeric	Partially hydrolyzed	One or more nutrients are hydrolyzed. Composition varies	Impaired digestive and absorptive capacity	
	Elemental			Vital High Nitrogen, Vivonex plus
	Peptide based			Putamen

Category	Sub-category	Characteristics	Indications	Examples
Disease specific	Renal	Less protein, low electrolyte content	Renal failure/ dialysis	Nepro
	Hepatic	High BCAA, low AA, low electrolyte content	Hepatic encephalopathy	Aminoleban
	Pulmonary	High % calories from fat	COPD/ARDS	Pulmocare
	Diabetic	Low CHO	DM	Glucerna
	Immune-enhancing	Arginine, glutamine, omega-3 FA, antioxidants	Metabolic stress Immune dysfunction	Oral Impact



先提升抵抗力

癌症病人才能打勝仗

抵抗力對癌症病人非常重要：

- 癌症治療會減弱癌症病人的抵抗力，抵抗力指數下降會延誤治療時間表，令病情有機會惡化
- 增強抵抗力可減低因癌症治療引起的副作用

速癒素—癌症治療專用營養品

醫學臨床研究証明可提升癌症病人抵抗力

根據統計*，

速癒素可有效改善以下癌症治療問題：

- 「血球數」檢驗不合格而需延遲或暫停治療
- 反胃嘔吐
- 食慾不振
- 口腔潰爛
- 體弱疲倦

速癒素是一種癌症治療專用營養品。為現時全球唯一同時含有 Arginine、Nucleotides 及 Omega3 Fish Oil 的專利配方，可顯著增加癌症病人的抵抗力，以緩和癌症治療的副作用。

Ingredients in commonly used formula for tube feeding

Formula	Na(mg)	K (mg)	Ca (mg)	Phosphorus (mg)	Protein (g)	Carbohydrate (g)	Energy (kcal)
Isocal (237ml)	125	310	150	125	15.3	59	250
Osmolite (235ml)	181	310	179	179	10.4	33	250
Isocal HN (237ml)	220	380	200	200	10.4	29	250
Osmolite HN (235ml)	317	425	282	282	13	37	285
Ultracal (237ml)	320	440	240	240	10.7	34	250
Glucerna (250ml)	232.5	392.5	187.5	176.25	10.45	23.9	250
Nepro (237ml)	200	250	325	165	16.6	52.8	474

Dietary intake

In this patient

- Isocal 237ml 5x/day given for 8 weeks
- Electrolyte given/day
- Na 125mg x 5 = 625mg
- K 310mg x 5 = 1550mg
- Energy 250 cal x 5 = 1250kcal

Recommended dietary intake

U.S. Food and Drug Administration Reference Daily Intakes, or RDIs

		Potassium (g)	Sodium (g)	Chloride (g)
RDA or AI [1]				
Age 51-70	Male	4.7	1.3*	2.0*
	Female	4.7	1.3*	2.0*
Age 70+	Male	4.7	1.2*	1.8*
	Female	4.7	1.2*	1.8*
Tolerable Upper Intake Levels[3]				
[illegible]			[illegible]	[illegible]
	Female		2.3	3.6
Age 70+	Male		2.3	3.6
	Female		2.3	3.6

Na given to this patient is below the recommended daily dietary intake !!

The values were excerpted from Institute of Medicine, the National Academies, Dietary Reference Intake

Recommendation of enteric feeding

Electrolyte	Daily Requirement	Comments
Sodium (chloride, acetate, or phosphate	1380 - 3450mg	Basal catabolism: 23-92mg/kg Mild-moderate catabolism: 26-69mg/kg Severe catabolism: 69-93mg/kg
Potassium (chloride, acetate, or phosphate	2730-5850mg	Basal catabolism: 27-35mg/kg Mild-moderate catabolism: [illegible] Severe catabolism: 78-156mg/kg

Na given to this patient is below the recommended Na intake !!

