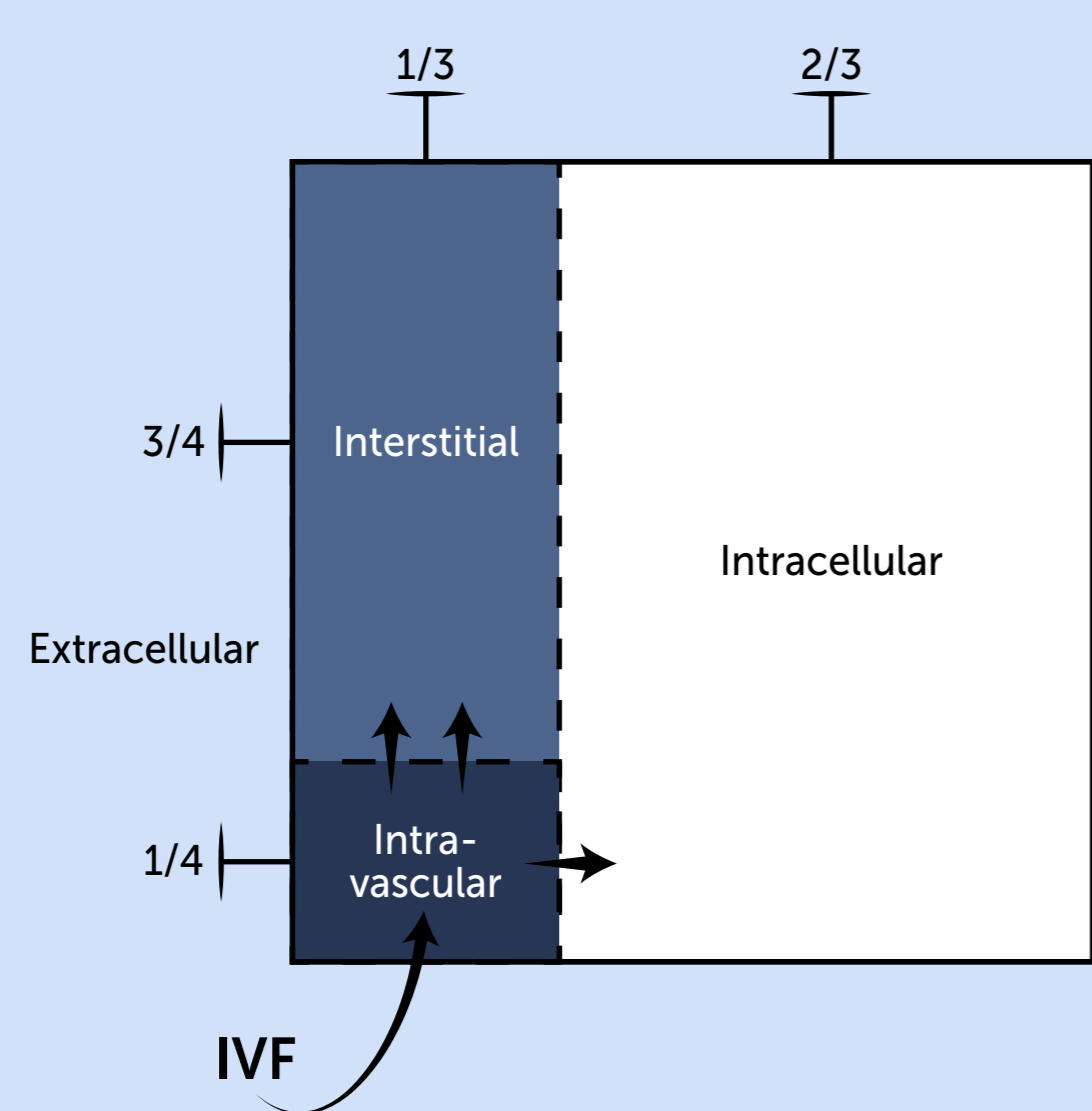


# IV Fluids

## Who needs IV fluids (IVF)?

This isn't always a straightforward question to answer. In general, the goal of giving IVF should be either **increasing intravascular volume** or aiding in the **correction of metabolic (electrolyte, acid/base) derangements**.



Recall that intravascular fluid is only 1/4th of total extracellular fluid, which is only 1/3rd of total body fluid.

Depending on the tonicity and composition of the specific fluid used, different amounts of the total fluid administered will end up in the intravascular space after redistribution. For example, of the total volume administered, only ~25% of isotonic crystalloids and less than 10% of free water (D5W) will remain intravascular!

Fluid	pH*	Osm (mOsm/L)	Na <sup>+</sup> (mEq/L)	Cl <sup>-</sup> (mEq/L)	Other
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<b>Human Plasma</b>	7.4	285	140	104	K <sup>+</sup> : 4 mEq/L Mg <sup>2+</sup> : 2 mEq/L iCa <sup>2+</sup> : 1.2 mmol/L Buffer: 24 (bicarb.)
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### Crystalloids

Crystalloids are salt solutions. They are the most commonly used IVF. They can be **isotonic** (NS, LR), **hypotonic** (1/2 NS), or **hypertonic** (3% saline). **Balanced** crystalloids (LR, Plasma-lyte) are buffered with **bicarbonate precursors**.

