Continuing Education:
Otoscopes

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continuing education

An otoscope is one of the most important pieces of equipment that hearing care providers will use on a routine basis.

Founded in 1992, Oaktree Products is a global multi-line distributor of audiology and hearing instrument supplies located in St. Louis, Missouri, currently providing over 3,200 items to audiologists, hearing instrument specialists and other professionals worldwide. In addition, Oaktree Products serves as a resource to the hearing industry and to hearing health care professionals providing education, training and general information in a variety of areas including infection control, hearing assistance technology and cerumen management. This particular article is on the topic of otoscopes, and this is a device that is certainly part of our catalog offering. An otoscope is one of the most important pieces of equipment that you will be using on a routine basis.

It is a device that is specifically designed to provide illuminated magnification of the ear canal and tympanic membrane, and as such, allows you to see what you need to see in order to do your job. Whereas the basic otoscope design has not changed that much over time, the quality of otoscopes has, and these quality improvements owe themselves to new developments in either enhanced functionality, new and improved technology or both. Since an otoscope is a tool commonly used by hearing health care providers and represents a standard investment that many clinicians personally pursue, the first thing to appreciate about otoscopes is that you essentially get what you pay for.

Whether it is at the level of the battery light source or actual otoscope design, the more advanced the technology integrated within the otoscope, the more expensive the cost of the otoscope. Certainly this does not mean that you have to spend a lot of money to purchase a quality otoscope. Rather, the purchase decision must be based on what one needs the otoscope to do, and to balance that with how you want your otoscope to perform. So by appreciating the advantages of different technologies that are currently available, you will be able to make the most informed decision in terms of which otoscope is the best fit for your specific needs.

With that in mind, the objectives of this article are as follows. First, to become acquainted with the general types of the more commonly purchased or used otoscopes; second, to address relevant technological factors associated with various otoscope components, including otoscope head options, light source

and bulb considerations, and battery technology; and finally, we will look at different otoscope models in order to understand the technology options and corresponding benefits of each.

What's in an Otoscope?

The most commonly used otoscopes generally fall into one of three different groups or types, according to their general design. The nomenclature used to identify general types remains somewhat arbitrary, and the purpose is not to establish some standard otoscope classification category. Rather, the intent is to establish a foundation from which we can expand upon as we discuss otoscopes in further detail. So with that in mind, the first general type of otoscope is the pocket otoscope. The second type is referred to, or may be referred to as the full-size otoscope. And finally we have a third general type of otoscope referred to as the video otoscope.

Without taking into account any technical considerations and simply taking these otoscope types that at face value, otoscopes get increasingly more expensive across types: a pocket otoscope will start out at slightly more than $100; a full-size otoscope will start out at about $250; video otoscopes traditionally start out at about $1,000. Keep in mind, this is a very general rule of thumb as there will be instances where a pocket otoscope will cost as much, if not even more, than a full-size otoscope. There will be other situations where a full-size otoscope can cost more than a video otoscope.

Regardless of the specific type, otoscopes are typically comprised of several standard components. On the outside are two basic components that are evident (Figure 1).

Figure 1. Traditional pocket otoscope, featuring external components.

First we have the otoscope head, which contains the eyepiece, and basically provides a magnified view of the tympanic membrane, ear canal and other structures of interest. It is also responsible for funneling light into the ear canal, which provides the necessary illumination in order to view the structures of interest. Second, we have the handle of the otoscope. Obviously this is the part of the otoscope held by the clinician during otoscopy. The handle shown in Figure 1 also comes equipped with an on/off button that will turn the illumination either on or off.

Figure 2. Handle of a full-size otoscope.

With full-size handles as seen in Figure 2, the power is turned on, usually by pressing down on a button that's located on the handle, keeping that button depressed, and then moving the button and that portion of the otoscope associated with that button in a clockwise direction. For pocket otoscopes, the on/off is usually an up/down sliding switch, as shown in Figure 1.

The inside of the otoscope houses two important components that we typically do not see. First, we have the batteries or battery, which is responsible for powering the otoscope and the batteries will reside within the handle of the otoscope. Second, we also have a light source in the form of a bulb that is located inside the head of the otoscope, although the exact position will differ according to the specific type of technology integrated in the otoscope. Let's take a look at each otoscope type in a little bit more detail.