Source: **Clinical Nutrition, *A Resource Book for Delivering Enteral and Parenteral Nutrition for Adults,*** University of Washington Medical Center and Clinical Nutrition Committee, Harborview Medical Center

Conclusion

- Hyponatremia was caused by low Na intake in this patient

Why did the patient have hyperkalemia?

K supply in RT feeding - 1550mg Not high

(RDI - 4700mg,

Recommended K supply in enteric feeding - 2730-5850mg)

Causes of hyperkalemia

Increase K intake	Potassium supplement, blood transfusion
Transcellular K shift	Acidosis, Cellular injury eg hemolysis, tumor lysis syndrome, rhabdomyolysis Hyperkalemic periodic paralysis

Causes of hyperkalemia

Decrease K excretion	Oliguric renal failure
	Addison disease
	Hyporeninemic hypoaldosteronism
	Renal tubular disease (pseudohypoaldosteron-ism I or II)
	Medications (potassium sparing diuretics)

Is it caused by Hyporeninemic Hypoaldosteronism?
Or Pseudohypoaldosteronism I/II (type IV RTA)?

Transtubular Potassium Gradient (TTKG)

TTKG = [U K /(U O sm /P O sm)] / P K

- Estimates mineralocorticoid activity
- Normal range 3-7
- Increase in potassium loading and appropriate aldosterone release and action
- A value of less than 3 in the setting of hyperkalemia usually means an aldosterone lack, either in its release or in its tubular effect.

TTKG 7.0

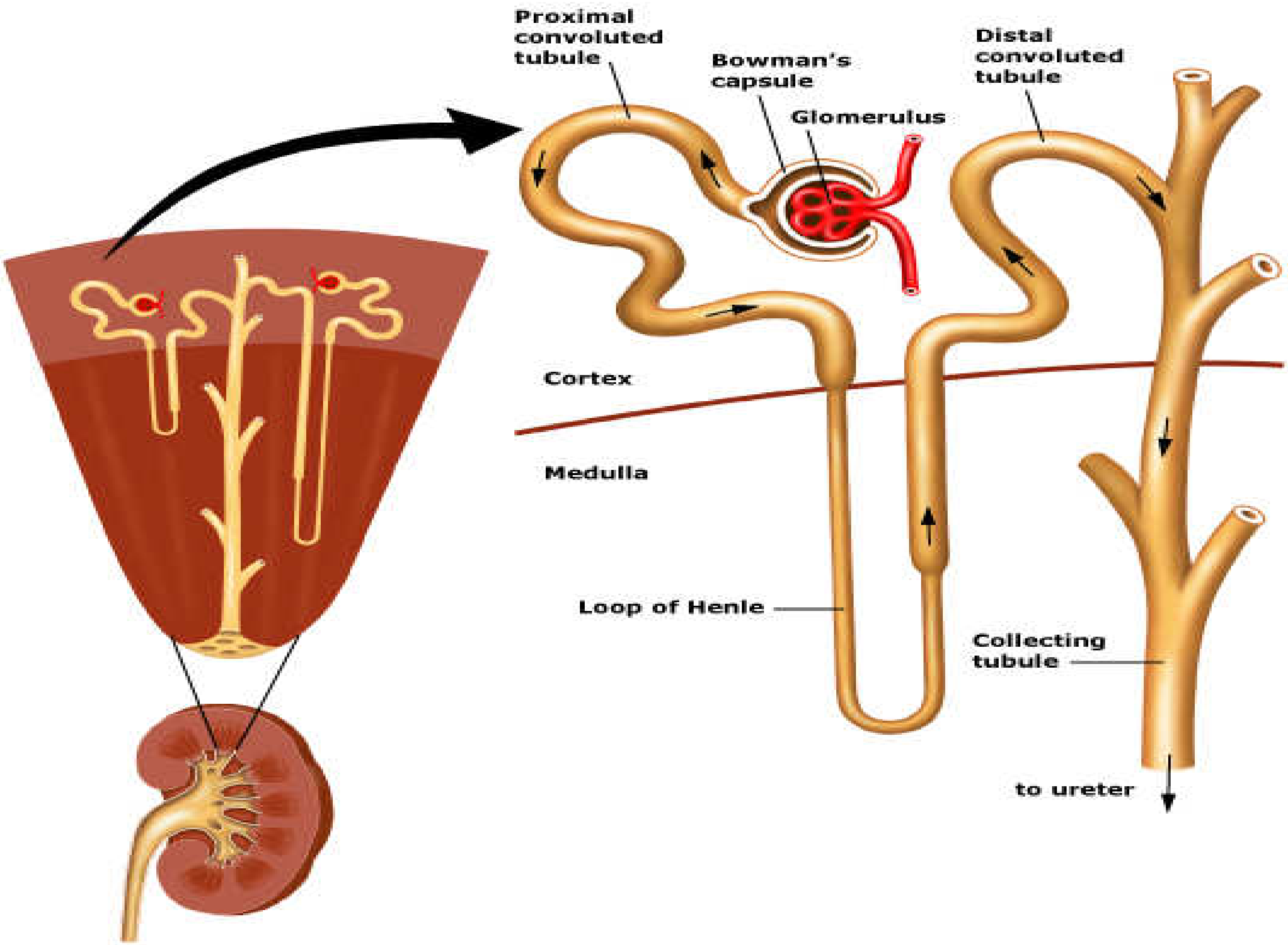
==> Aldosterone response or its action is not inadequate

