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 = $(135 - Na_{meas.})x0.6xWt$
- Always ½ correction
- Not more than 8 to 12meq/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)
- 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,ampho 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.—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_4intracellular
- All regulated at kidney
- Calcitonin,PTH,VitD regulates Ca & PO_4
- Normal plasma level:Ca—8.5 to10mg/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 & PO_4– 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

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HYPERCALCEMIA

- Hyperparathyroidsm & 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 ~1litre which was controlled.In casualty,parameters were HR 140/min;BP 60systolic;RR 30/min;cvp –3; severe dehydration,altered sensorium,residual urine 50ml. Na-135; K-5;Cl-80;pH 7.1; HCO_3-18;plasma osmolality300,urine Na <10 meq.Pt put on full ventilation & resuscitated.After 3hrs : CVP 2cm;Na 115 ,K 2, Cl- 90, HCO_3-24.Write the fluid prescription for the patient.

All the best..