No Infusion Pump? You Can Calculate IV Drip Rates Accurately

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How to Take This Course

Please take a look at the steps below; these will help you to progress through the course material, complete the course examination and receive your certificate of completion.

1. **REVIEW THE OBJECTIVES**

   The objectives provide an overview of the entire course and identify what information will be focused on. Objectives are stated in terms of what you, the learner, will know or be able to do upon successful completion of the course. They let you know what you should expect to learn by taking a particular course and can help focus your study.

2. **STUDY EACH SECTION IN ORDER**

   Keep your learning "programmed" by reviewing the materials in order. This will help you understand the sections that follow.

3. **COMPLETE THE COURSE EXAM**

   After studying the course, click on the "Course Exam" option located on the course navigation toolbar. Answer each question by clicking on the button corresponding to the correct answer. All questions must be answered before the test can be graded; there is only one correct answer per question. You may refer back to the course material by minimizing the course exam window.

4. **GRADE THE TEST**

   Next, click on "Submit Test." You will know immediately whether you passed or failed. If you do not successfully complete the exam on the first attempt, you may take the exam again. If you do not pass the exam on your second attempt, you will need to purchase the course again.

5. **FILL OUT THE EVALUATION FORM**

   Upon passing the course exam you will be prompted to complete a course evaluation. You will have access to the certificate of completion **after you complete the evaluation**. At this point, you should print the certificate and keep it for your records.

Introduction

Many medications are delivered intravenously (IV). Like all other medication administration procedures the "Five Rights" are essential – Right Patient, Right Medication, Right Dose, Right Time, Right Route. IV fluids with or without additives are medications. And it is essential that the correct patient receives the correct medication, in the correct amount, at the correct times when infusing IV solutions

Many nurses today work in facilities where electronic devices automatically calculate drip rate factors and deliver the amount of fluid/medication needed as scheduled. The nurse uses the device's built in computer and enters an amount of fluid and the time it is to run and the infusion machine calculates the rate of infusion. The nurses generally rely on the machines and never calculate a drip rate themselves. They believe the days of "counting drops" are long gone – they may even have forgotten how to calculate and measure intravenous drug dosages.

O'Brien (2001) urges nurses to demand adequate support and technology such as infusion pumps with built in software at the point of interaction with the nurse. She suggests that use of such equipment can reduce medication errors. It should also be noted that one of the 2004 Patient Safety Goals identified by the Joint commission on Accreditation of Healthcare Organizations (JCAHO, 2004) is to improve the safety of using infusion pumps and ensure free-flow protection on all general-use and patient controlled analgesia (PCA) intravenous infusion pumps used in an organization.

It is important to remember that even in facilities where the use of electronic devices is standard, the nurse is not absolved of the responsibility of administering medications correctly and must be knowledgeable and competent in the calculation of doses and IV flow rates.

What if there suddenly are not enough pumps to go around? What if the pump breaks and there is no replacement available? What if you change jobs and infusion pumps aren't used in the new place? If this happens there may not be time to look up a formula. It's never enough to rely on electronic devices; nurses must be prepared to administer IV solutions accurately with or without a pump. The ability to calculate accurate administration rates is essential. Errors that occur in IV medication/solution administration have the potential to be more deadly even more quickly than other medication errors. Ignorance is not an acceptable excuse or defense.

In an article in *Nursing 97* (1997), the author tells of her experience as a new nurse who "felt nervous about calculating an IV drip rate". Rather than calculate the drip rate she consulted the pharmacist who calculated for her. When she returned to work the next day an incident report had been filed because the patient had received half the required dose of dopamine. There is no acceptable defense for this and the author learned that there is also no substitute for doing one's own drug calculations and double checking them. Even if IV solutions come from the pharmacy with labeled directions for flow rates, the nurse administering the solution, as the individual responsible for the administration, must do the calculation and verify that it is correct before hanging.

This course covers basic principles of administration of IV fluids and calculation of IV drip rates. Mathematical calculations will be demonstrated and opportunities for self assessment included.

Objectives

After studying this self study module the learner should be able to:

- Describe general principles for the administration of intravenous therapy.
- Discuss the use of infusion devices for intravenous therapy.
- Calculate drip rates for IV infusions correctly.
- Explain the nurse's responsibility during administration of fluids.

About the Author

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Overview

There are many times patients will need fluids and/or medication administered intravenously (IV). IV therapy is initiated to replace fluids, for fluid and electrolyte balance, to administer medications, to administer blood or blood products, to keep a vein open (KVO) and ready for use, to administer diagnostic agents, to administer anesthesia, and for hemodynamic monitoring. In order to initiate and maintain IV therapy the registered nurse must understand basic principles of intravenous therapy, must know the legally authorized scope of practice for registered nurses, and must know how to accurately use infusion devices and how to calculate and set a flow rate.

This course covers basic principles of administration of IV fluids and calculation of IV drip rates and provides resources for information about the scope of practice of registered professional nurses. The primary focus will be on calculating flow rates accurately if/when an electronic pump is not available. Mathematical calculations will be demonstrated and opportunities for self assessment included.

