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A Trained Eye: Optometrists' View Into Primary Care

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by
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A thesis submitted to the faculty of The University of Mississippi in partial fulfillment of the requirements of the Sally McDonnell Barksdale Honors College.

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Abstract

Louis Coke Magee III: A Trained Eye: Optometrists' View Into Primary Care

(Under the direction of Dr. Susan Pedigo)

The aim of this thesis is to explore and present the auxiliary responsibilities of doctors of optometry, particularly those involved with primary health care such as screening for serious diseases. This idea was approached by researching the technological capabilities of optometrists, the diseases and conditions they commonly detect, as well as the barriers preventing some people from receiving proper eye care. The importance of optometrists as primary care providers is steadily rising alongside their capabilities. There are many instances within a routine eye exam in which an optometrist is able to detect and recommend treatment of a serious disease. Also discussed is the need for this high level of care to become more readily available in underserved communities. Optometric care is a critical pillar within the realm of health care and is underrepresented in that it also serves as primary screening for patients unlikely to visit a physician.

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Opening

The human eye is an incredibly complex organ. The ability of the eye to receive signaling and transmit it to the brain instantly is astounding and is crucial to the function of the human species. From the formation of a few light-sensitive cells to a multi-layered organ, the evolution that brought about the eye is nearly inconceivable, yet, life without the eye is unimaginable. Not only is the eye paramount in providing vision to a person, but it also serves as a means of communication between people. Silent messages can be sent or received using eye contact, and private emotions can be discerned through a person's eyes alone. The beauty of the eye has often been described by the expression, “the eyes are windows to the soul.” Though the origin of this quote is unknown, there is still truth to the words. I, however, would like to add to the original quote. The eyes are the windows to a persons’ soul and health.

The eye is a particularly unique organ, differing in many ways from all others within the human body. An eye provides a unique vantage point for any medical professional, particularly an optometrist. The necessary translucence of the eye that allows light to travel through it to eventually focus upon the retina allows not only for an individual to see out but also for a trained eye to see in. The eye, as an organ, is not disconnected from the rest of the body: meaning that diseases of the body manifest within the eye as they would within any other organ. However, no other human organ is as easily observable as the eye. Blood vasculature, an incredibly important component of all human function, is visible superficially only via the eye. Without invasive tools or technology, the amount of information an eye care professional can gather from the state of a person's eye is immense. Complimenting that, the technology available at nearly every optometry clinic allows for easy, non-invasive access to even more information about the state of the organ. The eye is an incredible organ, and a trained eye can utilize this to reveal ample information about a persons' well-being.

Eye care professionals' capabilities have increased dramatically with the development of new technologies. The original optometric tool, the Snellen chart which is depicted later, was invented over 150 years ago to test visual acuity. Now, optometrists have machines at their disposal that can create high-resolution cross-sectional images of the retina. These scans are known as optical coherence tomography and are discussed later. While these scans must be read and interpreted by an eye care professional, the amount of medical information that can be obtained from a routine eye visit is far more than the eyeglasses prescription that one might expect. An example of not only how far eye-specific technology has advanced, but also how important it is that these technologies are being invented, is the Occuity Indigo Device. The Occuity Indigo Device, while still under development, is expected to be the first handheld, pain-free glucose monitor, and it will be able to read an individual's glucose levels with a simple scan of the eye. Technologies like these not only increase the importance of eye care professionals but also illustrate the incredible ability of the eye to reveal information about an individual's health.

The diseases and conditions an optometrist can detect within a routine eye exam go far beyond the expected result of said exam. Though eye care professionals cannot diagnose certain diseases, they can see the warning signs of many bodily conditions that would allow for the patient to seek help earlier than they possibly would have received it on their own. Some of the most common severe diseases present themselves through damage to the vasculature of the eye.

The eye's vasculature is unique, and quite sensitive, in that it will rapidly induce angiogenesis of abnormal blood vessels if the original vessels are damaged or blocked. Instances of this occur in both the early stages of diabetic retinopathy, as well as hypertensive retinopathy. Though these diseases have names of their own when manifested within the eye, their precursor is a much more serious bodily ailment. With diabetes, unregulated blood sugar causes damage to the sensitive vascular within the eye, which can happen quickly in a patient that is either aware of their disease yet non-compliant with medication and lifestyle changes, or, a high-risk patient with low access to healthcare who may be unaware they have the original condition at all. Hypertensive retinopathy is caused by chronically high blood pressure, which in the same way manifests itself quickly within the vasculature of the eye. Both of these diseases, though commonly diagnosed and treated, can be silent killers for patients unaware they have them, or patients unaware of the damage their non-compliance to medication or other treatment is affecting their bodies. This type of disease identification, though not diagnosis, from an optometrist, allows for them to be considered among the front line of healthcare professionals.

Doctors of optometry have begun to adopt the title of optometric physician, a term I feel is much more appropriate for the job they do. Though the primary role of an optometrist is and always will be to assist patients with vision corrective services, their capabilities as physicians and primary care providers go far beyond that. The health care system favors primary care and optometry specifically, due to the fact that these providers interact with patients presenting minor symptoms and complaints allowing for perfect positioning to identify risk factors and affect the long-term health of these patients. This process lessens the chronic and long-term illness and dysfunction that are typically the real causes of escalating health care costs. (Edmonds, 2013) According to this ideology, optometry is in the best position to deliver these primary health care services to people who do not otherwise interact with professionals; this is driven by the refractive errors which optometrists correct for patients, specifically young patients who are otherwise healthy. For many of these patients, their optometrist is their primary medical provider, and optometrists must also be prepared to act as their primary physicians. (Edmonds, 2013) With the rapidly evolving world of health care, forced into even more disarray by the global pandemic, all health care professionals are taking on new roles, and none more so than the optometrists who are becoming the primary health screeners for all of their patients who may not be regularly visiting a general practitioner.

With the role and capabilities of optometrists rapidly expanding, it is crucially important that the ability of individuals to have access to high-quality optometric care expands as well. Access to care is typically affected by income-based disparities. For example, all Medicaid programs cover vision exams and eyeglasses for children, but not all cover the same for adults. Studies have shown that providing parental Medicaid vision benefits increases the utilization of vision care among low-income children. Also shown is that low-income children are more likely to have unmet vision care needs than their higher-income peers, with findings of a more than sixfold difference in an unmet need for glasses. (Lipton, 2020) Research has shown that access to vision screening and correction increases academic achievement, suggesting that the disparities shown could have lasting consequences on the health and lives of these children. (Lipton, 2020) These problems must be addressed, and optometric care must become more available. This is especially true of those who do not have access to it now, as they are often the very patients an optometrist would also be able to screen as a physician for issues unbeknownst to the individual.

Thankfully, however, programs and technologies are being created and funded to ease this disparity. Companies such as mHealth, or mobile health, have developed a technology that allows eye care professionals to provide vision screenings through the use of smartphones or wireless devices. (Manus, 2021) These new technologies are incredible and have enabled doctors to perform eye exams from anywhere in the world. These technologies are especially key in that they enable doctors to identify school-age children with vision loss in low-income communities with an approach that is low cost, scalable, and allows for early detection to avoid academic decline. (Manus, 2021) These types of technology further integrate optometrists into the world of primary health care. An issue discovered through screening is sure to increase the likelihood of a visit to an in-person optometrist, and therefore get an individual in front of a healthcare professional more often, which is the most important factor in the early detection of most diseases.

With the role of an optometrist expanding, there is no more important time to discuss their capabilities and the importance of their role as primary care physicians. To do this we must discuss the technologies an optometrist has at their disposal, as well as what they can see and detect with each tool. Alongside this, the wide range of diseases of the eye, as well as diseases that manifest in some form within the eye, must also be discussed. The things a trained eye can observe and detect within a patient's eye go far beyond the capabilities most would expect of an optometrist. However, it is these very capabilities that allow optometrists to serve their patients as not only eye care professionals, but also primary care physicians.

Introductory Anatomy of the Eye

Eyes immediately attract our attention, and they are the features we immediately respond to in a person's face. It is also a complex organ, made up of multiple layers with many different parts that must all function in sync in order for us to acquire and process visual images. The eye has an interesting structure, with a diverse range of tissues forming the various layers, and a wide void space through which light must travel. An optometrist is able to detect the slight changes or alterations to these many tissues in order to detect disease. This unique structure is integral to our discussion, so we must first fully understand the anatomy of the eye, and what each moving part does in order for the organ to function properly.

The sclera, or white of the eye, is a connective tissue made up of collagen fibers, oriented in different directions. The lack of parallel orientation in these fibers gives this white appearance, as opposed to the cornea which is transparent. The transparent cornea covers the outer layer of the eye and is made up of the same types of tissue, oriented parallel to one another so as to appear transparent. (Pradeep, 2021) The cornea consists of five layers: epithelium, Bowman layer, stroma, Descemet's membrane, and the corneal endothelium, listed in order of depth into the eye. (Pradeep, 2021) These external features of the eye are shown in Figure 1.