Pocket Otoscopes

As the name suggests, pocket otoscopes were intentionally designed to be carried in the pocket of a lab coat. Therefore, they are smaller and lighter than full-size and traditional video otoscopes. Many pocket otoscopes are equipped with a clip on the handle so that you can keep the otoscope fixed in the pocket of a lab coat, shirt or blazer.

Most pocket otoscopes rely on the use of disposable batteries to power the light source, usually requiring two AA alkaline batteries, although there are some pocket otoscope models that come equipped with special handles

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that will accept rechargeable batteries. Rechargeable configurations typically require the additional investment of a desktop charger, however. The AA batteries in a pocket otoscope are going to reside in the handle of the pocket otoscope. The battery compartment can be accessed simply by unscrewing the cap located at the bottom on the handle. The head of a pocket otoscope may also be detached by unscrewing the head from the handle. For some specific pocket otoscope models, it will be necessary to unscrew the head in order to access the bulb when the bulb needs to be replaced.

One limitation of pocket otoscopes is that once you have invested in one, you are now married to the technology of the purchased otoscope. Pocket otoscopes were not designed to offer interchangeable components. So in other words, if a company comes out with a new pocket otoscope that has a new, advanced battery technology in the handle, you will not be able to simply buy that new handle and attach it to your existing otoscope head. It will be necessary for you to reinvest in a completely new pocket otoscope in this case. Unlike pocket otoscopes, full-size otoscopes are much more substantial in size and weight, and as such, they inherently offer more flexibility in terms of component options.

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Full-size Otoscopes

Full-size otoscopes are also comprised of a head and a handle. However, unlike pocket otoscopes, both the head and the handle of full-size otoscopes are interchangeable. That interchangeability has been made possible by a handle feature that was developed by Welch Allyn many years ago called the interlocking tool. As the standard feature on full-size otoscope handles, the interlocking tool allows the attachment of different otoscope heads to the same handle. For example, if you previously purchase one handle and head combination from Welch Allyn, you can replace the original Welch Allyn head with a completely different Welch Allyn head that will now fit on your original handle. A full-size otoscope head for most other manufacturers will also be compatible with the original full-size handle. So in other words, a full-size otoscope head from Heine, for example, can also fit onto the original Welch Allyn full-size handle.

Furthermore, this level of interchangeability also applies to full-size handles. Different full-size handles from the same or from other manufacturers may be attached to your original full-size otoscope head. So the immediate benefit of full-size otoscopes over pocket otoscopes is the inherent flexibility that full-size otoscopes offer, allowing you to take advantage of new technology as it is developed, or as your needs change by allowing you to upgrade specific components, rather than requiring a reinvest in an entirely new full-size otoscope.

From a practical or financial perspective, this also does save you money. Unlike pocket otoscopes, the majority of full-size otoscopes will be powered by a rechargeable battery, rather than the disposable alkaline batteries. The main advantage of this configuration is the convenience of being able to recharge the battery every night by plugging the otoscope handle into a standard wall outlet, rather than needing to worry about maintaining a supply of replacement alkaline C or D batteries. As with pocket otoscopes, the rechargeable battery will reside in the handle of the full-size otoscope. However, there will be two aspects of the full-size handle that will occasionally need to be accessed.

First, it will be necessary to access the portion of the handle that plugs into a standard wall outlet so that you can recharge the battery. Second, although not as often, it will be necessary to access the actual battery compartment so that the rechargeable battery can be accessed and replaced when it needs to be. Figure 2 shows the Welch Allyn 71000-A rechargeable handle. In order to recharge the battery that is in otoscope handle, unscrew the handle at mid-point at the black ring to reveal the hidden outlet prongs, and then plug the handle into a standard wall outlet. To access the actual rechargeable battery, unscrew the cap located at the bottom of the handle, and this will gain you access to the physical rechargeable battery. This sounds straightforward, but there are some subtle idiosyncrasies associated with the design of most full-sized handles that can lead to a lot of confusion. Going back to the situation where we want to access the prongs to recharge the handle, the instruction was simply to unscrew the handle at mid point. However, if the handle is not unscrewed at the precise midpoint

junction, rather than gaining access to prongs, unscrewing the handle at midpoint will reveal the upper portion of the battery compartment. It is not uncommon for us to get a call from a customer inquiring as to how to recharge the handle because every time they unscrew the handle, they are accessing the top of the battery compartment rather than the prongs. The key is to take note of the black ring that is associated at a midpoint of the handle. Unscrewing the otoscope handle above the black ring will expose the prongs that are needed to recharge the battery. Unscrewing the otoscope handle below the black ring will expose the top portion of the rechargeable battery. This configuration may differ slightly from one handle model to another, as well as from manufacturer to manufacturer, although the same design idiosyncrasies seem to apply across the board.

