Reduction of Medical Errors
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Course Length: 2 hours
Course Level: Beginning/Intermediate
Intended Audience: Dispensing Opticians

There is no doubt that medical errors adversely affect many people each year. In 1999, medical errors were so ominous that the Clinton administration commissioned a study to further research the causes of medical errors in America, and to come up with solutions to slow down this disturbing epidemic. The report that followed, *To Err is Human: Building a Safer Health System*, detailed some alarming statistics. This report, written by the Institute of Medicine (IOM), estimated that 44,000 to 98,000 Americans die each year not from the medical conditions they checked in with, but from preventable medical errors. The statistics in the IOM report, which were based on two large studies, suggest that medical errors are the eighth leading cause of death among Americans, with error-caused deaths each year in hospitals alone exceeding those from motor vehicle accidents (43,458), breast cancer (42,297), or AIDS (16,516).\(^1\)

One of the most alarming facts is that most of the medical errors that are life threatening, or life altering, could have been avoided, had extra steps been taken for precaution. The following examples are just a small picture of this widespread problem:

*Cancer patient Harry Jordan checked into a California hospital to have his diseased kidney taken out, but surgeons, for some inexplicable reason, removed the healthy kidney instead. Mr. Jordan was forced to spend the rest of his life on dialysis* (USA Today, 4/14/95).

*In Denver, an 8-year-old boy died during a routine ear operation when the anesthesiologist fell asleep and failed to monitor the boy’s condition. That same anesthesiologist had fallen asleep during surgeries numerous times before but was never adequately disciplined* (Los Angeles Times, 8/24/95).

It is no wonder that medical professionals are mandated to take additional education credits to do our share to cut back on medical errors—the number of casualties demand that we take action. You may wonder, though, what is our role in all of this? We are licensed dispensing Opticians who do not diagnose medical conditions. How does this relate to us?

**Over 90% of eyeglasses examined by COLTS Laboratories failed to meet the minimum ANSI standards for quality…**

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COLTS Laboratories, led by John Young, is an independent ophthalmic testing site based in Florida. They are specialists in performing all types of testing for our profession, from impact resistant properties to contour plot comparisons/analysis for progressive addition lens designs. When COLTS was asked to participate in ABC’s 20/20 News Show exposé on prescription eyewear, they agreed to blindly test prescription eyewear purchased randomly at optical businesses throughout the US. The results are surprising…over 90% of the prescription eyewear failed to meet the minimum standards of the American National Standards Institute (ANSI).

While it is hard to prove death from bad lenses, there is no debate that the quality of life is adversely affected by problems with prescription eyewear.

This course will outline the costs of medical errors, common causes of medical errors, and what we, as opticians, can do to avoid future errors, hence adding to the quality of life of our clientele.

**It affects all of us!**

Americans have a real fear of medical errors. According to a national poll conducted by the National Patient Safety Foundation, 42% of respondents had been affected by a medical error, either personally or through a friend or relative. And, 32% of the respondents indicated that the error had a permanent negative effect on the patient’s health. As a result, it is not a surprise that the public’s confidence in the medical system has
suffered, as noted by a survey conducted by the American Society of Health System Pharmacists. This study also showed that Americans are “very concerned” about:

- being given the wrong medicine (61%)
- being given two or more medicines that interact in a negative way (58%)
- complications from a medical procedure (56%).

Is it all in our heads?

**Medical Errors – What Is the Reality?**

Does the public have reason to be leery of the American medical system? The numbers can be surprising! For instance, we know that the Intensive Care Unit of a hospital will typically have performance levels of around 99%. Sounds great... until we run into some real-life comparisons.

If Chicago’s O’Hare airport experienced the same accuracy rate, it would experience 20 dangerous landings per day. If the banking industry experienced a 99% accuracy rate, approximately 320,000 checks per hour would be deducted from the wrong account!

**Medical Errors – The Costs**

The IOM report estimates that medical errors cost our nation approximately $37.6 billion each year; *about $17 billion of those costs are associated with preventable errors.* About half of the expenditures for preventable medical errors are for direct health care costs. When divided by 260,000,000 Americans, the average cost is $144.62 per person, or $578.46 for a family of four.

