Critical Care Calculations

Physicians ordering critical care IV drugs generally order them by flow rates in cc/hr or gtts/ minute or by dosage which is mg/kg/min or mcg/kg/min. This then is the sort of calculation you have been doing all along. But it adds the 3rd and 4th step where you must convert back and forth between mg and mcg and you must calculate the rate based on weight.

It is necessary that you calculate these minute but critical dosages and flow rates to better assess the safe dose ranges and to monitor for any side effects or adverse reactions in drug response.

These drugs then are looked at in terms of dosage per hour, dosage per minute, per milliliter and per drop. All of these factors have interrelationships and those are important factors to compare and contrast;

Most critical care drugs require close and continuous monitoring. All of these drugs must be delivered via IV pump. But remember that pumps are simply mechanico-electrical devices that can go awry Since these settings require calculations before administration, many of the problems in this unit ask you to determine the flow rate, either in ml/hr or gtts/min. In the event that a pump is not available you would use Microdrip tubing to run the medication. Pumps now are requisites however to running these medications. Microdrips are still the safest sort of tubing to use, since they deliver smaller amounts of medication in each drop. This gives you greater control over flow rate and dosing.

Accuracy is imperative in these calculations for the medications we are talking about are exceptionally powerful. A mistake here can be life threatening, It is as usual imperative that you double check your math here This is MANDATORY and a routing part of care. These medications have a narrow margin of safety.

Read each example through slowly to ascertain what it is asking. Then work through each problem slowly and methodically. If you forget the steps then you are moving too quickly.

RULE: **In critical care drug calculations, always determine the dosage first. This will involve calculating the specific dosages per minute or per hour.**

ALWAYS DETERMINE DOASGE FIRST

To convert these flow rates to dosage per hour or per minute, the following steps are necessary.

Example 1 CC

The order is to infuse Dopamine 800 mg in 500 ml of D5W at 25 ml/hr. Calculate the dosage in mcg/minute and mcg her hour.

Methodically

A. Use ratio and proportion to determine the dosage per hour.

800 mg: 500 ml = X: 25 mL.

800 X 25 = 500 X (means and extremes)

20,000 /500 = X

X = 40 mg /hr

B. then convert milligrams to micrograms

40 mg = 40,000 mcg (by moving 3 decimal places to the right)

C. Then convert mcg/hr to mcg/min

40,000 mcg hr / 60 min = 666.6 of 667 mcg /min.

Lets look at the **intuitive relationships** of those numbers.

1) There are 800 mg in 500 cc. So lets find out how many there are in 1 cc.

2) 800/500 = 8/5 or 1 3/5 or (3/5 = 6/10 or 0.6 in decimals)

So there are 1.6 mg /cc

3) Making that micrograms – multiply by 1000 so there are 1600 mcg/cc

4) If we are going at 25 ml/hr we could multiply 1.6 mg X 25 cc to get the number of mg per hour- 25 X 1.6 = 40 mg per hour

5) Then see how many mg /minute we would divide that 40 mg/hr by 60 minutes to get 4/6 of a mg or 2/3 or 0.667 mg per minute.

6) Then to make that into micrograms we could multiply that by 1000 mcg in a milligram. = 667 mcg/min- the same answer as above.

Example 2 CC

Your post-op cardiac bypass patient has orders to infuse Nipride at 30 gtts/minute. The solution available is 100 mg of Nipride in 500 ml of D5 W. Calculate the mg/min and mg/hr that the patient is receiving. The set calibration is a Microdrip.

First convert gtts /min to ml/min

60 gtts: 1 ml = 30 gtts: X ml

60 X /30 = 0.5 ml/min

Then calculate mg/min.

100 mg: 500 ml = X mg: 0.5 mL

100 X 0.5 = 500 X

50 /500 = X = O.1 mg/min

Then calculate mg/hr.

0.1 mg/min X 60 = 6 mg/hr.

Intuitive example:

Your patient has 100mg Nipride in 500 ml or 100/500 or 1/5 of a mg- or 0. 2 mg/ml. The patient is getting 30 gtts min which is 1/2 a cc which has 60 gtts- or 1/2 of 0.2 mg = 0.1 mg/min. So in 1 hr, the patient would get 0.1 X 60 minutes or 6 mg/hr. This is just based in the interrelations of the numbers.

Example 3 CC

A patient with ventricular ectopics has a stat order for Lidocaine infusion, which will run at 30 ml/hr. The solution has 1 gram of Lidocaine in 500 ml of D5 W. Calculate the mg/hr and then the mg/min that the patient will receive.