RN Scope of Practice and Administration of Intravenous Medications

It is within the scope of practice of registered nurses in New York state to initiate and monitor administration of intravenous fluids and medication. Licensed practical nurses (LPNs) may also administer medications intravenously if they meet qualifications as identified by the New York State Education Department (NYSED), www.nysed.gov.

Answers to questions about the scope of practice, education, and updates required are available from the board for nursing. The New York State Education Department website, www.nysed.gov contains valuable information and telephone numbers for nurses in New York. For persons outside of New York state the applicable state board of nursing may be accessed on the web site of the National Council of State Boards of Nursing (NCSBN), http://www.ncsbn.org/.

The Infusion Nurses Society, http://www.ins1.org/, is a good resource for infusion therapy policies and procedures. They publish standards of practice for infusion therapy.

The NYSED Practice Alert regarding Practice of IV Therapy by LPNs can be found on the NYSNA website in the Nursing Advocacy and Information Program section, http://www.nysna.org/programs/nai/practice/alerts/alerts.htm.

Definitions

Aseptic Technique – using techniques that maintain sterility of sterile items and avoids introduction of pathogens into an environment or body.

Intravenous Therapy – the administration of fluids or medications directly into a vein. IV is a commonly used abbreviation.

Infusion Pump – an electronic device that delivers intravenous fluid under pressure and controls the rate of administration of fluid into the vein.

Nonvolumetric Pump – an electronic infusion device that delivers a certain number of gtts per minute.

Volumetric Pump – an electronic infusion device that delivers fluid in milliliters (ml) or cubic centimeters (ml) per hour.

Macro Drip IV Set – An intravenous tubing set that delivers 15 drops per ml. (Note: Some manufacturers may label their 10 or 20 drop sets as macrodrip.)

Micro Drip or Mini-Drip IV Set – An intravenous tubing set that delivers 60 drops per ml.

Infiltration – a complication of IV therapy in which the needle becomes dislodged or pierces the wall of the vein and the fluid collects under the skin.

Extravasation – a complication of IV therapy in which the fluid being administered seeps from the vein into the surrounding tissue.

Pyrogenic Reactions – an infectious response during IV therapy. Fever and chills are often present.

Abbreviations

Abbreviation	**Meaning**
IV	intravenously
ml	milliliter
gtts	drops
mEq	milliequivalent
u or U	units
KVO	keep vein open

JCAHO 2004 Patient Safety Guidelines also included a list of abbreviations that should never be used. This information is available on the JCAHO website, www.jointcommission.org/. JCAHO compliance standards require that accredited organizations implement systems to communicate the “do not use” list to staff members and adherence is assessed during accreditation visits.

Indications for Intravenous Therapy

The intravenous route of administration is used when immediate pharmacological treatment is needed. IV therapy is used to add fluid volume, to replace lost fluids, to maintain homeostasis, to replace blood, and to keep a vein open so that it is available immediately if needed. There are different kinds of fluids that can be administered and there are specific uses of each type fluid – isotonic, hypotonic, or hypertonic. The prescribing provider should specify the kind of fluid, the amount, and the amount of time it will take to administer it.

When rapid onset of action is needed, medications are administered intravenously – either as a bolus or as an additive to intravenous fluids. Medications can be administered intermittently or continuously. Again, specific patient related orders are required.

IV fluids and intravenous administration of electrolytes are used to restore or maintain fluid and electrolyte balance. Maintenance of nutritional status and monitoring of hemodynamic functions can also be accomplished with IV therapy.

Other indications for IV administration are not so frequently used by registered nurses. They include administration of radiologic diagnostic agents and administration of intravenous anesthesia.

It is imperative that the nurse understand the indications for IV therapy, the potential for quick action, and the sometimes irreversible consequences of intravenous injections. There must be a thorough understanding of fluids and medications used as well as of the legal scope of practice for nurses.

Infusion Pumps

Although the purpose of this course is to assure accurate calculation of IV drip rates when a pump is not used, most nurses will usually administer IV fluids via an electronic pump. For this reason a brief overview of the use of infusion pumps is included here. There are a number of things to know and keep in mind.

Most facilities now use electronic infusion devices to maintain intravenous therapy. These devices, or “pumps” are used because they maintain a more accurate flow than is possible with the IV set clamps and gravity flow.

JCAHO Patient Safety Goal #5 requires the use of free-flow protection infusion sets. As of January 1, 2004 intrinsic or built-in protections are required for infusion devices. The use of add-on devices such as anti-siphon sets supplied by pump manufacturers was approved by the JCAHO as an interim measure in 2003, pending availability of administration sets with the built-in free-flow protection equipment. It has been determined that the majority of pump manufacturers are now providing intrinsic free-flow protection (JCAHO, 2004.) A careful review of the instructions provided with infusion pumps and administration sets is an essential first step in the administration of IV fluids. Short cuts here can lead to errors!

JCAHO Patient Safety Frequently Asked Questions (FAQs) about the National Patient Safety Goals identifies the following procedure for determining whether an infusion pump has free-flow protection: “turn the power off with the infusion set primed and loaded in the device. With all tubing clamps open and the fluid container as high above the device as the tubing will allow, verify that no fluid flows out of the set as it hangs straight down from the device. Then remove the set from the device (tubing clamps still open) and again verify that no fluid flows out of the set”. This information was based on the ECRI’s Health Devices Inspection and Preventive Maintenance System , 5/30/03.