While these numbers are a testimony to our national epidemic, to me, hearing about one young child dying during a routine ear operation is enough to take note. It is likely that you are a parent, relative, or friend of a young child with a history of ear problems...it is a very common occurrence. To think that a child could lose his or her life due to a preventable medical error is outrageous and devastating.

**Medical Errors – The Sources**

Equipment failure (faulty or poorly maintained) is high on the list as to why medical errors occur. Some examples are: defibrillators with dead batteries or intravenous pumps whose valves are easily dislodged or bumped, causing increased doses of medication over too short a period.

One school of thought is to automate processes whenever possible. However, automating processes sometimes creates other sources of problems that are unforeseen. For example, pharmacists barcode medications to eliminate handwriting errors, but incorrect barcodes allow some errors to slip through when the pharmacy staff begins to rely on the assumption that the system will always work. Then, not only will one unit be off, the entire batch will be incorrect, as we relied on a system that doesn’t always work.

The bottom line is that nothing can replace *human discernment*...using our brain in each individual case to be sure that we are checking, double checking, and triple checking our work to avoid allowing errors to slip through.

What is our role as Opticians? How can we identify, and more importantly, *prevent* optical errors?

**Start with the basics...**

Does the work order match the doctor’s prescription? As Opticians, we are used to retaining the patient’s prescription and stapling it to the back of our job ticket or work order. Then, when the job comes back from the lab for verification/dispensing, it is all too easy to look at the written Rx on our job ticket for verification of accuracy.

We don’t retain the patients’ Rx to keep them in our office and to keep them from going somewhere else...we keep their prescription from the prescribing doctor so that we can check the accuracy based on the doctor’s written instructions.

When we verify the accuracy of the prescription based on our job ticket, we will not know if there was an error in transcription, and the job could slip through to the client.

**Check all parameters on the OLD glasses as well. This will reveal a lot!**

Was the prescription modified for vertex distance or Slab Off prism?

Were the glasses made correctly?
Listen for telltale symptoms…

If the patient states that he or she has blurred distance vision, blurred near vision, or blurred peripheral vision, what should you do?

One of our major challenges as Opticians is discerning the optical cause of a problem, when our clients/patients say that “they can’t see”. It is up to us to know the difference between a real problem and an issue of adaptation. For example, when a patient says that he or she can’t see, we need to ask more questions and dig a little deeper. One way to do this is to ask the patient, “Do you mean it is blurry, as in ‘blurry’ or blurry, as in “clear, but wavy, distorted, the floor feels like an ocean, etc.’”? Asking for clarification like this helps you to better discern the cause of the problem.

What if a progressive lens wearer comes in stating the following?

“My vision is good in the distance and good in the intermediate. However, when I try to read, I have to hold the paper like this.”…(She moves the paper to the extreme left, making it obvious that she is not looking through the near point reading area.)

What should you do?

One thing is for sure…do not send her back for refraction recheck! The fact that the patient stated that she can see clearly in the distance and intermediate is proof that the prescription is accurate. Her problem is at near.

Here is a tip to see exactly what is going on with a problem with near vision, when troubleshooting a problem with a progressive addition lens:

1. Take a mirror (about 8 inches square) and, using a sharpie pen, make a dot in the middle of the mirror.
2. Place the mirror on the dispensing table, between you and the patient, at the patient’s near working distance.
3. Place all of the markings back on the PAL lenses, and put them back on the patient, verifying a proper adjustment.
4. Ask the patient to look at the dot in the center of the mirror, keeping her head straight, as if she were reading a book through her progressive addition lenses.
5. Stand up, look into the mirror and look at your patient looking at the dot in the mirror.
6. Determine if your patient is actually looking through the near-point circle markings. (Chances are, she is not).
7. Now, proceeding with caution (so as not to place ink on your patient’s face by mistake!), carefully mark the lenses where the patient is actually looking…this will give you the subjective measurement for her near-point PD requirements.
8. Order the lenses from the lab with the markings on, and ask the lab to make the lenses with the near PD at the markings, and to “outset” the distance PD from the specified reference point. This will work with the majority of prescriptions, with the exceptions of very strong prescriptions (over +/- 7.00 D), and unbalanced prescriptions (optical difference of 1.50 Diopters or more, as in Anisometropia and Antimetropia).

