

# Electrolyte Disorders in ICU

Debashis Dhar

# INTRODUCTION

- Monovalent ions most important
- Na, K main cations and Cl &  $\text{HCO}_3^-$  main anions
- Mg, Ca & Phosphate are major divalent ions

# Normal Physiology

- Body tries to maintain electroneutrality & osmolality.
- Body actively maintains distribution of electrolytes in fluid compartments.
- GIT the major site of electrolyte absorption during enteral feeding
- Kidney the major site of reabsorption

# HOW?- normal homeostasis

- Balance between intake & loss
- Fluid balance
- Acid –Base balance
- Hormonal Factors :ADH,PTH,calcitonin,  
RAAsystem,Thyroxine
- Na-K ATPase system.

# WHY?- elec.disorder in ICU

- **Inadequate intake**
- **Improper supplementation & replacement**
- Acid –base imbalance
- Drugs ; Fluid imbalance.
- Primary disorders.

# ICU Protocol for electrolytes

- To maintain normal blood levels
- Maintenance of normal anion gap
- Daily estimation of monovalent ions
- Twice weekly divalent ions estimation
- Always assess ecf volume while managing any dys-electrolytemia.

# SODIUM

- Main extra cellular cation
- Functions : Maintenance of osmolality  
Neuromuscular transmission
- Requirements :1 to 2 meq/ kg / day
- Normal plasma level:135 to 145 meq/ l

# HYPONATREMIA

- Assess plasma osmolality & ecf volume status
- Hyperosmolar
- Hypoosmolar (common)
- Isoosmolar (pseudohyponatremia)



# Hypo-osmolar Hyponatremia

- **Reduced ecf vol.:** AGE, renal loss, "third space" loss.
- **Increased ecf vol.:** CCF, Renal disease, liver dis.
- **Normal ecf vol.:** Hypothyroidism, SIADH, drugs.
- *Urine Na > 20meq/l signifies renal cause.*

# Hyponatremia Management

- Upto 120 meq is well tolerated
- Treat the primary cause of hyperosmolarity Na increases 1meq/l ~60mg/dl glucose inc.
- Water restriction /diuretics(in hypoosmolar)
- Sodium replacement(reduced ecf vol.)
  - Enteral (upto 120 meq/l):
    - 1gm salt~17meq Na
    - saline~154meq/l Na
    - ~ 510 meq/l Na
  - Parenteral:0.9%  
3% saline

# Na Replacement

- Sodium deficit =  $(135 - \text{Na}_{\text{meas.}}) \times 0.6 \times \text{Wt}$
- Always  $\frac{1}{2}$  correction
- Not more than 8 to 12 meq/l/d or  
0.6 to 0.8 meq/l/hr
- Hypertonic saline via central vein

# Hypernatremia

- Rare as always associated with thirst
- **Increased Na** :hemodialysis,hypertonic saline
- **Decreased Na(excess water loss)** : diarrhea,osmotic diuresis,sweating
- **Normal Na(only water loss)** :Diabetes insipidus, HI,tumors,Li,Demeclocycline.

# HYPERNATREMIA

- Usually tolerated upto 160 meq/l
- Restore fluid volume & osmolality
- $Na_1 \times W_1 = Na_2 \times W_2$
- Reduce serum osmolality @ 1 mosm/hr & Na not more than 10 meq/l.
- Avoid high glucose containing fluids. Colloids & hypotonic solutions preferred
- Replenish water deficit in 48 to 72 h
- Desmopressin in DI

# POTASSIUM

- Mainly intracellular (130 to 140 meq/l)  
extracellular(3.5 to 5.5 meq/l)
- 1to2 meq /kg /d requirement
- Regulations :catecholamines  
insulin  
acid-base disorders  
hyperosmolality  
cell break down

# HYPOKALEMIA(causes)

- Increased loss: vomiting, diarrhea
- Renal loss: diuretics, aldosterone, amphotericin B, aminoglycosides etc
- Altered ecf:icf : insulin, bronchodilators , metabolic alkalosis