Nonvolumetric pumps are designed to administer a set number of drops per minute. Volumetric pumps are designed to deliver a set amount of fluid in a set amount of time. Volumetric pumps are the most common (Reiss and Evans, 1996).

Air should be flushed out of IV tubing before connecting because the danger of air embolism is greater since the fluid is being infused under pressure.

Controllers monitor the preset rate of administration and an alarm goes off if the rate falls below or exceeds the rate set. This beeping alarm is a signal for the nurse to assess the situation and initiate corrective action. Goal #6 of the JCAHO 2004 Patient Safety Guidelines requires preventive maintenance and testing of alarm systems (JCAHO, 2004.)

Alarms should not be turned off. A beeping alarm should be attended to and fixed immediately. Some machines stop the infusion if the alarm signals and this can lead to clogged lines and unnecessary sticks.

Patients and family members should be given explanations about the alarm and what to do if it signals. It should be emphasized that the machine is not to be turned off.

The flow rate should be checked and verified periodically. This is a responsibility that directly affects the effectiveness of therapy, prevents complications, and cannot be ignored. A number of studies have shown that approximately 50% of the nurses in each study did not monitor flow rates (Karadag and Gorgulu, 2000). Some facilities have policies that require hourly IV rounds/monitoring (*Nursing 95*, 1995). The use of a pump and the absence of an alarm does not guarantee continued, correct infusion. The pump will continue even if there is infiltration, pain, infection, etc. and there is no substitute for nursing observation and assessment.

If multiple IV lines are in place, the pumps and the IV lines should be labeled clearly (*Nursing 96*, 1996).

Documentation responsibilities and patient education requirements are the same whether pumps are used or not.

General Principles of IV Administration

There are a number of general principles to remember when administering IV fluids and medications. Each of the following principles must be adhered to whenever administering IV therapy. Learn and practice them until they are a part of everyday nursing practice.

1. Know your agency's policies and procedures and follow them.

   While every facility may have policies and procedures that address the same principles and methods there are subtle differences and you are responsible for following the procedure in your agency – it doesn't matter if your last employer had a procedure you liked better.

2. Be sure you have been properly educated on equipment and devices to be used.

   It is the responsibility of the agency to provide in-service education and orientation so that employees know about the equipment in use, but that doesn't mean that the individual nurse has no responsibility. You should never operate unfamiliar equipment and it is the professional's responsibility to maintain competency and to speak out and seek education if needed.

3. Use strict aseptic technique.

   When starting intravenous infusions, aseptic technique should be used in opening and handling equipment. Sterility of needles, cannulas, etc. must be maintained.

4. Incorporate use of standard isolation precautions in all procedures. These procedures can be found on the Centers for Disease Control website at http://www.cdc.gov/ncidod/dhqp/gl_isolation.html.

   The Centers for Disease Control have identified standard isolation precautions that should be used at all times for all patients. The precautions, formerly known as "Universal Precautions" essentially treat all body substance fluids as potentially infectious. The type and use of protective equipment is based on the potential for exposure. For phlebotomy or starting IV infusions, gloves are used to prevent contamination with blood.

5. Fluids that are cloudy or have visible precipitate should not be used

   Solutions should always be examined closely. Any unusual color, odor, cloudiness, etc should be questioned. The pharmacist is a good source of information. Never administer a questionable solution. The expiration date on the fluid container should be checked and outdated fluids cannot be given.

6. Select the appropriate equipment.

   Equipment changes continuously and the manufacturer's instructions should be made available for all equipment. If specific equipment is recommended for specific infusion pumps, it should be used. Equipment considerations include selection of needles and catheters, choice of needle gauge and use of appropriate administration set.

   <u>Needles and Catheters</u>

   Needles come in various styles – steel needles, over the needle catheter, and inside the needle catheters. The catheters are flexible and more comfortable for patients as well as safer. Generally over-the-needle catheters and cannulas are used for long-term therapy and for children.

Needleless devices are now mandated and should be used in order to prevent needlestick injuries. The Occupational and Safety Health Administration (OSHA) is now imposing monetary fines in institutions where needleless devices are not being used routinely.

There is much information available on the prevention of needlestick injuries - one of the most common means of transmission of bloodborne pathogens. Visit the OSHA (www.osha.gov) and CDC (www.cdc.gov) web sites or preview the New York State Nurses Association 's online course Prevention of Needlestick Injuries (http://web2.sedonamg.com/nysna/).

Needle gauge

Needles and catheters are produced in standard sizes or gauges – 16 gauge, 18 gauge, 20 gauge, 22 gauge, and 25 gauge. The larger the gauge, the smaller the diameter of the needle. Larger gauge needles are used to administer more fluid more quickly; smaller gauge needles administer fluid more slowly. The gauge of the needle is determined by the type and viscosity of the fluid/medication to be administered and the vein to be used. The smallest possible gauge needle should be used. Typically, an 18 or 20 gauge needle is used to administer IV fluids.

IV Administration sets

IV administration sets generally come in two basic sizes, macrodrip and microdrip. Information is printed on the wrapping of each administration set that identifies the number of drops per ml that flow into the drip chamber.