A. First convert the metric units in the stem of the problem which is in grams to the units asked for, mg.

So 1 gram = 1000 mg

B. Next determine the mg/hr

1000 mg: 500 mL = X mg: 30 ml

30000/500 = X X = 60 mg/hr

C. Convert mg/hr to mg/min

60 mg/hr /60 min = 1 mg/min

The average dose of Lidocaine is 1-4 mg/min. So the dose is within safe range.

Intuitive solution;

Lidocaine 1 gm = 1000 mg in 500 ml/ so there are 2 mg/ml. It is going at 30 ml/hr so that is 60 mg/hr. Since there are 60 min in and hr we can divide 60 mg.hr/60 min and get 1 mg/min. This is all done in one's head and checked on paper.

It does not matter how you do this as long as you are methodical, reasoned and orderly. Do less about trying to memorize a formula than to think about what you are trying to determine,

Final example 4:CC

0.5 Grams of Aminophylline is added to 500 mL of D5 /1/4 NS. The order is to infuse the IV over 6 hrs. Calculate the mg/hr the patient will receive.

Convert g to mg –0.5 mg = 500 mg

Calculate mg/hr.

500mg: 6 hrs = X mg: 1 hr = 500 = 6 X = 83 mg/hr

Intuitively, the first step is the same with 0.5 grams becoming 500 mg which is then divided by 500 cc to give a concentration of 1 mg/ml or per cc. The rate is 500 cc/6 hrs = 83 cc/hr. Since there is 1 mg per cc, The mg per hr is 83 again done in one's head.

Let's practice this type of problem.

Exercise 1 CC

1) A continuous infusion of Isuprel is ordered for a patient with Torsades des pointes. The rate is 40 ml/hr. The solution has 2 mg in 500 ml of D5W. Calculate the mg/hr,_____ mcg/hr_____ and mcg/ _____ the patient will be receiving,
2) The order is to infuse dobutamine (Dobutrex) 500mg in 500 ml of D5 W at 15 ml/hr. Calculate the mg/hr_____; mg/min_____ and mcg/hr the patient will be receiving.
3) Pronestyl 1 gram is mixed in 250 ml of D5W for a patient with frequent ventricular ectopics and runs of atrial arrythmias as well. The IV is to run at 1 ml/minute. Calculate the number of mg/min the patient is receiving._____. The normal dosage is between 2-6 mg/min. Is this dose within normal? _____
4) A patient has CHF following an MI and has an order for Nitrol (nitroglycerine) IV 3 ml/hr by pump. The IV solution has a dilution of 200 mcg /ml of Nitrol. How many mcg/min_____ and mcg/hr is the patient receiving.

5) Esmolol IV is ordered to control the rate of a patient during surgery. The solution available is 5 g in 500 ml of D5W. The doctor orders the infusion to start at 50 ml/hr. Calculate the dosage in mg/hr_____ and mg/min.

6) To help support the blood pressure of a patient in shock, a doctor orders Dobutamine 250 mg in 250 ml of D5W to run at 25 ml/hr on a pump. Calculate the mg/min_____, mg/hr_____ and mcg/min_____ that the patient is receiving.

7) The order is to infuse Dopamine 400 mg in 250 mL of D5W at 30 gtts/min using a microdrip set. Calculate the mg/min_____ and the mg/hr_____ that the patient will receive.

8) A doctor orders Pitocin drip at 45 microdrips per minute. The solution contains20 u of Pitocin in 1000 ml of D5W. Calculate the units per minute and the units per hour the patient is receiving.

9) 1 g of Aminophylline is added to 500 ml of D5W. The order is to infuse the IV over 10 hrs. Calculate the mg/'hr the patient will receive.

10) Amikacin is ordered for the patient with a very severe infection. Solution is available of 500 mg in 250 mL of D5W. to infuse over 30 minutes using a pump. Calculate the mg/min the patient will receive.

Critical Care Drugs are also ordered to infuse based on a dosage per kg per minute. For example, Nipride is ordered at 2 mcg/kg/min. The Nipride solution has 50 mg in 500 ml/D5W. This is like the other weight questions in that we must work with the patients body weight in kilograms.

Example: 5 CC

1mcg/kg/min Nipride

solution with 50 mg Nipride in 500 D5W

pt wt 128 lbs.