Video Otoscopes

The third type is the video otoscope. A video otoscope is designed to interface with a monitor, whether a TV screen or, more commonly today, a computer screen, via a cable connection that extends from the head of the video otoscope to the monitor. The image is transmitted from the otoscope directly to a video output on the monitor.

Video otoscopes offer the advantage of projecting the tympanic membrane in a larger manner, offering a much more detailed view of subtle structures. Unlike other otoscopes, video otoscopes are also designed to capture images. One of the benefits of this feature is that the integrity of the ear canal and tympanic membrane can be documented prior to and immediately following clinical procedures such as cerumen removal. It also enables image sharing for educational or consulting purposes. Beyond just taking image snapshots, most video otoscopes also provide the

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ability to record video up to a couple of minutes and to save that information as a video file for future viewing.

Technologically Advancing

Now that we have a better understanding of the basic otoscope categories, the second objective is to address the relevant technological factors related to different otoscope components. Specifically, we will review various otoscope heads, light source technology, as well as power source options.

In terms of otoscope heads, there are four primary types of otoscope heads. The first general type is the diagnostic otoscope head (Figure 3), initially designed for traditional otoscopy, providing illuminated magnification of the tympanic membrane. It is comprised of a wide angle-viewing lens, usually with 2.2 times magnification. Although lenses with higher levels of magnification are available, and you can simply slide the lens out to replace it.

Figure 3. Standard full-size otoscope head.

Figure 4. Pneumatic otoscope head.

Next is the pneumatic otoscope head (Figure 4). This otoscope head was specifically designed to not only provide illuminated magnification of the tympanic membrane, but to enable observation of tympanic membrane movement. It is comprised of an eyepiece, but also has a protrusion on the neck of the pneumatic otoscope that accommodates an insufflator bulb, which may be used to introduce puffs of air into the ear canal, thereby allowing observation of tympanic membrane movement. Most manufacturers have incorporated a connector for the insufflator bulb on diagnostic heads, eliminating the need to have to specifically invest in a pneumatic head to perform pneumatic otoscopy. The conventional pneumatic otoscope also has a viewing lens. In Figure 4, the lens of this particular example swivels open, rather than sliding from side to side.

Figure 5. Operating otoscope head.

The third traditional type of otoscope head is the operating otoscope head (Figure 5). This head looks most different from the rest of the otoscope heads because of its open-system design. There is a lot of open space that exists between the eyepiece and the tip of the otoscope head where the speculum is attached. By removing the speculum, the operating head otoscope becomes extremely useful for applications that not only require magnification, but also involve the insertion of instrumentation into the ear canal, including cerumen removal or deep insertion of ear dams for impressions. This open design does not limit you in terms of the instrument's range of motion when it is inserted into the ear canal. Conversely, one of the challenges associated with this otoscope head is the relatively small size of the viewing lens, which you can see at the left side of Figure 5. This is a much smaller viewing lens than what the clinical audiologist is used to seeing in a pneumatic or an operating head otoscope. It takes just a little bit of practice in order to acclimate to the smaller lens.

Figure 6. Video otoscope head and computer monitor.

Finally, the fourth type of otoscope head is pictured in Figure 6, which is the video otoscope head. Video otoscope heads do not come equipped with an eyepiece. Rather, there is a cable that extends from the head of the otoscope, and at the other end of that cable is usually a USB or other type of standard connection that allows it to interface with the monitor or computer, so that the tympanic membrane

and other structures can be viewed on a screen rather than through an eyepiece. With a better appreciation of otoscope head options, let's move on to light source technology.

The Light at the End of the Speculum

The light source of an otoscope comes in the form of a bulb, although the type of bulb can be one of several including incandescent, halogen, xenon, and now LED lights. To appreciate the advantages of the different bulbs, it is important to have a basic understanding of how each of these different light bulbs actually works.