==> X Hyporeninemic Hypoaldosteronism

==> X Pseudohypoaldosteronism

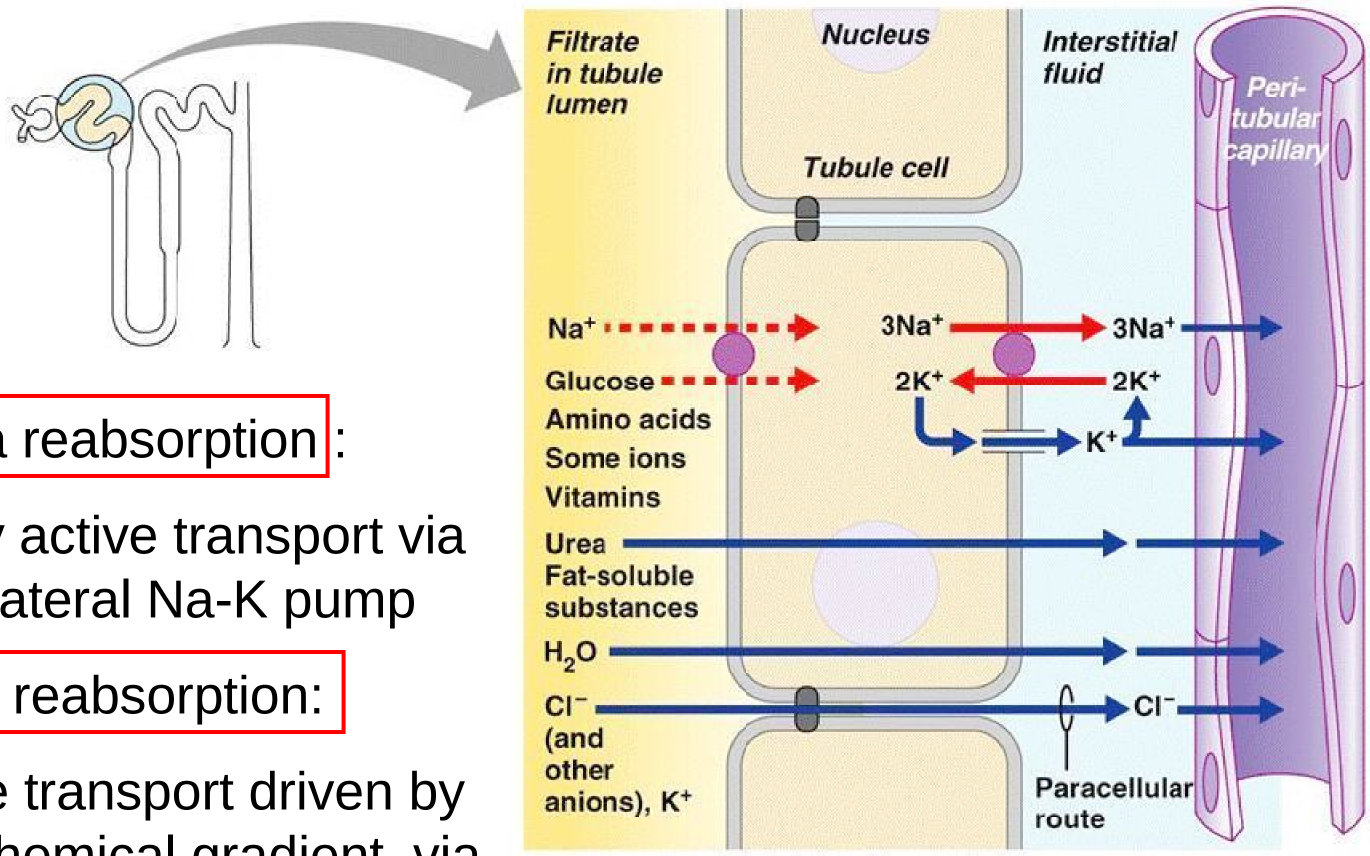
So what is the cause of hyperK?