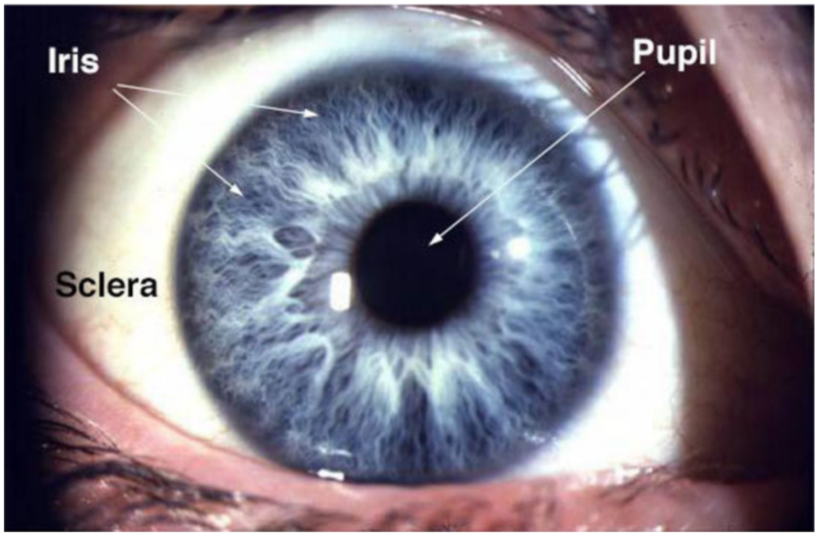

Figure 1: View of the Human Eye

Source: Kolb, H. (2007, May 1). Gross Anatomy of the Eye. Webvision: The Organization of the Retina and Visual System [Internet]. Retrieved March 1, 2022, from https://www.ncbi.nlm.nih.gov/books/NBK11534/

The Iris consists of a stromal layer with pigmented fibrovascular tissue and pigmented epithelial cells, located beneath the stroma. The pigmented layer of cells blocks rays of light and ensures that light must move through the pupil to reach the retina. (Pradeep, 2021) The ciliary body, as seen below, consists of muscle and epithelium tissue, and divides the posterior chamber from the vitreous body. The choroid consists of a network of blood vessels that provide nutrients to all structures of the eye and is housed in the loose connective tissues. (Pradeep, 2021) The choroid is imperative in our discussion of detecting severe disease, as the blood vessels and capillaries within the eye are typically damaged due to disease. This is depicted in Figure 2.

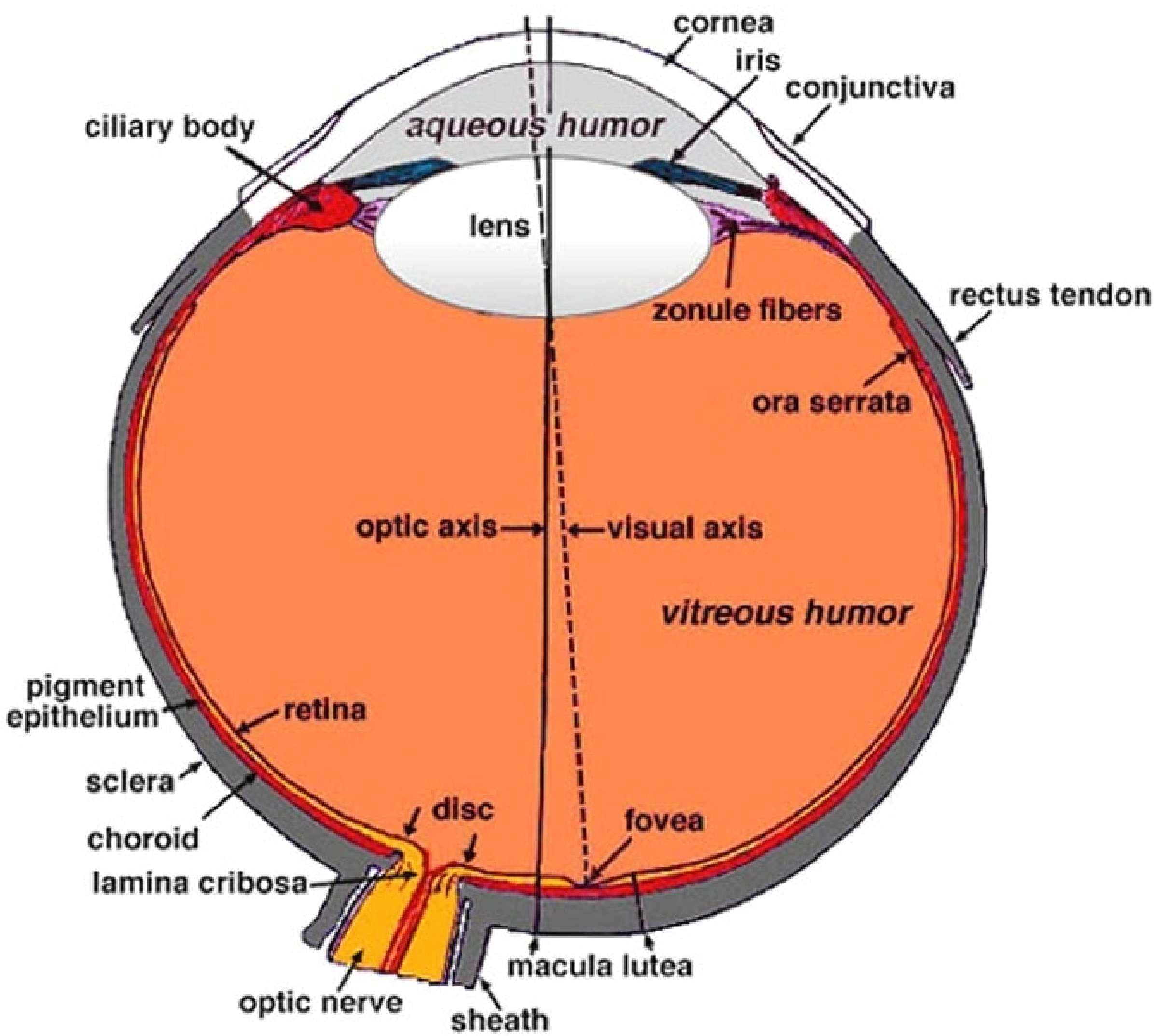

Figure 2: Sagittal Section of the Adult Human Eye

Source: Kolb, H. (2007, May 1). Gross Anatomy of the Eye. Webvision: The Organization of the Retina and Visual System [Internet]. Retrieved March 1, 2022, from https://www.ncbi.nlm.nih.gov/books/NBK11534/

The innermost layer of the eye is made up of the lens, vitreous humor, and the retina. The lens separates the aqueous and vitreous chambers of the eye, and the vitreous is simply a jelly-like space made of type 2 collagen which separates the retina and the lens. Finally, the retina is a nerve tissue where photons of light are converted to neurochemical energy via action potentials. (Pradeep, 2021) The retina is where the rod and cone cells reside, with rods located peripherally and sensitive to light and motion, and cones having higher visual acuity and specificity for color vision. (Pradeep, 2021) The macula is a small part of the retina that is key in seeing objects directly in front of you clearly. The macula has a small depression at its center, known as the fovea centralis. The fovea is the part of the retina that absorbs and transmits the most light, and it is where eyesight is the sharpest. The macula and fovea are key to eye function and are affected by many diseases, both local and systemic, due to the highly sensitive nature of the tissues. (American Academy of Ophthalmology, 2017) These components are shown in Figure 3.

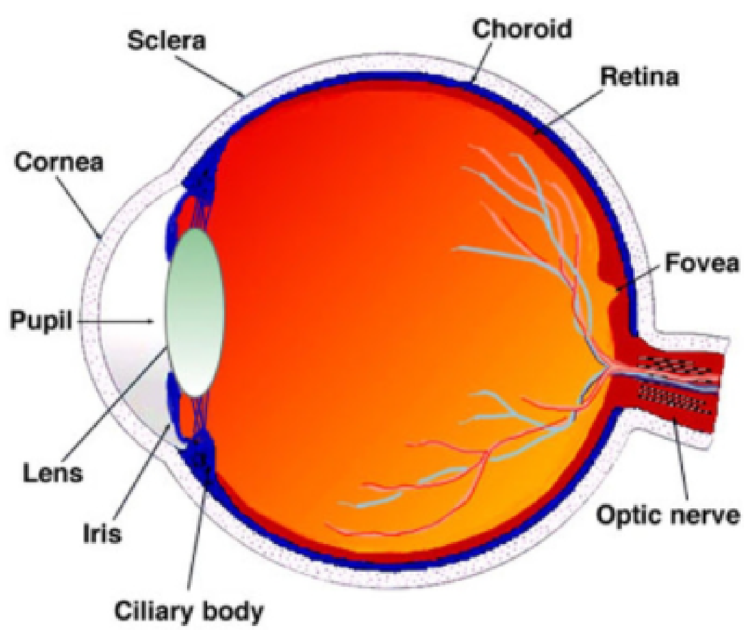

Figure 3: Horizontal Section of the Adult Human Eye

Source: Kolb, H. (2007, May 1). Gross Anatomy of the Eye. Webvision: The Organization of the Retina and Visual System [Internet]. Retrieved March 1, 2022, from https://www.ncbi.nlm.nih.gov/books/NBK11534/

Approximately one million myelinated axons arising from the ganglion cells of the retina come together at the optic disc to form the optic nerves. (Crumbie, 2022) Unlike typical nerves, fibers of the optic nerve are myelinated by oligodendrocytes, comparable to the Schwann cells which form the myelin sheath around other nerves. The optic nerves are approximately 45 mm in length and are divided into four sections: the optic nerve head, the intraorbital section, the intracanalicular section, and the intracranial section. (Crumbie, 2022) The optic chiasm, the X-shaped portion located directly in front of the forebrain, is where the optic nerves intersect and cross. Following this decussation, the visual input from the right half of the visual field will travel in the left optic tract, while the stimuli from the left half of the visual field will pass through the right optic tract. The optic tract terminates at the lateral geniculate nucleus of the diencephalon, the last step before the fibers emerge, known as optic radiation, travels in two separate loops to the visual cortex. (Crumbie, 2022) With light signaling finally arriving at the visual cortex, an image is formed by our brains of the world around us. This process is illustrated in Figure 4.