While this example is not mainstream, it does occur. Not everyone converges downward and inward at near the same amount…sometimes a patient has a condition known as cyclodextrophoria, a condition where the eyes do not converge downward and inward at a range within normal limits. In this case, the lenses need to be fabricated specifically for the patient’s unique reading levels.

What if the patient states that he has double vision, at distance or at near?

If diplopia (double vision) is present, it usually means unwanted induced prism. If the patient experiences diplopia at the distance, the first thing to check is the accuracy of the distance optical centers. Chances are, the PD is too far off. Remember the American National Standards Institute (ANSI) tolerance: a total of 2/3 diopters between the two lenses, or within +/- 2.5mm variation from the specified distance PD for high-powered Rx’s. And, for vertical prism, the maximum tolerance allowed is 1/3 prism Diopter between the two lenses.

If the patient states that he sees double at near (especially vertically), he likely has vertical imbalance at near issues. When a patient is Anisotropic or Antimetric, and, if that is combined with Presbyopia,
the needs compensation for vertical imbalance at near. The most common compensation for this is Bicentric Grinding, also known as Slab Off Prism. Two pair of SV glasses (one for distance, one for near) will work as well.

**Vertical Imbalance at Near**

A percentage of our society has a condition where their refractive error is not balanced between their two eyes. They may have *Anisometropia* or *Antimetropia*. *Anisometropia* is a condition where there is a 1.50 Diopter difference between the two eyes, and the signs are the same (both + or both -). For example, if an Rx is +1.00 D in the right eye and +3.00 D in the left, the client has *Anisometropia*. *Antimetropia* is a condition where there is an imbalance between the eyes of 1.50 Diopters or more, however, the signs are different (one + and one -). For example, if an Rx is +1.00 in the right eye and -1.00 in the left, the client has *Antimetropia*.

For single vision wearers, it is very important that we take extra steps to make sure that the patient is looking through the optical centers vertically as well as horizontally.

When we think of lenses, we should remember that, technically, they are like a series of prisms…plus lenses, as prisms attached base to base, and minus lenses, as prisms attached apex to apex.

The only place where light travels straight through, undeviated, is at the Optical Centers: where the bases meet for a plus lens, and where the apses meet for a minus lens. This is due to the laws of refraction of light. The optical center, for both plus and minus lenses, is the only place where the front surface and back surface (F1 and F2) are completely parallel to each other. When light travels though a medium that has parallel front and back surfaces (as in a window pane), it will travel straight through without deviation. When light travels through a medium that has sides that are at an angle to each other, it will bend. Specifically, when light strikes a prism, the refracted ray will bend towards the base, and the image will be displaced toward the apex. Like minus lenses, prisms produce a virtual image….always towards the apex.

This explains and demonstrates why plus lenses converge light rays, and why minus lenses diverge light rays…it is because light is bending towards the base in each case. Now, applying this concept to patients with an imbalance in prescription (*Anisometropia* or *Antimetropia*) combined with *Presbyopia*, it is easy to see why vertical imbalance compensation at near is necessary.

When the eye deviates away from the distance optical center to read, whether in a bifocal or in a progressive addition lens, vertical prism is induced. When the prescription is balanced, as in -1.00 sphere OU, for example, the vertical prism will cancel out. It is no different than looking above or below the halfway point (Datum Line) through the lenses…vertical prism cancels. However, if one lens is plus and one lens is minus, (Antimetropic patient), as the eyes deviate downward to read (as they must), vertical prism will be present, but in opposite directions. The eye looking through the plus lens will experience Base Up prism, and the eye looking through the minus lens will experience Base Down Prism. When this happens, the amount of prism per eye combines together, causing vertical imbalance (prism) at near.
Trying to Compensate

How does the brain compensate for vertical imbalance at near? The brain will try to deal with vertical imbalance at near issues in three ways:

1. Suppress vision in one eye
2. Alternate vision between eyes
3. See double

When the brain suppresses vision in one eye, it “shuts off vision” in one eye temporarily. The danger here, if not caught early on, is that it can lead to Amblyopia, especially if the condition exists in a young child. If the brain alternates vision, it can cause symptoms of Asthenopia (tired, uncomfortable eyes). A way to uncover this optical error is by asking the patient, “Do you like to read” or “Is reading for a period of time comfortable for you?”

