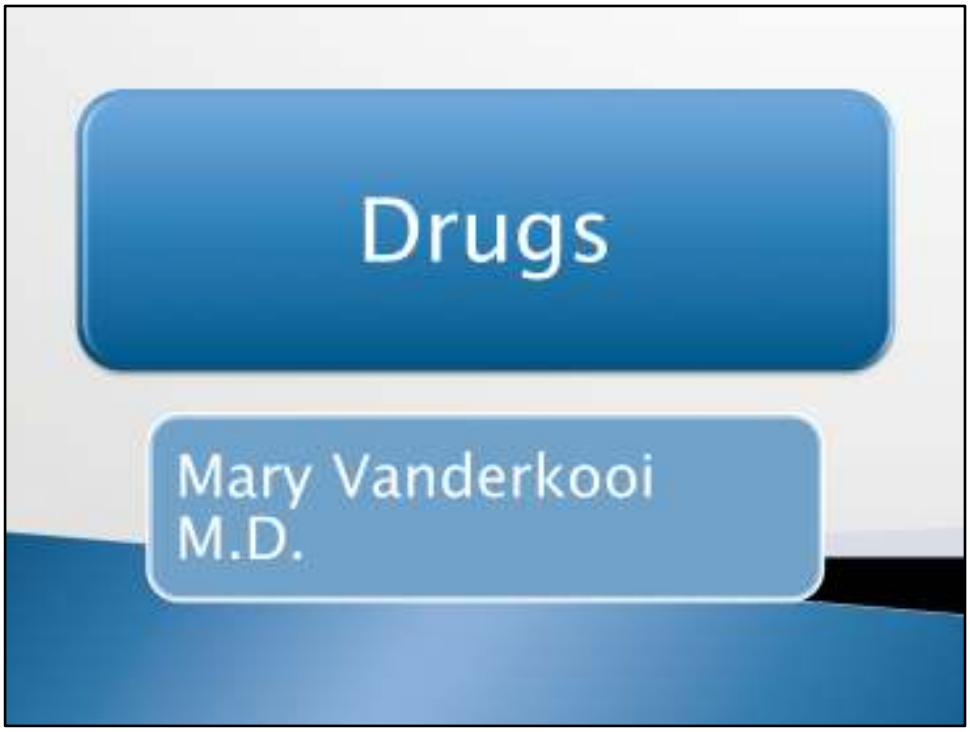


This presentation supplements chapter 3 in the Village Medical Manual. If you have not yet read that chapter and worked the problems, stop here and do so. The presentation presupposes that you know the basics of that chapter. Some of this material will be unnecessary for medical people. However, the unconventional procedures might be useful for medics embarking on a new ministry in a remote area. There is a lab that should be done immediately after this lecture.

First we will consider oral medications, ordinary tablets, capsules, and liquids.

Oral medications are cheaper than injectable, and one does not risk transmitting disease with inadequately sterilized syringes. Oral medications come as tablets, capsules, and liquids. Sometimes liquid medication is sold as powder in the bottom of a bottle to which water must be added. The bottle on the left is promethazine, an antivomiting medication. There is dry powder in the bottom of this 1 liter bottle. The instructions are to add clean water up to the one-liter mark. Once the water is added, the solution becomes unstable; it must be discarded within a week or two. The middle bottle contains white tablets. The bottle on the right contains capsules.

Tablets are made by combining a certain amount of the active drug with some filler. The filler is an inert chemical compound that is easily compressed into tablet form. It is necessary, to keep the tablets as tablets rather than powder. In general, the smaller the milligram dose of the active drug, the smaller the tablet. Small tablets are not heavy, and you can transport a lot of them in a small space. However, if you are treating a lot of children, dividing a miniscule tablet into tenths is an exercise in futility. It is impossible to get the dose right. If you are dividing adult medication for children, then you should avoid small tablets.

A scored tablet is one designed to be broken into parts for accurate dosing.. Theoretically, an unscored tablet should not be broken into parts. However, with most of the drugs you will be using, the margin of safety is big enough that you can do so anyway. Unscored tablets with precise dosage schedules should not be cut. They may be pulverized, the powder well mixed, and then a portion taken for a single dose.

In the photograph, the yellow tablet on the left is not scored. It is an antibiotic that should not be used for small children; the lack of scoring discourages inappropriate prescription. The middle tablet has a barely-visible groove down the center. It is a deworming medication that is useful for children. The tablet on the right is also useful for children. However, the margin of safety is not large. It is double-scored to enable the consumer to accurately obtain a quarter-tablet. The manufacturer has seen to it that each fourth-tablet contains a fourth of the total dose.

The size of capsules and the dosage of the contents does not correlate like it does with tablets. Sometimes one finds relatively small doses in large capsules.

In order to dispense a portion of a capsule, the two parts must be pulled apart and the powder divided into appropriate portions. The photograph on the left shows a red capsule in the process of being pulled apart. The person is squeezing the two ends of the capsule, rotating them back and forth, and trying to pull the two ends apart. Once they come apart, the powder inside spills out, as the right picture shows. The empty capsule can be discarded; the drug is all in the powder inside.

Drug companies cater to doting parents by marketing their medicines in pediatric-friendly forms. The assumption is that parents will not force junior to swallow a bitter tablet or powder. Pediatric preparations mean higher prices, more bulk, and more waste. It is a luxury that you cannot afford as you contemplate buying, transporting, and using medicines in Timbuktu.

Generally drugs dissolved in water are less stable than those sold in dry form. However, there are a few drugs that are stable in liquid form. The dry form is still preferable because of weight and bulk for shipment, but a liquid form in acceptable. As a general rule, if the drug is shipped from the company dry and the pharmacist or consumer adds water, the drug is not stable in solution. It needs to be discarded after a few days or a week. If the drug is manufactured, packaged, and shipped in liquid form, then the liquid form is stable.

That being said, some medicines necessarily are liquid because the active ingredient is liquid; the manufacturer has no choice. Tetrachloroethylene, a cheap deworming medication, is one example.

Rectal and vaginal medicines are usually suppositories. The photograph illustrates one of these. The package contains six suppositories like the pink one that has been removed from the package. This is a pain medication. It is absorbed into the blood stream through the pink, moist surface inside the rectum. Suppositories are useful for treating local infections in or near the rectum or vagina. They are also useful for whole-body diseases if the patient is vomiting. The packaging makes them bulky, and they are usually expensive and wasteful.

With many medications, you can put an oral tablet directly into the rectum. The natural secretions will dissolve the tablet, and the drug will be absorbed into the blood stream. An alternative is to dissolve the medication in water, take it up into a syringe, and then use a urinary catheter or a stomach tube to put the medication into the rectum as an enema.

