- *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*
  - *INO_2*
  - *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

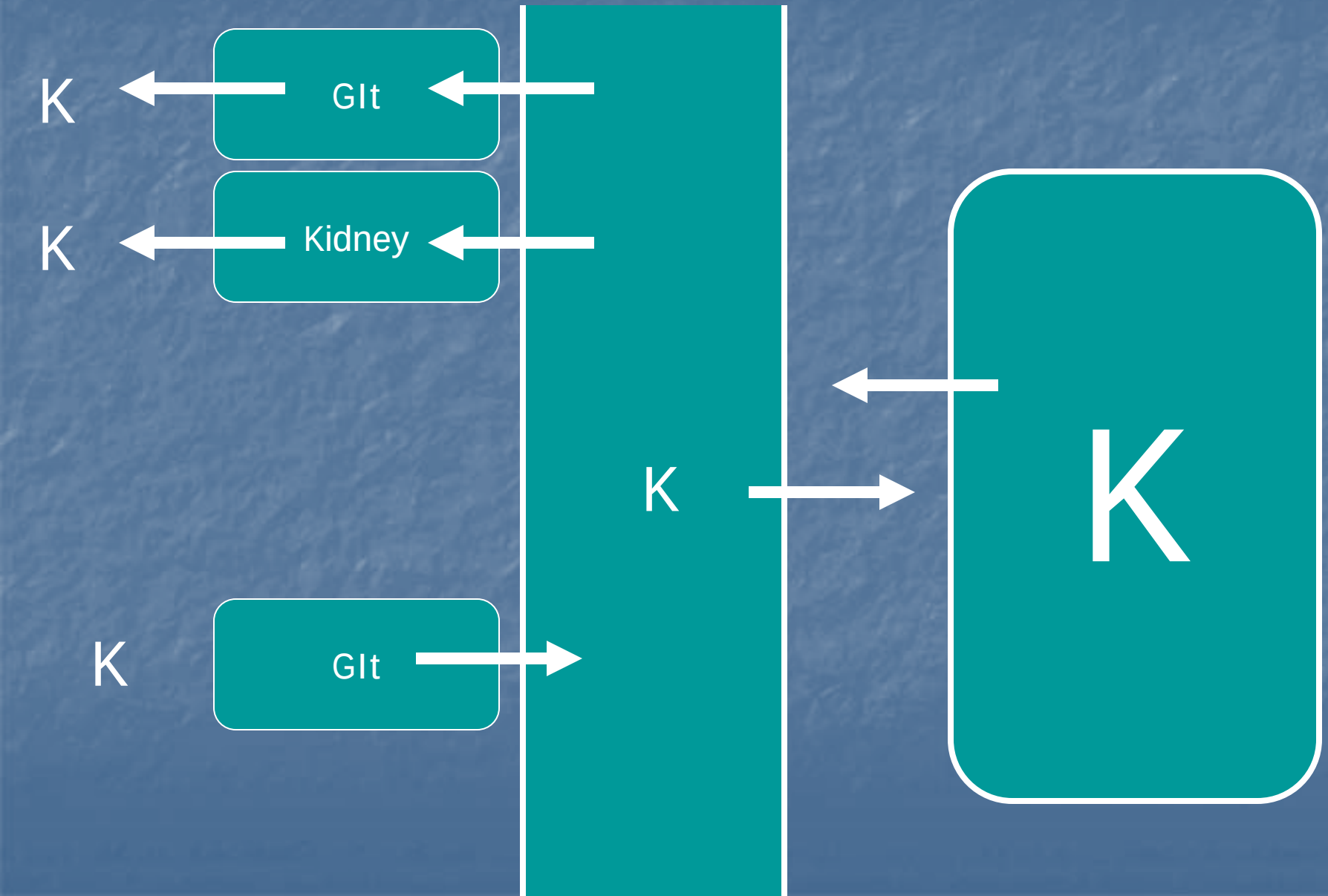
Wishful Hyponatremia

- *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*
  - *Not sodium deficiency*
  - *Not water overloaded*
  - *Not hyposmotic*
    - *May be hyperosmotic*
- *Don't give sodium (hypertonic)*
- *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 widespread insult
  - Hypoxic ischemic?
  - Inflammatory?
  - 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

