IV Calculations

Abbreviations

D	Dextrose	W	Water	S	Saline
NS	Normal saline	RL	Ringer's Lactate	LR	Lactated Ringer's

NS Normal saline 0.9% ½ NS Normal saline 0.45%

D5W or 5% D/W	Dextrose 5% in water
D5RL	Dextrose 5% and Ringer's Lactate
D5NS	Dextrose 5% in normal saline (0.9%)
D5 and ½ NS	Dextrose 5% in normal saline (0.45%)

Solution Strength:
Solution strength as a % means the number of grams of substance (NaCl, dextrose, etc) per 100 mL of fluid.

For example, 0.45% normal saline means 0.45 g of NaCl per 100 mL of fluid

Example
750 mL of D10 NS contains:

10% dextrose = 10 g dextrose/100 mL fluid

$$\frac{10\,\text{g dextrose}}{100\,\text{mL fluid}} = \frac{x\,\text{g dextrose}}{750\,\text{mL fluid}}$$

$$\frac{(10)(750)}{100} = x \text{ g dextrose} = 75 \text{ g dextrose}$$

0.9% saline = 0.9 g NaCl/100 mL fluid

$$\frac{0.9\,\text{g NaCl}}{100\,\text{mL fluid}} = \frac{x\,\text{g NaCl}}{750\,\text{mL fluid}}$$

$$\frac{(0.9)(750)}{100} = x \text{ g NaCl} = 6.75 \text{ g NaCl}$$

Flow Rates

IV fluids are ordered as number of mL in some time period, for example, 1,000 mL in 8 hr or 50 mL over 30 minutes.

If using an electronic infusion device, it needs to be programmed in mL/hour. If the order is not already in mL/hour, convert to mL/hr by dividing the total volume by the total time. Round decimals up or down to a whole mL.

for 750 mL of D5W in 16 hr:

$$\frac{750\,\text{mL}}{16\,\text{hr}} = 46.8 \text{ mL/hr} = 47 \text{ mL/hr}$$

Use a ratio-proportion when the time is *less than one hour*, using 60 min to represent 1 hour.

For 30 mL of antibiotic in 0.9 NS in 20 min:

$$\frac{30\,\text{mL}}{20\,\text{min}} = \frac{x\,\text{mL}}{60\,\text{min}}$$

$$\frac{60(30)}{20} = x = 90\ \text{mL/hr}$$

To manually control infusion rates, the order must be converted to **gtt/min**.

The size of the tubing determines the size of the drops and therefore *how many* drops make up a milliliter

Drop factor: calibration of tubing in gtt/mL

Macrodrop tubing: 10, 15, or 20 gtts are equal to 1 mL

Microdrop tubing: 60 gtt are equal to 1 mL

(since there are 60 min in one hour, mL/hr = microdrops/min)

Formulas

If time ≤ 60 min: x gtt/min $= \dfrac{\text{total amount in mL}}{\text{total time in min}}$ X drop factor (gtt per mL)

Example: Administer 60 mL of 0.9% NS in 40 minutes; drop factor is a microdrop.

$$x\ \text{gtt/min} = \frac{60\ \text{mL}}{40\ \text{min}} \bullet \frac{60\ \text{gtt}}{\text{mL}} = 90\ \text{gtt/min}\ \ (90\ \text{microgtt/min})$$

Example: Infuse 50 mL of medication in 45 min. Drop factor is 20 gtt/mL.

$$x\ \text{gtt/min} = \frac{50\ \text{mL}}{45\ \text{min}} \bullet \frac{20\ \text{gtt}}{\text{mL}} = 22.2 = 22\ \text{gtt/min}\ \ (22\ \text{macrogtt/min})$$

If time > 60 min:

1) Convert the order to mL/hour first, then replace "hour" with "60 min".
2) Then use the formula: x gtt/min $= \dfrac{\text{mL}}{60\ \text{min}}$ X drop factor (gtt/mL)

Example: Administer 1000 mL of RL in 16 hours. Drop factor is 15 gtt/mL.

