Technician Tutorial:
Dispensing Drugs for Pediatric Patients

Preventing medication errors is a top priority in the care of all patients. This is especially true in the pediatric population. Between 2.5% and 5.7% of pediatric patients are subject to a medication error while in the hospital. This rate is approximately three times of that seen in adults. In the outpatient setting, the rate of reported preventable medication errors in pediatric patients is closer to 3%. It is thought that rates are actually higher than these numbers due to underreporting.

Pediatric patients are not just "little adults." Essentially, this group encompasses children who weigh one pound or less, up to those who are the same size as adults. Pediatric patients are usually grouped according to age, and these groupings can vary, depending on the source. Pediatric age groups can help differentiate different stages of development. Examples of age groupings include:

- Pre-term - born before 37 weeks of pregnancy
- Neonate - newborn to one month of age
- Infant - one month up to 12 months
- Toddler - 12 months up to 36 months
- Child - three years up to 12 years
- Adolescent - 12 years up to 18 years

Pharmacy technicians play an important role in preventing medication errors and ensuring patient safety when filling prescriptions or orders for pediatric patients.

NYSTATIN 100,000 UNITS/ML SUSPENSION
DAW: 0=NOT SPCFD
UOM: SUSPENSION
QTY: QS
REFILLS: 0 DAYS' SUPPLY: 14
WRITTEN 12/8/2020
TAKE 200,000 UNITS BY MOUTH FOUR TIMES A DAY X 14 DAYS

Your pharmacy receives an electronic Rx for nystatin oral suspension for a 5-week-old baby girl. Her mother calls the pharmacy to make sure you received the Rx and to see if you need any additional information since this is the first time she's filling a prescription for her child. What information would you need from the mother before you can fill the Rx?

How are pediatric patients different from adult patients?

From birth to adulthood, a pediatric patient's body is still developing. As the body develops, biological systems react to and process drugs differently. As a result of this, there are several ways that pediatric patients are different from adult patients.

Pediatric patients have different proportions of fat, body water, and muscle than adult patients. These proportions also differ throughout the stages of development. It's important to consider these differences because they can impact drug dosing. For example, an adult's body is made up of about 60% water, which is less than neonates (over 70%) and premature infants (85%). Differences in water composition can impact the dosing of certain water-soluble drugs. To illustrate this point, let's look at the seizure med phenobarbital. The dose in adults is 1 to 3 mg/kg/day, while the dose in infants is 4 to 8 mg/kg/day. This is

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because phenobarbital is very water soluble and gets diluted out in the body's water. It's like making *Kool-Aid*. The more water (body water) you have, the more *Kool-Aid* powder (drug) you need.

Infants' and children's bodies don't eliminate drugs in the same way as adults. The liver and kidneys are the organs mainly responsible for breaking down and removing drugs from the body. As age increases, the liver and kidneys mature. In neonates and infants, for example, drugs are broken down and eliminated more slowly than in older children and adults. As a result of this, infants and children often get lower doses of meds, and in some cases, reduced dosing frequencies. For instance, in adults, the acid reflux drug famotidine is usually given twice a day. But in neonates, it's often given only once per day. Think of this as a slow leak versus a fast leak. Very young children have a slow leak (i.e., get rid of drug more slowly). Older children and adults have a fast leak (i.e., get rid of drug more quickly).

Why are medication errors more likely to happen in kids?

Children are prone to drug errors for a variety of reasons. Often, pediatric drug therapy involves complex steps that aren't necessary for adults. For example, many commercially available drugs are formulated and packaged for adults, so they may need to be compounded and/or repackaged for children. In addition, individualized doses are usually calculated based on the child's age and/or weight. Caregivers must precisely measure and administer medications to children. And many healthcare providers don't have formal training in pediatrics and may lack current pediatric drug references. All of these factors introduce the potential for mistakes to happen.

