

Resuscitation of the Critically ill Foal



Sick Cell Syndrome

- *Foal: Wishful*
- *Warm Blood filly*
- *DOB: March 25 1 AM*
- *Admission Date: March 25 11:25 AM*
 - 10 hours old

Wishful History

- *Born at 1 AM on March 25*
 - *Foal began to breathe with nostril flaring*
 - *As soon as the nostrils cleared the canal*
 - *Stage II 10 minutes*
 - *Foal was pulled*
 - *Stage III*
 - *Placenta came with the foal*
 - *Placental horn retained*
- *Foal "appeared slow"*
 - *From the beginning...but normal*
 - *Able to stand with help*
 - *Not searching the mare*
 - *Became weaker*
 - *Developed periods of somnolence*

Wishful Admission

- *Recumbent on arrival*
 - *Transported to the NICU*
- *Rapid assessment of essential organ function*
 - *Severe sepsis*
 - *Poor pulse quality*
 - *Cold legs and ice cold hooves*
 - *Temperature 99.6*
 - *dropped during initial hospitalization 97*
 - *HR 104 bpm*
 - *RR 18 bpm,*
 - *BP 73/30(37)*

Wishful Admission

- *Rapid, directed interventions*
- *Treatment of shock*
 - *INO₂*
 - *Crystalloid boluses*
 - *Responded after 3 X 1 liter boluses*
 - *BP after fluids 90/58(65)*
 - *PE – good perfusion*



Wishful Admission

- *Further examination after initial resuscitation*
 - *Bilateral entropion*
 - *Extreme scleral injection*
 - *Oral drying injuries*
 - *Icterus*
 - *Pseudopetechia*
 - *Moderate coronitis*
 - *Normal body condition*
 - *Neonatal skin wrinkling*
 - *Normally responsive*
 - *Searches, inducible suckle*
 - *Can stand with support with good balance*
 - *Somnolent periods*

Wishful Initial Laboratory Analysis

- *PCV = 50*
- *TP = 7.4*
- *Fibrinogen = 370 mg/dl*
- *WBC = 7000*
- *Segs = 5110*
- *Bands = 210*
- *Lymphs = 1680*



Wishful

Initial Laboratory Analysis

- *Venous Dextrose = 20 mg/dl*
- *BUN = 24 mg/dl*
- *Total Ca = 16.38 mg/ml*
- *Ca⁺⁺ = 6.84 mg/dl*
- *Mg⁺⁺ = 2.79 mg/dl*
- *IgG = 776 mg/dl*
- *Total Bili = 4.5 mg/dl*

Wishful Initial Laboratory Analysis

Value	Adm	1 hour
pH	7.251	7.305
Pco2	47.3	50.2
Po2	64.0	285
HCO3	20.9	25.1
BE	- 5.8	-0.9
SAT	94.5	100
Cont	17.9	15.9
Lactate	14.9	10.0
	RA	10 lpm

Wishful

Initial Laboratory Analysis

Value	Adm
Na	115
K	7.33
Cl	72
Cr	28
AST	657
CPK	3012



Wishful

- Major finding
 - Hyponatremia
 - Hypochloremia
 - Hyperkalemia
- Magnitude of changes
 - May require urgent intervention
 - Vital to understand the origin of the abnormalities
 - Direct rational therapy
 - Wrong choices – severe consequences
 - Many clinicians assume ruptured bladder
 - easily rule out
 - age
 - lack of fluid intake

Hyponatremia

- Spurious Hyponatremia
- Dilutional Hyponatremia
 - Ruptured bladder
 - Fenestrated ureters
 - Renal failure
 - Delayed renal transition from fetal to neonatal physiology
 - Water overload
- Depletional Hyponatremia:
 - Diarrhea
 - Sodium wasting nephropathy
 - Diuretics
- Redistribution Hyponatremia
 - Other osmoles in the blood
 - Hyperglycemia
 - Iatrogenic addition of osmoles (e.g. mannitol)
 - Sick Cell Syndrome