Nephron



Proximal convoluted tubule
Bowman's capsule
Glomerulus
Distal convoluted tubule
Cortex
Medulla
Loop of Henle
Collecting tubule
to ureter

Proximal Convoluted Tubule

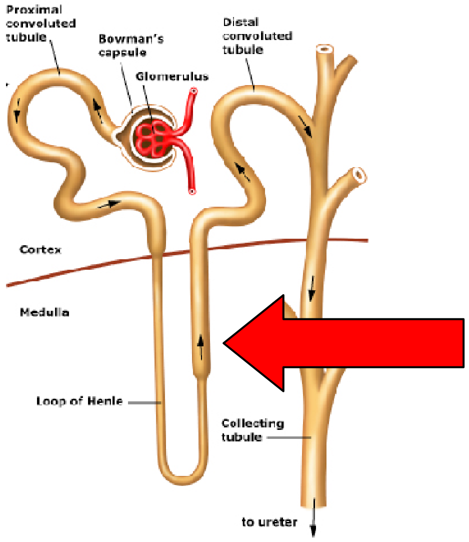


Na reabsorption:

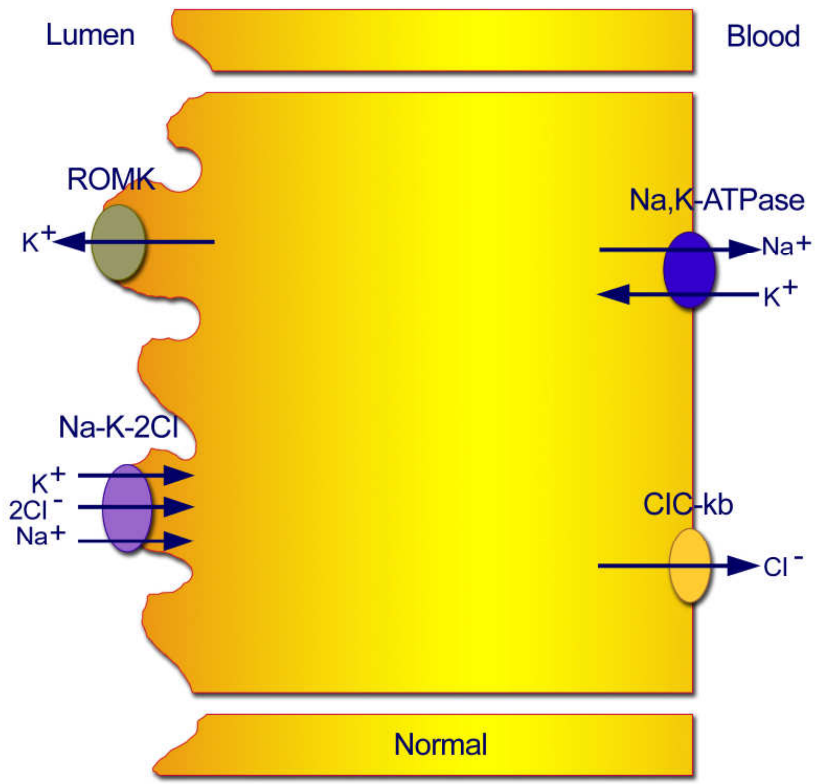
Primary active transport via basolateral Na-K pump