If a mistake occurs, children are less able to tolerate a drug error. As previously discussed, the absorption, distribution, metabolism, and elimination of medications in children can be different from that seen in adults due to immature organ systems (e.g., kidney, liver, immune system, etc). In addition, young pediatric patients cannot effectively communicate side effects they're experiencing.

How are drug doses for pediatric patients determined?

Drug doses for pediatric patients are usually determined on a milligram per kilogram (mg/kg) basis. For example, if a two-year-old patient weighs 12 kg and the age-appropriate dose of a drug is 25 mg/kg/dose, the patient's dose would be 300 mg.

Dose (mg/dose) = weight-based dose (mg/kg/dose) x patient weight (kg)

x = (25 mg/kg/dose)(12 kg)

x = 300 mg/dose

Pediatric doses can also be determined using body surface area (BSA). BSA is calculated from the patient's height and weight. This method is most commonly used for cancer meds. You'll rarely see it used for calculating the dose of any other type of drug. If you need to calculate a patient's BSA, you'll need their height and weight. You can then use an online calculator, instead of trying to do the math by hand. Make sure you enter the height and weight in the correct units. BSA is measured in kg/m^2, but some calculators may allow you to enter weight in either kilograms or pounds, or height in meters, centimeters, feet, or inches.

It is important to remember that generally, even in very large children, doses should not exceed the maximum adult dose.

What information should I gather about pediatric patients?

You can help prevent mistakes by making sure that needed information is available for the pharmacist. In the community setting, this might involve asking parents or caregivers of pediatric patients for information

when they bring in prescriptions. In the hospital setting, this might involve requesting information from nurses or looking at information on the patient's medication profile, medical chart, etc.

Verify current patient allergy information for all pediatric prescriptions. This should be done every time an Rx is processed for a patient. With the increase in use of electronic Rxs in the community setting, it's likely that the caregiver will not be there at the time of Rx data entry. Be sure to make a note to ask about allergies at pick-up.

Get the patient's date of birth so that age can be determined. Pediatric doses can vary significantly based on age, and the pharmacist will need this information to determine if a dose is appropriate. For example, the dose of amoxicillin/clavulanate 125 mg/5 mL (*Augmentin* [U.S.], *Clavulin* [Canada]) suspension is 30 mg/kg/day divided every 12 hours for children under three months of age when treating urinary tract infections. But it's 20 to 40 mg/kg/day divided every eight hours, or 25 to 45 mg/kg/day divided every 12 hours, for children three months or older.

Get the patient's weight. Ask for the patient's weight so the pharmacist can double check the patient's drug dose. Make sure you always clarify the unit of a patient's weight, either pounds or kg. One kg is equal to about 2.2 pounds. A misunderstanding about the patient's weight can lead to an underdosing by about half or overdosing by double. Always record weight in kilograms when entering it into any computer system to avoid confusion. Keep in mind that kids grow quickly. This means their weight will frequently change. Make a habit to ask caregivers for the most current weight of the child whenever possible.

Know how to convert from pounds to kg. Using the conversion of 1 kg equals 2.2 pounds (lbs), calculate how much a 45-pound child weighs in kg.

(45 lbs)(1 kg/2.2 lbs) = 20.5 kg

When asking for a patient's weight, take a glance at the patient if he or she is present. This is a good way to double check that the weight is roughly accurate. Ask yourself if the weight that you are recording makes sense. Drug dosing mistakes caused by using the wrong weight to calculate doses are common, yet so preventable. For example, a pharmacist recounts a situation where the infusion rate for an IV fluid for a **4.9 kg** (10.8 lb) three-month-old baby appeared to be unusually high. The pharmacist called the physician, who said "I disagree with you, this child weighs **30 lbs**." As it turned out, the physician read the weight as **14.9 kg**, which *is* roughly 30 lbs. But as he spoke it out loud to the pharmacist, he realized there was no way that the three-month-old baby weighed 30 lbs!