Imagine in your mind a traditional incandescent light bulb, the one comprised of a metal base that makes contact with an electrical circuit. The metal base screws into a lamp, making contact with the lamp's electrical circuitry. Two stiff wires extend from the base, and they attach to a very thin metal filament. This thin metal filament is comprised of a long and incredibly thin piece of tungsten metal that is actually about six-and-a-half feet long. But because it is coiled, the wire only takes up about one inch of space in a traditional light bulb. When you look closely at a light bulb, the filament sits in the middle of the bulb held up by a glass mount, which is supported by some thin support wires. The wires in the filament are housed in a glass light bulb, which is filled with an inert gas such as argon. While this is a complete oversimplification, when the bulb is hooked up to a power supply and electrical current flows through the wires and the filament, the filament heats up which produces incandescence, the emission of a visible light given off by a very hot object.

Incandescent light bulbs have a relatively short life span, and since the heating the tungsten filament gradually causes the tungsten to evaporate over time, the filament will become thin. When it becomes really thin, it snaps, resulting in a burned-out bulb. Because of this design, incandescent bulbs tend to fade in terms of the strength of the illumination over the life of the bulb prior to it burning out. Halogen light bulbs are actually a refined version of the standard incandescent light bulbs. They are similar to incandescent lights in that they also contain a tungsten filament. However, halogen bulbs utilize different bulb construction and elements to achieve longer bulb life and a distinctively brighter glow.

In halogen light bulbs, the bulb is filled with a halogen gas such as bromine or iodine. As the tungsten filament is heated to higher levels than the incandescent light, the halogen gas actually recycles the tungsten and deposits it back on the filament, which then extends the life of the bulb significantly. Since halogen bulbs must run at a hotter temperature than a normal incandescent bulb, the filament is actually encased in a small sheet of quartz, rather than the glass mount that you see in incandescent bulbs. Because of that small quartz sheet, the bulb does not feel as hot to the touch when compared to an incandescent bulb.

Unlike incandescent and halogen light sources, xenon bulbs do not contain a tungsten filament. Instead, xenon bulbs generate light from an electrical discharge between two electrodes that are contained in an environment of xenon gas, all of which are hermetically sealed in a tiny quartz capsule. A xenon bulb also consists of a fused quartz that is filled with xenon gas and contains tungsten metal electrodes at each end. Light is generated by the electrically energized gas that is formed and sustained between the two electrodes. Xenon lights do not rely on filaments to generate light, so they last much longer than incandescent as well as halogen light bulbs.

Lastly, we have light emitting diode, or LED lights. As with xenon bulbs, LED lights do not contain filaments, so they, too, will last for a much longer time than incandescent or halogen bulbs. Because there is no filament, LEDs do not get hot, and they require far less power to illuminate. What makes an LED light unique is that the bulb is actually comprised of a chip that fits directly into an electrical circuit, requiring far less power than the other bulbs to illuminate. Consequently, they are a much more efficient source of light. Now that we understand the differences of how different light bulbs work, we can compare them across several parameters that make sense, including illumination, color, and burn.

Illumination refers to how bright of a light the bulb is going to generate. Obviously, the brighter the better. Whereas incandescent lights are dull and not as bright, halogen, xenon and LED lights shine bright, brighter, brightest, respectively, providing increased illumination at the ear canal. Older otoscopes tend to incorporate

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incandescent technology, whereas newer ones rely mainly on halogen or xenon bulbs, with LED being relatively new to the otoscope scene. Incandescent lights give off a dull white color, while halogen bulbs emit more of bluish-white color. In contrast, xenon emits a really, really bright white light. LEDs are interesting because they are available in a variety of colors, but the most difficult color to create via LED is a pure bright white LED.

Most LED bulbs are white in color, but they do not generate a pure white color. Rather, they generate more of a bright whitish-blue. Since LEDs are available in a variety of other colors such as red, yellow and green, and since different colors absorb different amounts of light, future advancements in otoscope technology may provide the ability for us to change the color of the illumination during otoscopy so that we can basically enhance different ear canal and tympanic membrane structures more effectively.

We also have to consider burn. Burn simply refers to the amount of heat that the bulb is going to generate when it is on, or more specifically, how hot is an illuminated instrument when held.

Incandescent lights tend to burn very hot, whereas halogen remains cool because of the quartz encasement that was previously mentioned. Xenon bulbs, even though they do involve a quartz encasement, tend to burn more because of the way that the light is generated, whereas LED tends to burn cool. Ideally, you want something that burns cool so that the head of your otoscope does not become warm during otoscopy. The amount of time that you have an otoscope in someone's ear may not be sufficient for this to factor into the equation. However, it is something to keep in mind if you intend to use an otoscope for procedures such as cerumen removal that may require you to have an otoscope head in somebody's ear for five to ten minutes.