In some cultures any child a year old or more can be persuaded to swallow a small tablet or a portion of a larger tablet. In other cultures this is not feasible. If you divide a tablet by cutting, the edges of the tablet may be rough. It is helpful to round off the edges by rubbing them gently with your finger. Then see if the child will swallow the intact fraction of the tablet.

The picture on the left shows a tablet being cut with a commercial cutter.. A low-tech method of achieving the same end is shown on the right. A single-edge razor works fine for dividing a scored tablet.

If the child will not swallow the portion of the tablet, then take the piece and grind it between two spoons. It takes a little muscle power to grind this way. Put the powder into the child's mouth. The natural mouth moisture will make the powder stick to the inside of his mouth. Then if you offer him something sweet to drink, it will go down. This works better than trying to mix the powder with honey.

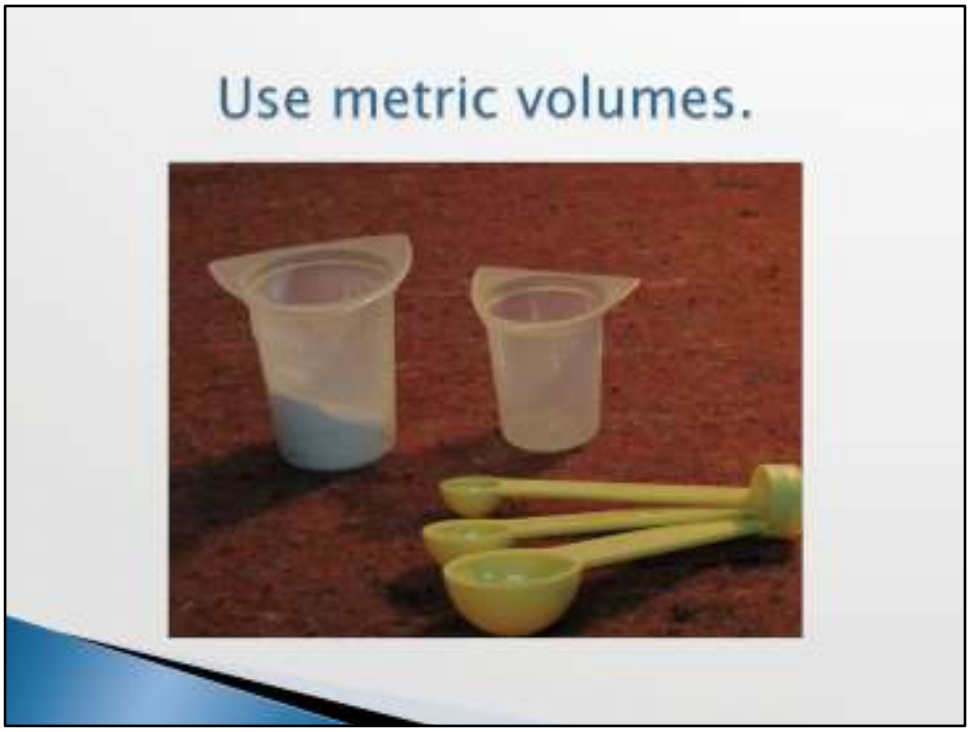
On the bottom there is the two-spoon system, useful for an occasional single dose. Behind the spoons are a mortar and pestle on the left and a coffee grinder on the right. These are useful for grinding intermediate amounts of medicines.

The advantages are these:
•Intact, labeled medicines are saleable on the black market. Powders usually are not.
•You can mix multiple medicines or use your own fillers.
•It eliminates misunderstanding of directions. “Take one capful of this powder every day.” is much more understandable than “Take two of this and three of that and one of the other.”

•One warning: Don’t do this if you have to struggle with math. It’s too easy to miscalculate and end up killing people. Be sure to check your calculations with another person who is good in math.

The photograph shows a grain grinder. Medicines, measured by the hundreds of tablets, can be pulverized for dispensing. There are some advantages to grinding medicines and then calculating dosages on the basis of the mg of active drug per unit volume of the dry powder. One can measure dry powder with uniform-sized small containers such as local spoons, the caps from syringe containers, or empty small vials. The measuring containers should be cheap, readily available, and of uniform and unmistakable size.

Although you should try to avoid pediatric antibiotic preparations, there will be times when you are forced to buy and use them. After adding water, most antibiotics need to be refrigerated, or they are useless within two or three days. In Timbuktu pediatric antibiotics are exceedingly bad news. Don't buy them unless forced to. If you have to buy a pediatric preparation, don't let the pharmacist add the requisite water unless you are prepared to refrigerate it thereafter. Measure the volume of the dry powder in milliliters. Divide that by the number of days it is supposed to last and then the number of doses per day. This will give you the number of milliliters of dry powder that you need to give per dose.

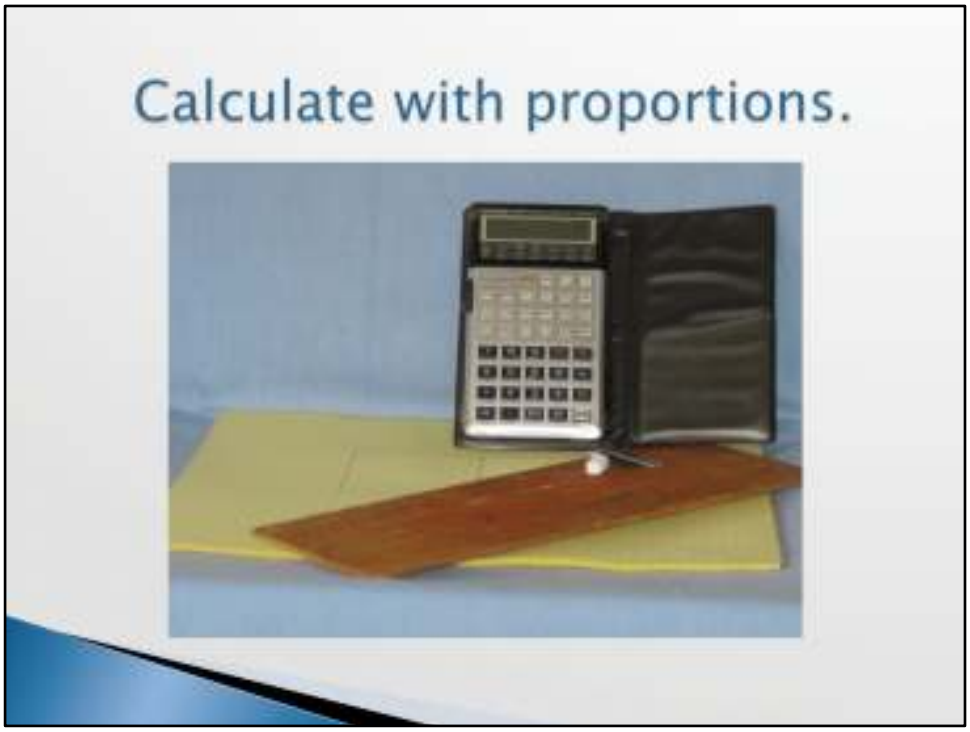


It is essential to buy a set a metric measuring devices. Cups, tablespoons, and teaspoons will excessively challenge your math skills. Metric measuring can be bought in Europe and Canada; they can also be obtained through American Science Supply in Niles, Illinois.