You confirm the patient's date of birth and ask for her weight. She is five weeks old as of today and she weighs 15 lbs. You calculate this to be 6.8 kg and enter it into the computer system (15 lbs x 1 kg/2.2 lbs = 6.8 kg). You also ask if the patient has any known allergies and gather her insurance information so that you can bill for the prescription.

What should I do to help prevent errors when dispensing prescriptions for pediatric patients?

When you dispense prescriptions for pediatric patients, there are a few things you should be sure to do.

Identify if a prescription may need to be compounded. Since some drugs are not available as liquids, but are used in pediatric patients, there may be a need to compound a liquid formulation. This is a fairly common practice in many hospital settings. In the community setting, even if your pharmacy does compound, sometimes you might not have the right "recipe." You may be able to get it by calling the hospital from which the patient was discharged (if this was the case). If you don't compound, the parent or caregiver may need a referral to a pharmacy that will be able to provide the product. Check with your pharmacist to find out what to do, and how you can help.

Double-check that you are picking the right product. A number of drugs come in different concentrations, but not all concentrations are appropriate for all pediatric patients. For example, amoxicillin/clavulanate 600 mg/5 mL (*Augmentin ES-600* [U.S.]) is not approved for use in kids under three months of age. As per product labeling, amoxicillin/clavulanate 125 mg/5 mL is the most appropriate product for those below three months. Or in the hospital setting, injectable vitamin K doses for newborn babies should be dispensed as the 1 mg/0.5 mL product, not the 10 mg/mL product, which is for older patients.

Drugs also come in a variety of dosage forms: regular tablets and capsules, extended-release tablets and capsules, sprinkle caps, chewable tabs, orally disintegrating tabs, oral solutions, etc. For example, in the U.S., generic versions of methylphenidate used for ADHD include a chewable tablet, capsule, tablet, and oral solution.

Determine the correct dose and be careful when entering it into the computer. Ten-fold dose errors are not uncommon in pediatric patients. This occurs when patients inadvertently receive either ten times more or one-tenth the amount they were supposed to receive. In the hospital, this error is often associated with morphine and other opioids, as well as antimicrobials. (For instance, you may need to prepare a 4 mg/mL dilution of gentamicin or tobramycin from the commercially available 40 mg/mL concentration for babies.) The wide range of doses that can be appropriate for pediatric patients increases the risk for dosing errors. Ten-fold dose errors occur most often during prescribing or administration. Always check calculations and make sure you have the patient's correct weight. Assess doses with decimal points very carefully. Leading zeros should always precede a decimal (e.g., 0.5 mg rather than .5 mg) but trailing zeros should never follow a whole number (e.g., 1 mg rather than 1.0 mg).

In most cases, doses will be written out, just like an adult dose. For example, an Rx for azithromycin suspension might simply say: 250 mg PO once daily. On the other hand, a dose might be written as mg/kg/dose or as mg/kg/day. It's important to make sure that the dose is clear on the Rx so that it can be calculated correctly. For example, if an Rx were to say 25 mg/kg given every 12 hours, this is not clear. Alert the pharmacist to clarify whether the intended dose is 25 mg/kg/**dose** or 25 mg/kg/**day**.

Make sure the label directions have the right amount of drug per dose. Since prescriptions for pediatric patients are usually liquids, you need to make sure that the volume of drug per dose is correct.

To calculate the volume of medicine needed per dose for a prescription, you can use a simple ratio. For example, let's say the concentration of an antibiotic suspension is 250 mg/5 mL. You get an Rx for a patient with a dose of 125 mg twice a day for 10 days. To figure out how many mL are needed per dose, follow the steps below:

1. Set up a ratio: 250 mg/5 mL = 125 mg/x mL
2. Cross-multiply on each side of the equal sign: (x mL)(250 mg) = (5 mL)(125 mg)
3. Divide by 250 mg on each side to find the unknown variable: x mL = (5 mL)(125 mg)/250 mg
4. Solve for x: x = 2.5 mL

Alternatively, you could note that 125 mg is half of 250 mg, so the volume needed will also be half of 5 mL, or 2.5 mL. It's good to get in the habit of double-checking your calculations by using two different methods, or by working backwards.