First convert lbs to kg

128/2.2= 58 kg

Now dosage per minute

58 kg X 2 mcg = 116 mcg/min

So you can figure out now how many drops per minute, etc using the work we did before,

Example 6CC

Infuse 1 gram of Aminophylline in 1000 ml D5 1/2 NS at 0.7 mg/kg/hr. The patient weights 169 lbs. Calculate the dosage in mg/hr and in mg/min/ The FDA recommends that you not exceed 20 mg/min when infusing Aminophylline.

First convert lbs. to kg = 169/2.2= 77 kg

Then calculate dosage/hr

77 kg X 0.7 mg = 54 mg/hr

Then calculate the dosage per minute

54 mg/hr / 60 min = 0.9 mg/min

Example 7 CC

A patient with Hodgkin's disease weighs 90 lbs. has an order for Bleomycin 0.25 u/kg to be diluted in 50 ml of NS. Infuse this over 30 minutes using a microdrip set. Calculate the dosage to be diluted then determine the u/min the patient will receive. This calculation has 1 additional step.

Convert lbs. to Kg

90 lbs/2.2= 41 kg

Calculate the dosage to be diluted

41 kg X 25 u= 10. 3 units to be added to the solution

Calculate the dosage in u/min.

10.3 u: 30 min = X u : 1 min

10.3/30 = 0.3 u/min

Exercise 2 CC

Calculate the drug dosage of the following orders.

1) A patient weighing 120 lbs. has orders for 6 mcg/kg/min of Nipride. The solution available has 50 mg in 250 ml. of D5W. Calculate the mcg/min _____ and the mg/hr. _____
2) A patient weighing 46 kg with testicular cancer has order for Adriamycin 25 mcg/kg IV. The dosage is to be added to 1 liter of 0.9 % Normal Saline and infused over 6 hrs. Determine first the dosage you will prepare_____. Then calculate the mcg/hr that the patient will receive during the infusion.
3) Give amphotericin B 1.5 mg/kg IV diluted in 500 mL of D5 W over 4 hrs, The patient weights 136 lbs. Calculate the dosage you will prepare. _____Determine the mg/hr the patient will receive._____.
4) Infuse Nipride at 2.5 mcg /kg/min. The solution available is 50 mg of Nipride in 500 mL of D5 W. The patient weighs 62 kg. Calculate the mcg/min _____and the mg/hr_____
5) A 70-kg adult has orders for a Lidocaine continuous infusion of 25 mcg/kg/min. The solution available is 500 mg of Lidocaine in 250 mL of D5W. Calculate the mcg/min _____ and the mg/hr_____.

Calculating Critical care flow rates

Once you have calculated the drug dosage, the IV flow rate can be determined. The flow rate is most often calculated in mL/hr or gtts/min as these are the most common methods of administration, Pumps deliver all of these drugs but a specific flow rate needs to be determined before you can set the pump.

Example 8 CC

Dopamine 400 mg is added to 500 ml of D5W. The order is to infuse this medication at 400 mcg/min IV. How will you set the pump in mL per hour?

This is the reverse of the previous type of question,

Step 1: Determine the dosage per hour

400 mcg/min X 60 min = 24000 mcg/hr

Step 2: convert the mcg to mg which will be like units.

24000 mcg/hr = 24 mg/hr

Step 3: Calculate the flow rate (mL/hr)

400 mg: 500 mL = 24 mg : X mL

1200 = 400 X

X= 30 ml/hr

So you set the flow rate to 30 ml/hr to deliver 24 mg/hr.

Intuitively there is 400 mg in 500 cc so there is 4/5 of a mg (or 0.8 mg) per cc. 0.8 mg = 800 mcg per cc. The order is for 400 mcg/min so that is 1/2 or 0.5 cc/min. (Make sure to label). Per minute, There are 60 minutes in an hr and we are giving 0.5 cc/min or .X60 = 30 cc/hr.

Example 9 CC

A patient has an order of Nipride to reduce his afterload during an acute angina attack. The order reads to add 50 mg of Nipride to 500 mlD5W and infuse it at 2 mcg/kg/min on a pump. The patient weighs 70kg. Calculate the flow rate in mL/hr.

Step 1 Determine the dosage per minute

70 kg X 2 mcg/kg = 140 mcg/min

Step 2: Convert to dosage per hour.

140 mcg/min X 60 min = 8400 mcg/hr.

Step 3: Convert to like units.

8400 mcg = 8.4 mg

Step 4 **Calculate the flow rate in mL/hr.**

50 mg: 500 ml = 8.4 mg: X ml

500 X 8.4 = 50 X

4200 /50 = X

X = 84 ml set the pump to deliver the pump at 84ml/hr to deliver 8.4 mg/hr.