You can divide powdered antibiotic for a child, making up one dose or one day's portion at a time. This circumvents the need for refrigeration. Measure the entire volume of powder and divide this into clean vials, each enough for one dose. Have the mother add water to one vial for each dose. You needn't be scrupulous about making sure each vial is exactly the same as every other. Oral antibiotics have a large margin of safety and efficacy.

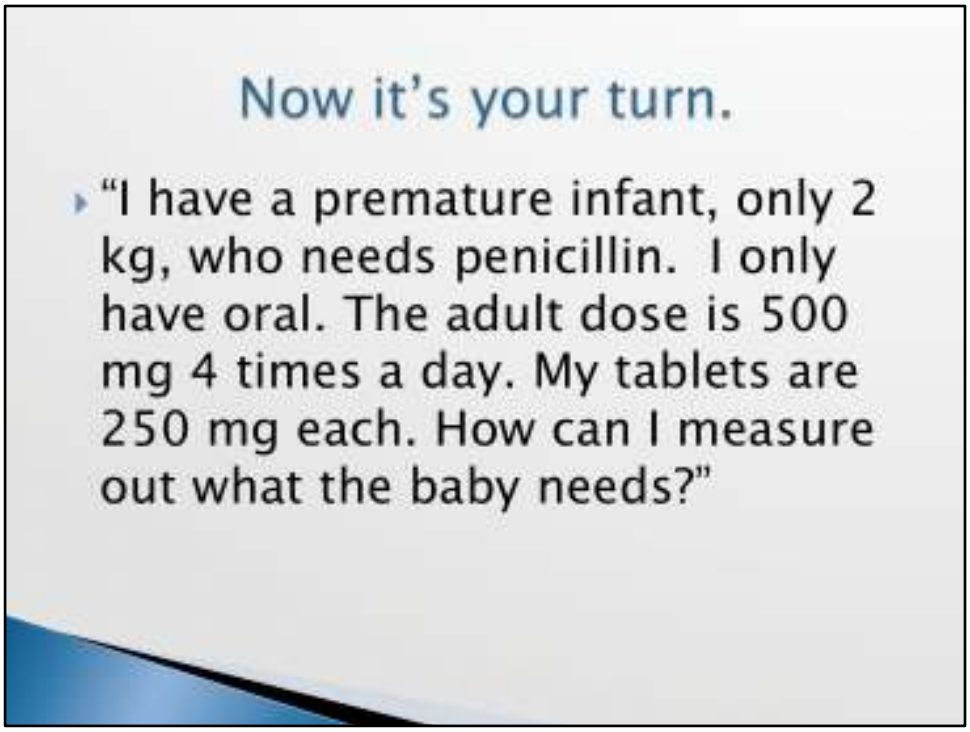
For measuring small portions for very tiny patients, it is useful to use graph paper. Mark out an area of 10 by 10 little squares. Spread the powder uniformly over this area or a portion of this area. Then use a knife to take the portion that you need. In this way it is possible to divide the powder from an adult tablet or capsule to accurately medicate a premature infant.

In the example above, the author broke apart a rifampin capsule. It was not feasible to spread this over the marked-out area of 10 by 10 units, so she spread it evenly, instead, over an area of 50 squares. For this drug, the usual adult dose is two capsules of 300 mg each. Therefore a 25 kg child would get the contents of one full capsule, in this case spread out over 50 squares. Therefore, for each 1 kg of child, the appropriate dose is the powder spread over two squares. A 17 kg child would get the powder on 34 of the 50 squares.



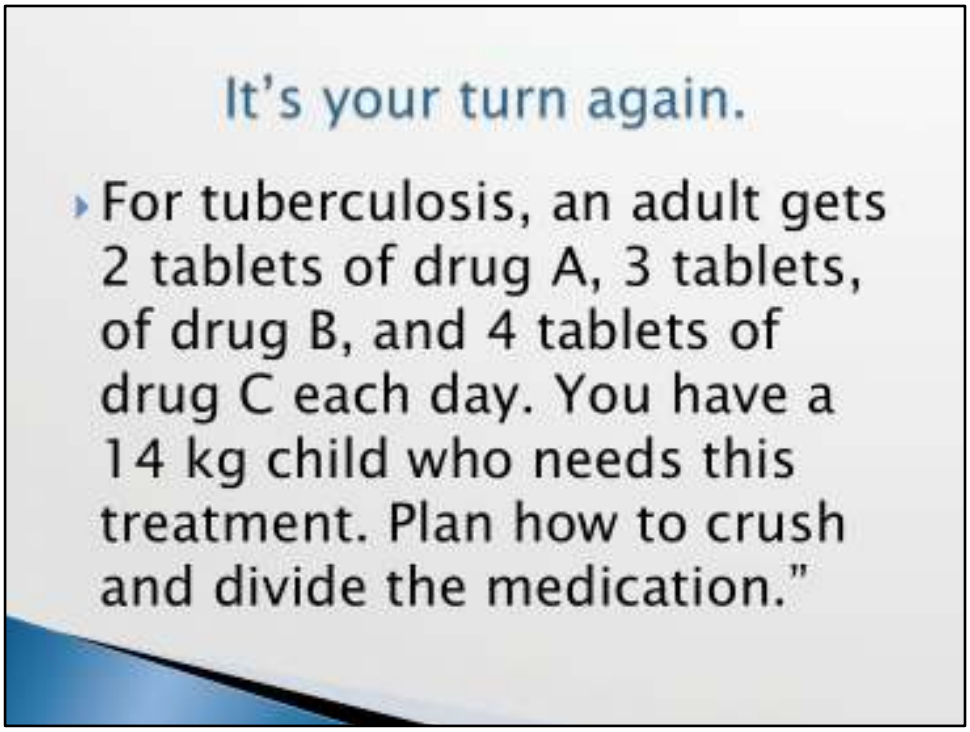
A workable assumption in dividing adult medicines for children is that an adult weighs 50 kg. Actually, the average adult weighs more than that, but children need a higher dosage on a per-kilogram basis than adults. It works out that the 50 kg assumption is both safe and convenient. This means that for every 10 kg of child, one gives 20% of the adult dose.