K reabsorption:

Passive transport driven by electrochemical gradient, via paracellular route

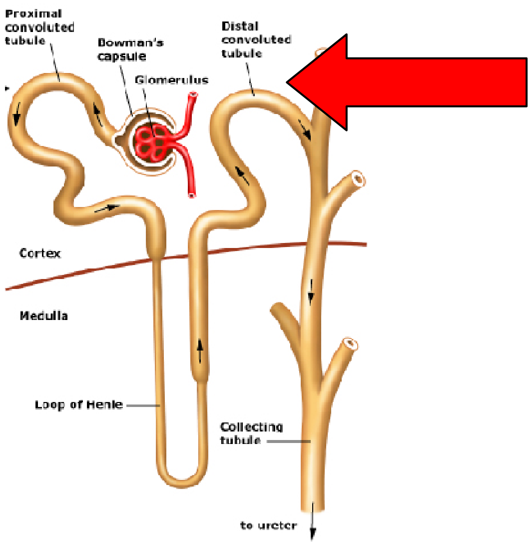


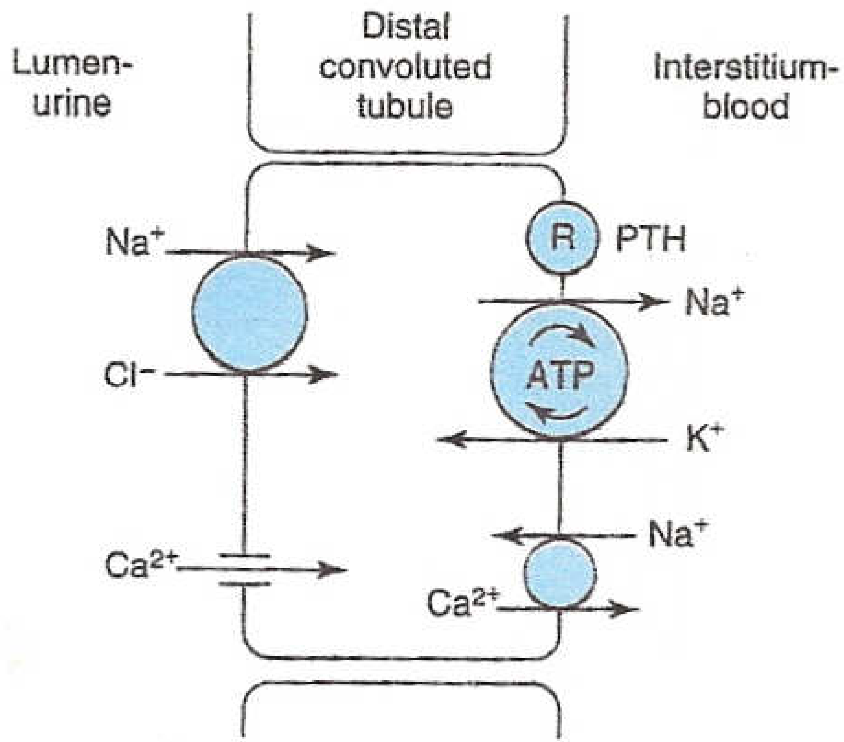
Loop of Henle



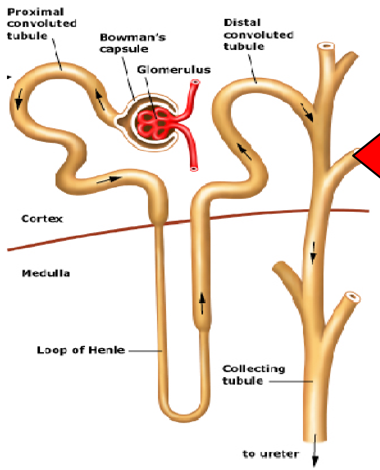
Reabsorption of sodium chloride is achieved with the sodium-chloride potassium-chloride cotransporter, which is driven by the low intracellular concentrations of sodium, chloride, and potassium.