Macrodrip sets will provide 10-15 drops per ml. These sets are routinely used for IV fluids and are good for rapid delivery of fluids.

Microdrip sets provide 60 drops per ml. Microdrip sets are good for administering medication in IV fluids and are used for pediatric IV fluid administration.

7. Equipment should be maintained in good working order and properly cleaned. Disposable equipment should not be reused.

8. Fluids must be clearly labeled.

   It is the responsibility of the nurse starting an IV or adding fluids to be sure that there is labeling that provides complete documentation and informs other workers what medication is administered, the timing, and who initiated the procedure. The name of the patient on the solution container also assures that the “right medication” is given to the “right patient.” Some labeling is done by the manufacturer, some by the pharmacy, and some must be done by the nurse. Regardless of who does what, the following documentation must be on the IV solution container.

   a. Name of solution and additives
   b. Patient’s identification data
   c. Date and time started
   d. Infusion rate
   e. Initials of the nurse

9. Patients must be monitored carefully during IV infusion for response and possible side effects or complications related to the medication or the procedure.

   It is essential that nursing observation and assessment continue throughout the infusion period and post treatment, also. There is no substitute for nursing judgment. Complications that can occur and must be recognized early include:

   - Infiltration
   - Extravasation
   - Thrombophlebitis
   - Pain
   - Pyrogenic reactions
   - Allergic reactions
   - Tissue necrosis
   - Electrolyte imbalance
   - Fluid overload

10. Documentation of the type and amount of IV fluids and medications administered and the patient's reaction is essential.

    The name of the solution and additives, the rate of infusion, and the patient's response to the infusion must be documented in the patient's record. Whether electronic or handwritten charting is used, this information must be documented. Remember, "If it's not charted, it's not done." This is a good time to remember, too that the patient's response to the therapy and any untoward effects must be documented promptly and accurately – but not **before** fluid is administered. This documentation provides not only direction to other staff; it can provide valuable protection in the event of any legal action.

11. Patient education must be provided, must be thorough, and must be documented.

    Both the nature of the medication used and the equipment need to be thoroughly explained to the patient. Patient education also provides an opportunity to relieve anxiety associated with the intravenous stick, the infusion of the solution, the equipment used and to teach the side effects or reactions to report. The education must be documented in the patient record.

12. Know your mathematics and the formula for calculating flow rates of intravenous solutions. Practice problems are in all nursing pharmacology textbooks and drug reference books. Periodic refreshers are good for everyone and reinforce earlier learning. When you are sure you're proficient with basic math, practice IV drip rate problems – again they are in the textbooks and drug references. Have a colleague check your calculations, check his or hers. It's useful to use the same formula for all drip rate calculations – use it even when you "can do it in your head." This will reinforce your understanding and help develop good practice habits.

Mathematics – Keep it Simple

Because mathematical errors are often the cause of medication errors it is good to talk about some basic math before getting into calculation of IV drip rates. This review will focus on ways to simplify the math and lessen the chance for error.

Dealing With Decimals

1. Never lead with a decimal point. Always put a zero in front.

Correct	0.3	or	0.35	or	0.3456
Incorrect	.3	or	.35	or	.3456

2. When adding or subtracting numbers with decimals, be sure to line up the decimal points **FIRST**

Correct	436.67	**Incorrect**	436.67
	+ 43.97		+ 43.97
	480.64		876.37

There is a **big difference** in these responses. In calculating a medication dosage this miscalculation can be deadly.

Try this: 4.245 + 235.89

Is the answer
a. 240.
b. 278.34135
c. 2401.35
d. 0. 66039

Did you answer *a*? If not, line up decimals and try again.

3. When multiplying decimals,

Do the multiplication.

Count the total number of places after the decimals (to the right of the decimal point) in both numbers.

Place the decimal point that total number of places to the left of the answer. Add zeros if necessary.

Here's how that works: 0.2 X 0.75
Do the multiplication – 2 X 75 = 150
Count the number of places after the decimals – total of 3
Place decimal 3 places to left – 0.150 or 0.15

54.36	X	34.163 =	185710068 =	1, 857.10068	(total of 5 numbers after decimal)
3.2	X	1.5 =	480 =	4.80	(total of 2 numbers after decimal)
3.2	X	15 =	48.0 =	48.0	(only 1 number after decimal)
.32	X	.15 =	480 =	0.0480	(total of 4 numbers after decimal)

Again, there is a **big difference** and the error can be deadly.

Again, there is a **big difference** and the error can be deadly.

Try this: 4.245 X 235.89

Is the answer

a. 100.13530
b. 1,001.35305
c 1,000,353.05
d. 100,135.205

Did you answer *b*? If not, multiply the two numbers, then count the total number of numbers to the right of the decimal point and put the decimal point in the answer that same number of places to the left.

Hint *- the decimal is three places to the right in the first number and two places to the right in the second for a total of five places to the left in the answer.*

Dealing with Fractions

1. A fraction (ex. ½) is expressed in terms of a numerator and a denominator. These represent a portion of a whole number and for purposes of this review can be remembered simply as the number on top (numerator) and the number at the bottom (denominator) in the fraction.