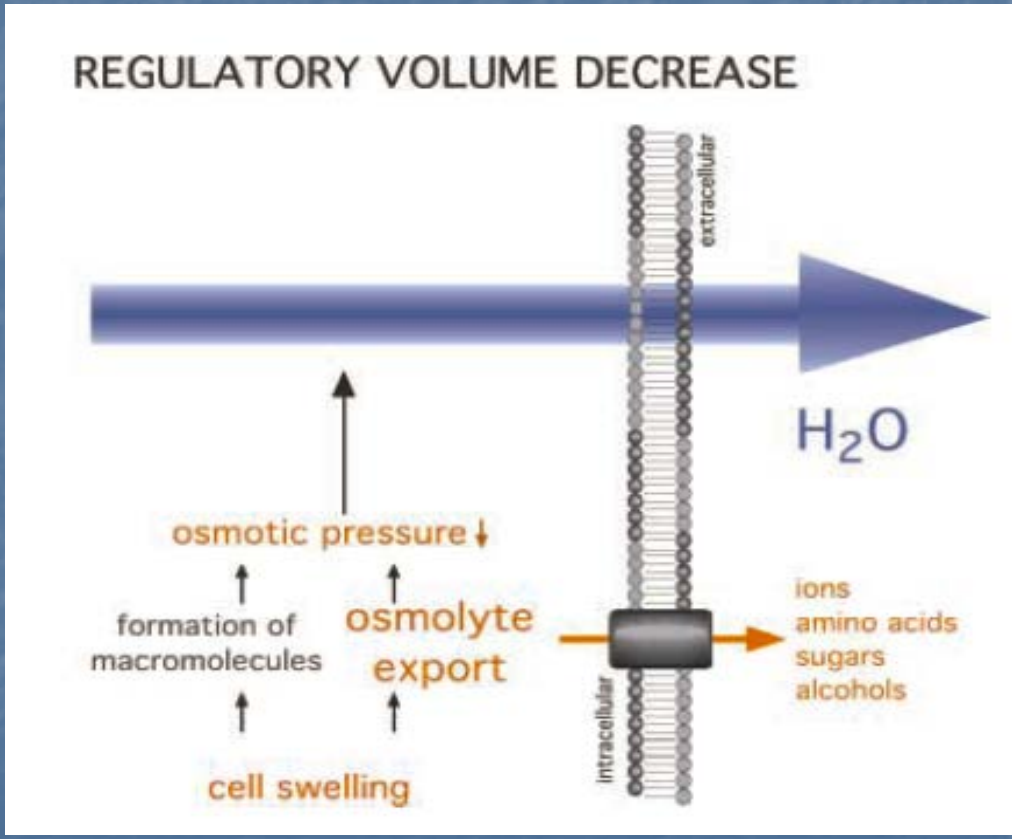
Value	Adm
Na	115
K	7.33
Cl	72
Cr	28
AST	657
CPK	3012
Osm_m	312
Osm_c	240
Osm Gap	72

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 hyponatremia
  - Not sodium deficit
    - Osmolarity high normal
  - Not water overload

Sick Cell Syndrome Therapy

- Hyperkalemia
  - If ECG changes
    - Mg ($MgSO_4$)
  - Enhance cell entry
    - Insulin
    - B_2 adrenergic
      - Albuterol
    - Na HCO_3 – not recommended
  - Enhance excretion
    - Osmotic diuresis
    - Furosemide
    - GI cation exchange resin
  - Is treatment necessary??

Wishful Outcome

Value	Adm	24 hr	48 hr
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 – catabolsim, SIRS*
- *Sepsis*
  - *High fibrinogen, left shift*
  - *Inject, icterus*
  - *Shock, increased lactate, acidosis*
  - *Admission blood culture*
    - *Flavobacerium*
- *Neonatal Encephalopathy*
  - *Inconsistent nursing behavior*
  - *HD 6 - nursing from mare*