If a patient weighs 100 kg, he or she still gets the usual adult dose of most medications. There are exceptions.



(Pause but do not read the slide aloud.) Discuss this with your group and come up with a plan.

Your baby is 1/25 of the size of an average adult. That means that he gets 20 mg. Crush up one of your 250 mg tablets. Spread this over graph paper, an area 50 times 5 little squares. You will have, on the average, 1 mg in each little square. Scrape off the powder from 20 of these squares for each dose. There are other correct solutions for this problem; this is only one way of doing the math. As long as you end up giving him 20 mg, that's fine.



(Pause but do not read the slide aloud.) Discuss this problem with your group and make a plan.

Crush 2 tablets of drug A, 3 tablets of drug B, and 4 tablets of drug C. This is enough for an adult who is about 50 kg. A 14 kg child is about ¼ of the adult size. Therefore, you would measure this volume of medication powder and divide it into four, putting a fourth in each of 4 vials. Then mix the medicines in this proportion and put it all through a grain grinder. Put the same volume (a fourth of the daily adult dose) into each of 14 or 28 vials, give the vials to the parents, and tell them to give the child one vial-full each day. This is not the only solution to the problem; there are other ways to figure this out.

Although the vast majority of your dispensing should be oral medications, on occasion you will need to give injections.

Some medicines do not work in oral form; they must be given by injection. An example is magnesium sulfate, which is not absorbed from the bowel into the blood stream; taken orally it simply causes diarrhea. Given by injection, either IM or IV, it works well for some whole-body illnesses.

Sometimes you need to use injectable medication because the patient has persistent vomiting. She just cannot keep anything down until her stomach is settled. Medication that is promptly vomited does the patient no good.

Thin glass vials are vials that can be broken with one's bare hands. There is a point of glass on an end. The vial in the photograph has points on both ends. Either end can be broken off easily to access the contents.

Thick glass vials are sturdier than thin glass vials. The thick glass is harder to break. You need to have a glass file in order to create a weak spot in the glass. If you try to break it without filing the glass first, either you won't be able to or else the vial will break in an unpredictable and dangerous manner, possibly cutting your hands in the process. Once a thick glass vial is broken open, it can be held upside down as long as air is not introduced through the needle.

Once an end is broken off a vial, a needle can be introduced to withdraw the contents. The vial can be held upside down without the contents running out, as long as you don't introduce air. This situation is different than with stoppered vials. With stoppered vials you must introduce air in order to withdraw the contents. With vials that are open, if you inadvertently do inject air, the contents will run out and be wasted; they will not enter the syringe.

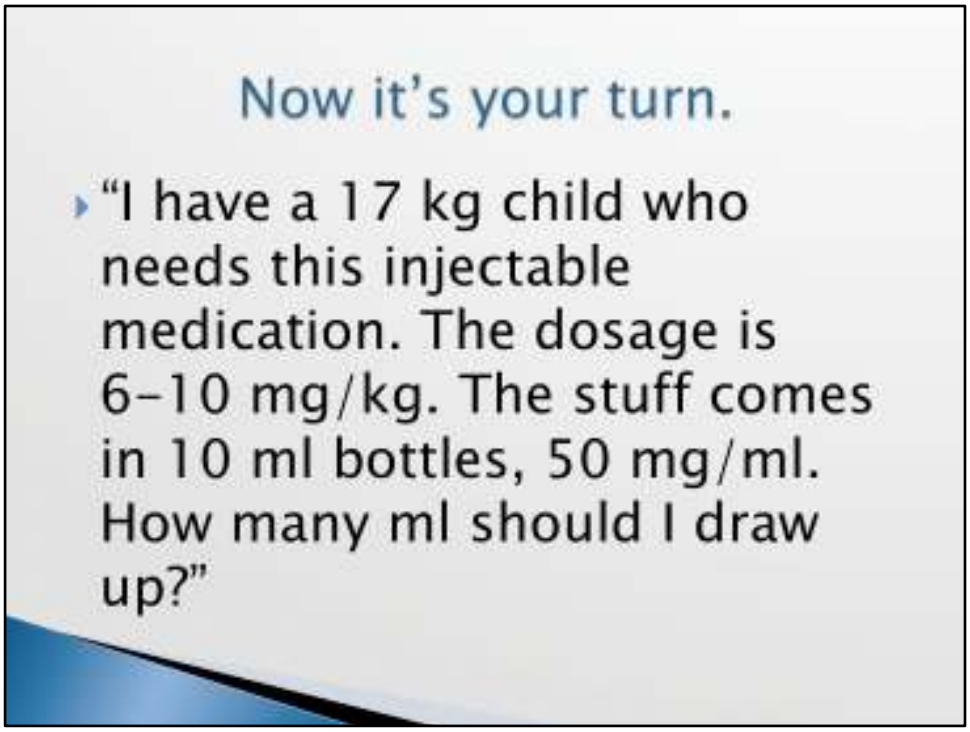
Stoppers on vials are made of a rubbery substance that can be pierced. The black arrow points to the stopper. The blue plastic disc lying beside the bottle is a cap that was removed right before the photograph was taken. The hole in the stopper made by the needle seals itself after the needle is withdrawn. You need to clean the stopper with alcohol before piercing it. You should have a volume of air in your syringe equal to the volume of medicine that you intend to withdraw. Inject that air and then withdraw the medicine. Since stoppered vials are sealed, the liquid will not withdraw easily unless it is replaced by air.

The bottle on the left with the orange cap is lidocaine. It is manufactured and shipped as a liquid solution and is very stable that way. The bottle with the green cap is a powdered antibiotic; you can see the off-white powder in the bottom. Next to it is a stoppered but uncapped bottle of water. If the contents are wet, then you have only to withdraw the desired amount. If the contents are dry, then you must add water or saline, mix them, and then withdraw the desired amount. Toward the end of this presentation there is a section on using sterile water for this purpose.

If the medicine that you buy is a powder in a stoppered bottle, then you must add water for injection in order to use it. Water for injection has to be sterile. Commercial products are available but, for IM injections, your own preparations are just as good. Do not use homemade water for injection intravenously.

The vial on the left is made of sealed, soft plastic. It is intended for only one use. Clean the top with alcohol and pierce it with your needle to withdraw the contents. Injecting air is helpful but not necessary since the plastic is soft enough to collapse. The glass vial with the blue writing is made of thick glass. These vials are a pain. In front of it is a metal file, useful as a saw for making a weak line in the neck of the vial. In theory, the top of the vial can then be easily broken off and the contents removed. In real life this is difficult. The stoppered vial with the pink label is sterile water. It is labeled bacteriostatic because it contains a substance to discourage bacterial growth. On the far right is a bottle of saline, that is salt water of a certain concentration. Previously it was a bottle of local anesthetic but the author replaced the anesthetic with saline from an IV bottle and then resterilized it.