<b>Normal saline (NS)</b>	4.5-7	308	154	154	Note that all formulations of NS (1/2, 1/4) have equivalent fractions of these values.
<b>Lactated ringer's (LR)</b>	6-7.5	273	130	109	K <sup>+</sup> : 4 mEq/L Ca <sup>2+</sup> : 1.4 mmol/L Buffer: 28 (lactate)
<b>Plasma-lyte</b>	4-6.5	294	140	98	K <sup>+</sup> : 5 mEq/L Mg <sup>2+</sup> : 3 mEq/L Buffer: 27 (acetate) Buffer: 23 (gluconate)

### Colloids

Colloids are solutions made of large molecules (starches, dextrans, proteins). They are more expensive than crystalloids and generally have more **specific** indications. **Albumin** and **blood products** are the most commonly used colloids.

<b>5% albumin</b>	6.4-7.4	309	130-160	---	Albumin: 50 g/L
<b>25% albumin</b>	6.4-7.4	312	130-160	---	Albumin: 250 g/L

### Free Water (+)

Free water solutions are usually composed of varying concentrations of **dextrose** (D5W / D10W / D20W). Because they contain **no** salt, they distribute evenly throughout **all** fluid spaces. They are often combined with crystalloids\*, especially in the setting of prolonged NPO (maintenance fluids).

<b>D5W</b>	3.5-6.5	252	---	---	Dextrose: 50 g/L 1L = 1L free water*
<b>D5-1/2NS</b>	~4.5	406	77	77	Dextrose: 50 g/L 1L = 500 mL free water*
<b>D5-LR</b>	~5.0	526	130	109	K <sup>+</sup> : 4 mEq/L Dextrose: 50 g/L Ca <sup>2+</sup> : 1.4 mmol/L Buffer: 28 (lactate)

\*When a crystalloid is mixed with D5 the amount of free water **decreases**. D5-LR contains **no** free water!

\*Note that the **in vitro** pH of most IV fluids fall within a dynamic range that tends to be acidic. This is largely due to dissolved atmospheric CO<sub>2</sub>, ionic activity, and the degradation of the PVC packaging. However, **in vitro** pH measurements have little to do with the **in vivo** effects of the fluids on pH. **In vivo** changes of pH are almost entirely mediated by the **buffering capacity (or lack thereof)** of each fluid.

## So, which should I use?

- Crystalloid or colloid?**  
 Albumin is the IVF of choice for a few specific indications }  
**Otherwise, usually crystalloids are best (SAFE<sup>1</sup>, ALBIOS<sup>2</sup>).**
- Isotonic, hypotonic, or hypertonic?**  
 Like colloids, hypo-/hyper-tonic fluids have specific indications }  
**Otherwise, isotonic fluids are best.**
- What about free water?**  
 Frequently combined with crystalloids, indications may include }  
**Otherwise, regular isotonic crystalloids are best.**

hepatorenal syndrome  
spont. bacterial peritonitis  
large volume para

HYPO in ↑ Na  
HYPER in ↓ Na or ↑ ICP

Prolonged NPO  
↑ Na

Without a clear indication otherwise, **isotonic crystalloids** will be the fluid of choice for most patients. Given the frequency that these medications are given, **small differences in efficacy become important**.

### The case against Normal Saline (NS)

- Causes/exacerbates acidosis (NAGMA)
- Acidosis shifts K<sup>+</sup> out of cells, causing/worsening hyperkalemia
- Causes ↑ Cl<sup>-</sup> and renal vasoconstriction, resulting in AKI (SALT-ED<sup>3</sup>, SMART<sup>4</sup>)

### The case for Balanced Crystalloids (LR, Plasma-Lyte)

- Safe for pts w/ ↑ lactate (metabolized by liver to HCO<sub>3</sub><sup>-</sup>)
- Safe for pts w/ ↑ K<sup>+</sup> (NS ↑ K<sup>+</sup> more 2/2 acidosis)
- ↓ risk of adverse renal events in non-critically ill pts (SALT-ED<sup>3</sup>)
- ↓ rate of death, renal dysfxn, RRT in critically ill pts (SMART<sup>4</sup>)
- Less likely to cause acidosis, ↑ Cl<sup>-</sup>, or ↑ K<sup>+</sup>

LR is **contraindicated** in ↑ ICP due to its tonicity. Also, in ↑ Ca<sup>2+</sup> **NS > LR** (contains Ca<sup>2+</sup>), but the first step in treating hypercalcemia is **fluid resuscitation** so use what you have! **Plasma-Lyte has no strong contraindications**. Also, while both are more expensive than NS (LR ~25 cents/bag > NS; Plasma-Lyte is \$\$\$ and may be unavailable), the ↑ cost (particularly of LR) is likely negligible when compared to the possible benefit by averting negative outcomes.

**Balanced crystalloids (esp. LR) are the preferred IVF in almost all cases.**