   A. Numerator

   In the fraction 2/4, the numerator is 2.
   In the fraction 16/98, the numerator is 16.

   B. Denominator

   In the fraction 2/4 the denominator is 4.
   In the fraction 16/98, the denominator is 98.

   Try this:

   In the fraction 23/89 the numerator is_____ the denominator is _____.

   Did you answer 23 for numerator and 89 for denominator?

   In the fraction 7/10 the denominator is _____ the numerator is_______.

   Did you answer 10 for denominator and 7 for the numerator?

2. Reduce a fraction to the lowest common denominator. To reduce the numbers using common denominators the largest number that can be divided into both the numerator and denominator is divided into both numbers.

2/4 =	1/2	both the numerator and denominator are divided by 2
6/8 =	3/4	both the numerator and denominator are divided by 2
15/25 =	1/5	both the numerator and denominator are divided by 5
480/60 =	8/1	both the numerator and denominator are divided by 60

   Reduce these fractions to the lowest common denominator:

   27/45, 9/18, 45/63

   Are the answers 3/5, 1/2, and 5/7? If not go back and divide every number by 9.

3. If fractions have zeros at the end of the numerator and the denominator cross off the same number of zeros in each.

20/40 =	2/4	One zero is removed from the end of 20 and 40.
6700/32000 =	67/320	Two zeros are removed from the end of 6700 and 32000.
30/1000 =	3/100	One zero is removed at the end of 30 and 1000.

Reduce these numbers:

50/100, 60/4,500, 3,800/245,000

Are the answers 5/10, 6/450, and 38/2,450? If not go back and remove equal number of zeros in each fraction (1 in the first two examples and 2 in the third).

4. To multiply fractions multiply the numerators, then multiply the denominators, and then divide the numerator by the denominator.

$$\frac{2}{5} \times \frac{7}{9} = \frac{14}{45} =$$ 14 ÷ 45 or 0.3 or approximately 1/3

$$\frac{12}{20} \times \frac{4}{5} = \frac{48}{100} =$$ 48 ÷ 100 = 0.48 or approximately 1/2

Try this multiplication problem:

$$\frac{3}{5} \times \frac{1}{3}$$

Is the answer
a. 15/3
b. 8/3
c. 9/5
d. 3/15

Was the answer *d*? If not, go back and multiply the top numbers and put the answer 3 on the top and then multiply the bottom numbers and put that answer 15 on the bottom of the new fraction – the answer 3/15

5. It is important to review the work and verify the answer at least twice.

6. It should also make sense, so an answer that seems logically incorrect probably is incorrect.

Calculating IV Drug Dosage Administration

In an ideal world each order for an IV infusion would specify the drug dose, the type and amount of fluid, and the number of drops to be infused each minute. What really happens is that orders specify a medication dose or the amount of drug or fluid to be administered in a given time period. The nurse using a nonvolumetric pump or gravity drip (IV pole) will calculate the correct volume of fluid in ml or ml's to be administered in a specified time allotment. He or she will then select the appropriate equipment and calculate the number of drops of solution to be delivered each minute based on the equipment used.

There are several steps that must be followed for all IV infusion calculations. Although some are basically a 1:1 ratio or division, all steps should be used to insure accuracy and reduce the potential for mathematical errors or careless mistakes.

<u>Step 1</u>

Check the medical order to determine the dose of drug and/or amount of fluid to be delivered and the amount of time the delivery is to take.

<u>Step 2</u>

Select the IV administration set to be used and determine the drop factor.

IV sets have different size openings in the drip chambers.
The size of the openings determines the size of the drops of fluid.
The size of the drops determines the number of drops in a ml.
Packaging is always clearly labeled with the number of drops per milliliter or ml.
IV sets come in 10, 15, 20, and 60 drops per ml.
Never use a set if you do not see the drop factor labeled on the package.

<u>Step 3</u>

Calculate the number of drops of the solution to be given per minute

If the order is for an identified amount of solution or drug over a specified time frame and the set to be used has been selected the following formula can be used:

The amount of fluid to be given divided by the time in minutes the solution is scheduled to run and multiplied by the drip factor of the set being used = drops per minute.

↓

Amount of fluid to be given ÷ time in minutes the solution is to run X drip factor of IV set to be used = drops per minute

↓

$$\frac{\text{Amount of fluid}}{\text{Time in minutes}} \times \text{drip factor of IV set} = \text{drops per minute}$$

<u>For example:</u>

If the order is for 1000 ml of D5W to be given over 8 hours with a 15 drop set

$$\frac{\text{1000ml (the amount of fluid ordered}}{\text{480 (8 hours x 60 minutes)}} \text{ X 15 (drip factor of IV set)} = \frac{15{,}000}{480}$$

↓

$$\frac{15{,}000}{480} = \text{31.24 or 31gtts/minute}$$

If the order is for 1000ml of D5W to be given over 8 hours with a 60 drop set

$$\frac{\text{1000 ml (the amount of fluid ordered)}}{\text{480 (8 hours x 60 minutes)}} \text{ X 60 (drip factor of IV set)} = \frac{60{,}000}{480} \text{ gtts}$$

$$\downarrow$$

$$\frac{60{,}000}{480} = \text{125 gtts/minute}$$

Checking/Rechecking Answers

In order to minimize medication errors by using a consistent approach to calculation of IV doses and reducing the number of mathematical steps involved, nurses are encouraged to follow the steps outlined above.

