Electrolyte Disorders in ICU

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INTRODUCTION

• Monovalent ions most important
• Na,K main cations and Cl & 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
  - Parenteral:
    - 0.9% saline~154meq/l Na
    - 3% saline ~ 510 meq/l Na
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@ 1mosm/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)
• 1 to 2 meq/kg/d requirement
• Regulations: catecholamines, insulin, acid-base disorders, hyperosmolality, cell break down
HYPOKALEMIA (causes)

- Increased loss: vomiting, diarrhea
- Renal loss: diuretics, aldosterone, 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⁺
- 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 ~8 precipitates dysrrhythmia
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.—1 to 3 meq/kg
• Normal level — 95 to 105 meq/l
• Goes hand in hand with Na & K
DIVALENT IONS

• Ca in ecf and Mg & PO$_4$ intracellular
• All regulated at kidney
• Calcitonin, PTH, VitD regulates Ca & PO$_4$
• Normal plasma level: Ca—8.5 to 10mg/dl
  Mg—1.7 to 2.4 mg/dl
  PO$_4$—2.5 to 4.5 mg/dl
• 50% is at least ionized & active
DIVALENT IONS

• Requirements: Ca & PO₄– 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 <5mg/dl
- Ca Gluconate (10%)~ 9mg/ml
  Ca Chloride (10%)~ 27 mg/ml
- 0.5 to 1 mg/kg/hr may be given
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 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; HCO₃⁻-18; plasma osmolality 300, urine Na <10 meq. Pt put on full ventilation & resuscitated. After 3 hrs: CVP 2 cm; Na 115, K 2, Cl- 90, HCO₃⁻-24. Write the fluid prescription for the patient.
All the best..