Occasionally you will find vials of water for injection which are sold as companions to powdered antibiotics. Commonly these have twist tops which are easy to use. One can remove them very readily. Then they are open vials which can be inverted like any other open vial. These are nice to use, but they are unnecessary weight and volume to transport when luggage allowance is severely limited.



(Pause but do not read the slide aloud.) Discuss this with your group and come up with an answer.

At 6 ml/kg you will need 102 mg which is just a little over 2 ml. At 10 mg/kg you will need 170 mg. This will be about 3.5 ml. If you draw up 2.5 or 3 ml, that should be enough.

Non-medical people need to be acquainted with the equipment needed for injections.

Some manufacturers dispense medications in preloaded syringes. These may be tubes with plungers that fit into holders (as in the photograph above), or they may be full syringes, complete with plungers. This kind of packaging is expensive and wasteful. However, you may encounter this kind of thing. Use the syringe and dispose of it carefully. These syringes are never reusable.

Because of the risk of transmitting diseases, disposable syringes are in vogue. On the left is a disposable syringe packaged in paper and thin plastic. On the right is a disposable syringe packaged in rigid plastic. The rigid plastic is heavier but the cap off the back side is very useful for measuring and dispensing powdered medicines.

There are several problems with disposable syringes. Buying and using them is wasteful. When you travel, your luggage allowance is very limited. You don't want to use it for transporting anything that can be used only once. Another problem is that disposing of the syringes is problematic. Poor people in developing areas are very resourceful in recycling western waste. An apparently new syringe might have been retrieved from a garbage pit, washed in swamp water, dried, and then sealed in a discarded package. Many times you cannot tell the difference.

If and when you do use disposables, collect the waste in a sturdy tin can such as a 2.5 kg powdered milk can or a gallon-sized cooking oil can. When the can is full, heat it in an oven or an outdoor fire so that the plastic and the sharps all congeal into an unusable mass. Then bury that mass or dispose of it in an outhouse.

Reusable glass syringes are the author's choice, but there are also problems. One is that they are hard to find and expensive to buy. Another problem is that they need to be cleaned promptly after each use. Once a new glass syringe is wet the first time, the glass becomes sticky. Thereafter the barrel and the plunger must be stored separately, or else the glass will seal together. Once sealed, the two parts are very difficult to separate, though it can be done. Glass syringes are breakable.

It is necessary to sew syringe envelopes to maintain sterility and for protection during transport. The cloth envelopes tend to wear out and become permanently stained. Making a set of cloth envelopes is a good project for your women's missionary society.

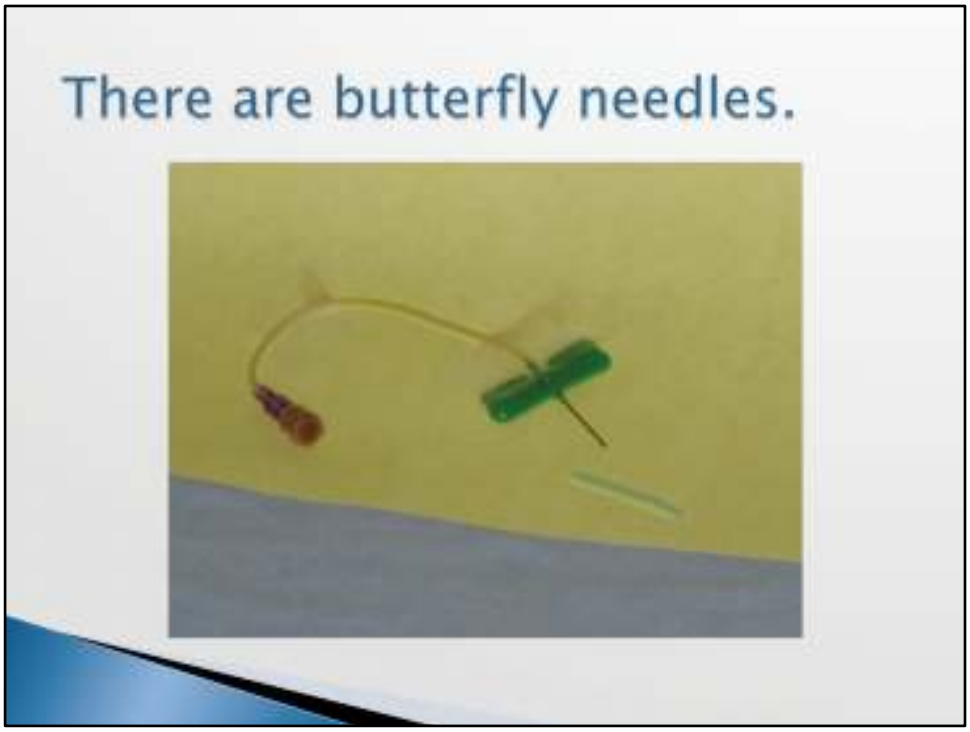
Reusable nylon syringes also need to be sterilized. They are cheaper than glass syringes, but they do eventually break down. Reportedly they can be reused 300 times before being discarded. The author has not had good fortune with these. The plunger tends to stick in the barrel. When forced, it moves suddenly. These also need envelopes to maintain sterility.

Gauge numbers run from about 13 to 27. The smaller the number, the larger the diameter of the needle. The larger diameters hurt more when they pierce the skin, but it is easier to force thick medicine through them. IV fluids run fast through large diameters, but only slowly through smaller diameter needles. The smaller diameter needles (larger numbers) hurt much less.

Gauge 13 needles are usually used only by veterinarians to inject thick medication into the hide of a cow. However, this gauge also works well when inserted into the nose end of a stomach tube made from discarded IV tubing. If you can get yourself some 13 gauge needles, do so. They are hard to find.

