IN THIS CHAPTER

- Looking at the basics of medical math and dosage calculations
- Taking a look at healthcare careers and the need for math
- Remembering the importance of compassion, empathy, and other important skills

Chapter 1

Brushing Up on Your Math Skills and Entering the Healthcare Field

If you're a healthcare professional (or planning to be one), you're in one of the most important careers around today. In essence, you help healthy people stay healthy and you help sick people get well. You also help people with critical health conditions manage their illness and maintain quality of life. Of course, nursing and all health professions involve more than just calculating and administering medications. They're vocations for *comforting* the sick and injured — clearly they involve much more than just "pushing meds."

Being a successful healthcare provider means being an able mathematician. After all, the field of medicine relies extensively on administering medications, and you must be able to calculate meds correctly before you dispense them. In any healthcare education program, medical dosage calculations come up in practically every course (or they should). In addition, many schools of nursing have an entire course devoted to medical dosage calculations.

In this chapter, we introduce you to the math you need to know to perform basic and complex medical dosage calculations. We also provide an overview of the

different careers available in the healthcare field (and show you how they all use medical math). Finally, we go beyond math and focus on the other essential components of being a good healthcare provider.

DID YOU KNOW

Florence Nightingale was a nurse with a great gift for mathematics. She was a pioneer in presenting information visually — especially health statistics. She has been recognized for developing a form of the pie chart now known as the polar area diagram.

Knowing What Math You Need to Know in Healthcare

In healthcare, you need to know the following three kinds of dosing math:

- **School math:** The math you learn to pass tests while getting an education
- **NCLEX (National Council Licensure Examination) math:** The math you learn to get your license
- **Real-world math:** The math you use to handle your job

It's true; you'll sometimes find questions on tests in school or in practicing for the NCLEX that may never come up in real life, but you still need to be prepared for those questions. Conversely, real life will surely present you with math problems that you never practiced in school. In this section, we cover the math concepts and calculation methods you need to know to be prepared for just about any scenario in healthcare.

REMEMBER

Never despair about medical dosage calculations. Each principle in this book is easy if you look at it the right way. Medical dosing math isn't harder than you think; it's actually easier!

Nailing down basic arithmetic

Nursing and related professions require basic math skills, but don't worry if math hasn't always been your favorite subject in school. The best part about medical math is that it's easy to identify just how much math you need to know.

Basic math is essentially just arithmetic — addition, subtraction, multiplication, and division. And you mostly use multiplication and division in your dosage calculations. But don't forget that *counting* is math, too. For example, when you count out 4 tablets, you're doing addition ($1+1+1+1=4$).

In case you missed some of what you need to know math-wise in school, we cover the most important principles in Chapters 2 through 4.

Fiddling with fractions in four forms

Medical dosage calculations use fractions 90 percent of the time (or 9/10 of the time or in a 9:1 ratio). In case you're wondering, all those phrases mean the same thing.

The four forms a fraction can take are:

- **Common fraction (also called a *vulgar* fraction):** $\frac{100 \text{ units}}{50 \text{ mL}}$
- **Decimal fraction:** 0.56 mL
- **Percent fraction:** 0.9% normal saline (NS)
- **Ratio:** 1:9

Of these four types, you use only two (common fractions and decimal fractions) to do most of the work in your dosage calculations.

Conquering the calculation methods

A word to the wise about the complex math used in this book*: there isn't any*. All the math used in medical dosage calculations is very simple. For example, one of the most common calculations you see in dosing problems is unit conversion. To convert units, you just have to know how to use some simple formulas, called *conversion factors,* like 1 kg (kilogram) = 2.2 lb (pounds). You use conversion factors mostly to convert mass (weight) and liquid volumes. Chapter 4 explains everything you need to know about units and conversion.

As far as figuring out drug dosage and administration, you use the following three basic calculation methods: the formula method, the ratio-proportion method, and the dimensional analysis method. Chapter 8 walks you through each method and shows you when and how to use it.

EXAMPLE

The following problem is an example of some of the math you have to do when calculating medical dosages. It uses the ratio-proportion method (see Chapter 8 for more details).

If 250 mg are in 5 mL and you need to give 333 mg, what's the dose in mL?

To find out, follow these steps:

1. **Set up the following proportion:**

$$\frac{\text{known equivalent}}{\text{known equivalent}} = \frac{\text{known equivalent}}{\text{desired equivalent}}$$

$$\frac{250\text{ mg}}{5\text{ mL}} = \frac{333\text{ mg}}{x\text{ mL}}$$

2. **Cross-multiply and solve.**

$$250x = 5 \times 333$$
$$250x = 1{,}665$$
$$x = 6.66$$

The answer is 6.66 mL. You give 6.7 mL to provide the needed 333 mg.