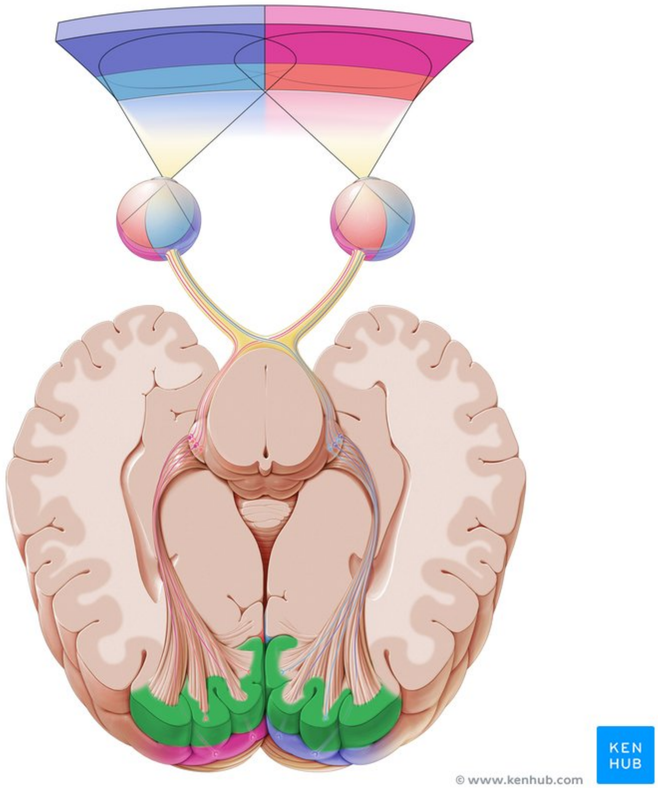

Figure 4: Brodmann's Area 17 (axial view)

Source: Crumbie, L. (2022, February 28). Visual Pathway. Kenhub. Retrieved March 1, 2022, from https://www.kenhub.com/en/library/anatomy/the-visual-pathway

Eye Care Technologies

As a way to digest the many technologies employed by eye care professionals today, we will begin with the simplest test, whose intended usage lies exclusively on the outside of the eye. As we move deeper into the eye, the technologies become more recent and advanced, and the resulting information becomes richer and more complex. First, I will discuss the technologies developed to detect visual acuity and measure refractive error to provide corrective lenses.

Snellen Chart

Invented in 1862 by Dutch ophthalmologist Herman Snellen, the Snellen chart is the most widespread technique in clinical practices for measuring visual acuity. (Figure 5)

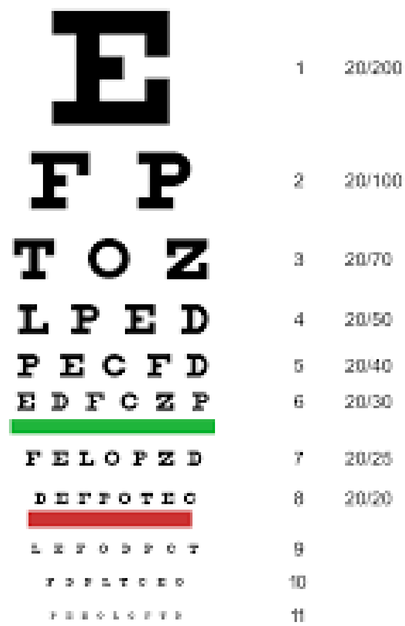

Figure 5: The Snellen Chart

Source: Azzam, D., & Ronquillo, Y. (2021, May 9). Snellen Chart. StatPearls [Internet]. Retrieved March 1, 2022, from https://www.ncbi.nlm.nih.gov/books/NBK558961/

The Snellen Chart uses a geometric scale to measure visual acuity, with normal vision at a distance being set at 20/20. This number is commonly associated with “perfect” or healthy vision but is simply an explanation of the measurements associated with the chart. The numerator represents the distance that the patient is standing from the chart in feet, while the denominator represents the distance from which a person with perfect eyesight is still able to read the smallest line that the patient can visualize. This is possible due to the sizing of the letters, which is geometrically consistent, meaning that the optotypes representing the 20/40 line are twice the size of those representing 20/20. When interpreting Snellen chart results, it is important to note that 20/20 vision is not synonymous with perfect vision, but rather simply indicates the patient's clarity of eyesight from a distance. Certain visual abilities not able to be measured by the Snellen chart include peripheral vision, eye coordination, depth perception, the ability to focus on objects, and color vision. A visual acuity assessment using the Snellen chart may inform a doctor that a patient requires corrective lenses, but it cannot provide a patient's prescription; this must be measured using a separate evaluation. This chart does present some difficulties, as it is less accessible to individuals unfamiliar with the Roman alphabet, or individuals dealing with any language, literacy, or verbal communication difficulties. The Snellen chart is crucial to optometrists not only due to its original purpose but also for its wide range of applications when performing other tests in an optometry clinic. (Azzam, 2021)

<u>Phoropter</u>

A phoropter is an instrument that uses adaptive optics to test individual lenses on each eye during an exam. After an initial screening using the Snellen chart, if an issue is detected with a patient's eyesight further assessment will likely be carried out using a phoropter with the Snellen chart as a clarity reference. (Figure 6)

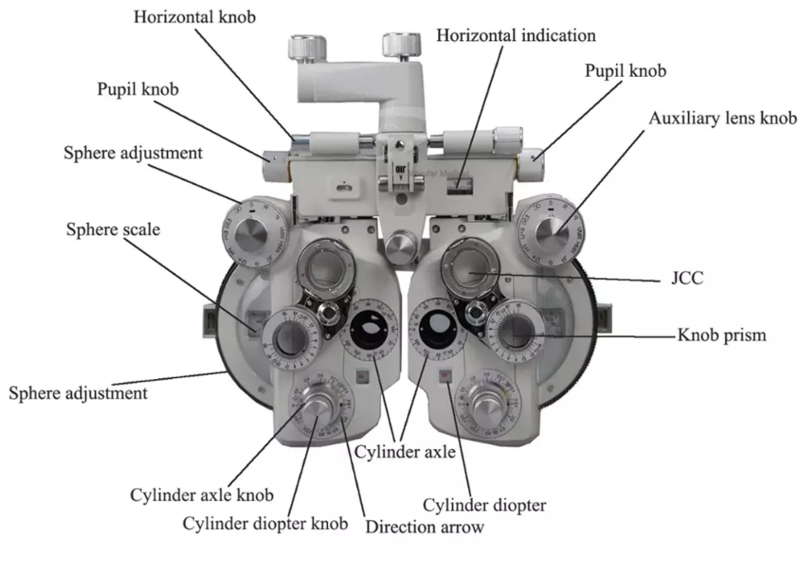

Figure 6: Diagram of a Phoropter

Source: Refracting Phoropter for Ophthalmic Testing Device Plus or Minus Cylinders. Alibaba.com. (n.d.). Retrieved March 1, 2022, from https://www.alibaba.com/product-detail/Refracting-Phoropter-for-Ophthalmic-Testing-Device_60748226190.html

Phoropters function by making use of adaptive optics, which is a mature technology that has been adopted for many uses. It was first developed for astronomy within telescopes, to compensate for the effects of atmospheric turbulence; however, it can also be used to correct the aberrations of the eye. A phoropter works exactly how you think it might, it switches lenses in front of the eye of the patient, allowing for a direct comparison of eyesight through each possible lens configuration. One drawback of the phoropter, however, is that the examination with it is entirely subjective. The optometrist must ask constant questions about which lens is clearer for the patient, and the patient must be able to decipher it for themselves, providing feedback to the optometrist to determine an accurate prescription. (EyeGlassGuide, 2022)

Retinoscope

Retinoscopes are used in an exam to determine the refractive error of the eye. (Figure 7)