When we have good binocular fusion with good tracking skills, reading should be enjoyable. After all, there is something out there for everyone in regard to subject matter. However, when we have poor binocular vision (as in vertical imbalance at near issues), or poor tracking skills, the ability to keep our eyes focused on the words becomes increasingly difficult.

Try to imagine that you are trying to read, but the image of what you are looking at keeps “jumping away”. That is, your eyes may begin to follow a sentence, and suddenly, you find yourself “jumping” to another part of the page. Then, after you redirect your focus back on the original sentence, it occurs again and again. After about five minutes of this, your eyes (brain) will become so exhausted, you will either fall asleep or put the book down, not even realizing why. Many times people who experience binocular problems while reading simply think that they “don’t like to read”, when, in actuality, it is that they have vertical imbalance at near problems.

How to Avoid this Error

The best way to catch this optical problem is to know when patients need vertical imbalance compensation at near before it becomes a problem or redo. The best way to do this is to get into the habit of identifying problem prescriptions ahead of time. The key here is to be able to calculate the power of the lens along the 90-degree meridian for any prescription, regardless of the written cylinder axis in the Rx.

If we take a simple example of a prescription written at axis 180, for example, we can go from there:
Rx: -4.00 -2.00 x 180.

If I wanted to know the power of this lens at 90 degrees, it would be simple: I would transpose the Rx:
Rx: -6.00 +2.00 x 090

That is simple enough. You could also memorize this:

The sphere power is felt at the written axis, and a combination of the sphere and cylinder is felt 90 degrees away.

This makes total sense when transposing. The sphere power (alone) is felt at the written axis: given the example above, we know that -4.00 D is felt at 180 degrees. And, a combination (total cylinder combined with sphere) is felt 90 degrees away: -6.00 D is felt at 90 degrees.

What if the Rx axis is at 45 degrees? You could memorize: 45 degrees away from the written Rx axis, 50% of the cylinder is felt. In that case, I would combine ½ of the cylinder, combine it with the sphere, and calculate the power in the 45th meridian.

In the above example, -6.00 D (-4.00 combined with -1.00)

From here, you can memorize a chart:

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<table>
<thead>
<tr>
<th>Degrees away from written axis</th>
<th>Power felt</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0% of cylinder</td>
</tr>
<tr>
<td>45</td>
<td>50% of cylinder</td>
</tr>
<tr>
<td>90</td>
<td>100% of cylinder</td>
</tr>
</tbody>
</table>
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Now, fill in the rest:

0 degrees away……0% of the cylinder is felt
30 degrees away……25% of the cylinder is felt
45 degrees away……50% of the cylinder is felt
60 degrees away……75% of the cylinder is felt
90 degrees away……100% of the cylinder is felt

Then, combine the percentage of cylinder power felt with the sphere…it will give you the power at 90 degrees.

This is a very important thing for Opticians to be able to do. It is the only way to be able to discern whether an Rx needs to be compensated for vertical imbalance at near. When the optical difference between the two eyes is found to be 1.50 Diopters or more, we know that we need to compensate with Slab Off prism. And, it is not up to the prescribing doctor to recognize the problem and prescribe Slab Off…it is up to us! By all means, we should notify the prescribing doctor to let him or her know that we need to do this, and to see if there is any reason the doctor does not want this done, just to keep the lines of communication open. If we don’t do this extra step, we are not dispensing eyewear that will yield the best possible vision…comfortable, binocular vision absent of suppression or Asthenopia.

Calculating for Slab Off Prism:

Calculating for Slab Off Prism is not as complicated as it seems. Breaking it up into a step-by-step process will help make this important process simple. Here is an example:

Step 1: Calculate the power at 90 degrees for the OD.
Step 2: Calculate the power at 90 degrees for the OS.
Step 3: Calculate the Optical Difference between the two eyes.
Step 4: Using an average of 10mm for a reading level, calculate the amount of vertical imbalance using Prentice’s Rule.