Beyond the type of bulb that is used in an otoscope, the technology used by the otoscope to direct the light from the otoscope will involve either fiber optic or non-fiber-optic technology. Non-fiber optic technology involves illuminating the ear canal by directing the light emitted by the bulb directly from the otoscope head into the ear canal. Fiber-optic technology also involves illuminating the ear canal via the light emitted by the bulb. However, rather than the actual bulb directing the light from the otoscope head, the light is directed from the otoscope head via fiber-optic cables. A fiber-optic cable consists of a bundle of optical fibers made of extremely fine quality gas.

An optical fiber is as thin as a strand of a hair. When a ray of light travels in such a narrow path, the concentrated light travels in a very straight path which causes very negligible loss of light intensity, allowing the light to reach its destination in a highly concentrated manner. This translates into the provision of an extremely enhanced quality of light and improved visibility and clarity of the external auditory canal and tympanic membrane. The easiest way to tell whether or not an otoscope is non-fiber optic or fiber optic is to look into the eyepiece of the otoscope and take note of what you see.

Non-fiber-optic otoscopes need the bulb to be positioned on the floor of the otoscope head. As such, the bulb is going to be in clear view through the eyepiece. In contrast, fiber-optic otoscopes will not have a bulb positioned on the floor of the otoscope head, and therefore, you will have a clear view of whatever it is that you are looking at through the eyepiece. The obvious advantage is that fiber-optic otoscopes offer an unobstructed view of the tympanic membrane. Since fiber-optic technology offers superior light-source technology and an unobstructed view of the ear canal, fiber-optic otoscopes rend to cost more than non-fiber-optic otoscopes.

From a more practical perspective, one of the most common questions that comes up regarding light sources is how to access the light bulb of the otoscope so that it can be changed out. In the case of the non-fiber-optic otoscope, the bulb is accessed by simply moving the eyepiece out of the way, and then manually removing the bulb from its holding place and replacing it. In the case of fiber-optic otoscopes, since the bulb is not located behind the eye piece, in order to access the light bulb, you will need to unscrew the otoscope head from the handle and the bulb is going to be located at the bottom of the otoscope head. You would need to manually remove the bulb.

In terms of power source, otoscopes may be considered hard-wired or battery operated. A hard-wired otoscope is usually part of a wall-mounted diagnostic set, and it involves having the otoscope physically attached to the wall unit via a cord. Hardwire systems are designed to reside in the room that they are installed in, with limited to no portability in these types of instru-

ments. Battery-operated otoscopes are more popular, and they rely on the use of a variety of batteries to power the handle, including alkaline batteries. More commonly, however, you will see some form of a rechargeable battery. Some handles have been designed to accept either alkaline or rechargeable batteries, but you will have to invest in additional components to get this type of flexibility.

Battery Life

There are three general types of rechargeable batteries including nickel cadmium or NiCd, nickel metal hydride, and lithium ion. To appreciate the differences between the three, let's compare them across memory effect, capacity and discharge rate. By doing this, we can appreciate the difference in cost as well.

Of the three battery technologies, NiCd batteries are prone to what is referred to as a *memory effect*, whereas the other two are not. Memory effect refers to a battery's inability to remember how much reserve capacity it has left prior to getting recharged. In other words, if you are using your NiCd battery to a point where only 60 percent of the battery's capacity has been used, and you then decide to charge it, the battery is going forget that it still has that 40 percent available in reserve. So when you go to recharge the battery, it will only recharge the 60 percent and will completely forget that it still had another 40 percent to use. So if you invest in a NiCd otoscope handle, what you want to do is make sure you fully use the NiCd battery prior to fully recharging it. So instead of recharging it overnight every night, you basically do it once a month. Capacity basically refers to the amount of power the battery contains.

Both the nickel metal hydride and the lithium ion batteries maintain a higher capacity than NiCd batteries, with nickel metal hydride delivering about 30 percent greater capacity than the NiCd, and lithium ion providing way more than either of the two. This translates to an increased run time for the batteries with higher capacities without the additional bulk or weight. So NiCd batteries not only have a smaller power capacity, but the battery itself is going to weigh a lot more than the other two.

Discharge rate refers to how quickly a battery extends its capacity. By far, lithium ion batteries have much slower discharge rates than the other two, and will therefore retain their charge for about twice as long as the other two. In addition, lithium ion batteries will retain most of their charge even after months of no use. In contrast, the nickel metal hydride and the NiCd batteries can lose anywhere from 1 to 5 percent of their charge per day, respectively, even if the battery is not being used. Based on the advantages of the lithium ion battery, it should come as no surprise that you will pay more for the better battery technology. Lithium ion batteries tend to cost twice as much as NiCd batteries.