1) $\dfrac{1000\ \text{mL}}{16\ \text{hr}} = 62.5\ \text{mL/hr} = 62.5\ \text{mL/60 min}$ (change 'hr' to '60 min'!)
2) $\dfrac{62.5\ \text{mL}}{60\,\text{min}} \bullet \dfrac{15\ \text{gtt}}{\text{mL}} = 15.63 = 16\ \text{gtt/min}\ \ (16\ \text{macrogtt/min})$

Example: Infuse 1500 mL D5W in 8 hours. Drop factor is 10 gtt/mL.

1) $\frac{1500 \text{ mL}}{8 \text{ hr}} = 187.5 \text{ mL/hr} = 187.5 \text{ mL/60 min}$

2) $\frac{187.5 \text{ mL}}{60 \text{ min}} \bullet \frac{10 \text{ gtt}}{\text{mL}} = 31.25 = 31 \text{ gtt/min}$ (31 macrogtt/min)

Alternative Method

1) Convert the order into mL/hour (even if it is for a time period less than one hour).

2) Divide 60 by the drop factor, eg., 60/15 = 4. This is the drop factor constant.

3) Divide the mL/hour number by the drop factor constant to get gtt/min.

Example: 0.9% NS 1500 mL in 12 hrs. Drop factor is 20 gtt/mL.

1) Convert: $\frac{1500 \text{ mL}}{12 \text{ hrs}} = 125 \text{ mL/hr}$
2) Divide 60 by the drop factor 20: 60/20 = 3 (the drop factor constant).
3) Divide 125 mL/hr by the drop factor constant 3: 125/3 = 41.7 = 42 gtt/min (42 macrogtt/min).

Example: 40 mL of D5W in 20 minutes. Drop factor 15 gtt/mL.

1) Convert: $\frac{40 \text{ mL}}{20 \text{ min}} \bullet \frac{3}{3} = \frac{120 \text{ mL}}{60 \text{ min}} = 120\text{mL/hr}$

$$\left(\text{or } \frac{40 \text{ mL}}{20 \text{ min}} = \frac{x \text{ mL}}{60 \text{ min}} ; \frac{(40)(60)}{(20)} = x = 120\text{mL/hr} \right)$$

2) Divide 60 by the drop factor 15: 60/15 = 4.
3) Divide 120 mL/hr by 4: 120/4 = 30 gtt/min (30 macrogtt/min).

When several fluids are ordered for the same time period, add the amounts to get the total amount, then calculate gtt/min as usual using the total amount.

Medication
When medication is added to the IV, units of medication must be converted to mL of fluid before determining the flow rate.

1) Use a ratio-proportion to determine how many mL of solution are needed to deliver the hourly dose of medication.

2) Determine flow rate in gtt/min as before (remember to replace hour with 60 min).

Example
20 mEq of potassium chloride (KCl) in 1000 mL of D5 at the rate of 5 mEq/hr.
Drop factor is 15 gtt/mL.

1) $\frac{20\,\text{mEq}}{1000\,\text{mL}} = \frac{5\,\text{mEq}}{\text{x mL}} \quad \rightarrow \quad x = \frac{5(1000)}{20} = 250\ \text{mL}$

250 mL contains 5 mEq of KCL – this is the hourly fluid amount. So the flow rate is 250 mL/hr

2) x gtt/min $= \frac{250\,\text{mL}}{60\,\text{min}} \bullet \frac{15\,\text{gtt}}{\text{mL}} = 62.5$ gtt/min $= 63$ gtt/min (63 macrogtt/min)

Example
25 mg of medication in 250 mL D5W at 30 mcg/min IV. Drop factor is 60 gtt/mL.

1) $\frac{30\,\text{mcg}}{\text{min}} \bullet \frac{60\,\text{min}}{\text{hr}} = 1800$ mcg/hr

Convert units: $1800\,\text{mcg} \bullet \frac{1\,\text{mg}}{1000\,\text{mcg}} = 1.8$ mg $\rightarrow$ we need 1.8 mg/hr

$\frac{25\,\text{mg}}{250\,\text{mL}} = \frac{1.8\,\text{mg}}{x\,\text{mL}} \quad \rightarrow \quad x = \frac{1.8(250)}{25} = 18\ \text{mL}$

18 mL contains 1.8 mg of the medication – this is the hourly fluid amount. So the flow rate is 18 mL/hr

2) x gtt/min $= \frac{18\,\text{mL}}{60\,\text{min}} \bullet \frac{60\,\text{gtt}}{\text{mL}} = 18$ gtt/min.