Distal Convoluted Tubule





Na and Cl are reabsorbed via a NaCl cotransporter in the apical membrane and the Na-K ATPase system in the basolateral membrane



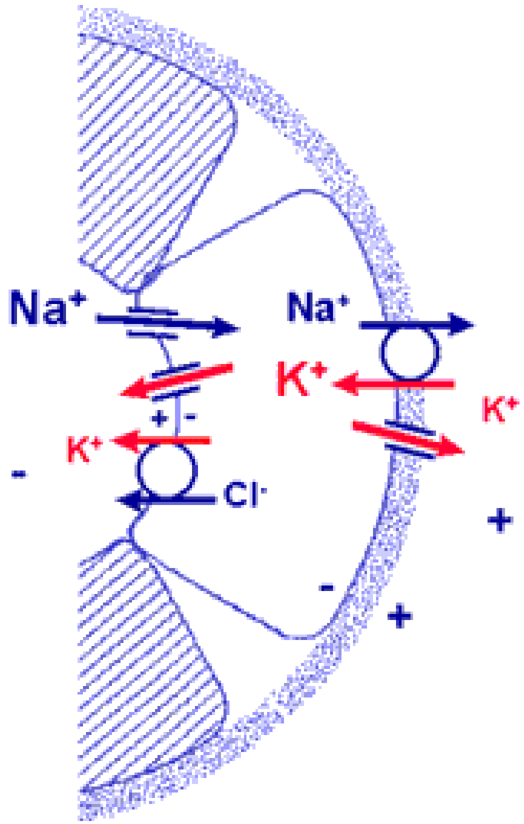
Principal cells in Cortical Collecting Tubule

Reabsorption of Na

Na crosses the apical membrane via a Na channel (the ENaC, epithelial Na channel) and is pumped out of the cell across the basolateral membrane by Na-K ATPase.

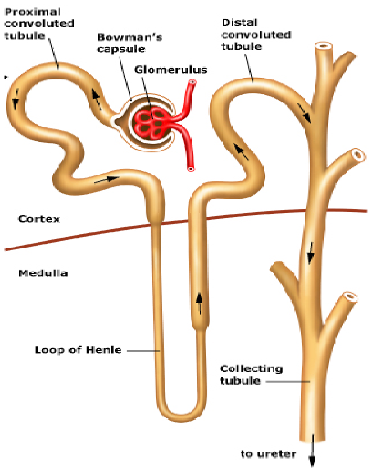
Passive secretion of K through apical K channels is driven by steep chemical gradient(maintained by basolateral membrane Na-K ATPase)

Stimulated by aldosterone



Factors that affect Potassium excretion

1. Sodium delivery to that site must be adequate
2. Aldosterone must be present to facilitate the sodium-potassium (Na-K) exchange
3. Principal cells must respond to aldosterone
4. Urine flow must be brisk enough to wash out the excreted potassium