Many nurses learned to do IV calculation problems in a way that reduces the time so that it is always 60 minutes. To do that it is necessary to determine the amount of fluid to be given in each 60 minute period. In that case divide the amount of fluid needed by the number of hours and derive the amount of fluid to be delivered in 60 minutes, and then multiply by the drop factor of the set to be used.

The following information is provided as a review for nurses and as a method of verifying answers.

For example:

1000 ml D5W ordered for 8 hours using 15 drop set

1000 ml ÷ 8 hours = 125 ml to be given in 1 hour or 60 minutes

$$\frac{125 \text{ ml}}{60 \text{ minutes}} \quad X \quad 15 \text{ drop set} = \frac{1875}{60} = 31.25 = 31 \text{ gtts/minute}$$

1000ml D5W ordered for 8 hours using a 60 drop set

1000 ml ÷ 8 hours = 125 ml to be given in 1 hour or 60 minutes

$$\frac{125 \text{ ml}}{60 \text{ minutes}} \quad X \quad 60 \text{ drop set} = \frac{7500}{60} = 125 \text{ gtts/minute}$$

500 ml of Ringer's Lactate to be given in 4 hours using a 20 drop set

500 ml ÷ 4 hours = 125 ml to be given in 1 hour or 60 minutes

$$\frac{125 \text{ ml}}{60 \text{ minutes}} \quad X \quad 20 \text{ drop set} = \frac{2500}{60} = 41.66 = 42 \text{ gtts/minute}$$

1000 ml Normal Saline to be given in 12 hours using 15 drop set

1000 ml ÷ 12 = 83.33 ml per hour

$$\frac{83 \text{ ml}}{60 \text{ minutes}} \quad X \quad 15 \text{ drop set} = \frac{1245}{60} = 21 \text{ gtts/minute}$$

Now you can see that it doesn't matter what volume is ordered, how long it is to run, or the drop factor of the IV set, the mathematical calculations follow exactly the same steps. If you use these steps for all calculations you will calculate the correct number of drops for each minute and administer the correct amount/dosage.

What to Do if You Don't Know the Amount of Fluid Needed?

Drug dosage calculations may need to be done before you begin to calculate the IV drip rate. Take time to read all orders very carefully. If the order specifies a drug dosage and the solution available specifies the dose of medication per a designated volume of solution, it will be necessary to set up a proportion and calculate the desired amount of fluid before calculating the drip rate. Although the problems may appear to be complex they are very manageable if broken into steps.

Study these examples:

The order reads: Give Heparin 5000 units over 60 minutes. The IV solution contains 5000 units of Heparin in 100 ml D5W.

First, decide how many ml's of fluid are needed to provide the ordered 5000 units by setting up a proportion. If there are 5000 units in 100 ml's of fluid how many ml's will be needed to administer 5000 units.

Set up a proportion	5,000 units is to 100 ml's as 5,000 units is to x ml's
	↓
Multiply the two outer numbers	5,000 X x (outer) = 5,000x
Multiply the two inner numbers	100 X 5,000 (inner) = 500,000
	↓
State the ratio	5,000 x = 500,000
	↓
Do the division	500,000 ÷5000 = 100 ml
	↓

The amount of fluid needed to provide 5,000 units of Heparin is 100 ml.

You can then proceed to calculate the IV drip rate for 100 ml/hour based on the equipment to be used.

With a **60 drop micro drip set** - $\frac{100 \text{ ml}}{60 \text{ minutes}}$ X 60 gtts/ml = 100gtts/minute

or

With a **15 drop set** - $\frac{100 \text{ ml}}{60 \text{ minutes}}$ X 15 gtts/ml = 25 gtts/minute

The order reads: Humulin R 2 units per hour. The IV solution contains 20 units Humulin R in 1000ml D1/2 NS.

20 units is to 1,000 ml's as 2 units is to x ml's

20X x (outer) = 20X
↓
1,000 X 2 (inner) = 2,000
↓
20 x = 2,000
↓
x = 100 ml's

Using a 60 drop/ml set the calculation that proceeds as before:

$$\frac{100\text{ml}}{60\text{ minutes}} \times 60\text{gtts/ml} = 100\text{gtts/minute}$$

It is important to point out that there are times when the order or problem may appear complex and a closer examination will reveal that the amount is already stated.

For example,

The order reads 1 liter of D5W with Aminophylline 500 mgm at 140ml/hour.

Note that in this example the amount of fluid to be infused is already given. There is no need to calculate how many mgm of Aminophylline is in a ml. Proceed to calculate the amount of solution to be given over the specified time using the drip factor of the equipment being used.

Using a 60 drop micro drip set $\frac{140\text{ ml}}{60\text{ minutes}} \times 60\text{ gtts/ml} = 140\text{ gtts/minute}$

Test Yourself

Try the following problems. Write down your calculations so that you can figure out what you did right or wrong. Try the following problems. Write down your calculations so that you can figure out what you did right - or wrong. After you have finished answering all the problems, go to the next page to view the correct answers.