If you do not want to use 10mm as an average reading level, measure the distance from the distance Major Reference Point (MRP) and the point below on the lens where the patient actually reads. You can also spot this point by using the mirror tip mentioned above for troubleshooting PAL problems at near. By having the patient/client look into the mirror at the dot at the normal reading level, you can spot the pupils positioned at near point. Then, spot the distance monocular PD (as you would for measuring for PAL/fitting cross placement) and measure the vertical difference between the two spots. This is the reading level, to be used in the formula Prentice’s Rule (as small “d”).

Prentice’s Rule:

\[
\frac{D \times d}{10}
\]

Where: \( D \) = Optical Difference at 90 degrees
\( d \) = Reading level in millimeters

Once you have calculated the amount of vertical imbalance at near, apply Slab Off prism for the same amount. For example, if you calculated total vertical imbalance at near to be 2.25 Diopters, you would order 2.25 Diopters of Slab Off in the most minus eye, or 2.25 Diopters of Reverse Slab in the most plus eye. Most minus and most plus are dependent on the total power at 90 for each eye, not the sphere or cylinder powers.

Blurred Peripheral Vision

What if the patient states that her vision is blurry “at the sides” (in the periphery)? This is not always an issue of PAL lens design, it could be caused by one of the two most complained about aberrations: Spherical Aberration and Chromatic Aberration.

There are five optical aberrations that we need to be aware of as Opticians.

They include:
1. Spherical Aberration (Marginal Astigmatism)
2. Chromatic Aberration
3. Coma
4. Curvature of Field
5. Distortion (Pin Cushion and Barrel)

Of the five optical aberrations, the two main ones, those that patients will subjectively complain about the most, are Spherical Aberration and Chromatic Aberration.

Spherical Aberration: Spherical Aberration occurs at the periphery of the lens, due to the variant refraction of light at the edges. When light strikes a lens, it refracts everywhere at the lens, and travels straight through the optical center. The further away from the optical center, the greater amount of refraction will occur. It would make logical sense that, if the base curve is spherical
throughout (as in a +6.00 Base Curve), light would refract the same at all areas. That is not, however, the behavior of light at the lens’ periphery. In fact, due to the curvature of the lens, and due to the angle at which the light is incident, it bends, or refracts, at a greater angle. The result is different foci, known as sagittal and tangential foci. All of the refracted light rays in between will come to a focus in the middle...the result is spherical aberration.

This optical aberration feels the same to the brain as unwanted marginal astigmatism. This is sometimes referred to as astigmatic error, or excessive cylinder. Although the astigmatic error is happening at the surface of the lens, the brain can feel its affects as if there were cylinder ground into the lens. This optical problem is greater as we flatten curvatures in an attempt to provide our patients/clients with the thinnest, flattest lens possible.

The only way to avoid this optical error is to utilize corrected curve theory, AKA Vogel’s Formula. Simply put, there is an optimum base curve for every prescription, and when we calculate and request the correct base curve, we will eliminate spherical aberration issues. The formula, known as Vogel’s formula is as follows:

For PLUS lenses,
add the Spherical Equivalent, to a +6.00 D.

For MINUS lenses,
add ½ of the Spherical Equivalent, to a +6.00D

To calculate the Spherical Equivalent,
simply combine the sphere with half the cylinder.

Here are some examples in calculating the Spherical Equivalent:

Rx: +4.00 -2.00 x 90
Spherical Equivalent =
+4.00 combined with -1.00, which equals +3.00.

For this prescription, the best base curve is +9.00D.
(+3.00 (+) +6.00 = +9.00D.)

When we compromise optical quality for cosmetic gains, we are doing our clientele a great disservice. This is where optical errors will run rampant, and the quality of vision goes down.

If the client wishes to have a more appealing lens profile, the ONLY solution is to add Asphericity. Using an aspheric surface design is the only optical solution to maintaining good optics and adding to cosmetic appeal (thinner, flatter lenses). Note: If you are dispensing aspheric lens designs for plus prescriptions, you will use the same rule of thumb to calculate Base Curve, and then deduct 2.00 Diopters at the end. Aspheric designs are typically ground with flatter base curves, usually 2.00 D flatter. It is also a good idea to use the lens manufacturers recommended base curves for aspherics.