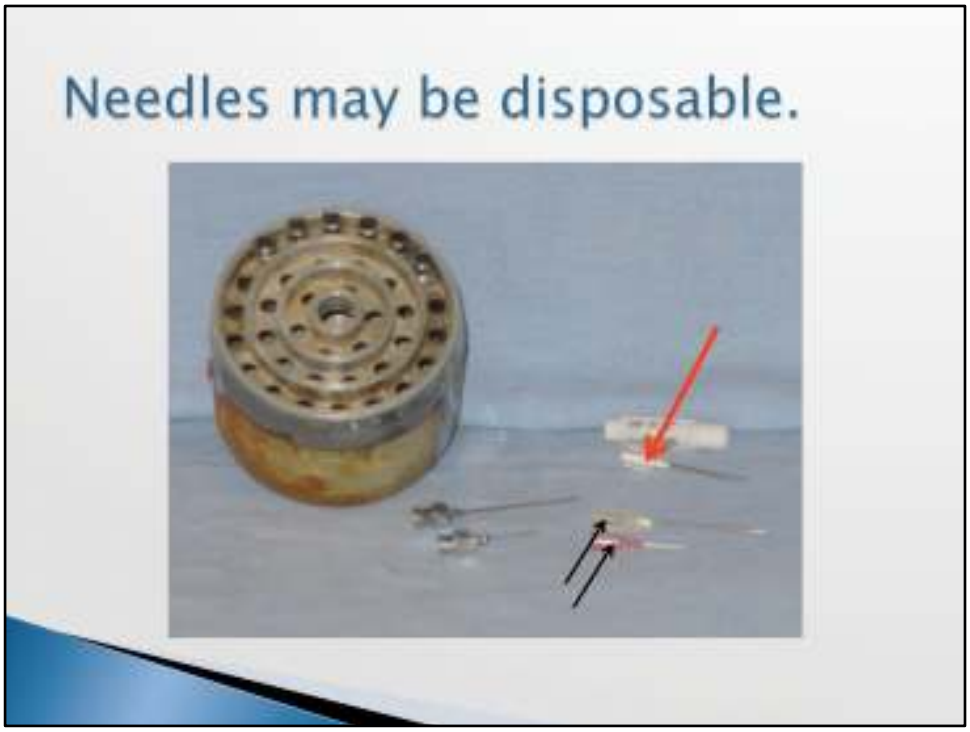
For injecting humans, the largest diameter that you will use is 16-18 gauge. These are used for giving IV fluids fast or for injecting thick medicines IM, medicines such as long-acting penicillin. For most medications, you will use 19-23 gauge needles, the 19 gauge for antibiotics that are opaque and the 23 gauge for medications that resemble water. Gauge 25-27 needles are usually used for injecting local anesthetic before suturing a cut as well as injecting small amounts of watery medication subcutaneously, right underneath the skin.

In the photograph the needles are, from left to right 16 gauge, 19 gauge, a butterfly needle of 21 gauge, and the needle on the end of the syringe, 25 gauge. In real life it



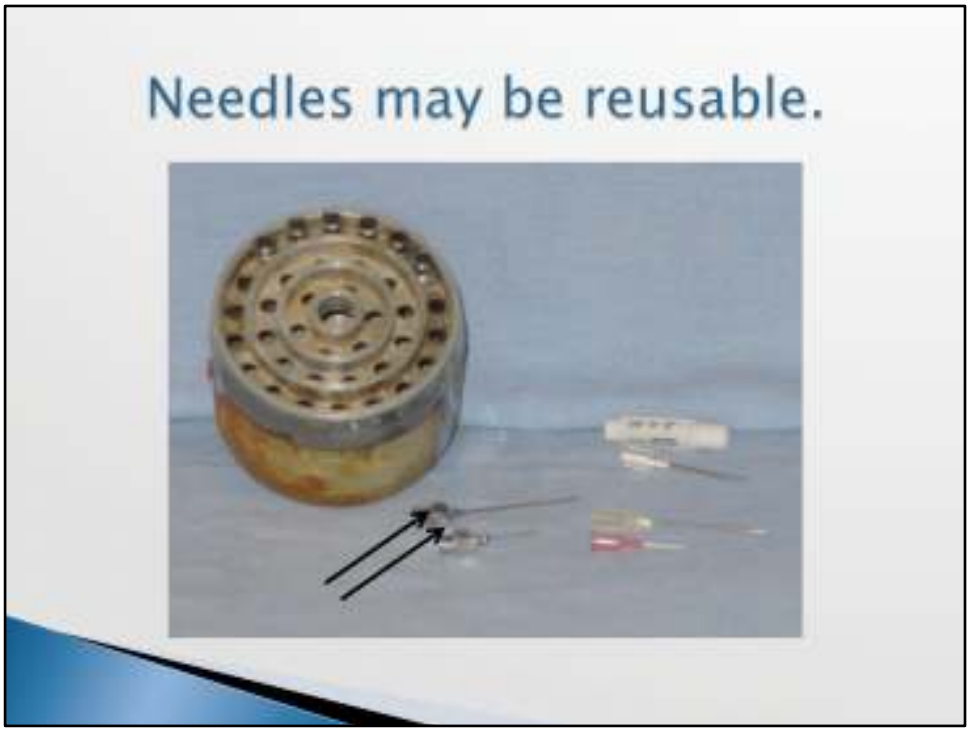
For non-medical people who want to access a vein, butterfly needles are easier than straight metal hypodermic needles. Butterfly needles have two plastic wings, in this case green. There is a short plastic tube that covers the sterile needle, in this case taken off and lying nearby. The long, flexible plastic tubing ends in a cap-type structure. In this case it is a plug that can be pierced with a needle on the end of a syringe. In other cases it is an open cap that attaches directly onto a syringe.

Generally larger gauge needles are longer and smaller gauge needles are shorter. However, this does vary. Short needles are on the order of 5/8 of an inch, or 1.5 centimeters, like the pink-hubbed needle in the photograph. Some may be even shorter. Short, fine needles are used to inject anesthetic into wounds, and they are used for medications such as insulin and epinephrine that are injected subcutaneously (right under the skin). Longer needles run about 1.5 inches or 3.5 centimeters long. These are intended for IM injections, when the medication must go deep into the muscle. Usually 19-23 gauge needles are longer. The upper needle in the photograph is 22 gauge and 1.5 inches long



Disposable needles usually attach to a syringe by means of a plastic hub. See the black arrows above They cannot be sterilized for reuse because the plastic will melt. Once in a while disposable needles will be fashioned from thin, cheap metal. See the red arrow above, pointing to the hub of the 16 gauge needle. Metal-hubbed, disposable needles can be resterilized but should not be. They become dull easily.

Be sure to dispose of used needles in such a way that no one will be accidentally stuck with one. A metal oil can with a small mouth makes a good needle disposal. If you have at least some plastic in with the needles, then heating the can in an oven or over an open fire will make retrieval impossible.



Reusable needles are made of good-quality stainless steel, so they are expensive. The black arrows point to the stainless steel hubs of two reusable needles. The top one is 22 gauge and the bottom one is 25 gauge. The container above these needles is a special, stainless steel device for holding the needles so their tips don't become dull by being thrown around. In years past these were commonplace but now these containers are hard to find.

Reusable needles must be cleaned immediately after each use by running clean water through them. If they are not cleaned, then tissue and medicines congeal inside of them, making them useless. It is very difficult or impossible to clean a plugged needle. They must be sharpened periodically but not often. They must be sterilized between each use.