Recall that the Rx in this example instructed the patient to take "125 mg twice a day for 10 days." It's helpful to give caregivers specific dosing instructions on the Rx label to avoid confusion. In this case, it would be good to include a dose volume on the label. For example, the label may read as follows:
"Give 2.5 mL (125 mg) by mouth twice a day for ten days."

Be careful not to mix up units of measurement on prescription labels. One teaspoonful is equal to 5 mL. And one tablespoonful is equal to three teaspoonfuls, or 15 mL. Some prescribers may write directions in terms of teaspoons or tablespoons. So, it's important to know that the abbreviation for a teaspoon is usually a lower case "t," while tablespoon is an upper case "T." Using teaspoons, tablespoons, ounces, and other non-metric dosing units for oral liquids isn't preferred. This is because of mix-ups and errors. For example, caregivers may be tempted to use a household teaspoon. Unfortunately, typical household teaspoons can hold 2 to 10 mL, which can lead to inaccurate doses. Stick to using mL on label directions to avoid confusion. Or talk to your pharmacist about including both metric and non-metric units on Rx labels.

Prescribers might use the abbreviation "cc" instead of "mL" on prescriptions. These mean the same thing, but don't use cc on prescription labels. Use mL instead. Patients are unfamiliar with cc and may mistake it for teaspoons instead of mL, which can lead to a five-fold overdose.

For the baby's Rx, the dose is 200,000 units and the concentration of nystatin suspension is 100,000 units per mL. What would be the volume of the dose?

The volume is 2 mL (set up as 100,000 units/1 mL = 200,000 units/x mL).

Calculate the correct quantity and choose the right container size. Since most pediatric meds are liquids, you'll need to make sure you dispense the right amount so there's enough drug for the course of therapy. Usually, pediatric antibiotic suspension Rxs are written with the duration of treatment. This info is sometimes needed to help determine the correct quantity and container size. Talk to the pharmacist if the duration of treatment is NOT given on these Rxs. The prescriber may need to be contacted for clarification.

You will need to calculate the total volume of medicine needed so that you can select the correct container size. In the above example about the antibiotic suspension, the patient will be taking 125 mg (2.5 mL) twice a day for 10 days. Calculate the entire volume needed to dispense using the following method:

Total dispensing volume = (volume/dose)(doses/day)(total number of days of therapy)

For this patient, the calculation would be as follows:

(2.5 mL/1 dose)(2 doses/1 day)(10 days) = 50 mL suspension needed to complete therapy

Sometimes, pediatric suspensions for reconstitution might not come in the exact volume needed. In the example above, if only a 100 mL bottle is available then there will be excess medication remaining. It's important to let the caregiver know about this so that they don't give more drug than needed. Check with the pharmacist on how they prefer to communicate this information. Be aware that there are auxiliary labels that can help get this message across. Conversely, sometimes the volume that needs to be dispensed may be too large for one package size. Some patients may need two bottles or more. Make sure you check with your pharmacist regarding how to handle these situations. Some pharmacies may reconstitute the entire amount and dispense the volume needed in one bottle. However, this might not be feasible if the suspension won't be stable for the length of therapy. For example, cefdinir suspension only lasts 10 days once reconstituted, which could be a problem if the patient needs to take it for 14 days. Check the label on the stock bottle to find out how long a product lasts after reconstitution.

The patient will be taking doses of 2 mL each, four times per day, for 14 days. So, (2 mL per dose)(4 doses per day)(14 days) = 112 mL. This is the total volume that will need to be dispensed.