The second most common optical aberration that we hear subjective complaints about is Chromatic Aberration.

Chromatic Aberration is a result of the amount of dispersion of light inherent in a material. Dispersion of light is the breaking up of white light into its color components. When light refracts through a lens, it bends and disperses. The dispersion of light is often described using the wavelength colors, red, orange, yellow, green, blue, indigo and violet (ROYGBIV). Of the color wavelengths, red light has the longest wavelength, violet light has the shortest wavelength, and the colors in between have varying wavelengths, measured in nanometers. We often hear about UV 400, an ultraviolet coating which absorbs light up to 400 nanometers, which is where UV light ends, and Visible light begins.

Of the five aberrations, four of them (Spherical Aberration, Marginal Astigmatism, Coma and Distortion) can be corrected with good lens design (as described above) and with proper fitting techniques. The one aberration that cannot be corrected for in any way is Chromatic Aberration. Chromatic Aberration is inherent in the material, dependent upon the amount of dispersion present.

This fact that the amount of dispersion/chromatic aberration is inherent in the material reminds me of a conversation I once had with a client years ago at an upscale optical boutique I once managed, Lugene Opticians in Boston. This particular client, a pediatric cardiologist, was extremely funny and laughed all the time. He was also the chief of surgery at Children’s Hospital in Boston and did a lot of charity work for
children with heart disease. Knowing he was an accomplished cardiologist, I once asked him what the secret was to good heart health and lowering cholesterol…real butter or margarine, real sugar or sugar substitutes, etc. Upon hearing my question, he laughed and stated, “Do you want to know how to have the best heart health and to avoid heart disease? Pick good parents!” This sticks in my head today, and reminds me that much of our health and cholesterol numbers have more to do with our genes than with our lifestyles. These traits are inherent in us—the way we were born.

With this in mind, it helps me relate to and remember that chromatic aberration is inherent in a lens… the way light disperses through a particular material. Each material has its own amount of dispersion inherent within it. The amount of light dispersion through a material will determine the amount of chromatic aberration present in the lens.

Simply stated, the less light disperses through a lens, the lower the chromatic aberration. When the amount of light dispersion is greater, the lens is said to have more chromatic aberration.

In optics, we communicate these parameters in Abbe Value. Abbe Value indicates the amount of chromatic aberration (also called chromatism) present in a lens. This is indicated by number. One thing we want to remember is that, when it comes to Abbe Value, less is not best. That is, the lower the Abbe Value number, the greater the amount of chromatic aberration. The higher the Abbe Value number, the lower the amount of chromatic aberration. The materials with the best Abbe Values are Crown Glass and CR-39 plastic. The material with the worst Abbe Value and therefore the most amount of chromatic aberration is high index 1.8 glass. And, materials in between have Abbe Values in between.

The following table gives you an “at a glance” look at varying Abbe Values in commonly used ophthalmic materials:

<table>
<thead>
<tr>
<th>Material</th>
<th>Abbe Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown Glass</td>
<td>58</td>
</tr>
<tr>
<td>CR-39</td>
<td>58</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>30</td>
</tr>
<tr>
<td>Trivex</td>
<td>43 to 45 depending on manufacturer</td>
</tr>
<tr>
<td>High Index glass</td>
<td>25</td>
</tr>
</tbody>
</table>

You can see that there is a wide range of Abbe Values, and therefore amounts of chromatic aberration in various lenses. When a patient experiences chromatic aberration, it is usually in the periphery of the lens. And, the patient will not necessarily see colors. He or she will often complain about a general blurriness, or aberration in the outside area of the lens. High myopes may actually see color fringing, as a result of the thickness of their lenses in the periphery. This is referred to as lateral chromatic aberration.

Do you want to know the secret to correcting for chromatic aberration? Remembering Dr. Castenada’s funny story… Pick a good material! That is, choose a material with the highest possible Abbe Value. Trivex was introduced to our market with impact resistance and Abbe Value/Chromatic Aberration in mind, and is a great alternative to polycarbonate for this reason.