TIP

Calculations with multiple steps may look complex, but they aren't because the math involved in each step is fairly simple. For example, when you calculate a weight-dependent dosage that you must administer intravenously, your calculations typically follow this pattern:

- Convert the patient's weight from lb (pounds) to kg (kilograms).
- Determine the number of mg (milligrams) of the med to give for that body weight.
- Because the med is in a liquid suspension, calculate the mL that contain the number of mg you need to give.
- Because intravenous (IV) meds are often ordered to be dosed per min (minute) but are infused in mL/hr (milliliters per hour), calculate the flow rate by converting from mL/min (milliliters per minute) to mL/hr so you can program an electronic infusion pump.

MEASURING PRECISELY IS HALF THE BATTLE

After you calculate a dose accurately, you must dispense it accurately. Sometimes accurate dispensing is as simple as counting out the right number of tablets. However, many doctors' orders call for administering liquid volumes via injections and intravenous (IV) infusions. When administering liquid volumes, accurate dispensing means measuring exactly the amount of the med you need and drawing it up into the syringe.

When you give a med intravenously, you usually dispense it over time. For IV administration, you must calculate accurate IV flow rates and/or drip rates and then set them accurately (see Chapter 11 for details).

Living in a metric world

Dosing medications — whether you're working in a hospital, clinic, rehab center, or home setting — is built on the metric system. Don't start panicking — because the metric system is based on a system of tens, it's easy to learn and to use.

For a long time, medicine used an older system (once called the *English system*) with units like lb (pounds) and fl oz (fluid ounces). Medicine also used the obsolete *apothecaries' system* with units such as the grain, dram, and scruple. The United States still commonly uses its household system, which includes units like fl oz (fluid ounces) and Tbsp (tablespoons), but it does so mostly in the kitchen, not the hospital.

Because the older systems haven't disappeared completely, be aware that you sometimes have to convert units from one system to units of another. (See Chapter 4 for tons more details on units and conversion.)

Tools of the Trade for Dosing Meds

It goes without saying, so we'll say it, but accurate dosing is vital in the healthcare profession. It's a good thing the math isn't hard, because there's no room for error. After all, the practice of medicine relies primarily on medications to get healing done, so errors in dosage calculations can mean critical errors in patient health and safety.

Following are three tools of the trade that help you do medical dosing calculations accurately every time:

- **Undivided attention:** Anyone who works in healthcare knows how busy the day can get. When you're dealing with medications, especially when you're performing medical dosage calculations, your undivided attention is paramount to reducing the chance of any dosing error. Take the time to double-check your calculations. The most important mathematical tool you have is your mind.
- **Calculator:** When you're dealing with decimals, percentages, and complex calculations, you have tools that are more reliable than your fingers and a pen and paper. You need a calculator to do more complex calculations. There's one on your smartphone and there are plenty of calculators on the Internet.
- **Medication reference guides:** It's impossible to keep straight all the medications and dosages out there. So you need to use some of the many excellent reference guides available in book form, smartphone apps, and on the Internet. Use them to research medication names, dosages, possible drug interactions, and clinical applications of the drugs.

NOT MISSING THE GOOD OL' DAYS

In the olden days, when Rich (one of the authors) was in medical school, health professionals often walked around with wads of papers and small medical guides stuffed in their pockets. Lucky for you, with modern technology, using a "portable brain" has never been easier. You can download great drug reference guides and computer programs on a smartphone or other device that can help you do your dosage calculations with just a few clicks. In fact, they're far more efficient than wads of paper and pocket guides that can fall out anytime.

Most (if not all) hospitals are fully integrating information technology (IT) and becoming fully computerized. With electronic patient records, computerized drug orders, and computer-based patient charting, this is the new medical technology age.

All this new technology certainly beats walking around with wads of crumpled-up paper shoved in the pockets of your white coat!

Surveying Healthcare Careers (They All Use Medical Math!)

In this section, we introduce you to various types of healthcare professions. Each of these professions requires knowledge of medical math in one form or another.

REMEMBER

No one is an island. It's important for all healthcare providers to work as a team. Nurses, doctors, pharmacists, patients, and parents of young patients need to be on the same page. It's not unusual for a nurse or doctor to call a pharmacist for dosing assistance, especially when it comes to giving complicated medications, like those used in chemotherapy. Being on the same page and working as a team are critical to providing both optimal and safe care, with a reduced likelihood of errors.

Looking at the classic nursing careers

A career in nursing takes various forms. Some are based on your level of education, while others are based on where you do your work. No matter what initials come after your name, however, you still need to know all about medications and to be able to do dosing calculations.