1. Give 1 liter of NS IV in 5 hours. The IV set is a regular 15 drop set.
2. Give 1 unit (250 ml's) of packed red cells IV within 4 hours. The blood set delivers 10 gtts/ml.
3. Give 1000 ml D5W to keep vein open over the next 24 hours. The set to be used delivers 60 drops/ml.
4. Give 150 ml of Normal Saline over 4 hours. The micro drip set delivers 60 gtts/ml.
5. Give 4000 ml of D5W over 24 hours. The IV set package reads 20gtts/ml.
6. Give 3000 ml of D1/2 NS over 16 hours. The macro drip set delivers 15 gtts/ml.
7. Give 3000 ml of D5W over 24 hours. The IV set delivers 15 gtts/ml.
8. Give 100 ml of Ringer's Lactate in 1 hour. The micro drip set delivers 60gtt/ml.

Test Yourself Answers

Below are the answers to the problems on the previous page.

1. Give 1 liter of NS IV in 5 hours. The IV set is a regular 15 drop set.

   $\frac{1000\text{ ml}}{300\text{ minutes}}$ X 15 gtts/ml = **50 gtts/minute**

2. Give 1 unit (250 ml's) of packed red cells IV within 4 hours. The blood set delivers 10 gtts/ml.

   $\frac{250\text{ ml}}{240\text{ minutes}}$ X 10 gtts/ml = 10.41 gtts or **10 gtts/minute** (the fraction is not rounded up)

3. Give 1000 ml D5W to keep vein open over the next 24 hours. The set to be used delivers 60 drops/ml.

   $\frac{1000\text{ ml}}{1440\text{ minutes}}$ X 60 gtts/ml = 41.66 gtts or **42 gtts/minute** (the fraction is rounded up)

4. Give 150 ml of Normal Saline over 4 hours. The micro drip set delivers 60 gtts/ml.

   $\frac{150\text{ ml}}{240\text{ minutes}}$ X 37.5 gtts/ml = **38 gtts/minute** (the fraction is rounded up)

5. Give 4000 ml of D5W over 24 hours. The IV set package reads 20gtts/ml.

   $\frac{4000\text{ ml}}{1440\text{ minutes}}$ X 20 gtts/ml = 55.55 gtts or **56 gtts/minute** (the fraction is rounded up)

6. Give 3000 ml of D1/2 NS over 16 hours. The macro drip set delivers 15 gtts/ml.

   $\frac{3000\text{ ml}}{960\text{minutes}}$ X 15 gtts/ml = 46.87 gtts or **47gtts/minute** (the fraction is rounded up)

7. Give 3000 ml of D5W over 24 hours. The IV set delivers 15 gtts/ml.

   $\frac{3000\text{ ml}}{1440\text{minutes}}$ X 15 gtts/ml = 31.24 gtts or **31gtts/minute** (the fraction is not rounded up)

8. Give 100 ml of Ringer's Lactate in 1 hour. The micro drip set delivers 60gtt/ml.

   X 60 drops = $\frac{100\text{ml}}{60\text{minutes}}$ X 60 gtts/ml = **100gtts/minute**

These examples are pretty simple to calculate, as easy as **A B C**.

A. As you see, the amount of fluid is always stated as the amount ordered. There is no need to calculate or change anything.

B. The time the solution is to run is calculated each time and the number of hours it is to run is multiplied by 60 – the number of minutes in one hour.

C. The number of drops per ml is stated in each problem in the type of IV set used – again – nothing to calculate or change.

Did you get the answers right? If not, go back and redo the problems. Compare your work the first time with the second time and with the explanations.

The most important thing, however is to learn a formula and **<u>always</u>** calculate the problem with the same steps. Learn the formula and plug in the facts as given in the medication order.

More Complicated Problems

Try the following problems. They are a little more complicated. You have to first calculate the amount of fluid needed to administer the correct dose of the medication. Check the answers and the math on the next page.

1. Give Heparin 500 units IV per hour. The IV solution contains 20,000 units per 1000 ml D5W. A micro drip set is to be used (60 gtts/ml).

2. Give 1,000,000 units of Ampicillin IV in 2 hours. The drug comes from the pharmacy with 5,000,000 units in 1000ml D5W. A 15 drop IV set is to be used.

3. Give 40 mEq of potassium chloride IV over 8 hours. The solution available contains 80 mEq in 1000 ml of D5W. The IV set delivers 10 gtts/ml.

More Complicated Problems Answers

Below are the answer to the problems on the previous page.

1. Give Heparin 500 units IV per hour. The IV solution contains 20,000 units per 1000 ml D5W. A micro drip set is to be used (60 gtts/ml).

   A. First - determine how much solution to give per hour by setting up a proportion

   If $\frac{20{,}000 \text{ units}}{1{,}000 \text{ ml}}$ Then $\frac{500 \text{ units}}{x \text{ ml}}$

   ↓

   20,000 x = 500, 000

   ↓

   500, 000 ÷20,000 = 25 ml

   B. Now – calculate the IV drip rate using the same formula as before. (Remember the IV set delivers 60 gtts/ml)

   $\frac{25 \text{ ml}}{60 \text{ minutes}}$ X 60 gtts/ml = **25 gtts/minute**

2. Give 1,000,000 units of Ampicillin IV in 2 hours. The drug comes from the pharmacy with 5,000,000 units in 1000ml D5W. A 15 drop IV set is to be used.