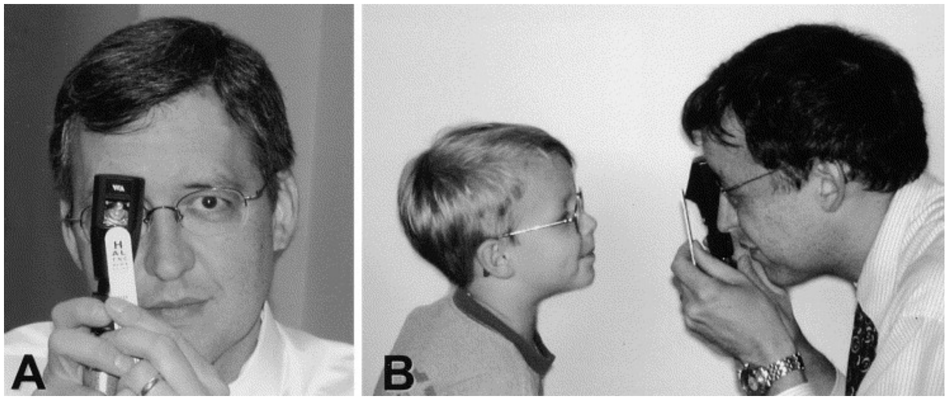

Figure 7: Eye Exam Using a Retinoscope

Source: Hunter, D. G. (2001, December 1). Dynamic retinoscopy: The missing data. Survey of Ophthalmology. Retrieved March 1, 2022, from https://www.sciencedirect.com/science/article/abs/pii/S0039625701002600

The retinoscope is a handheld instrument that projects a beam of light into the eye. When the light is moved vertically and horizontally across the eye, it allows the optometrist to see the movement of the reflected light from the back of the eye, known as the red reflex. The examiner then introduces lenses in front of the eye of different powers, until reaching a power that indicates the refractive error of the patient's eye. Patient's eyes are typically dilated for retinoscopy, this is due to the reflex being much easier to see when the pupil is large; Dilation also reduces the eye's ability to accommodate or focus, allowing for a more accurate determination of the refractive error. This particular assessment is commonly used in children and other instances when communication may be difficult between the patient and the optometrist, as an assessment using a phoropter requires much patient-doctor interaction. (American Association for Pediatric Ophthalmology, 2020)

Autorefractor

The foremost technology currently in eye refraction error detection is the autorefractor. (Figure 8)

Figure 8: The Autorefractor

Source: Beye.com. (2022). M3 autorefractor. Beye. Retrieved March 1, 2022, from https://www.beye.com/product/m3-autorefractorautokeratometernon-contact-tonometer

Autorefractors are machines that automatically determine the refractive error, and correct lens prescription, of the patient's eyes. Autorefractors can automatically measure the exact value of an eye's refraction error. The patient will be seated with their chin stabilized and asked to focus on a picture or point of light within the lens of the machine. From there, the machine can automatically determine the correction needed to place your "focus point" on top of the retina, which is the goal of all corrective lenses. This exam is especially effective for small children, and people with special needs who may have trouble sitting still for a longer exam or verbally describing their vision problems. Autorefractors are commonly used in conjunction with phoropters to double-check and confirm the patient's prescription. (EyeGlassGuide, 2022)

Refractive errors are seen from the outside of the eye looking in, however, most other conditions of the eye are detected from within. Atypical eye pressure is a serious sign of illness of the eye, and early detection of this can prevent further deterioration of the eye or worsening of the condition. This led to the development of easily used devices to detect the interior pressure of the eye.

<u>Tonometer</u>

Tonometry is a test designed to measure Intraocular pressure, and the use of a Tonometer is common in routine eye exams. (Figure 9)

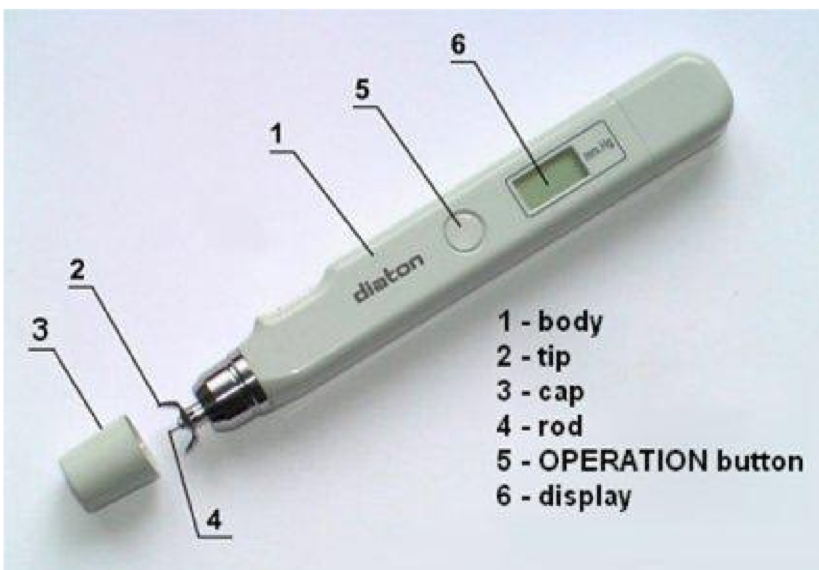

Figure 9: Diagram of a Tonometer

Source: Nadeem, S. (2015). The Diaton Tonometer. Research Gate. Retrieved March 1, 2022, from https://www.researchgate.net/figure/The-Diaton-tonometer_fig2_320422033

Intraocular pressure, or IOP, is an important metric for an Optometrist to assess an individual's risk of glaucoma. The aqueous humor of the eye provides nourishment to many tissues vital for vision functionality. The balance between its production and drainage pressurizes the eye, creating intraocular pressure. IOP elevation is a key factor in the development of glaucoma, and reduction of this pressure has been shown to delay or prevent the onset of glaucoma in individuals with high IOP. Early detection of glaucoma is vital in preventing vision loss, though it is a serious disease, the effects of glaucoma are often painless and can progress for years without one noticing. A tonometer test is critical in detecting even the smallest changes in pressure very early and therefore allowing for effective treatment of glaucoma. (Griff, 2020)

Applanation is the flattening of the cornea by pressure. Applanation tonometry was developed using the Imbert-Fick law, the pressure inside a sphere surrounded by an infinitely thin and flexible membrane can be measured by the force required to flatten a certain area of the membrane. A tonometer uses an applanating force to flatten an area of the cornea to detect intraocular pressure. (Aziz, 2018)

While optometrists can gather a lot of information from outside of the eye, much more is waiting to be discovered by looking inside. The view of the interior of the eye allows an eye doctor to screen for many more diseases than those that are visible at surface level. Particularly, it allows for the viewing of the retina, optic nerve, and vasculature that lines the back of the eye. These main components of the eye shed light on the general health of the organ in a substantial way. With the use of these new technologies, optometrists are afforded new views and more extensive treatment options than ever before.

Retinal Camera

A retinal camera is used for digital retinal imaging, which is a non-invasive diagnostic procedure that produces a high resolution, color image of the patient’s retina, optic nerve, and blood vessels in the back of the eye. An image of the machine is depicted in Figure 10. Retinal imaging is not a substitute for other components of a regular eye exam, but it enables a more precise view of the retina for the early detection of many different ocular diseases. These images are stored and used as benchmarks, allowing doctors to detect any changes visible between visits. This test typically requires the dilation of the patient's pupils, allowing for a wider framed picture to be taken through the pupil of the back of the eye. The retinal blood vessels, captured in the image taken by a retinal camera, are the only blood vessels in the body that can be seen by a doctor without making an incision. (Figure 11) This allows the digital retinal imaging test to detect a wide variety of general health conditions. (Lazarus, 2021)

Figure 10: The Retinal Camera

Source: NIDEK. (2022). Non-Mydriatic Auto Fundus Camera AFC-330. Eye & Health Care NIDEK CO., LTD. Retrieved March 1, 2022, from https://www.nidek-intl.com/product/ophthaloptom/diagnostic/dia_retina/afc-330.html