# HYPOKALEMIA

- 1meq/l decrease in  $K^+$  ~ 200meq deficit in physiological limits
- 0.5meq/l decrease ~ >400meq deficit when  $K^+$  is 3.0 meq/l
- <2.0meq/l  $K^+$  ~ ~ >1200-1600meq deficit



# POT.REPLACEMENT

- Treat primary cause
- Oral KCl 15ml~20meq(1.5g) of K<sup>+</sup>
- I/V supplement 2meq/ml soln.
- 4-5 meq/hr; In severe deficiency 20to30 meq/hr may be given
- 20-40 meq of potassium increases ecf potassium by 2-4 meq/l
- Severe upto 5to7 meq/kg/d may be given

# HYPERKALEMIA

- PSEUDO--- eg tourniquet, sampling
- Redistribution– drugs, acidosis, familial paralysis.
- Excess of  $K^+$  --- Renal dis., Addison's dis, myeloma, Diuretics etc
- Plasma level  $\sim\sim 8$  precipitates dysrhythmia

# Hyperkalemia Management

- Intake restriction
- Physiological antagonism: Ca-gluconate
- Intracellular transfer: Glucose-Insulin infusion, Sod. Bicarb.
- Removal from body: Dialysis, diuretics, cation exchange resin

# CHLORIDE DISORDERS

- Major extracellular anion
- Daily req.—1to3 meq/kg
- Normal level –95 to 105 meq/ l
- Goes hand in hand with Na & K

# DIVALENT IONS

- Ca in ecf and Mg & PO<sub>4</sub> intracellular
- All regulated at kidney
- Calcitonin, PTH, VitD regulates Ca & PO<sub>4</sub>
- Normal plasma level: Ca—8.5 to 10 mg/dl  
Mg—1.7 to 2.4 mg/dl  
PO<sub>4</sub>--2.5 to 4.5 mg/dl
- 50% is at least ionized & active

# DIVALENT IONS

- Requirements :Ca & PO<sub>4</sub><sup>-</sup> 1000mg/d  
Mg----- 300 mg/day
- ICU requirements:-- Alimentation  
Renal failure  
Primary disorders
- Deficits coexist with other ions
- Slow to develop & non specific features

# HYPOCALCEMIA

- Rule out hypoalbuminemia & hypomagnesemia
- Symptomatic when  $<5\text{mg/dl}$
- Ca Gluconate (10%)~ 9mg/ml  
Ca Chloride (10%)~ 27 mg/ml
- 0.5 to 1 mg/kg/hr may be given

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# HYPERCALCEMIA

- Hyperparathyroidism & Malignancy  
commonest cause
- ICU– immobilization common
- Management: Hydration , Mobilization,  
Dialysis, diuretics(loop)
- Others: mithramycin, calcitonin.,  
phosphonates ,chelation



# MAGNESIUM DISORDERS

- HypoMg –65 to 70% ICU patients
- Associated with prolonged ventilation
- Mg Sulphate soln. 1gm~~98mg of Mg
- 30 to 40 mg /kg @ 0.5 to 1g/hr
- Hyper Mg – GI infusion, Diuresis, dialysis, Ca gluconate.

# PHOSPHATE DISORDERS

- Most abundant intracellular anion
- Upto 30% incidence of Hypophosphatemia in ICU & prolonged ventilation
- Na Phos. Soln 93 mg/ml
- 15mg /1000 calories/day recommended
- Hyper  $\text{PO}_4^-$ — diuresis ,dialysis,antacids

50kg adult with severe AGE for 24 hrs found in shock at home & shifted to hospital; met with an accident on way to hospital and bled ~1 litre which was controlled. In casualty, parameters were HR 140/min; BP 60 systolic; RR 30/min; cvp -3; severe dehydration, altered sensorium, residual urine 50ml. Na-135; K-5; Cl-80; pH 7.1; HCO<sub>3</sub>-18; plasma osmolality 300, urine Na <10 meq. Pt put on full ventilation & resuscitated. After 3hrs : CVP 2cm; Na 115, K 2, Cl- 90, HCO<sub>3</sub>-24. Write the fluid prescription for the patient.

All the best..