Intravenous (IV) Fluids

IV fluids are utilized for resuscitation, to replace fluid losses, and for maintenance hydration in patients who are not able or not allowed to drink water. Like all prescribed medications, IV fluids have benefits and risks. Fluid therapy should be carefully administered, with specific goals or end points established to avoid inadvertent fluid overload or acid-base alterations.

Crystalloids

Crystalloid solutions contain small molecules that flow easily across semipermeable membranes, from the bloodstream into the cells and body tissues. Crystalloid solutions are distinguished by the relative tonicity (before infusion) in relation to plasma and are categorized as isotonic, hypotonic, or hypertonic.

Isotonic solutions

Isotonic solutions have a concentration of dissolved particles similar to plasma, and an osmolality of 250 to 375 mOsm/L. These fluids remain within the extracellular compartment and are distributed between intravascular (blood vessels) and interstitial (tissue) spaces, increasing intravascular volume. They are used primarily to treat fluid volume deficit.

General nursing considerations:

- Document baseline vital signs, body weight, lung sounds, heart sounds, and note presence or absence of edema. Continue monitoring during and after the infusion.
- Monitor for continued signs of hypovolemia, including urine output < 0.5 mL/kg/hour, poor skin turgor, tachycardia, weak pulse, and hypotension.
- Monitor for signs of hypervolemia such as hypertension, bounding pulse, pulmonary crackles, dyspnea, shortness of breath, peripheral edema, weight gain, jugular vein distension (JVD) and extra heart sounds such as S3.
- A daily serum metabolic panel is recommended for patients receiving continuous IV fluids to monitor sodium, potassium, and glucose levels, as well as renal function.

I.V. Fluid Osmolarity Composition	**Uses/Clinical Considerations**
0.9% NaCL (Normal Saline Solution, NSS) 308 mOsm/L Na^+ 154 mmol/L Cl^- 154 mmol/L	• Fluid of choice for resuscitation efforts. • Used to replace fluid loss from hemorrhage, severe vomiting or diarrhea, heavy drainage from GI suction, fistulas or wounds. • Use to treat shock, mild hyponatremia, metabolic acidosis, hypercalcemia. • Caution in cardiac or renal disease. • The only solution that should be administered with blood products. • Monitor for hyperchloremic acidosis with large volumes of fluid replacement with 0.9%NaCl.

Lactated Ringer's Solution (LR, Ringer's Lactate) 273 mOsm/L Na^+ 130mEq/L K^+ 4 mEq/L Ca^{++} 3 mEq/L Cl^- 109 mEq/L	• First-line fluid resuscitation for burn and trauma patients. • Used to treat acute blood loss or hypovolemia due to third-space fluid shift; GI loss and fistula drainage; electrolyte loss; and metabolic acidosis. • Contraindicated in patients who cannot metabolize lactate, (i.e. liver disease). • Do not administer if pH > 7.5. (Normal liver will convert LR to bicarbonate, worsening alkalosis). • Caution in patients with renal failure (LR contains some potassium and hyperkalemia can occur).
5% dextrose in water (D_5W) 253 mOsm/L 5 g dextrose/100mL 50 g dextrose/L 170 calories/L	• Both isotonic and hypotonic. Initially dilutes osmolality of extracellular fluid (hypotonic); once cell has used dextrose, remaining saline and electrolytes act isotonic, expanding the extracellular compartment. • Provides free water for the kidneys, aiding renal excretion of solutes. • May be used to treat hypernatremia. • Should not be used alone to treat fluid volume deficit because it dilutes plasma electrolyte concentrations. • Contraindicated in resuscitation, early postoperative period, and patients with known or suspected increased intracranial pressure (ICP). • Provides some calories, but not enough nutrition for prolonged use.
Additional isotonic solutions:	
Ringer's Solution Similar to LR but does not contain lactate. Not an alkalizing agent; not ideal for patients with metabolic acidosis.	
PlasmaLyte Electrolyte composition similar to plasma; can be infused with packed red blood cells. Less likely than other fluids to lead to dilutional or hyperchloremic acidosis.	

Hypotonic solutions

Hypotonic solutions have a concentration of dissolved particles lower compared to plasma and an osmolality < 250 mOsm/L. Hypotonic fluids lower serum osmolality within the vascular space by causing fluid to shift out of the blood into the cells and tissue spaces. Typically used to treat conditions causing intracellular dehydration, such as diabetic ketoacidosis and hyperosmolar hyperglycemic states.

General nursing considerations:

- May worsen existing hypovolemia and hypotension causing cardiovascular collapse.
- Monitor for signs of fluid volume deficit, such as confusion in older adults and dizziness.

- Never administer to patients at risk for increased ICP as the potential fluid shift may cause cerebral edema. Avoid in patients with liver disease, trauma or burns.

I.V. Fluid Osmolarity Composition	**Uses/Clinical Considerations**
0.45% NaCl (1/2 NS) 154 mOsm/L Na^+ 77 mEq/L Cl^- 77 mEq/L	• Used to treat hypernatremia. • Caution in patients with heart failure, severe renal insufficiency, and edema with sodium retention. • May cause fluid overload resulting in decreased electrolyte concentrations, over hydration, congested states or pulmonary edema. • Rapid infusion may cause hemolysis of red blood cells (RBCs).
Additional hypotonic solutions:	
0.33% NaCl Allows kidneys to retain needed amounts of water. Caution in patient with heart failure and severe renal insufficiency. Adverse effects include pulmonary edema, febrile reactions. Typically administered with dextrose to increase tonicity.	
0.225% NaCl The most hypotonic fluid available, often recommended as maintenance fluid for pediatric patients. Avoid rapid infusion to prevent hemolysis. Avoid use unless mixed with dextrose.	
2.5% dextrose in water ($D_{2.5}W$) Used to treat dehydration and decrease sodium and potassium levels. Not administered with blood as it can cause hemolysis of RBCs.	