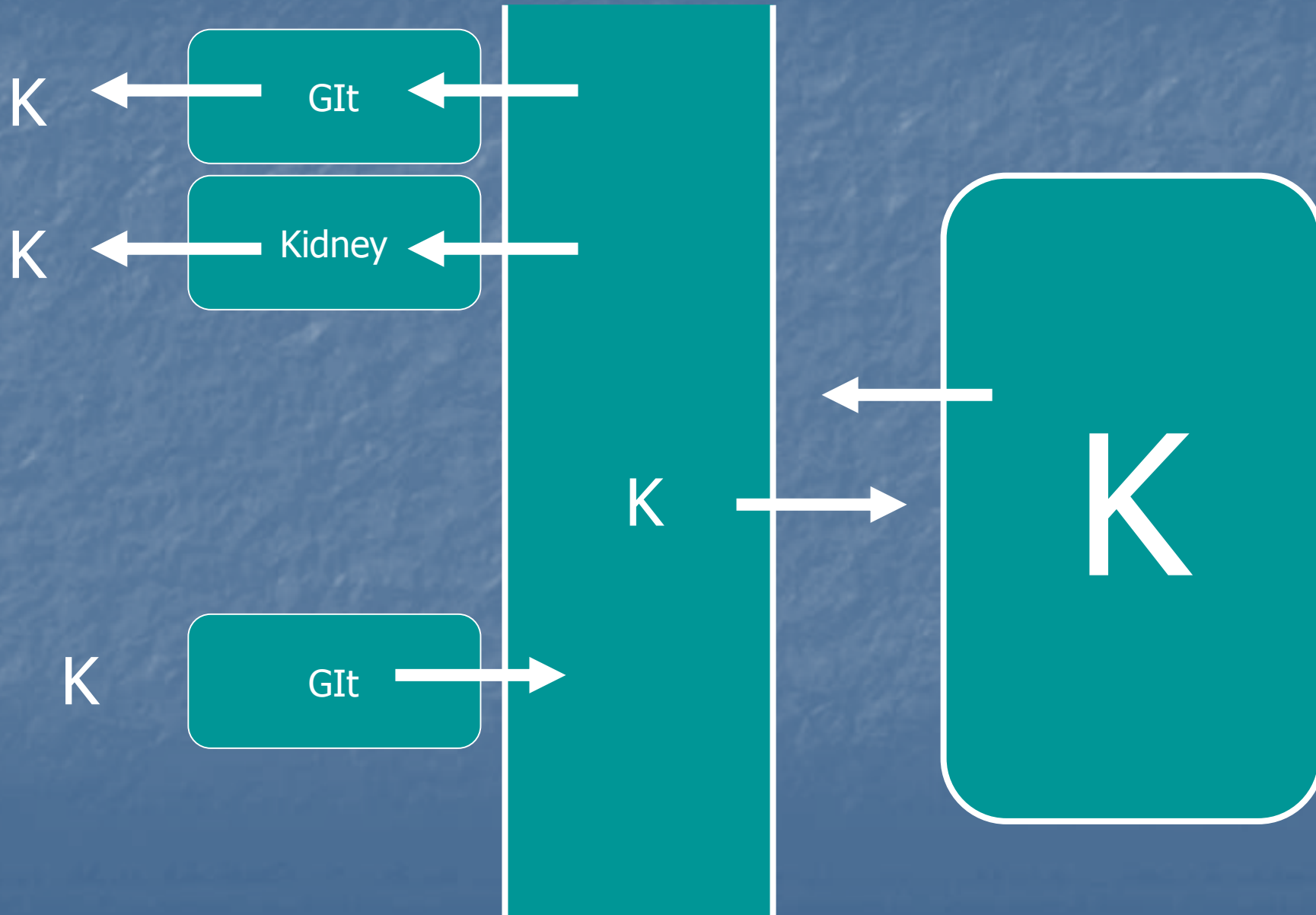
Wishful Hyponatremia

- *Spurious hyponatremia*
- *Dilutional hyponatremia*
 - *No intake since birth*
- *Depletional hyponatremia*
 - *Not begun to urinate*
 - *Has not past meconium yet*
- *Redistribution hyponatremia*
 - *Water diluting Na come from cells*
 - *Some osmolyte other than sodium*
 - *Drawing water from cells*
- *Source of osmoles?*
 - *Hypoglycemic*
 - *Not received exogenous substances*
 - *Presence of endogenous osmolytes*
 - *Leaked from cells*

Wishful Hyponatremia

- *Significant therapeutic implications*
 - *No sodium deficiency*
 - *Not water overloaded*
 - *Not hyposmotic*
 - *May be hyperosmotic*
- *Don't give sodium*
- *Don't induce an unsupported diuresis*

K Kinetics



Hyperkalemia

- Mechanisms
 - High intake
 - Dietary
 - Parenteral
 - Blocked excretion
 - Must have continued intake
 - Leak from cell
- Wishful
 - No intake
 - Must be cell leak

Sick Cell Syndrome

- Global loss of integrity of cell membranes
- Acute, severe hypoxic ischemic insult
 - Globally affect cells
 - Loss of cell wall integrity
 - Transient or permanent
 - Allowing solutes to leak
 - Drawing fluid with them
 - Dilution of extracellular sodium
- Redistribution hyponatremia
 - Osmolar Gap (OG)
 - Unmeasured osmolytes
 - $OG = Osm_m - Osm_c$
 - $Osm_m = (2X [Na]) + (glucose/18) + (BUN/2.8)$

Sick Cell Syndrome

- OG > 10 mOsm
 - osmoles other than Na or glucose
 - Associated with
 - MODS
 - High fatality rate
- What are the osmoles?
 - Organic phosphate
 - Pyruvate
 - Lactate
 - Amino acids,
 - Unidentified middle molecular weight substances

Wishful Initial Laboratory Analysis

Value	Adm
Na	115
K	7.33
Cl	72
Cr	28
AST	657
CPK	3012
Osm _m	312
Osm _c	240
Osm Gap	72