Each type of nurse needs education, testing, credentialing, and usually licensing. The basic types are:

- **Registered nurse, or RN:** An RN usually has a degree (an AS, ASN, AAS, ADN, BSN) or a diploma from a hospital-based school of nursing. To be an RN, you must pass exams and be licensed. Education and other requirements vary widely, and state law regulates what you can do as an RN. RNs are the largest healthcare occupation in the United States; according to the U.S. Bureau of Labor Statistics, there are about 3.3 million registered nurses.
- **Nurse practitioner, NP, DNP:** If you're an NP, you're an RN with an advanced education. NPs are certified and licensed, but the duties permitted vary according to different states. Often, NPs do many tasks that doctors do (for example, they take histories and manage chronic conditions such as diabetes). The NP's ability to prescribe drugs varies according to state law. These days, NPs are very common in the offices of family practice providers.
- **Public health nurse, or PHN:** Public health nursing is a specialized form of nursing that combines nursing and public health principles. A PHN knows about community health, health maintenance, and disease prevention. Counties and school districts employ one or more PHNs.

- **Licensed practical nurse, or LPN:** An LPN is known as a *licensed vocational nurse* (LVN) in California and Texas. If you're an LPN/LVN, you're well-educated, you've passed exams, and you're licensed. You work under the supervision of an RN. You do many nursing tasks, but you can't do other tasks, depending on what the law and hospital policy allow. The U.S. Bureau of Labor Statistics estimates that about 650,000 people are employed as LPNs/LVNs.
- **Certified nursing assistant, or CNA:** This certification lets you assist patients with activities of daily living and give care under the supervision of an RN or an LPN/LVN. According to law and hospital policy, this care may include answering patients' call signals, observing patients' conditions, measuring and recording food and liquid intakes and outputs, taking vital signs, and reporting changes to the nursing staff. After the CNA completes a certificate training program (sometimes just one course at a community college), they are required to take and pass a state certification exam.

  In the United States, a certified nursing assistant may be called a *nursing assistant certified* (NAC), *patient care assistant* (PCA), or *state-tested nurse aid* (STNA). Generally such a person would be referred to as "unlicensed assistive personnel."

TIP

THE INTERNATIONAL COUNCIL OF NURSES' PLEDGE

In full knowledge of the obligations I am undertaking, I promise to care for the sick, with all the skills and understanding I possess, without regard to race, creed, color, politics, or social status, sparing no effort to conserve life, to alleviate suffering, and to promote health.

I will respect at all times the dignity and religious beliefs of the patients under my care, holding in confidence all personal information entrusted to me, and refraining from any action that might endanger life or health.

I will endeavor to keep my professional knowledge and skills at the highest level, and to give loyal support and cooperation to all members of the health team.

I will do my utmost to honor the international code of nursing ethics and to uphold the integrity of the professional nurse.

Probing other medical careers

In addition to nursing, several other medical careers, including the following, require an understanding of medical dosage math:

- **Physician assistant, or PA:** Like the NP, a PA is a midlevel practitioner who can work in a physician's office, hospital, or rehabilitation center. PAs are licensed and work under the supervision of a physician. California requires PAs to complete an American Academy of Physician Assistants-accredited education program and pass a national exam to get a license. PAs can prescribe medications and other medical treatments. You can bet they need to know their math!
- **Medical assistant:** A medical assistant typically works in a physician's or other health practitioner's office. You find them in the offices of virtually any specialty, from family practice and internal medicine to *cardiology,* the heart doctor, and *nephrology* (ne-*frall*-a-gee), the kidney doctor. In an office setting, they're often multitasking — recording heights and weights, taking vital signs, recording and trending blood chemistries, and reviewing patient medication dosages and frequency.
- **Pharmacist, or PharmD (Doctor of Pharmacy):** Pharmacists know pharmacology (drugs and drug action) and are also excellent mathematicians. They're responsible for filling prescription orders from doctors and other healthcare professionals. In the United Kingdom, pharmacists are called *chemists.* In a hospital setting, pharmacists use basic math, different systems of measurement, conversions, and more as they fill prescriptions and make up medications.
- **Physician, or MD (Doctor of Medicine) or DO (Doctor of Osteopathic Medicine):** When physicians, also called *doctors,* write prescriptions, they're doing basic math calculations. Some specialties require more math than others. For example, an *oncologist* (ahn-*kall*-a-gist) — a doctor who specializes in cancer — needs to do math calculations when dosing chemotherapy. The calculations are often based on the patient's *body mass index* (or BMI), a vital mathematical calculation based on height and weight. One of the authors, Rich, is an internist and nephrologist. Because nephrology relies a lot on numbers, he's always doing math.

