

Intravenous fluid administration should be considered as any other pharmacological prescription.<sup>5</sup> Regarding distribution of Glucose solutions a) 20kg) Further consideration Once the maintenance requirements have been calculated, additional potential losses need to be considered to avoid under or over hydration, the following sources of fluid loss and the electrolyte composition of these fluids need to be appreciated: o Nasogastric aspirates o Vomit o Diarrhea o Stoma, drains, fistula etc.e) sever sodium depletion 3– best for parenteral maintenance fluids rather than aggressive intravascular volume repletion a) 0.9% normal saline b) 0.45% saline c) Dextrose 5% d) Ringer lactate e) Albumin 4– Dextran (all true except one) a) Not used for volume expansion b) high incidence of anaphylactic reactions c) negative effects on coagulation .In the 1930s Alexis Hartmann (American pediatrician) proposed the addition of sodium lactate buffer to Ringer's solution for the treatment of metabolic acidosis.The lactated Ringer's solution is also known as Hartmann's solution 28 Lactated Ringer's uses o Have sodium, potassium and chloride contents similar to extracellular fluid have fewer adverse effects on acid–base balance (in case of hyperchloremic metabolic acidosis).<sup>30</sup> Dextrose solutions disadvantages Lactate Production: The proportion of a glucose load that contributes to lactate formation o 5% in healthy subjects o 85% in critically ill patients Thus, in patients with circulatory compromise, abnormal glucose metabolism can transform glucose from a source of useful energy to a source of toxin production.There are three main indications: o Resuscitation o Replacement o Maintenance For maximizing benefits and minimizing harms intravenous fluid administration should follow the four Ds: Drug, Dosing, Duration, De–escalation.0.9% Sodium Chloride (Normal Saline) Indications for the use of normal saline infusion that have been approved by the FDA: o Extracellular fluid replacement (e.g., dehydration, hypovolemia, hemorrhage, sepsis).Fluid's classification I.V fluids are classified as Crystalloids or Colloids based on their ability to diffuse through barriers separating body fluid compartments, i.e., intravascular and extravascular (interstitial) fluid compartments.Lactated Ringer's disadvantages o The calcium in lactated Ringers can bind to certain drugs and reduce their bioavailability and efficacy e.g., Amphotericin, Ampicillin, Thiopentone etc.Hydroxyethyl starches COP 28 mm Hg Long elimination half–life (17 days) but the oncotic effects of hetastarch disappear within 24 hours The earlier HES fluids were associated with coagulation dysfunction and pruritis, but the tetrastarches used these days have no effect on bleeding times.Infusion of 100 mL of 20% albumin can increase the plasma volume 400 to 500 mL. It is intended for shifting fluid from the interstitial space to the vascular space in hypoproteinemic conditions, Should not be used for volume resuscitation in hypovolemia.<sup>25</sup> Comparison of Plasma and Crystalloid Resuscitation Fluids Infusion of common fluids Infusion of 1 L of 0.9% NACL adds 275 mL to the plasma volume and 825 mL to the interstitial volume Note: the total volume expansion (1100 mL) slightly greater than the infused volume.Hypotonic concentrations of sodium chloride (0.45%) are best for parenteral maintenance fluids rather than aggressive intravascular volume repletion.Fluid resuscitation in patients with severe intravascular fluid deficits (e.g., hemorrhagic shock) prior to the arrival of blood for transfusion (in conjunction with crystalloids).A Colloid solution contains large molecular weight particles such as proteins or hydroxyethyl starches (HES) suspended in a crystalloid solution.When glucose gets utilized, only water remains, Distribution: o > This cause Cellular swelling o 5% dextrose–in–water solution is not an effective volume

expander. Renal impairment in critically ill patients is associated with osmotic nephrosis like lesions in the proximal and distal tubules.

- o Calcium binding to the citrated anticoagulant in blood products can inactivate the anticoagulant and promote the formation of clots in donor blood.<sup>24</sup>

**Crystalloids and Colloids**

A Crystalloid solution is an aqueous solution composed of water and small solutes such as electrolytes and glucose. The intravascular half-life of a crystalloid solution is 20–30 min, most colloid solutions have intravascular half-lives between 3 and 6 h. Crystalloids when given in sufficient amounts

1. Severe intravascular fluid deficits can be more rapidly corrected using colloid solutions. The rapid administration of large amounts of crystalloids (>4–5L) is more frequently associated with tissue edema. The solution was designed to promote the contraction of isolated frog hearts, and contained  $\text{Ca}^{+}$  and  $\text{K}^{+}$  in a sodium chloride diluent. Dextrose solutions D5% is used to prevent protein breakdown in an NPO patients after consumption of endogenous glycogen (24–48hr). This is the result of a fluid shift from the ICF to extracellular space, because isotonic saline is slightly hypertonic to the Plasma <sup>26</sup>

**Lactated Ringer's solution:** introduced in 1880 by Sydney Ringer (UK) who studied mechanisms of cardiac contraction.

- o Hemacel and gelofusine have the same concentration of sodium (154 meq/L) but gelofusine contain less chloride (120 meq/L). Fluid resuscitation in the presence of severe hypoalbuminemia or conditions associated with large protein losses such as burns.
- o Polyuria <sup>37</sup>

**MCQ TEST 1– Disadvantages of glucose infusion**

- a) Decreased  $\text{CO}_2$  production
- b) Hyperglycemia.