Refer computer or payer alerts to the pharmacist for review. For example, you may see "drug-age" warnings pop up when filling certain medications for kids, such as drugs on the KIDs List (codeine, tramadol, paroxetine, etc). And "high-dose" alerts can help draw attention to a dose that was calculated incorrectly.

Use auxiliary labels to help caregivers remember how to administer or store meds. For instance, you'll want to make sure to include the appropriate auxiliary labels, such as "shake well" for suspensions (e.g., amoxicillin, amoxicillin/clavulanate, nystatin, etc) and "refrigerate" for liquids such as amoxicillin/clavulanate, cefprozil, etc.

It is also important to indicate the beyond-use date for a reconstituted liquid. For example, cephalexin suspension is good for 14 days when stored in the fridge after it is mixed. Apply a "discard unused portion" or "discard after date" label to drugs that are likely to have an excess amount remaining or that must be discarded after a certain date. Labels about taking the drug on an empty stomach or with food should be given attention too; for example, cefuroxime should be taken with food to avoid stomach upset.

Nystatin suspension should be shaken before use, so you add an appropriate auxiliary label to the amber bottle containing the patient's nystatin.

Make sure a calibrated measuring device is provided with all oral liquids. As mentioned, household spoons aren't good for measuring pediatric doses. Caregivers should use the measuring device that comes with the product if possible. If the product doesn't come with a device, provide a proper calibrated measuring device such as an oral syringe or dosing spoon. Make sure that the dosing units on the device match the dosing units on the Rx label. Try to choose a device that's a correct size for the caregiver to measure the dose just once. For example, if a dose is 15 mL, dispense a device that holds at least 15 mL. If you dispense one that holds only 5 mL, the caregiver has to measure the dose three separate times to get to 15 mL. This increases the risk for error. Suggest that patients mark these dosing devices with a permanent marker to indicate how much drug to give. The pharmacist may want to do this for the caregiver before dispensing the drug. If that is the case, let the caregiver know that the device has been marked by the pharmacist. Also let them know to throw away any marked device after treatment is complete to avoid confusion with future meds.

Since each dose of the patient's nystatin will be 2 mL, you choose an oral syringe that measures out at least 2 mL to dispense with the Rx.

Be sure that powders for suspension are reconstituted before handing them to a caregiver. A number of errors of this type have been reported, where caregivers actually administered unreconstituted powders to children. This can lead to an overdose which may require medical care to treat. Use "Mix" cards or other ways to flag these Rxs to alert your colleagues that a medication needs to be reconstituted before given to the patient.

Is there anything that I should consider for pediatric medications in the hospital setting?

In the hospital setting, exact doses are usually prepared individually for pediatric patients. This is different from adult doses. If a container doesn't have the exact adult dose that was ordered, it will still be provided along with a "note dose" sticker; but this is a risky practice for pediatric patients and should be avoided.

Ensure you're capturing ALL meds pediatric patients take when obtaining medication histories. Omissions are one of the biggest problems when these patients are admitted. Make sure to document the

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drug name (include both generic and brand names, if applicable, and both prescription and over-the-counter meds), drug strength, route of administration, regimen (dose and dosing schedule), and indication for use. Since pediatric patients are often on liquid formulations, you'll want to make sure to include doses in milligrams, not just milliliters. For example, azithromycin (*Zithromax*) 200 mg/5 mL oral suspension, 250 mg (6.25 mL) by mouth three times a week, for cystic fibrosis. Keep in mind, med lists from previous admissions may be a less reliable resource for pediatric patients than adults, since med regimens can change as children grow. Verify pediatric med histories with parents whenever possible.

Know when to prepare pediatric dilutions. There will be times when a dose ordered for a pediatric patient is so small that it cannot be measured accurately. This may be especially true for newborn babies. For example, if a drug comes in a concentration of 100 mg/mL, and the ordered dose is 5 mg, the volume of drug needed for the dose will be 0.05 mL. Usually, the minimum measurable dose is 0.1 mL. To solve this problem, you will need to make a pediatric dilution. Most commonly, the drug is diluted by ten times. The drug concentration in our example would then be 10 mg/mL. The volume needed for the 5 mg dose would be 0.5 mL, which is measurable. Follow your pharmacy's policies for pediatric dilutions, including the formulation, beyond-use dating, and storage.