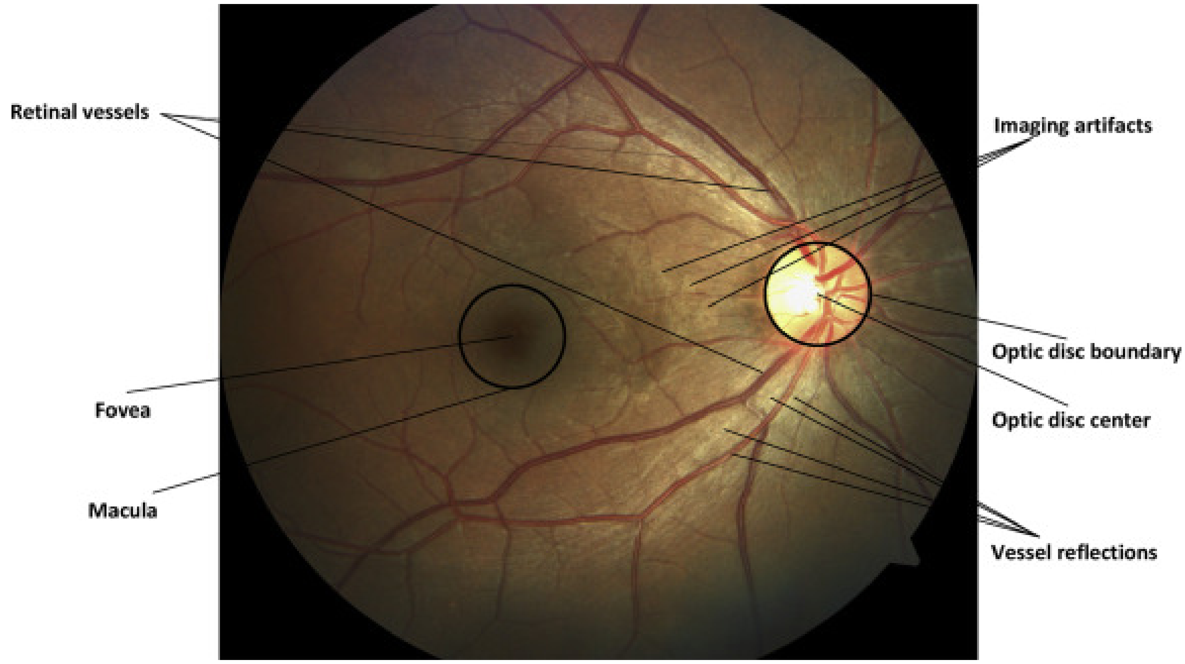

Figure 11: Scan of the Interior of the Eye Captured by a Retinal Camera

Source: Chalakkal, R. J., Abdulla, W. H., & Hong, S. C. (2020, April 3). Fundus retinal image analyses for screening and diagnosing diabetic retinopathy, macular edema, and glaucoma disorders. Diabetes and Fundus OCT. Retrieved March 1, 2022, from https://www.sciencedirect.com/science/article/pii/B9780128174401000036

Many conditions are detectable by an optometrist using a retinal camera. A retinal exam is an example of a physical exam that identifies conditions pointing to disease elsewhere in the body. As it can reveal problems with the patient's overall health, not just issues within the eye. Conditions that are commonly detectable with a retinal camera include but are not limited to diabetic retinopathy, hypertensive retinopathy, retinal tear and detachment, papilledema, and optic atrophy. (Hill-Rom, 2021)

Ophthalmoscope

Another tool used to view the back of the eye is an ophthalmoscope. (Figure 12) An ophthalmoscope is essentially a magnifying tool that is used in conjunction with a light source to peer through the pupil, to the back of the patient's eye, which is sometimes referred to as the fundus. Direct ophthalmoscopy is as described above, with the doctor using a small tool with many lenses that can magnify up to 15 times. (Romito, 2020)

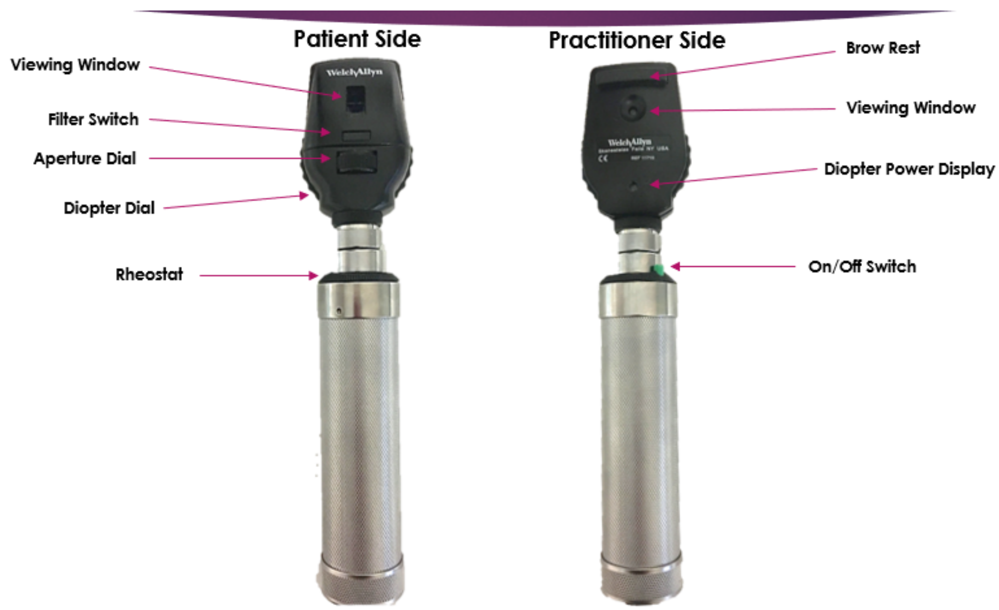

Figure 12: Diagram of Ophthalmoscope

Source: Conde, T. P. (2018). How To Use The Direct Ophthalmoscope. Moran CORE. Retrieved March 1, 2022, from https://morancore.utah.edu/basic-ophthalmology-review/how-to-use-the-direct-ophthalmoscope/

Indirect ophthalmoscopy is slightly different, with the doctor using a small handheld lens, and either a slit lamp microscope or a light attached to a headband. This variation of the test allows the doctor to have a wider, often better view of the eye. It also allows the doctor to view the fundus even if the lens is clouded by cataracts. (Romito, 2020)

VT 1 Vision Screener

Finally, The VT 1 Vision Screener is an excellent example of just how advanced an optometrist's technology has become. (Figure 13)

Figure 13: The Automatic Vision Screener

Source: BerkTree. (2022). Depisteo LLC VT1 Vision Screener. Berktree.com. Retrieved March 1, 2022, from https://www.berktree.com/depisteo-llc-vt1-vision-screener-vision-screener-with-usb-model-vt1-mat060-each.html

This vision screener allows optometrists to assess a wide variety of visual tests that would typically take many separate tools and much longer. Though it can not detect more serious issues, it can test a wide range of minor eye conditions, including hyperopia, astigmatism, glare sensitivity, vertical and horizontal Phorias, fusion, depth perception, as well as color and night vision. (Depisteo, 2020)

Finally, it is time to discuss some of the most advanced and complex technologies employed by optometrists and other eye health professionals. Several of these discuss scans or readings, which take a trained eye to digest or understand. Then, a groundbreaking new machine is discussed. This technology, though still under development, serves as an example of not only how important eye health is, but the implications that eye health has on the entire body's wellbeing.

<u>Corneal Topography</u>

Corneal topography is a non-invasive medical imaging technique optometrists use to map the anterior curvature of the cornea. (Figure 14) It creates a 3D model, allowing the identification of even the smallest peaks and valleys along the outer surface of the eye. (Figure 15)

Figure 14: An Optometrist Administering a Corneal Topography Exam

Source: Corneal topography. Primary Eye Care. (2022). Retrieved March 1, 2022, from https://primaryeyecarect.com/services/corneal-services/corneal-topography

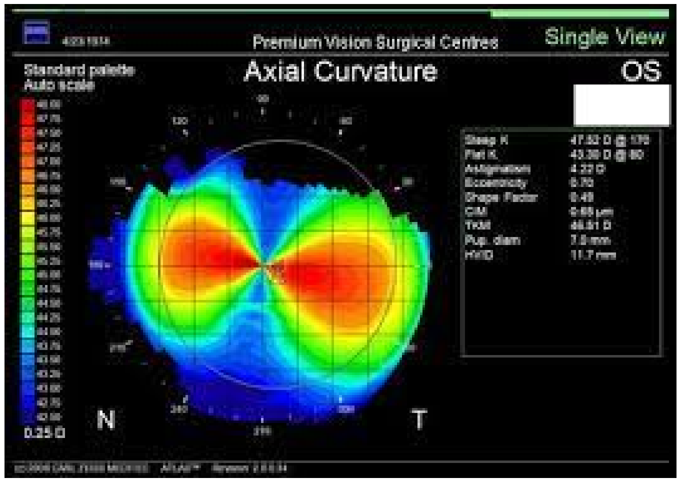

Figure 15: The Image Resulting from a Corneal Topography Exam

Source: Premium Vision. (2015, May 29). Corneal Topography. Premium Vision Surgical Centers. Retrieved March 1, 2022, from http://premiumvisionsc.com/corneal-topography/

The single largest advancement in corneal topography was Placido's disc, developed in the late 19th century. This tool is still utilized today, as current topographers work using the same principle of assessing the reflection of a concentric set of black and white rings from the convex anterior surface of the cornea. The most useful application of corneal topography is screening for keratoconus, an eye disease that affects the structure of the cornea resulting in loss of vision. Many other tests fail to detect the tiny changes that indicate the early stages of keratoconus, making topography the gold standard in screening keratoconus suspects. It is also used importantly in monitoring progression for the treatment of keratoconus. Before refractive surgery by an ophthalmologist, an optometrist may screen candidates for normal corneal shape, and patterns, and rule out suspicious or keratoconic patterns; postoperatively, topography can assess the effective change in the cornea and confirm there are no further issues to be assessed. Other possible applications include surgical planning in cases with astigmatism, detecting and monitoring other corneal and ocular surface disorders, as well as contact lens fitting. (Prakash, 2014)