**2– Indications of normal saline (all true except one)**

- a) Dehydration
- b) Hypovolemia
- c) Hemorrhage
- d) sepsis).

**Concept of 'four Ds' when prescribing fluids**

**Drug** – consider the indication for the fluid and what effect is being sought. Crystalloids passed readily through the membrane, whereas colloids did not (Greek word–glue). Crystalloid solutions can be further categorized as hypotonic, isotonic, or hypertonic. Some evidence suggests that marked tissue edema can impair oxygen transport, tissue healing, and return of bowel function following major surgery.

- o It is used in DKA when there is severe hypovolemia and when serum sodium less than 140meq/L.

**Hypertonic saline**

Hypertonic 3% saline is employed in therapy of severe symptomatic hyponatremia.

**Disadvantages of Glucose infusions**

- o Enhanced  $\text{CO}_2$  production (which can be a burden in ventilator– dependent or COPD patients).

**Albumin solution 20% COP of 70 mm Hg**

Expands the plasma volume by 4 to 5 times the volume infused.

- o Rapidly excreted by the kidneys (shorter duration 3–4 hr).<sup>23</sup>

**Tonicity**, a term that is often used interchangeably with osmolarity, refers to the effect a solution has on cell volume. Replacing an intravascular volume deficit with three to four times the volume needed when using colloid

3. Additionally: diluents for the infusion of compatible drug additives.
- o It is used as a replacement fluid in burn patients when BSA >20% (Parkland formula).
- o For this reason, lactated Ringer's solution is contraindicated as a diluent for blood transfusions.

D5% (D5W) is used for replacement of pure water deficits and as a maintenance fluid for patients with hypernatremia. D20%, D25% or D50% are used in TPN (The use of 5% dextrose solutions to provide calories is obsolete).<sup>31</sup>

**Colloids** Do not pass across diffusional barriers as readily as crystalloids. Approximately half of the infused volume of 5% albumin stays in the vascular space.

- o Gelofusine is compatible with blood but hemacel contains  $\text{Ca}^{+2}$ . Not used for volume expansion because of a high incidence of anaphylactic reactions and negative effects on coagulation. Decrease in blood viscosity and inhibition of erythrocyte aggregation.

**Osmolarity and Tonicity of a solution**

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osmolality of a solution is equal to the number of osmoles per liter of solution.
 

- o Hypertonic solutions decrease cell volume. Tonicity describes the effective osmolality of a fluid. Are just as effective as colloids in restoring intravascular volume.
- o It is the preferred solution for diluting packed red blood cells prior to transfusion. Hypertonic 3%, 7.5% or 23.4% saline can be used in case of severe brain edema.
- o 0.45% Sodium Chloride A hypotonic concentration of sodium chloride.
- Natural (plasma-derived) colloids:
  - o Human albumin. Commercially is available as 5% solution or 20% solution in an isotonic saline diluent. 5% solution has colloid oncotic pressure (COP) 20 mm Hg (similar in oncotic activity to plasma).
  - Gelatins
    - o COP 27–34 mmHg
    - o The cheapest colloid available.
  - Dextran
    - COP 40 mm Hg (greater increase in plasma volume).
- \* Shortcut formula: body weight + 40 (= 80 mL/hr.
- o Hypotonic solutions increase cell volume.
- o Treatment of metabolic alkalosis in the presence of fluid loss.
- o Mild sodium depletion. Other indications
  - o Used also in traumatic brain injury or any brain edema.
  - o Replacement fluid in hyperkalemia.
  - o Increased mortality in septic shock.
- Synthetic colloids:
  - o Dextran (e.g., dextran 40 and dextran 70).
  - o Gelatin (e.g., gelofusine and hemaccel).
  - o Starch (e.g., Hydroxyethyl starch (HES)).
- Albumin solution Responsible for 75% of the oncotic pressure of plasma. Acts as buffer, antioxidant and transport protein.
  - o Unlimited volume for resuscitation.
  - o Unimpaired renal function and hemostasis.
  - o Anaphylactoid reactions: direct histamine release.
  - e) Increased mortality in septic shock.
- Dosing -- consider how much fluid to give. De-escalation -- consider when the fluid therapy is no longer effective or required.
- o An isotonic solution has no effect on cell volume.
- o Increased risk of infection, Neuropathy.
- o Aggravation of ischemic brain injury. The oncotic effects of albumin last 12–16 hours