Dispense oral liquids in amber oral syringes, never in IV syringes. There are reports of patients receiving drugs meant for oral administration through their IV lines. This is very dangerous, and it is easy to see how this could happen since most oral liquids for pediatric patients are dispensed in syringes in the hospital. Never draw up an oral liquid in an IV syringe. Always use syringes, usually amber, that are designated for oral meds only. Also, attach an "oral use only" auxiliary label over the cap of the syringe, to prevent IV administration of the oral med.

Stock only appropriate drug formulations in automated dispensing cabinets, on patient care units, etc. Some medications or concentrations of medications are inappropriate for use in pediatric patients. An example of this is heparin flushes that contain preservatives. Some preservatives are dangerous, when given in adequate amounts, to very young children. Another example is hepatitis B vaccine, which is routinely given to newborn babies. Specific formulations are meant for newborns and others are only for older patients. When you're stocking meds for use in pediatric patients, be extra careful to make sure you have the right drugs in the right concentrations and formulations. If you're not sure about something, check with the pharmacist.

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"Cheat Sheet" for Dispensing Pediatric Meds

What are the different pediatric age groups?

Pediatric patients are usually grouped according to age, and these groupings can vary, depending on the source. Pediatric age groups can help differentiate different stages of development. Examples of age groupings include:

- Pre-term - born before 37 weeks of pregnancy
- Neonate - newborn to one month of age
- Infant - one month up to 12 months
- Toddler - 12 months up to 36 months
- Child - three years up to 12 years
- Adolescent - 12 years up to 18 years

Why are pediatric patients at a greater risk for medication errors?

There are several factors that increase the risk for mistakes and medication errors to occur in pediatric patients:

- From birth to adulthood, a pediatric patient's body is still developing; these patients have immature organ systems responsible for processing, breaking down, and eliminating drugs.
- Young children often cannot effectively communicate side effects they're experiencing.
- Caregivers must be relied upon to precisely measure and administer individualized doses to children.
- Complex steps, such as compounding or unique calculations, are often required when preparing drug therapy.
- Many healthcare providers don't have formal training in pediatrics.

What can I do to help prevent errors when dispensing prescriptions for pediatric patients?

- Obtain or verify date of birth, current allergy information, and patient weight with every encounter.
- Always record weight in kilograms to avoid confusion (1 kg = 2.2 pounds).
- Handle Rxs that need to be compounded carefully, such as by double-checking calculations, ingredients, and quantities before they're combined; reaching out to a hospital pharmacy to get a compounding formula; etc.
- Confirm you are picking the right product with the right concentration, strength, and dosage form.
- Make sure that doses calculated based off of weight do not exceed the maximum adult dose.
- Assess doses with decimal points very carefully – leading zeros should always precede a decimal, but trailing zeros should never follow a whole number.
- Ensure label directions have the right volume of drug to be given per dose for liquid meds.
- Use mL on Rx directions to prevent confusion with teaspoons (5 mL) and tablespoons (15 mL).
- Be careful to select the right container size, especially when dispensing antibiotic suspensions to ensure there's enough drug for the entire course of therapy.
- Refer computer or payer alerts to the pharmacist for review.
- Apply the appropriate auxiliary labels, such as "shake well" for suspensions or "discard unused portion" for meds that are only used for a specific length of time (e.g., antibiotics).
- Provide a proper calibrated measuring device, such as an oral syringe, which has the same dosing units as the dosing units on the Rx directions and that is the correct size (volume not too large or small).
- Be sure powders for suspension are reconstituted before handing them to caregivers or patients.

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