Putting it Together, Piece by Piece

Now that we have a more thorough understanding of otoscope technology, let's put it all together by dissecting some otoscope models. We will approach this from the perspective of reviewing the more common otoscopes in which we see our customers invest, and present it as a function of purchase trends that occur as providers transition through different stages of their career.

Figure 7 shows an image of the Heine Mini 3000 Series Non-Fiber-Optic Pocket Otoscope. This is one of the more popular otoscopes purchased by students and newly licensed professionals, not only because it is a good otoscope, but because of the relatively low price point. This particular otoscope will cost about $130. As a pocket otoscope, it is light and easy to carry around. But the more important question to ask is, what are you actually getting for this $130 investment? The head of this pocket otoscope is the traditional diagnostic head, although it does offer magnification of 3 times rather than the standard 2.2 in some other full-size heads.

Figure 7. Heine Mini 3000 pocket otoscope.

Furthermore, you are also getting a xenon light bulb that will provide a very bright white light. In terms of illumination, the xenon bulb generates a brighter light than both the incandescent and the halogen bulbs, and it is going to last longer than either one

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of those two types of bulbs. Since this is a non-fiber-optic otoscope, the location of the bulb will be positioned on the floor of the otoscope head, so when you look through the eye piece the bulb will partially obstruct your view of the ear canal and tympanic membrane during otoscopy. As a pocket otoscope, it is also powered by two AA disposable alkaline batteries, which reside in the handle. The main reason this otoscope is available at such an attractive price is because of its non-fiber-optic design and the fact that the battery technology is inexpensive.

The Heine Mini 3000 Fiber-Optic Pocket Otoscope looks identical on the outside as the non-fiber-optic otoscope in Figure 7. However, this otoscope costs about $100 more. So why are we paying $100 more for this particular otoscope? First and foremost, in terms of the otoscope head, you are getting the same diagnostic head as the previous one. The light source remains the same in the form of a xenon bulb, which will illuminate in a very bright white capacity. It also runs on two AA batteries. The only difference between the two otoscopes is the fiber-optic light source. As previously outlined in this article, the fiber-optic otoscope will deliver light from the bulb via fiber optic cables, which translates not only to a more robust illumination, but also provides a completely unobstructed view of the ear canal and the tympanic membrane during otoscopy.

When you simply flip through a catalog of otoscopes, sometimes it s hard to appreciate why fiber-optic otoscopes cost more. If price is a factor in the decision making process, the Mini 3000 Non-Fiber-Optic Otoscope is still a really good investment. If price is not that big of an issue, you will need to determine whether or not it makes sense for you to spend the additional $100 for the advantages that are offered by fiber-optic technology. As providers grow in their hearing health career, otoscope tastes and needs tend to change, and they are not driven so much by cost as they are by the fact that they want an otoscope that has a little bit more meat on it than a pocket otoscope.

In this situation, there is a tendency to gravitate towards full-size otoscopes. As with pocket otoscopes, full-size otoscopes are comprised of a head and a handle, and they are usually sold as a complete set. Keep in mind, however, that one of the advantages of a full-size otoscope is the fact that you can interchange the head and the handle. One very popular full-size otoscope combination is the Welch Allyn Full-size Diagnostic Otoscope specifically

comprised of the 71000-A rechargeable NiCd handle (Figure 2), and a diagnostic otoscope head (Figure 3). Individually, this particular handle in Figure 2 will run about $170, and the diagnostic head will be about $150. If you buy it as a set, the combination will run you about $260, which saves you about $65. Now $260 is more than either of the pocket otoscopes, so what are we actually getting for $260?

First of all, the head of this full-size otoscope is a traditional diagnostic head with a magnification piece that offers 2.2 times magnification, slightly less than what is offered with the other pocket otoscope. The type of bulb that is used in this specific combination is a halogen bulb, which will provide you with bluish-white illumination, and perhaps not as bright as the xenon bulb that we saw with the pocket otoscope. In addition, the halogen bulb will not last as long as the xenon bulb, so you may have to replace this bulb a little bit more often. As a full-size otoscope, this particular Welch Allyn is fiber optic, which will provide you with an unobstructed view through the eyepiece.