(Remember, if the drop rate is 60 gtt/min, then the flow rate in gtt/min is numerically the same as mL/hr.)

Infusion Time

If a certain volume of fluid is infusing at a certain rate, how long will it take to infuse the entire quantity? If you are working with rates in gtt/min, then:

$$x \text{ time in minutes} = \frac{(\text{total volume in mL})(\text{drop factor})}{(\text{flow rate in gtt/min})}$$

(This is just a rearrangement of the flow rate equation.)

To find the time in hours, divide the number of minutes by 60.

If you know the rate in mL/hr, it's much simpler:

$$x \text{ time in hours} = \frac{\text{total volume in mL}}{\text{flow rate in mL/hr}}$$

Example
An IV is flowing at 25 gtt/min, calibrated at 20 gtt/mL. How long will it take for 100 mL to infuse?

$$x \text{ min} = \frac{(100\,\text{mL})(20\,\text{gtt/mL})}{25\,\text{gtt/min}} = 80 \text{ min} \qquad 80/60 = 1.3 \text{ hr}$$

Example
500 mL RL is to infuse at a rate of 80 mL/hr. It was started at 5 am. What time will it be completed?

$$x \text{ hours} = \frac{500\,\text{mL}}{80\,\text{mL/hr}} = 6.25 \text{ hr} = 6 \text{ hr } 15 \text{ min}$$

5 am + (6 hr 15 min) = 11:15 am

Infusion Volume

Volume of fluid received over a certain time period can also be calculated by another rearrangement of the flow rate equation:

$$x \text{ total volume in mL} = \frac{(\text{time in min})(\text{flow rate in gtt/min})}{(\text{drop factor})}$$

Example
An IV is regulated at 19 gtt/min, with a drop factor of 20 gtt/mL. How much fluid will infuse in 6 hours?

First, convert hours to minutes by multiplying by 60: (6 hr)(60 min/hr) = 360 min.

$$x \text{ mL} = \frac{(360\,\text{min})(19\,\text{gtt}/\text{min})}{(20\,\text{gtt}/\text{mL})} = 342 \text{ mL}$$

Example
An IV is regulated at 30 gtt/min, with a drop factor of 15 gtt/mL. How much fluid will infuse in 5 hours?

First, convert hours to minutes by multiplying by 60: (5 hr)(60 min/hr) = 300 min.

$$x \text{ mL} = \frac{(300\,\text{min})(30\,\text{gtt}/\text{min})}{(15\,\text{gtt}/\text{mL})} = 600 \text{ mL}$$

Recalculating Flow Rates

If an IV is ahead of or behind schedule, the flow rate may be adjusted (provided the new rate does not increase or decrease the old rate by more than 25%). The flow rate is calculated for the amount of fluid remaining in the usual way.

Example
A 1 L IV bottle was to infuse over 8 hours. After 5 hours, there is 450 mL left. What flow rate should be used to administer the amount remaining in the next 3 hours? Drop factor is 10 gtt/mL.

450 mL/3 hr = 150 mL/hr = 150 mL/60 min

$$x \text{ gtt/min} = \frac{150\,\text{mL}}{60\,\text{min}} \cdot \frac{10\,\text{gtt}}{\text{mL}} = 25 \text{ gtt/min}$$

What was the original rate?

1000 mL/8 hr = 125 mL/hr = 125 mL/60 min

$$x \text{ gtt/min} = \frac{125\,\text{mL}}{60\,\text{min}} \cdot \frac{10\,\text{gtt}}{\text{mL}} = 21 \text{ gtt/min}$$

What is the % increase? $\dfrac{\text{difference}}{\text{original}} = \dfrac{25-21}{21} = \dfrac{4}{21} = 0.19 = 19\%$