Optical Coherence Tomography

Optical Coherence Tomography, or OCT, is a noninvasive imaging technology used to obtain high-resolution cross-sectional images of the retina. (Figure 16) This allows the layers within the retina to be differentiated, as well as retinal thickness to be measured to aid in the early detection and diagnosis of retinal diseases and conditions. OCT testing has become a standard for the assessment and monitoring progression of treatment for most retinal conditions. OCT uses rays of light to measure retinal thickness and is best comparable to ultrasound, except it employs light rather than sound and thereby achieves a clearer, higher resolution scan. (University of British Columbia, 2022)

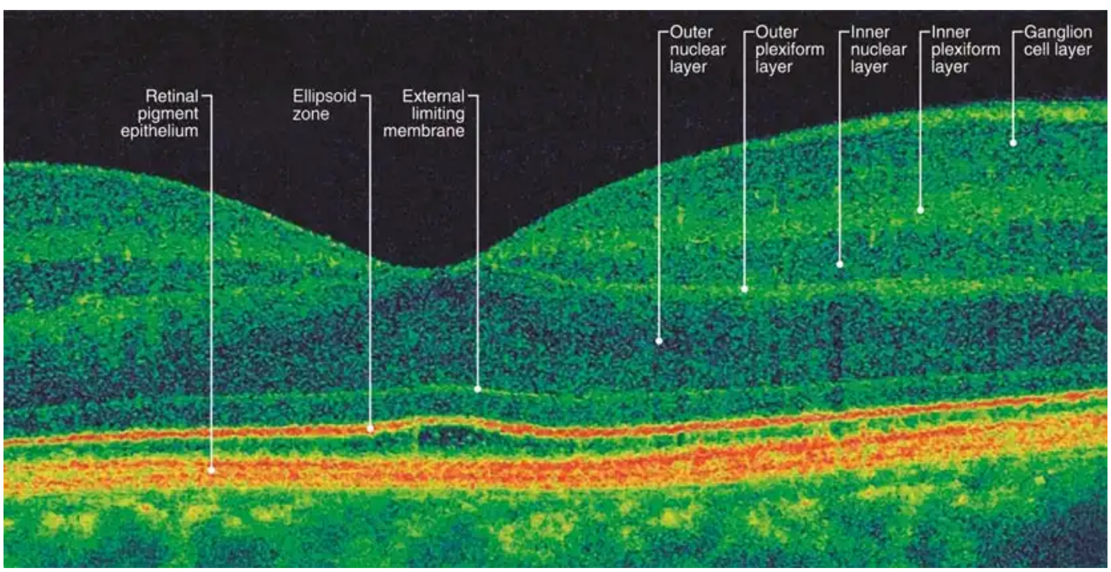

Figure 16: Optical Coherence Tomography Scan

Source: Turbert, D. (2021, May 19). What is Hyphema? American Academy of Ophthalmology. Retrieved March 1, 2022, from https://www.aao.org/eye-health/diseases/what-is-hyphema#:~:text=A%20hyphema%20usually%20happens%20when,subconjunctival%20hemorrhage%20does%20not%20hurt

Optomap

Optomap is another type of retinal imaging tool, that allows for an ultra-wide-angle picture of the posterior of your eye to be captured. Another example of the rapid advancements in optometrist technology is the optomap allows the doctor to view up to 82% of the back of the eye, with older technologies only capturing around 15%. An optomap retinal exam is able to detect the same diseases, including retinal diseases, stroke, cancer, diabetes, and cardiovascular disease, as a typical retinal exam; however, this advanced technology makes it much more likely that an optometrist will be able to clearly see and more appropriately diagnose this issue. (Optomap, 2022)

Occuity Indigo

One of my favorite examples of just how far the world of eye technology can be evolved is the Occuity Indigo device. As mentioned previously, the eye reflects not just vision issues, but health concerns within our entire body. The Occuity Indigo is currently under development as a reusable, pain-free, glucose monitor. The user would simply have to press the device, allow the protected optical lens to pop up, hold the device up to their eye for a few seconds allowing for measurements, and the device would display their current glucose levels. It is clear how a device like this, developed by eye health experts, would be radically new and exciting for the diabetic community. (Occuity, 2022)

Eye Conditions and Diseases Presenting in the Eye

An optometrist can detect and often diagnose a wide variety of conditions that present themselves within the eye. The most common diseases diagnosed by optometrists are those that are exclusive to the eye. Though other bodily diseases present themselves in the eye, there are still a host of issues that affect the eye organ alone. These diseases vary drastically, from simple refractive errors due to the shape of the eye, to blindness causing glaucoma. Regardless, it is an optometrist's responsibility to use all of the technologies at their disposal, mentioned in the previous chapter, to detect and treat the various conditions of their patients.

Refractive Errors

Refractive errors are without doubt the most commonly known vision problem. These errors occur when the shape of one's eye prevents light from focusing correctly on the retina. Over 150 million Americans suffer from some form of refractive error. There are four common categories of refractive error. Myopia, or nearsightedness, makes far-away objects look blurry. Hyperopia, or farsightedness, makes nearby objects look blurry. Astigmatism, caused by a misshapen lens or cornea specifically, can make objects of all distances appear blurry or distorted. Finally, presbyopia, caused by the lens of one’s eye no longer focusing light appropriately, causes older adults to have difficulties seeing objects up close. (Figure 17)

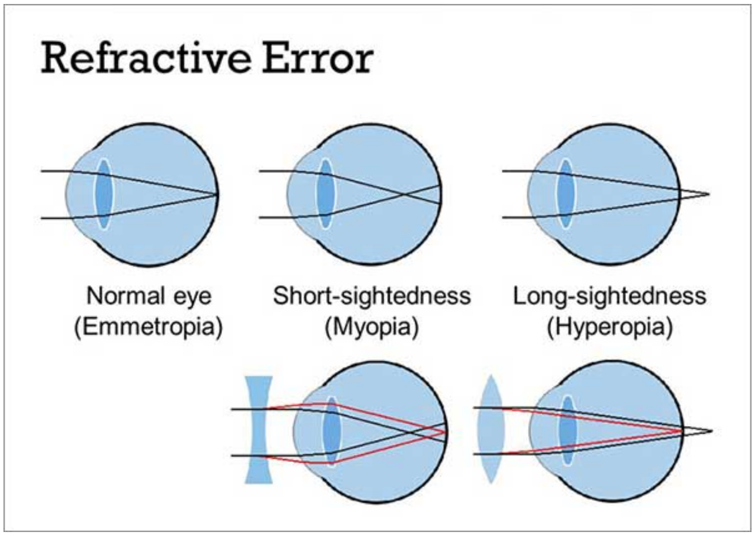

Figure 17: Differences Between the Most Common Refractive Errors

(The bottom images represent corrective lenses assisting the eye in focusing light.)

Source: AMRIT. (2022). Eye refractive errors - symptoms, diagnosis, and treatment. Amrit Hospital. Retrieved March 1, 2022, from https://www.amrithospitals.com/ophthalmology/refractive-error

Optometrists routinely diagnose and treat all four types of refractive error. This problem is easily diagnosed with several technologies discussed previously, including the phoropter in conjunction with a Snellen chart, a retinoscope, as well as the more advanced technology of the autorefractor. An Optometrist can prescribe glasses or contacts to treat a refractive error. Both options use a curved lens to help one's eye correctly focus the light over the retina. It is becoming more common, however, for patients to undergo laser eye surgery to correct their eye's refractive error. The most common type is known as LASIK (laser-assisted in situ keratomileusis). An extensive eye exam is required, in which an optometrist will scan and make an image of the cornea to program the laser used for the surgery. During surgery, a doctor will cut a small flap of the cornea and fold it back, allowing the laser to shine into the eye and change the cornea into the correct shape, based on the scan it received earlier. In 5 states legislation has been passed allowing optometrists to perform laser operations, with the legislation currently in the works for the state of Mississippi. This will allow many more patients to have access to laser eye surgery, as well as continue to increase the importance and capabilities of a doctor of optometry. (National Eye Institute, 2022)

Floaters

Floaters are a common eye problem, caused by tiny strands of vitreous sticking together in the eye and casting a shadow on the retina. These shadows block a small portion of one's vision and are known as floaters. Anyone can develop a floater, but they are more common in patients with severe myopia, diabetes, or who have had surgery to treat cataracts. While there are rare causes of floaters including an eye infection, injury, bleeding, or a retinal tear or detachment, these often have their symptoms presenting before a floater is caused. Treatment of floaters varies greatly. Typical floaters are commonly left untreated and typically dissipate over time. More severe floaters that interfere with vision sometimes require a surgery known as a vitrectomy to remove the vitreous fibers bound together in the eye. (National Eye Institute, 2020)

Cataracts

Cataracts are a cloudy area in the lens of the eye negatively affecting vision. Most cataracts are caused by old age. Around the age of 40, proteins in the lens of the eye begin to break down and clump together causing a hazy area in the lens, or a cataract; these often get more severe over time, continually clouding more of the lens and worsening vision. A cataract's most common symptoms are causing blurry, hazy vision, and reducing one's sensitivity to colors.