Hypertonic solutions

Hypertonic solutions have a concentration of dissolved particles higher than plasma and an osmolality > 375 mOsm/L. A higher solute concentration causes the osmotic pressure gradient to draw water out of cells, increasing extracellular volume. These fluids are often used as volume expanders and may be prescribed for hyponatremia (low sodium). They may also benefit patients with cerebral edema.

General nursing considerations:

- Administer only in high acuity areas.
- For short-term use to correct critical electrolyte abnormalities.
- Monitor electrolytes and assess for hypervolemia. May cause fluid volume overload and pulmonary edema.
- Avoid in patients with cardiac or renal conditions who are dehydrated, and in patients with diabetic ketoacidosis.

I.V. Fluid Osmolarity Composition	**Uses/Clinical Considerations**
3% NaCl 1030 mOsm/L --- **5% NaCl** 1710 mOsm/L	• Used for treatment of severe, critical symptomatic hyponatremia and cerebral edema. • Give slowly and cautiously to avoid intravascular fluid volume overload, pulmonary edema, and the rare life-threatening complication of central pontine myelinolysis. • Rapid infusion may cause hypernatremia or hyperchloremia.
Dextrose 5% in 0.45% NaCl (D_5 ½ NS) 406 mOsm/L	• Used as maintenance IV fluid for patients unable to ingest adequate fluids orally. • Monitor closely for fluid volume overload. • Monitor blood glucose, sodium, and potassium levels.
Dextrose 5% in 0.9% NaCl (D_5NS) 560 mOsm/L	• Provides calories, water and electrolytes • Monitor closely for fluid volume overload and pulmonary edema.
Dextrose 5% in Lactated Ringer's (D_5LR) 527 mOsm/L	• Provides calories, water and electrolytes • Contains sodium lactate which may be used to treat metabolic acidosis.
10% Dextrose in water (D_{10}W) 505 mOsm/L 10 g dextrose/100mL 340 calories/L	• Provides free water and calories, but no electrolytes. • Contraindicated in patients with intracranial or intra-spinal hemorrhage, delirium tremens, severe dehydration, anuria, hepatic coma. • Use central line if possible. Do not infuse through same IV line as blood products due to possibility of RBC hemolysis. • Monitor blood glucose closely. Use with caution in patients with diabetes mellitus. Monitor for hypokalemia. • May cause phlebitis, vein damage and thrombosis at the injection site. • Rapid infusion may cause diuresis, hyperglycemia, glycosuria, • hyperosmolar syndrome (mental confusion, loss of consciousness), fluid and/or solute overload, overhydration, or pulmonary edema.

Additional hypertonic solutions:
20% Dextrose in water ($D_{20}W$): Acts as an osmotic diuretic, causes a fluid shift between various compartments. Promotes diuresis.
50% Dextrose in water ($D_{50}W$): Administered via IV bolus to treat patients with severe hypoglycemia.

Colloids

Colloid solutions contain large molecules that do not pass through semipermeable membranes and therefore remain in the blood vessels. Also known as volume/plasma expanders, colloids expand intravascular volume by drawing fluid from the interstitial space into the vessels through higher oncotic pressure. Less total volume is required compared to IV fluids. Colloids are indicated for patients in malnourished states and patients who cannot tolerate large infusions of fluid.

General nursing considerations:

- Before administering a colloid, take a careful allergy history.
- Use 18-gauge or larger needle for administration of colloid solutions.
- Monitor intake and output closely and for signs of hypervolemia:hypertension, dyspnea, crackles in lungs, jugular venous distension, edema, bounding pulse, extra heart sounds such as S3.
- Monitor coagulation indexes.

I.V. Fluid Osmolarity	**Clinical Considerations**
Albumin (5%) 309 mOsm/L ---------- **Albumin (25%)** 312 mOsm/L	• Human albumin solution • Used for moderate protein replacement, to achieve hemodynamic stability in shock states, and during large volume paracentesis in patients with cirrhosis. • Considered a blood transfusion product, use the same protocols and nursing precautions when administering albumin. • Contraindicated in severe anemia, heart failure or known sensitivity to albumin. • Angiotensin-converting enzyme (ACE) inhibitors should be withheld at least 24 hours before administration due to risk of atypical reaction (flushing and hypotension).

Additional Colloid solutions (less commonly used):
Low-molecular weight dextran (LMWD); **High-molecular weight dextran** (HMWD) Contains polysaccharide molecules that behave like colloids. Used for volume expansion, fluid resuscitation. Contraindicated in thrombocytopenia, hyperfibrinogenemia, avoid with hemorrhagic shock.
Hetastarch (6%); **Hespan** Used for hemodynamic volume replacement. Does not interfere with blood typing or cross matching. Contraindicated in liver disease and severe cardiac/renal disorders. Monitor for anaphylaxis.

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