  Doctors come in many varieties. For example, a dentist (DDS) is a Doctor of Dental Surgery. A foot doctor (DPM) is a Doctor of Podiatric Medicine.
- **Home healthcare aide, or HCA:** HCAs, also called *home health aides (HHAs),* are not nurses. They're in a special category. HCAs must complete a certificate training program and pass an examination from the National Association for Home Care. They're usually certified by the state. HCAs usually help in elder care settings and convalescent hospitals. They often assist disabled people in their homes. See the section "Offering help at home" for more details.

DID YOU KNOW

The exciting field of *biomedical engineering* combines engineering, math, and medical science. This specialty takes concepts studied in engineering and applies them to medicine. Many of the great new inventions in medicine (for example, the artificial heart, artificial hip joints, prostheses, and medical imaging) can be attributed to the wonderful work of biomedical engineers.

We also have glimpses of the future! CRISPR (gene editing) takes place at the DNA level. *Biotechnology* is a field that integrates natural sciences and engineering. You may be part of this.

Examining emergency medicine

You probably know that a hospital's emergency room (also called the *ER* or the Emergency Department) has doctors and nurses who specialize in emergency medicine. The ER may also have LPNs/LVNs working in it, depending on state law or hospital policy. But what about those who do emergency medicine outside of the ER?

The emergency medical technician (EMT) takes an examination, is certified, and, in some states, is licensed. Television shows have popularized this particular medical position, and sometimes people call EMTs *paramedics.* However, whether that term applies depends on the EMT's level of training. To add to the mix, EMT designations are different in different states, and Canada, the United Kingdom, and Ireland are all different from the United States and from each other.

In the United States, the National EMS Scope of Practice Model has four levels of EMT, and only one is called a paramedic:

- Emergency Medical Responder (EMR)
- Emergency Medical Technician (EMT)
- Advanced Emergency Medical Technicians (AEMT)
- Paramedic

The major difference among EMT levels is the kind of treatment each level can provide.

Offering help at home

Nurses and other healthcare professionals can and do visit patients in their homes. This aspect of nursing is especially valuable, given the cost of treatment in a hospital and the fact that some hospitals discharge patients quite soon after procedures are done.

The three main types of healthcare professionals (or lay people, in the case of caregivers) who spend a lot of time in the patient's home are:

- **Visiting nurse:** This type of nurse is an RN who comes to the patient's home to provide vital nursing assistance. Home care can involve helping with diabetes management, giving injections, and working as part of a team that may include physical therapists or speech therapists. They can also be a hospice nurse, one who cares for hospice patients and their families.
- **Home health aide, or HHA:** An HHA (also known as a home healthcare aide, or HCA) cares for patients (often elderly, convalescent, or handicapped people) in their homes. The HHA may help the patient bathe, dress, and groom, as well as prepare meals and change the bed linens. The aide may also administer oral medications under supervision. To work as an HHA in California, you need to earn a certificate issued by the Department of Health Services, which requires that you complete 120 hours of specialized training.
- **Caregiver:** A caregiver is a family member or a friend who helps take care of a patient at home. The caregiver's job includes a lot of daunting and exhausting work, especially when the patient is recovering from a stroke or has a progressive disease, such as multiple sclerosis (MS) or Alzheimer's. Caregivers are better able to do their work when they're familiar with medical dosing and calculations, and they benefit from getting instructions from a nurse.

Beyond the Math: Remembering the Human Side of Healthcare

Nursing is a comprehensive discipline. A successful nurse is:

- Well-educated
- Knowledgeable about medications, procedures, and equipment
- Sensitive to reading the state of the patient
- Sensitive to patients, families, and caregivers
- A great time manager
- An able administrator
- Experienced (a quality that comes with time on the job)

In *Notes on Nursing*, Florence Nightingale said, "I use the word nursing for want of a better. It has been limited to signify little more than the administration of medicines and the application of poultices. It ought to signify the proper use of fresh air, light, warmth, cleanliness, quiet, and the proper selection and administration of diet — all at the least expense of vital power to the patient."

Nursing and healthcare careers, in general, can be very demanding. Because you're taking care of the sick and injured, it's more than a job — it's a vocation (from the Latin word *vocáre*, meaning "a calling"). Any healthcare professional will tell you it's a lot of work, too, and (as Vanessa can attest) it requires a lot of working hours and many sacrifices. But it's rewarding as well. Helping someone heal and being an integral part of the process is one of the most rewarding things anyone can do. Being a nurse or other healthcare professional is essentially the giving of oneself to help another.

REMEMBER

Two major criteria for any healthcare professional are *empathy* and *compassion*. If you don't have these qualities, maybe you should rethink your decision to go into nursing or any career that involves patient care. While good organizational and math skills are important, being both empathetic and compassionate is essential.

With the world's population getting older, you'll find yourself taking care of patients with many complex, chronic conditions. Translation: You have to administer more medications, do more medical calculations, and have a lot more empathy and compassion. When you're sensitive to patients (and their families and caregivers), you're doing your job right.