Cataracts are often treated by surgery. An optometrist is not qualified to perform cataract surgery but can diagnose cataracts and refer you to an ophthalmologist who can perform the operation. During cataract surgery, the doctor cuts a tiny hole into the eye, breaks up the old lens and removes it, and then places a new artificial lens in place of the old one. (National Eye Institute, 2019)

Amblyopia

Amblyopia, more commonly known as lazy eye, is the most common cause of vision loss in children. Amblyopia is caused when one eye has some error or condition causing it to see significantly worse than the other eye. When this happens, the brain attempts to work around this by shutting off signals from the weaker eye and relying only on the stronger eye. This causes vision in the weaker eye to further deteriorate, and, if left untreated, no longer function at all. The first step to treating amblyopia is correcting the vision of the patient, particularly the weaker eye, with prescription contacts or glasses. Secondly, the brain must be re-trained to use the weaker eye. This can be accomplished by wearing an eye patch on the stronger eye or using eye drops to worsen the vision of the stronger eye, either way forcing the brain to rely on the formally weaker eye for vision. With early detection and treatment, almost all cases of amblyopia can be cured. (National Eye Institute, 2019)

Age-Related Macular Degeneration

Age-Related Macular Degeneration, or AMD for short, is a disease that blurs the central vision, commonly occurring as aging naturally causes damage to the macula. (Figure 18) The macula is an important part of the retina, in that it controls the focused, straight-ahead vision.

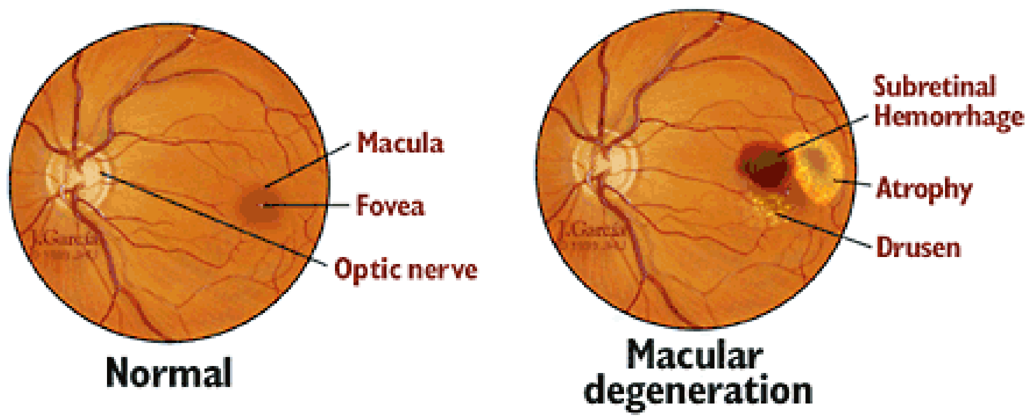

Figure 18: Retinal Scans of Normal Eye and Eye With Macular Degeneration

Source: Age-related macular degeneration (AMD). Johns Hopkins Medicine. (2022). Retrieved March 1, 2022, from https://www.hopkinsmedicine.org/health/conditions-and-diseases/agerelated-macular-degeneration-amd

The most common type of Age-Related Macular Degeneration is dry AMD, also known as atrophic AMD. This condition occurs when the macula gets thinner with age. This disease occurs in three stages, with early dry AMD not causing any symptoms, intermediate dry AMD causing mild symptoms such as some blurriness or difficulty seeing in low lighting, and late-stage AMD causing a significant impact on vision with the most noticeable symptom being straight lines looking wavy. Wet AMD, or advanced neovascular AMD, is a less common form that typically causes rapid vision loss. Dry AMD can turn into Wet AMD during any stage, as it is caused by abnormal blood vessels growing in the back of the eye and damaging the macula.

Treatment for Age-Related Macular Degeneration varies greatly depending on the stage or type. Early AMD has no available treatment, and the only preventative care one can take at this stage is regular exercise, eating healthy, and quitting smoking. Intermediate AMD is often treated with special dietary supplements to try and prevent the progression of the disease. Late dry AMD currently has no available treatment, though researchers are working with stem cells in an attempt to find a cure. Wet AMD is treated often by photodynamic therapy, a combination of injections and laser treatments, as well as injections of anti-VEGF drugs. VEGF is the signal the body receives to induce angiogenesis, the creation of more blood vessels, which is why anti-VEGF drugs are used to treat the abnormal blood vessels growing in Wet AMD. (National Eye Institute, 2021)

Glaucoma

Glaucoma is a general name for a group of eye diseases that may cause vision loss and blindness due to excessive eye pressure damaging the optic nerve. (Figure 19)

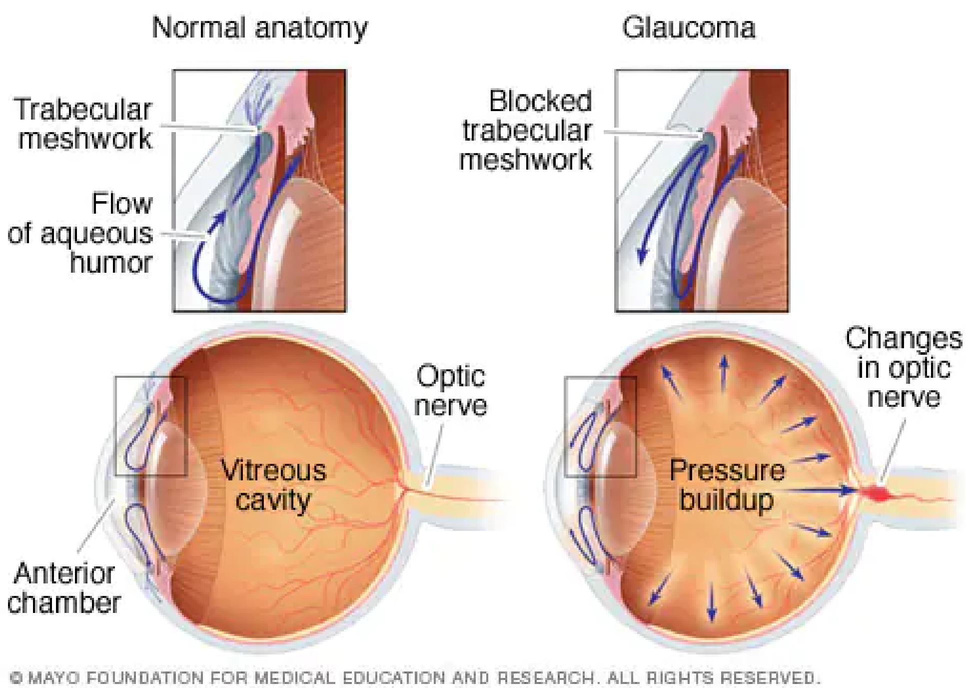

Figure 19: Anatomy of Normal Eye and Eye with Glaucoma

Source: Mayo Foundation for Medical Education and Research. (2020, October 23). Glaucoma. Mayo Clinic. Retrieved March 1, 2022, from https://www.mayoclinic.org/diseases-conditions/glaucoma/symptoms-causes/syc-20372839

Glaucoma that develops on its own, without any other medical condition causing it, is known as primary glaucoma. By far the most common type of glaucoma is a form of primary glaucoma, known as open-angle glaucoma. This glaucoma is caused by a pressure buildup in the eye, commonly occurring when the fluid in the eye cannot drain fast enough. This pressure pushes on the optic nerve in the back of the eye and, after a while, begins to damage the optic nerve which affects vision. This damage can become so severe that the patient becomes permanently blind due to irreversible damage to the optic nerve. If detected early enough, this can be treated using medicines, laser treatment, and other methods designed to relieve the pressure buildup in the eye. Patients with high blood pressure or diabetes are at a much higher risk to develop open-angle glaucoma. There are three other less common types of primary glaucoma. Normal-tension glaucoma is a rare occurrence, in that the eye must be below normal-tension levels to avoid damaging the optic nerve. Angle-close glaucoma is much more serious, with the outer edge of the iris blocking fluid from draining out of the front of the eye causing pressure to build rapidly in the eye. If not treated immediately, angle-close glaucoma can build up pressure so rapidly that it causes blindness in just a few days. Finally, congenital glaucoma is an instance in which babies are born without the ability to drain eye fluid normally, early detection and surgery are key to preventing permanent vision loss for the child. Secondary glaucomas are very rare but are caused by other diseases which present symptoms preventing the eye from properly draining fluid. Often the underlying condition must be treated to prevent vision loss from these types of glaucoma. (National Eye Institute, 2021)

Eye injury is typically a small portion of the cases an optometrist sees on a daily basis, but they are still a very important part of the job. In fact, when dealing with eye injury an optometrist encounters one of their foremost opportunities to act as a primary care physician. Eye injury can be caused by a variety of things, but most often it is some type of blunt force trauma to the head. An idea worth exploring is how an optometrist would be able to approach an eye injury suspected to be caused by violence, specifically domestic violence. As physicians, optometrists are mandated reporters, but the care and thought that must go into a situation like that are immense. Optometrists are not simple glasses providers, but doctors who play an important role in their patient's life.