   A. First - determine how much solution to give per hour by setting up a proportion.

   If $\frac{5{,}000{,}000 \text{ units}}{1{,}000 \text{ ml}}$ Then $\frac{1{,}000{,}000 \text{ units}}{x \text{ ml}}$

   ↓

   5,000,000 x = 10,000,000,000

   ↓

   5,000, 000 ÷10,000,000,000 = 200 ml

   B. Now – calculate the IV drip rate using the same formula as before. (A 15 gtts/ml IV set is being used.)

   $\frac{200 \text{ ml}}{120 \text{ minutes}}$ X 15 gtts/ml

   ↓

   3,000 ÷ 120 = **25 gtts/minute**

3. Give 40 mEq of potassium chloride IV over 8 hours. The solution available contains 80 mEq in 1000 ml of D5W. The IV set delivers 10 gtts/ml.

   A. First - determine how much solution to give per hour by setting up a proportion.

   If $\frac{80 \text{ MEq}}{1{,}000 \text{ ml}}$ Then $\frac{40 \text{ MEq}}{x \text{ ml}}$

   ↓

   80 x = 40,000

↓
40, 000 ÷ 80 = 500 ml

B. Now – calculate the IV drip rate using the same formula as before. (A 15 gtt/ml IV set is being used.)

$$\frac{500\ ml}{480minutes} \times 10\ gtts/ml$$

↓

5,000 ÷ 480 = 10.41 or 10 **gtts/minute**
(the fraction is not rounded up)

Conclusion

Because you can't always rely on electronic equipment or computers to be available and in working order, basic nursing competency must include the knowledge and ability to calculate IV drug doses and drip rates accurately. It can be helpful for the nurse administering intravenous solutions and medications to become familiar with one formula and use it for every drug dosage calculation problem. Because IV medications are immediately infused into the blood stream, systemic reactions can occur at once and can be very serious. Errors in mathematical computations can be life threatening and it may not be possible to "stop the medication."

Steps to eliminate the math errors include always using the same method to calculate IV drip rates and checking calculations at least twice. Don't eliminate any steps and don't do it "in your head".

Any time the answer seems questionable or doesn't seem logical, ask another nurse to do the calculations and verify your results. It is important to know the usual doses so that unusual results can be questioned.

Lastly, it is important to remember that IV administration errors are medication errors that can subject a nurse to professional discipline, to charges of malpractice, and to legal actions.

Take time to read the order carefully, do the math and check your work, verify that the answer is a logical dose or quantity. There is no room for careless errors. Save your patient and your license!

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No Infusion Pump? You Can Calculate IV Drip Rates Accurately

Course Exam

*NOTE: After studying the downloaded course and completing the exam, you need to enter your exam answers ONLINE; answers cannot be answered and graded on this downloadable version of the course. To enter your answers return to NYSNA's website, www.nysna.org and click on the Online Continuing Education icon. Next, login using your username and password, follow the prompts to access the course material, and proceed to the course exam.

1. It is not necessary to perform mathematical calculations when administering IV fluids if the pharmacy prepares and labels the solution.

   a. True
   b. False

2. All of the following must be labeled on a container of fluids for IV infusion **EXCEPT**:

   a. time the solution was started
   b. name of the physician who ordered the fluids
   c. identification data of nurse who started the solution
   d. name of any medications added to solution

3. When using which of the following type pumps will the nurse have to calculate the number of drops to be delivered each minute?

   a. volumetric
   b. non volumetric

4. All of the following decimals are correctly stated EXCEPT

   a. 67.4
   b. 67.0
   c. .67
   d. 06.74

5. When multiplying fractions the answer will always be a smaller fraction than either/any of the fractions in the problem.

   a. True
   b. False

6. The order reads give 1000 ml's of D5W in 8 hours. Use a 15 drop macrodrip set. The number of drops to be administered per minute is:

   a. 250 gtts
   b. 125 gtts
   c. 31 gtts
   d. 7 gtts

7. The order reads give 200 ml's of Ringer's Lactate over 2 hours. Using a 60 gtt microdrip set how many drops will be administered per minute?

   a. 100gtts
   b. 200 gtts
   c. 25 gtts
   d. 50 gtts

8. If the IV set delivers 10 drops per ml how many drops will it take to administer one unit of packed red cells (250 ml) in 1 hour?

   a. 4 gttts
   b. 42 gtts
   c. 15 gtts
   d. 150 gtts

9. The order reads give 40 mEq Potassium Chloride IV in 12hours. The drug is available in 80mEq /1000ml of D5W. The IV tubing set delivers 60 gtts/minute. How many drops per minute will you infuse?

   a. 42 gtts/minute
   b. 85 gtts/minute
   c. 125 gtts/minute
   d. 500 gtts/minute

10. If there is an adequate supply of pumps on a unit it will not be necessary for the nurse to have to calculate drip rates.

   a. True
   b. False