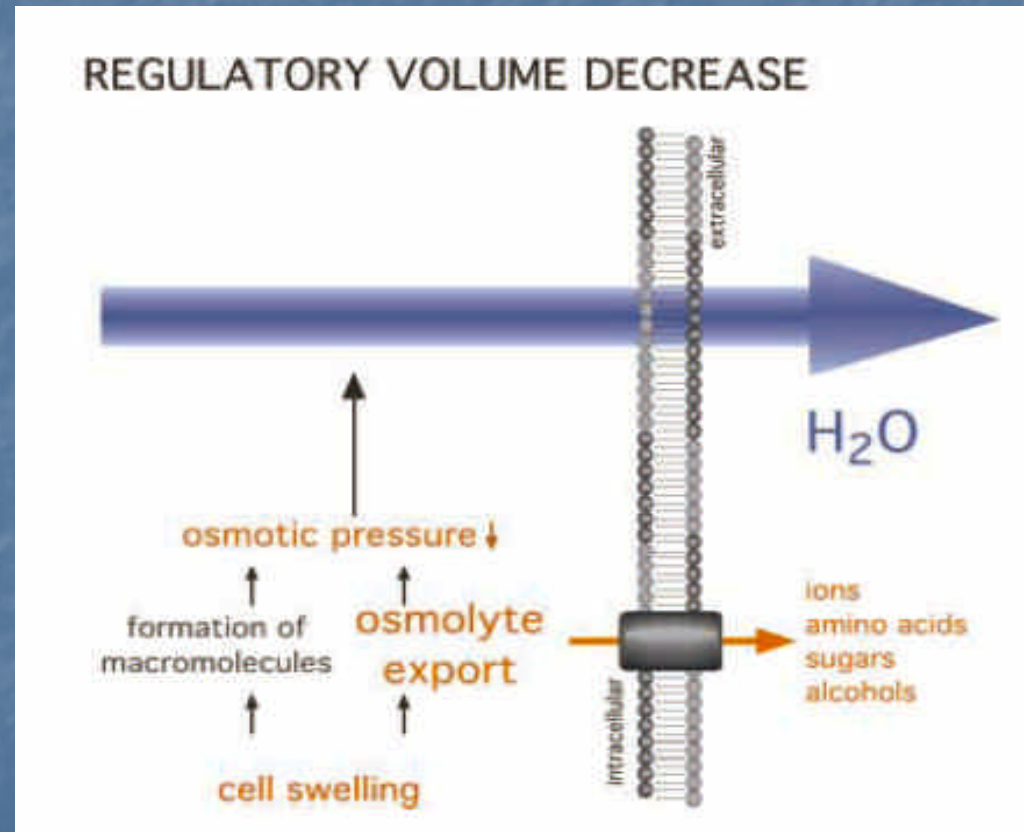
Regulatory Volume Decrease

- Another explanation
- Regulatory Volume Decrease (RVD)
 - Fluid overloaded cells
 - All mammalian cells
 - Protective mechanism
 - Limits cell swelling
- Reasons cells swell
 - Hyponatremia
 - Hyposmotic interstitium
 - Initial stages of hypoxic ischemic insults
 - Hyperosmotic cell interior

Regulatory Volume Decrease Mechanism

Voltage-independent, volume-sensitive channels

- Activated by cell swelling
- Allow outflow of
 - K⁺
 - Cl⁻
 - Amino acids
 - Other organic molecules
- Water follows
 - restoring cell volume.



Redistribution Hyponatremia Neonatal Foals

- Both SCS and RVD are involved
- Mild insults
 - Compromise cellular function
 - Allow fluid to leak
 - RVD - protective mechanism
- More severe damage
 - Initially result in RVD
 - Evolve into SCS

Sick Cell Syndrome

- Other cell constituents also leak
 - K⁺ leak
 - Both RVD and SCS
 - High intracellular levels of K
 - Mild increase in efflux globally
 - Increase plasma K levels significantly
 - CPK
 - AST
- Outcome
 - About 60% of SCS cases do not survive
 - Identification of SCS - guarded to poor prognosis.

Sick Cell Syndrome Therapy

- Don't treat hyponatemia
 - Not sodium deficit
 - Osmolarity high normal
 - Not water overload
- Hyperkalemia
 - If ECG changes
 - Mg
 - Enhance cell entry
 - Insulin
 - B₂ adrenergic
 - Albuterol
 - Na HCO₃ – not recommended
 - Enhance excretion
 - Osmotic diuresis
 - Furosemide
 - GI cation exchange resin
 - Is treatment necessary??

Wishful Outcome

Value	Adm	HD 2	HD 3
Na	115	126	132
K	7.33	4.26	4.76
Cl	72	87	96
Cr	28	9.24	1.74
AST	657	781	534
CPK	3012	625	74
Osm _m	312	312	295
Osm _c	240	270	275
Osm Gap	72	43	20

Wishful Outcome

- *Intrauterine Insult – catabolism, SIRS*
- *Sepsis*
 - *High fibrinogen, left shift*
 - *Inject, icterus*
 - *Shock, increased lactate, acidosis*
 - *Admission blood culture*
 - *Flavobacterium*
- *Neonatal Encephalopathy*
 - *Inconsistent nursing behavior*
 - *HD 6 - nursing from mare*