Reusable needles come in boxes, usually with a dozen each of one gauge only. Within these boxes there are fine wires, used for cleaning the insides of the needles if they should become plugged. On the right side of the photograph is a single, fine wire lying on top. Underneath are bundles of wires, each bundle held together with a spiral. The spiral must be removed in order to separate and use the cleaning wires.

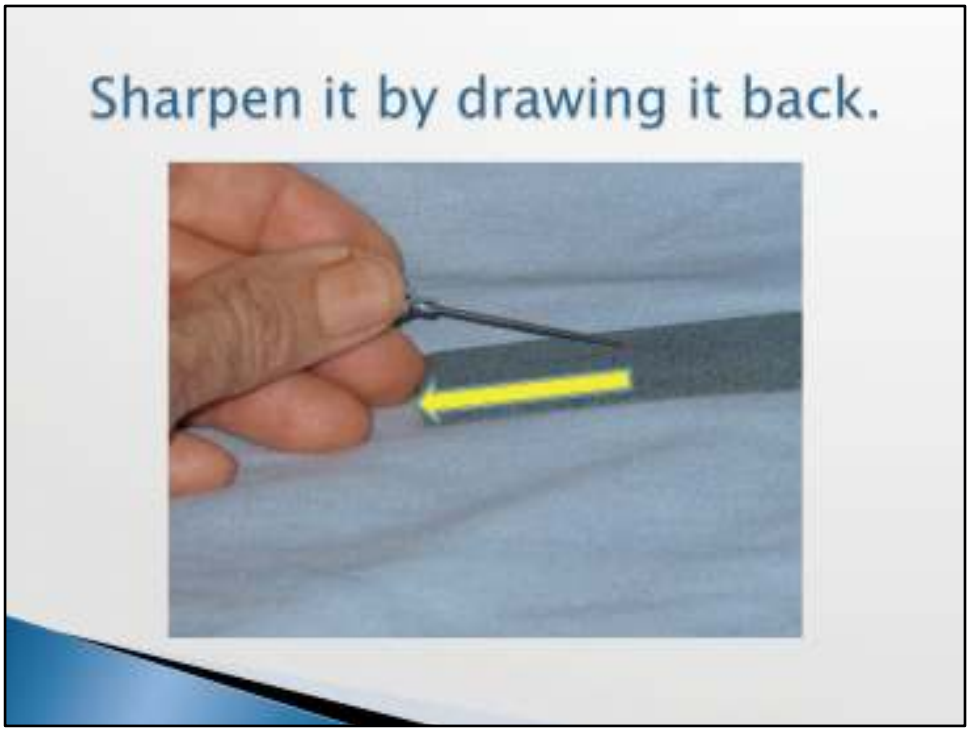
Reusable needles do eventually become dull and need to be resharpened. To sharpen a needle you need a good magnifying glass, a fine sharpening stone, and a can of oil. Do not sharpen a blood-contaminated needle; sterilize it first. There is a risk of a needlestick injury during the sharpening process. Look at a new needle and at your needle that needs sharpening.

This is a highly magnified picture of the end of a reusable needle. The length of the bevel (yellow arrow) should be about 4 times the diameter of the needle (red arrow), neither longer (6:1) nor shorter (2:1).

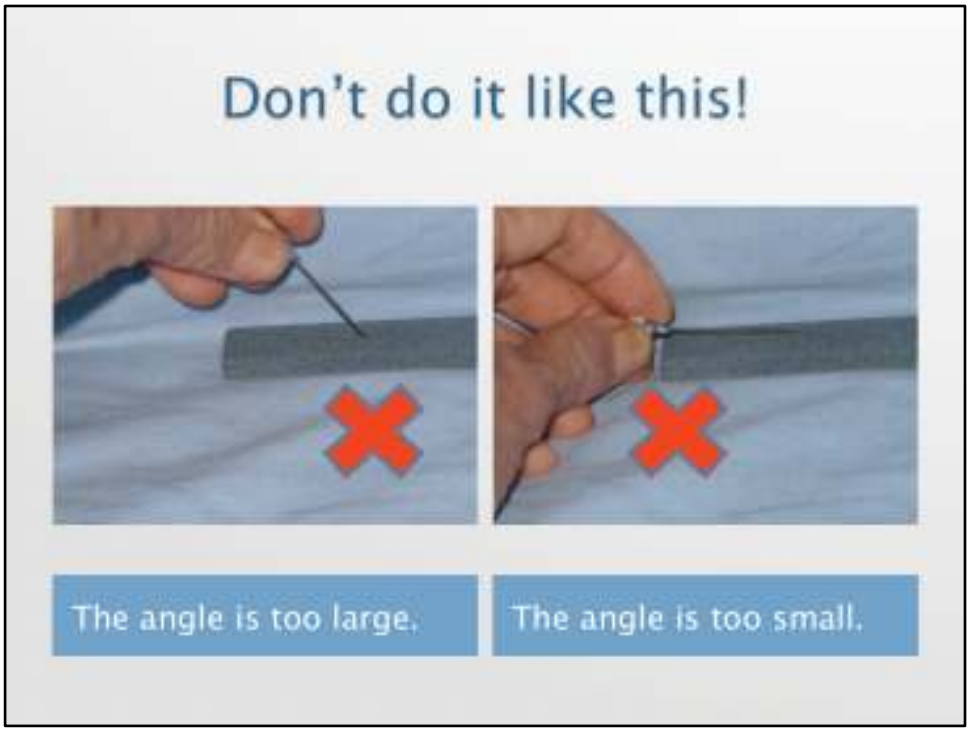
The sides of the bevel should be sharp. These edges and the tips should be smooth, without any barbs on them. Rub your finger along these parts to detect barbs.

Put a drop of oil on a fine sharpening stone. Usually small stones like the one pictured have the necessary, fine texture.