At this point you may be asking yourself, why am I paying $30 more for this full-size otoscope over the fiber-optic-pocket otoscope? Well, one big reason is that this full-size otoscope comes equipped with a rechargeable NiCd battery that is housed within the handle. So rather than needing to replace the alkaline batteries periodically, the NiCd battery can be recharged by unscrewing the handle at midpoint and plugging the handle into a standard wall outlet. Basically, the extra money is for the rechargeable battery. A second reason you will pay more for this full-size otoscope over the pocket otoscope is that the handle of this full-size otoscope comes equipped with that standard interlocking tool, providing you with the ability to change out the originally-purchased otoscope head with a different otoscope head. For example, often times we talk to audiologists who, just a few years ago, purchased the 71000-A handle as well as the diagnostic head. They are very happy with it, but have since expanded the scope of services that they provide, and they are looking for additional otoscope options. In many cases, an audiologist or hearing aid

specialist permitted by state law, gets more involved in cerumen management, and realizes that while they like to use this full-size otoscope as the magnification and light source for cerumen removal, they feel that the diagnostic head is perhaps not the most appropriate choice in these situations, and would rather use an operating otoscope head. So instead of paying $310 for a new operating head as well as a handle, the only thing they have to invest in is the actual operating head, which saves money in the long run. For $200 you can basically upgrade your otoscope to include the new piece.

As you get a few more years under your belt, one of the comments heard over the years was the need to have an otoscope that would provide greater magnification, particularly for those who are over 40 and suddenly find themselves in a position where the eyesight is not as sharp as it used to be.

Figure 8. Welch Allyn Digital MacroView otoscope head.

Several years ago Welch Allyn came out with a solution in the form of a Digital MacroView Otoscope head that you see in Figure 8. The head does look like a diagnostic otoscope head, although it is a little bit bulkier. The reason it is bulkier is because it actually provides twice the field of view, and about 30 percent greater magnification than traditional diagnostic otoscope heads. It is also equipped with a focus control that enables you to adjust the focus for variable ear canal lengths, or for anyone who may be far sighted. It also has an ejection feature that releases the speculum for disposal without actually having to touch the speculum.

The other nice thing when you invest in a full-size otoscope set, rather than having to buy the full-size otoscope all over again, for $260 you can basically invest in the Digital MacroView head which will fit your original 71000-A handle. Keep in mind that the same flexibility that we have seen in changing out otoscope heads also applies to handles.

For example, seven years ago as a young practitioner, you purchased this Welch Allyn 71000-A diagnostic handle (Figure 2), and then you purchased the MacroView head (Figure 8). Suddenly you realize that over the years you have become annoyed with the fact that the NiCd battery in your original handle has not maintained its charge very well. In addition, you may be using your otoscope for cerumen removal, and the weight to the handle sometimes makes it difficult for you to maintain an advantageous position of your light and magnification source without needing to do a lot of positioning and re-positioning of the otoscope. One solution would be to replace the 71000-A handle with a lithium ion rechargeable handle (Figure 9). This is specifically the Welch Allyn model 71900, which is the lithium ion rechargeable handle.

Figure 9. Welch Allyn lithium ion otoscope handle.

Video Otoscopes

Video otoscopes were originally introduced in the late 1980s and provided the advantage of being able to view the ear on a monitor screen. So the larger the monitor you had, the larger the image was. This allowed clinicians to view the subtle ear structures in greater detail. It also provided the ability to record and capture images. However, when they were first introduced to the market, these video units were very expensive, costing about $20,000. A few years later, a less expensive version came out at around $1,000. However, the only thing that you were buying was the otoscope head. These packages did not include a monitor or otoscope handle, which you needed to attach to the head to make the system functional. In addition, if you wanted to capture the picture, you had to invest another $1,000 for the software to capture the images.

Fortunately, in recent years, there have been huge advancements in the video otoscope line that have made

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these otoscopes relatively affordable. Figure 8 is the Welch Allyn MacroView that is available in a diagnostic head, but also in a video otoscope capacity (Figure 10). This Welch Allyn MacroView represents one of the most significant advances in otoscope technology in recent years. As previously mentioned, it provides twice the field of view compared to standard otoscope heads. This allows visualization of the tympanic membrane and the surrounding tissues without have to manipulate the otoscope around.

Figure 10. Welch Allyn MacroView video otoscope head.