In the kidney

Severe hyponatremia

↓

Na is avidly resorbed more proximally

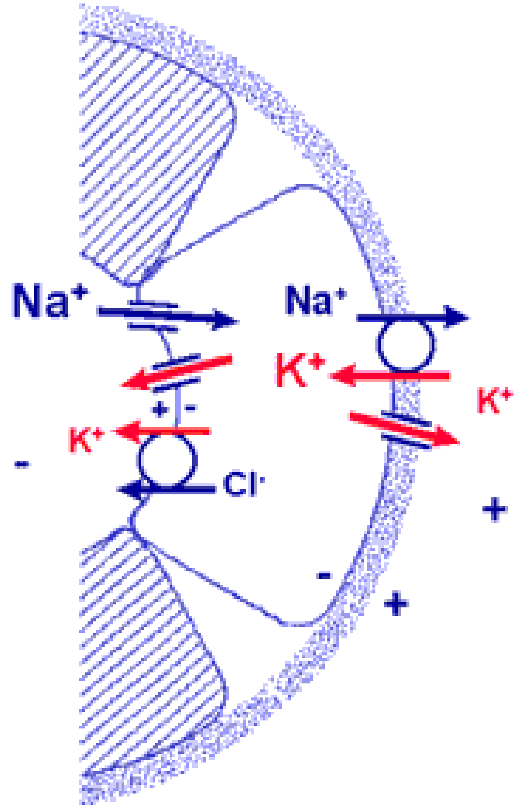
↓

Inadequate Na was delivered to the aldosterone-mediated Na-K exchange site

↓

Decrease Potassium Excretion

Hyperkalemia



Progress

- Add NaCl tablet 900mg bd
- Change tube feeding to Isocal HN 150ml x 5/day (Na 1100mg/day)

- Na supply

  = [(900 x 23)/58] x 2 + 1100 = 1800mg/day

- K supply

  = 380 x 5 = 1900mg/day

+ NaCl

Change RT feeding formula

Progress

	0	2 weeks	3 weeks	2 months	4 months	
Sodium	95 L	142	136	130 L	131 L	mmol/L
Potassium	6.3 H	3.0 L	4.1	4.6	4.1	mmol/L
Urea	7.1 H	7.5 H	8.8 H	5.9	7.0	mmol/L
Creatitine	21 L	25 L	32 L	34 L	39	umol/L
Albumin	30	23	26		36	g/L
Calcium, alb-adj			2.34		2.34	mmol/L
Phosphate			0.56 L		1.26	mmol/L

Is electrolytes disturbance common in tube feeding?

Hyponatremia in a nursing home population.

Miller M, Morley JE. Rubenstein LZ.

Journal of the American Geriatrics Society. 43(12):1410-3,1995 Dec.

- 119 nursing home patients ages 60 years or older
- Prevalence of hyponatremia

Nursing home patients	18%
Similarly aged ambulatory patients	8%
At least one episode of hyponatremia during 12 months study	53%
Tube feeding patients	92% (11 out of 12)

Hyponatremia resolved after dietary Na intake raised to 2 grams/day

Hyponatremia in tube-fed elderly men.

Rudman D. Racette D, Rudman IW, Mattson DE, Erve PR,

Journal of Chronic Diseases. 39(2):73-80, 1986

- 15 men with organic brain syndrome receiving Isocal via gastrostomy as sole source of nutrition.
- Tube feeding duration 3 months - 3 years
- Mean age 68 {46-92}

Result

- About half of them had intermittent hyponatremia

Hyponatremia in tube-fed elderly men.
Rudman D. Racette D, Rudman IW, Mattson DE, Erve PR,
Journal of Chronic Diseases. 39(2):73-80, 1986

Isocal supplemented with NaCl to give 2g Na/day	1 had hyponatremia
Unsupplemented Isocal providing 1g Na/day	8 had hyponatremia 40% <135mmol/L 14% <130mmol/L

4 hyponatremic patients changed to 2g Na/day

--> normalisation of Na

Metabolic abnormalities in patients supported with enteral tube feeding.

Valandingham S, Simpson S. Daniel P , Newmark SR,

Journal of Parenteral and Enteral Nutrition. 5(4):322-4, 1981 JUL-Aug

- 100 patients supported with tube feeding were evaluated.

Result

- 31% has hyponatremia, 40% has hyperkalemia

Conclusion

- Electrolyte disturbance is common in patients on tube feeding
- Regular monitoring of RFT at the initial phase of starting RT feeding
- Consider to correct hyperkalemia by means of adding Na supplement to tube feeding in case of insufficient Na supply by enteric feeding regimen

Thank you!