Intuitively, there is 50 mg of Nipride in 500 ml so there is 1/10 a mg or 0.1 mg/cc. Or **100 mcg/ml.** This is to go at 2 mcg/kg per min, So the weight is 70 and we multiply that by 2 to get **140 mcg/min,** We know we have 100 mcg/ml and we need to give 140/100 or 1.4 cc/min. So we multiply 1.4 cc/min X 60 mins to get 84 cc/hr.

Example 10 CC

A patient in CHF has orders for Nitrostat 5 mcg/min IV. The solution available has 8 mg of Nitrostat in 250 ml of D5W. Calculate the flow rate in gtts/min using a microdrip set.

1) **Convert** the dosage per minute to dosage per hour.
   5 mcg/min X 60 = 300 mcg/hr
2) **Convert** to like units.
   300 mcg = 0.3 mg
3) **Calculate** mL/hr
   8mg : 250 ml = 0.3 mg: X mL
   X= 9.4 or 9 ml/hr
4) **Calculate** the flow rate in gtts/min.
   9 ml/1= 9 gtts min
   So set the flow rate to **9 gtts/min.**

Intuitively, there are 8 mg or 8000 mcg in 250 ml of fluid. So that give 32 mcg/ml. The order is for 5 mcg/ min. There are 60 microdrops/cc. so there are 0.533 mcg/drop, and we have to divide the 5 mcg by 0.533= 9.38 gtts/min. This is harder intuitively than with the above method.

Exercise 3 CC

Calculate the following flow rates.

1) For a patient experiencing an acute MI with symptoms of cardiogenic shock, the doctor orders an infusion of Isuprel at 3 mcg/min. Isuprel 2 mg is added to 500 ml of D5 W. Calculate the ml/hr you will set the pump to deliver.
2) Nitroglycerine 10 mcg /min is ordered to help sustain the cardiac output. The solution strength available is 25 mcg/ml. Calculate the flow rate in a gtts/min for the IVAC pump that is using a microdrip.
3) A patient with ventricular irritability has orders to get Pronestyl at 4 mg/min. The solution available contains 500 mg Pronestyl in 250 ml of D5W. Calculate the ml/hr the pump should deliver.
4) A Doxapram solution provides 20 mg/ml. Orders are to infuse at 3 mg/minute IV. The set is calibrated at 60 gtts/ml. Calculate the flow rate in gtts/min.
5) A patient with angina has orders for a continuous IV infusion of Nitrostat. The solution available has 8 mg in 250 ml of D5W. Orders are to infuse at 10 mcg. Min, Calculate the flow rate in gtts/min. using microdrip.

Tips
Always calculate dosage first and check your math.
Double check your accuracy and then calculate the flow rate.
Convert to like units.
Give these meds on a pump.
Ratio and proportion is the safest way to calculate these problems. Some of you may do this intuitively if you have a numeracy sense. Still Check Your Work.

Critical Care answers

Exercise 1

1) 0.16 mg/hr 160mcg/hr; 2.7 mcg/min
2) 15 mg/hr; 0.25 mg/min; 250 mcg/min
3) Yes; 4 mg/min
4) 600 mcg/hr 10 mcg/min
5) 500 mg/hr; 8 mg/min
6) 25 mg/hr; 0.42 mg/min; 420 mcg/min
7) 0.8 mg/min; 48 mg/hr
8) 0.015 u/min; 0.9 u hr
9) 100 mg/hr
10) 16.7 mg/min

Exercise 2

1) 330 mcg/min; 20 mg/hr
2) 1150 mcg; 192 mcg/hr
3) 93 mg; 23.3 mg/h
4) 155 mcg/min; 9.3 mg/hr
5) 1750 mcg/min; 105 mg/hr

Exercise 3

1) 45 ml/hr
2) 24 gtts/min
3) 120 ml/hr
4) 9 gtts/min
5) 19 gtts/min.

Exercise 4

1) 108 ml/hr
2) 31 ml/hr
3) 75 mg/hr
4) 16 mg/hr
5) 0.8 u/hr
6) 1.5 mg/min; 90 mg/hr
7) 16 ml/hr
8) 150 ml/hr
9) 60 gtts/min
10) 345 mg; 83 mL hr; 115 mg/hr
11) 36 mg/hr. 600 mcg/min
12) 27 mg; 63 ml/hr
13) 75 mg/hr
14) 12 gtts/min
15) 20 mg/h; 333 mcg/min