The new video version means that for about $1,200, you can purchase a video otoscope that gives you the same quality as a $4,000 or $5,000 unit. This $1,200 includes the otoscope head and the 10-foot USB cable; the handle is not included, but typically runs an additional $170 to $350. The USB cables plugs into a laptop or computer. On the back of the head are two different buttons. One is an image-capture button and the other is a zoom feature. This is a plug-and-play system, so there is no additional software required. The other nice thing is that you can save, copy, e-mail, delete, rotate, enlarge, draw, and write on pictures. The pictures that ou take can be stored as files on your hard drive as JPEG, TIF, BMP, or PNG files. This video otoscope system is compatible with Windows XP or newer.

Another more affordable series is the Dino-Lite. Figure 11 shows the original version of the Dino-Lite. There are two versions, including the original in white and also a newer high-resolution version available in black (Figure 12). This is an amazingly affordable, handheld video otoscope that also uses a USB connection to interface with a laptop or PC. So what are the differences between the two versions? Well, a picture is worth a thousand words. First and foremost, there is a difference in price. The original Dino-Lite costs about $250, but if you think about it, this is the first video otoscope available at that price point. It is unbelievably inexpensive compared to other previous options. In contrast, the high-resolution unti is significantly more expensive at just under $1,000.

Figure 11. Dino-Lite digital video otoscope.

Figure 12. Dino-Lite high resolution video otoscope.

The other difference between the two Dino-Lite versions is the field of view. The original Dino-Lite projects an image that includes a large amount of black on the screen. The high-resolution Dino-Lite provides a field-of-view on the screen that is significantly bigger. Both versions use LED lights, which allows you to introduce the otoscope into the ear canal and provide a very bright illumination to the canal and tympanic membrane, however, the original Dino-Lite uses four lights while the high-resolution Dino-Lite uses six, which results in a brighter picture.

Summary

There are many quality otoscopes available at price points that can fit any audiologist's budget and skill level. The price and function of each otoscope is dictated by different technological factors. Consider routine use for the otoscope when selecting features such as the light source, battery technology and size. The key is allowing function and need to dictate purchase decisions. ■

IHS Continuing Education Test

1: In general, pocket otoscopes offer the following except:
- A: Small, lighter version of full-size otoscopes
- B: Only non-fiber optic light source technology
- C: Power source in the form of alkaline batteries in most cases
- D: None of the above

2: In general, full-size otoscopes offer the following except:
- A: Flexibility in changing out otoscope head
- B: Flexibility in changing out otoscope handle
- C: Flexibility in utilizing either rechargeable or alkaline batteries
- D: None of the above

3: The major advantage of video otoscopes over other types includes:
- A: The capability of video otoscopes to wirelessly transmit images
- B: The capability of video otoscopes to capture images
- C: Offering an otoscope at a much less expensive price
- D: All of the above

4: The otoscope head offering the largest open area for passing instrumentation during cerumen removal procedures is:
- A: Diagnostic
- B: Pneumatic
- C: Operating
- D: Macroview

5: Which of the following light sources is associated with the dullest amount of illumination?
- A: Incandescent technology
- B: Halogen
- C: Xenon
- D: LED

6: In terms of power sources, memory effect refers to:
- A: An effect observed in nickel cadmium batteries that causes them to hold less charge
- B: An effect observed in nickel metal hydride batteries that causes them to hold less charge
- C: An effect observed in lithium ion batteries that causes them to hold less charge
- D: An effect observed in all rechargeable batteries that causes them to hold less charge

7: The battery technology associated with the highest power capacity and slowest discharge rate is:
- A: Alkaline
- B: NiCad
- C: NiMH
- D: LI-ON

8: The battery technology associated with the highest cost is:
- A: Alkaline
- B: NiCad
- C: NiMH
- D: LI-ON

9: The otoscope bulb in a non-fiber optic otoscope is located:
- A: Inside the otoscope handle
- B: Within the floor of the otoscope head, out of direct line of site
- C: Within the base of the otoscope head, in direct line of site through the magnification piece
- D: None of the above

10: Which of the following statements about otoscopes is false?
- A: Newer video otoscopes require software to operate properly
- B: In general, fiber-optic otoscopes will cost more than non-fiber optic otoscopes
- C: In some cases, it is possible to attach an otoscope head made by one manufacturer to an otoscope handle made by a completely different manufacturer
- D: The more advanced the technology inside the otoscope, the more expensive it will be

For continuing education credit, complete this test and send the answer section at the bottom of the page to:

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5.	A	B	C	D	10.	A	B	C	D