Avoiding Optical Errors: Remember Optical Principles

Dispensing Opticians must play many roles and wear many hats. We must be proficient in lens theories, relating fashion trends, and, at times, play psychotherapist. After all, we are faced with the challenge of helping people select eyewear that they must spend a lot of money on, which they really don’t want, and which makes them feel old!

With all of the challenges of keeping up to date with new innovations in lens and frame technologies, it is easy to forget important optical concepts that we don’t see every day. In addition to knowing how to compensate for and calculate Slab Off Prism, we need to know how to compensate and calculate for Vertex Distance Compensation.

Vertex Distance Compensation

When we are dealing with a high prescription (+/- 7.00 Diopters or greater), we need to consider that the effective power (what the brain sees) is not the same as the prescribed power. During the refraction, the patient is sitting behind the phoropter, against the head rest, and usually 14-18 mm away from the lenses inside the encasement. This means that the refracted vertex distance (the distance between the patient’s cornea and the back surface of the lenses inside the phoropter) will be different than the fitting vertex distance (the distance between the cornea and the back surface of the spectacle lenses).
How to Compensate

Find out the refracted vertex distance. If this is not written on the spectacle prescription, call the prescribing doctor’s office. In many cases, the phoropter is set to a standard distance, and the doctor (and sometimes office staff) can answer this question for you without hesitation. The distance will vary from patient to patient depending on how thick the patient’s brow is and how back the eyes are set in relation to the brow. All phoropters have a gauge that allows for this distance to be measured.

Then measure the fitting vertex distance. Get out a distometer (kind of like a thickness caliper), and place the eyewear on the patient as they will be worn. Be sure that there is a demo lens, or tape inside the eyewire.

Next, ask the patient to close her eyes and explain that you will be taking a measurement which will require you to gently place the measuring device on her eyelid. Reassure her that she will hardly feel a thing, and that you will be very gentle. Next, gently squeeze the lever at the bottom until the “arms” of the distometer are touching the patient’s closed eyelid, and the back surface of the lens. Simply look at the numbers on the gauge to read the vertex distance. This is already calibrated for the thickness of the eyelid, so you do not need to compensate for that.

Next, compare the fitted vertex distance and the refracted vertex distance, and calculate the difference in millimeters. This number represents the amount of “shift” in vertex distance.

Then, calculate the approximate change in effective power, or use the guide provided with the distometer to determine how much to calculate.

The approximation method:

\[
\frac{D \times D \times \text{mm moved}}{1000}
\]

Where:

- \(D\) = total power of lens
- \(\text{mm moved}\) = amount of “shift”

Finally, Memorize:

- CAP = Closer Add Plus
- FAM = Farther Add Minus

To compensate. That is, Closer Add Plus, Farther Add Minus to compensate.

Example:
What should we order for a patient with a -8.00 D Rx, with a fitted vertex distance of 10mm, and a refracted vertex distance of 15mm?

To Solve for Vertex Distance Compensation:

Step 1: Find the square value of the Dioptric power (D x D)

Step 2: Divide that number by 100

Step 3: Multiply that number by millimeters moved (vertex shift)

To follow the example:

\[8 \times 8 = 64\]
\[64/1000 = .064\]
\[.064 \times 5 = 0.32\] (Round off to 0.25 D)

Then, apply CAP or FAM.

In this example, the fitted vertex was closer, so we should add plus power...this is the compensated power, what we should order from the lab. The power to be ordered in this case would be -7.75 D. If the Rx requires a sphere-cylinder lens, simply place the Rx on an Optical Cross, compensate for each meridian, and rewrite the Rx in its modified form as a sphero-cylinder lens.

High refractive errors are more common than we think. Taking the extra steps to uncover and correct for vertex distance compensation will help out a lot of clients we may have otherwise missed. It’s worth the extra effort.

Reference Foot Notes:

1. Institute of Medicine (IOM) Report, 1999
   [http://www.iom.edu/CMS/2955.aspx](http://www.iom.edu/CMS/2955.aspx)


3. Institute of Medicine (IOM) Report, 1999
   [http://www.iom.edu/CMS/2955.aspx](http://www.iom.edu/CMS/2955.aspx)