# Fluid and Electrolyte Therapy

Purposes of fluid administration

1- Replace insensible fluid losses (evaporation, diffusion) during the anesthetic period, leads to fluid shifts
2- Replace sensible fluid losses (blood loss, sweating) during the anesthetic period
3-Maintain an adequate and effective blood volume
4- Maintain cardiac output and tissue perfusion
5- Maintain patency of an intravenous route of drug administration
6-Dehydrated
7-Old age
8-Anesthetic agents block the physiological response to hypovolemia and stress.
9-Mechanical ventilation suppresses ADH, ANP→ Na+ water retention.

Factors controlling body water

1-ADH
2-Renin/ angiotensin
3-PTH/ calcitonins
4-PG, dopaminergic and a receptors
5-Intrinsic renal properties.

**Fluid Compartments:**

Body fluids divided into
1-Intracellular compartment
2-Extracellular compartment, further divided into:
a-Interstitial compartment
1-Larger than intravascular compartment
2-Water and electrolytes pass freely between blood and interstitial spaces, which have similar ionic composition
3-Plasma proteins are not free to pass out of the intravascular space unless there is damage to capillaries, e.g., septic shock or burns
4-With fluid loss or fall in blood pressure, water and electrolytes pass from interstitial compartment into blood (intravascular) to maintain volume (physiologic priority)

b-Intravascular compartment
Consists of:
1-Plasma
2-Proteins
3-Ions – mainly sodium, chloride and bicarbonates
4-Minor contributions come from potassium ($K^+$), magnesium ($Mg^{2+}$), and plasma proteins (mainly albumin)
Normal blood volume is about 72 mL/kg of body weight

**Water distribution**

1-Osmotic forces are the primary determinants of the water distribution in the body.
2-Osmolality is determined by the number of moles of a chemical compound that contributes to the solution's osmotic pressure and is expressed as milliosmoles per kilogram of water (mOsm/kg).
3-Solutes that cannot freely cross the cell membrane are restricted to a specified compartment, determine the *effective osmolality (or tonicity),* that is, the osmotic pressure of that compartment, and generate fluid shifts
4- The *distribution of water between ECF(extra cerebro-spinal fluid and ICF(intra cerebro-spinal fluid) compartment* depends largely on $Na^+$ and $K^+$ content of each compartment
5- The distribution of water between the intravascular and interstitial space differs from that across cell membranes.
other mechanisms are involved in this exchange→bulk flow and diffusion. The rate of exchange in either direction (i.e., net filtration) can be calculated by the law of Starling.

Principles of Fluid Therapy

1. Fluid replacement should be as close as possible in volume and composition to those fluids lost
2. Acute losses should be replaced quickly
3. Chronic losses—replace with caution; rapid infusion may cause fluid overload and heart failure
    a. Better replaced by oral or rectal rehydration
    b. Mostly deficient in water: Do not overload with sodium

Abnormal Fluid Losses

1. Normal loss of Na and K ions – 1 mmol/kg/hr
2. Loss of water – ½ mL/kg/hr (+ ½ mL/kg/hr by kidney)
3. Abnormal losses:
   a. Increased sweating in hot environment
   b. Fever – 1 degree rise=10% higher than normal fluid requirement per day
   c. Gut losses – diarrhea
   d. Renal losses – including diuretics and diabetes
   e. Trauma (third space loss) – burns

Types of IV Fluids

Crystalloids:
hypotonic- 5% dextrose ,D5 1/2 NS OR 1/4NS
Isotonic- 0.9%Nacl, ringer lactate, ringer acetate
Hypertonic- 3%,5%, 7.5% Nacl.
Colloids:
Hydroxyethyl starches
Gelatins
Dextran
Albumin.

Distribution of IV Fluids in Body Compartments

| Distribution of 1,000 mL of fluid given IV | | Intracellular Fluid | Interstitial Fluid | Intravascular Fluid |
|---|---|---|---|---|
| 5% Dextrose | | 666 | 249 | 83 |
| Crystalloid | | 0 | 750 | 250 |
| Colloid | Immediate | 0 | 0 | 1,000 |
| | After 4 hours | 0 | 750 | 250 |
| Blood | | 0 | 0 | 1,000 |

Example of fluid therapy

*0.9% NaCl FT*
500ml, isotonic ( na-154, cl-154)
Ph –acidic to prevent degradation during sterilization
Mol wt-58
Uses-
1-Along with insulin in diabetic patients
2-Dehydration- vomiting, sweating, heat stroke
3-Irrigation fluid
Side effects
1-No calories
2-Hyperchloremic acidosis
3-Sodium retention- risk in ccf, liver kidney dysfunction
4-Other prepeartion-0.45%, 3,5,7.5%- hypertonic

*RINGER LACTATE*

-500 ml ( 130, 5, 4, 111, 29)
-Ph-acidic
-Lactate→bicarbonate, glucose→ CO2 + H20
-Uses:-

1. Fluid therapy intra, post-op
2. Preloading and maintainance ( blocks)
3. Diabetics

*5% DEXTROSE*

-500ml bottle containing dextrose in water
-5 gms of dextrose in 100ml (25gms/500 ml)
-1gm-4.1cal & 0.6 water for oxidation.
-Mol wt-109, acidic pH to prevent degradation of sugar
-This prevents hemolysis and is isotonic with plasma
Uses :

1. minimizes hypoglycemia, hydration.
2. Carrier for drugs
3. Maintain patency of Iv line

Side effects :

1. diuresis,
2. electrolyte imbalance,
3. hyperventilation,
4. rise in ICP, & fetal hypoglcemia

*5% DEXTROSE IN SALINE*

-Dextrose on 5gms/100ml in 0.9 NaCl
-It provides electrolytes.

Other formulations
5% with 0.45% Nacl
5% with 033% Nacl ( sweat loss)\
5% with 0.22% Nacl
2.5% dextrose in 0.45 %Nacl(children)
10% , 25, 50 % dextrose

*Hypertonic Saline*

-7.5-23% NaCl
-Used to rapidly expand vascular volume (e.g. severe hypovolemia with impending death, low volume resuscitation in head trauma, GDV (cannot get fluids in fast enough))
-Dogs 4-8 ml/kg, cats 204 ml/kg at 1 ml/kg/minute
-Lasts 30 minutes intravascularly
-Follow with crystalloids, colloids

*Albumin*

- Source of oncotic pressure in plasma
- Leaks in inflammation
- 1 g albumin retains 18 ml of fluid in intravascular space
- Normal distribution: 40% intravascular, 60% interstitial
- Hepatic synthesis regulated by osmoreceptors in interstitium, not by blood levels
- t ½ = 8-9 days in man
- Carries drugs and endogenous substanecs
- Scavenges free radicals, reactive oxygen species, Fe
- Helps to maintain vascular integrity

*Hetastarch (HES)*

1-Synthetic colloid, plant starch

2-Degraded by amylase, rate is proportional to degree of hydroxyl substitution

3-Dogs at 20 ml/kg/day say changes in clotting tests but no clinical effects

USA: 6% HES (450 KDa/0.7 C2:C6)

Europe: lower MW higher substitution products

→ less coagulation change, balanced electrolyte solution → less inflammatory

Dose:

1-Dog 20 ml/kg/day (up to 40 ml/kg/day)

2-Cat 5-10 ml/kg/day

-After initial volume administration can mix with crystalloids in a ratio of 30% HES:70% crystalloid x rate of fluids

-Monitor for overhydration with all synthetic colloids