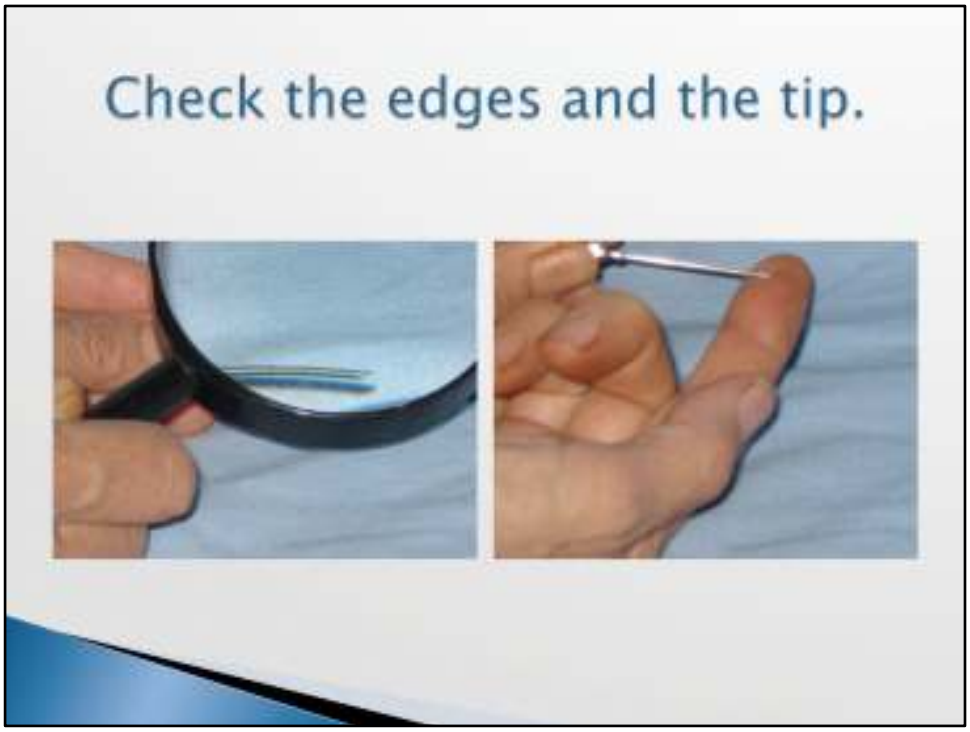
Note the angle between the needle and the sharpening stone. It is about 20 degrees.



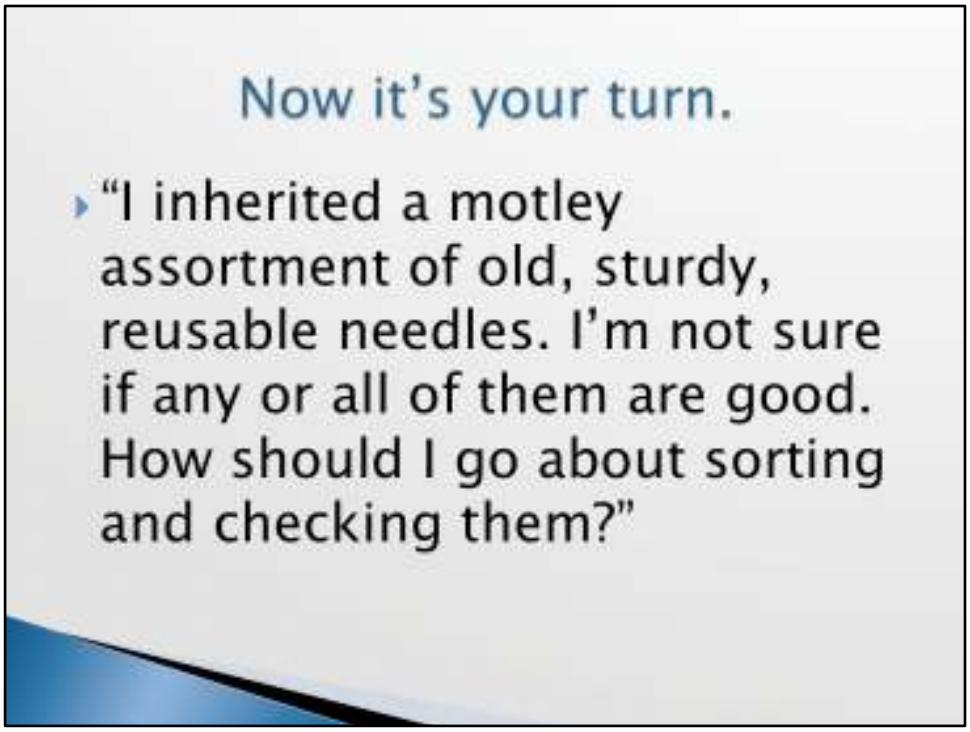
Keep the angle between the needle and stone constant as you draw the needle back to sharpen it.



The angle between the needle and stone should be about 20 degrees.



Look at it with a magnifying glass to be sure that the tip resembles the tip of a new needle. Then run the tip over your finger to be sure there are no burrs on it. If it looks and feels good, then it may be washed, resterilized, and used again.



Pause but do not read the slide aloud. Have the students discuss this and offer a solution.

First look over the needles to see if any of them are new, in the original packages. These are good for sure. Then check the others. Try to run plain water through them; set aside the ones that are plugged. They are probably more trouble than they are worth. Then check the unplugged needles to see which are sharp. You should sharpen a few needles of various sizes, so you have a selection.

Topical means applied to the surface, not swallowed or injected.

Your use of topical medications will be limited because they are expensive, bulky, and heavy. However, sometimes topicals are mandatory. The long, narrow tube in the picture is for inserting vaginal creams. The small tube on top of the box is eye ointment. The bottle with the dropper contains special drops that can be used in ears or eyes.

The large jar of brown goo is povidone iodine ointment. The container is labeled petrolatum which is the British term for petroleum jelly. A common brand name is Vaseline. Povidone iodine powder can be bought by the kilogram and mixed with the petrolatum to make a powerful antiseptic.

Topicals intended for skin are usually not suitable for eyes and ears. Both eyes and ear drums are very sensitive to commonly used topical ingredients. However, if the drug is right, eye medicine may be used in the ears. On the left is a bottle of eye drops. On the right is a tube of eye ointment. By law, eye drops and eye ointments are sold in small quantities to avoid bacterial contamination.

There is nothing more frustrating than treating a patient, noting that he has not responded, and then finding out that you have been giving him sugar pills, deceptively labeled as antibiotic.

Usually (but not always) medicine manufactured in Europe or North America is of good quality. Nevertheless, beware of generosity. The author was given some Swiss-manufactured medicine that was badly defective; the donor was using the author as a convenient garbage disposal. I used precious luggage allowance to transport sugar pills to Ethiopia; my patients suffered an inordinate delay in effective treatment as a result. Some medicines manufactured in Asia are good, and some are defective. Usually a national from the country in question can tell you if a particular manufacturer is reliable or not. The level of honesty of the individual and your relationship determines whether you will hear the truth or not.

This picture compares two specimens of the same drug, the left of Asian origin and the right of Western origin. The drug is, by its nature, brown; there is no added color. Both specimens were labeled 300 mg. You can see that the specimen on the left is a much lighter color than the one on the right. There was probably less than 100 mg of the drug in the Asian tablets, labeled as containing 300 mg. In particular, drugs manufactured in India, China, and Africa are highly suspect. However, if these drugs are purchased from the UK or the States, then they may be acceptable, having passed Western import controls.


THE END
Questions, comments, and
suggestions are welcome.
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