Retinal Detachment

Retinal detachment is an eye injury that occurs when the retina is pulled away or torn from the back of the eye, its usual position. If a small part of the retina is detached, it may not be noticeable at first, but as more comes dark shadows and floaters begin to cloud one's vision. These symptoms can progress rapidly, and without immediate treatment is likely to cause permanent vision loss or blindness. Patients are at higher risk for retinal detachment after a significant eye injury or eye surgery such as cataract surgery. Other conditions, such as diabetic retinopathy and extreme nearsightedness, can increase the likelihood of a retinal detachment. There are 3 types of retinal detachment, named for how they cause the retina to detach. Rhegmatogenous retinal detachment is simply a tear or break in the retina, often caused by aging due to the vitreous of the eye shrinking and stretching the retina, which then allows fluid to push the retina completely off the eye. Tractional retinal detachment is typically caused by diabetic retinopathy, which damages the blood vessels in the retina, scarring the retina, which in turn causes it to pull the retina and detach it from the eye. Exudative retinal detachment is caused by fluid buildup between the retina and the eye, typically caused by leaky blood vessels or swelling, which builds up pressure and pushes the retina away from the back of the eye. Freeze treatment, known as cryopexy, or laser surgery, is used to treat and seal any small tears or holes in the retina. A more significant surgery is required if a large part of the retina has detached from the eye. (National Eye Institute, 2020)

Hyphema

A hyphema occurs when blood collects in the front of the eye, between the cornea and the iris, this may cover the pupil and partially or totally block vision in the eye. A hyphema is caused by an injury that tears the iris or pupil, causing the bleeding to occur. (Figure 20)

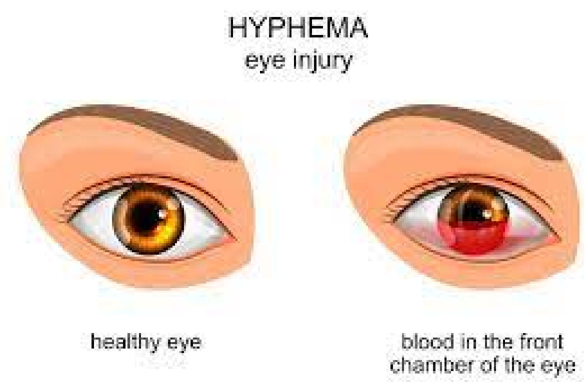

Figure 20: Frontal View of Healthy Eye and Eye with Hyphema

Source: Understanding Hyphema: Symptoms, treatment & more. NVISION Eye Centers. (2021, December 1). Retrieved March 1, 2022, from https://www.nvisioncenters.com/conditions/hyphema/

Hyphemas must be diagnosed by an eye care specialist, and in some cases, the doctor may order a CT scan to analyze the condition of the eye and eye socket, as the injury causing the hyphema could also have caused other structural damage. Treatment for a hyphema usually calls for no physical activity, a protective eye covering, and prescription eye drops which decrease swelling within the eye to aid the healing process. In severe cases, the hyphema can cause eye pressure to rise so high that surgery is required to remove the excess blood, to prevent glaucoma or damage to the cornea. (Turbert, 2021)

Finally, systemic diseases are also visible for detection thanks to optometrists' various abilities and tools at their disposal. The eye as an organ is intricately connected to the body, and signs of systemic disease are present in the eyes oftentimes before or in line with the rest of the body. As mentioned before, this allows yet again for an optometrist to serve in the even greater role of a primary care physician. These things aside, how these diseases are presented in the eye is very interesting, and the anatomy of the eye allows for the exploitation of its translucent to see the damaged or improperly functioning portion of the organ. The diseases that present in the eye oftentimes are silently progressing throughout the body, and early detection of these is key in their treatment.

Diabetic Retinopathy

People suffering from diseases that affect the entire body, such as diabetes mellitus, commonly present symptoms of the disease in the eye. The prevalence of diabetic retinopathy in patients with known diabetes is 28%, and 10.5% in newly diagnosed diabetes. (Ruta, 2013)

Diabetic Retinopathy can affect patients with Type 1 or Type 2 diabetes. This disease is caused by the misregulation of sugar in the blood. Too much sugar in the blood can lead to damage and blockages of the blood vessels that supply the eye, particularly the retina, with blood; this eventually causes rushed angiogenesis to occur, where the new blood vessels do not function properly and leak into the retina. (Figure 21)

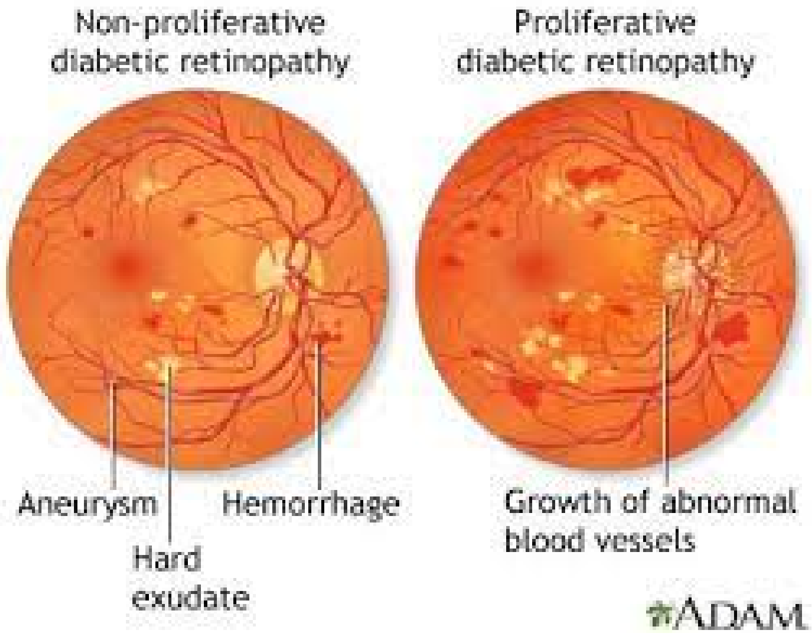

Figure 21: Retinal Scans of Non-proliferative and Proliferative Diabetic Retinopathy

Source: Diabetic Retinopathy. EyeRis Vision. (2022). Retrieved March 1, 2022, from http://www.eyerisvision.com/diabetic-retinopathy.html

While there are two types of diabetic retinopathy, the most common form is the early stage known as nonproliferative diabetic retinopathy or NPDR. This indicates that new blood vessels are not yet being formed, however, the walls of the existing blood vessels in the retina are already significantly weakened. This weakening of walls can cause leaks from the smaller vessels and dilation of the larger ones, with the disease progressing from mild to severe as more blood vessels become blocked. The more advanced stages of diabetic retinopathy are known as proliferative diabetic retinopathy. Now, the damaged blood vessels completely close off causing angiogenesis of abnormal blood vessels in the retina; these abnormal blood vessels are weak and will often leak into the vitreous. The damage done by the malfunctioning blood vessels in the eye causes a wide variety of problems, all attributing to a decline in vision. A vitreous hemorrhage occurs when these blood vessels leak into the vitreous, causing floaters and in more severe cases complete blockage of the retina with blood. Retinal detachment is a more severe possibility, with the scar tissue produced by the angiogenesis in the retina growing large enough to pull the retina off the back of the eye, causing a retinal detachment and possible blindness. Another complication is glaucoma, with pressure buildup likely due to new blood vessels blocking the typical fluid drains out of the eye and eventually damaging the optic nerve. A combination of all these things will eventually lead to blindness due to diabetic retinopathy, especially if the disease is poorly managed. (Mayo Clinic, 2021)

Alcoholism

Excessive consumption of alcohol is known to lead to various eye problems. Heavy drinking over a period of time can cause rapid, involuntary eye movement and in severe cases permanent loss of vision. Alcohol weakens the muscles in the eye and can damage the optic nerves permanently, preventing the interaction of the brain and eye. (Thomas, 2018) Chronic alcoholism affects all vital organs, including the eyes. Development of functional and organic eye disorders may occur in up to 70% of cases. Nutritional optic neuropathy is known to cause a slow decline in visual acuity. (Iskhakova, 2013) Nutritional optic neuropathy, formally known as tobacco alcohol amblyopia, is a rare condition characterized by visual impairment due to alcohol abuse and is typically associated with nutritional deficiencies. This visual impairment presents as a centrocecal scotoma or area of diminished vision. Though the pathophysiology is not totally understood, it is generally accepted that this occurs due to the toxic effects of cyanide and vitamin B12 deficiency. (Syed, 2013) The optic nerve is sometimes damaged in various ways by alcoholism. Generally, eye disorders in patients with chronic alcoholism manifest as central retinal area damage and a combination of retinal and optic nerve involvement. (Iskhakova, 2013)

<u>Hypertensive Retinopathy</u>

Chronically elevated blood pressure is known as hypertension, with 33% of United States adults having been diagnosed with hypertension and only 52% of that group having medically controlled blood pressure. Untreated high blood pressure can also affect eyesight and lead to eye disease, damaging the blood vessels in the retina, this disease is known as hypertensive retinopathy. (Seltman, 2020)

Hypertensive retinopathy is caused by chronically elevated blood pressure and affects up to 17% of those diagnosed with hypertension. This disease is diagnosed by eye exam, based on its appearance by dilated ophthalmoscopic exam and coexistent hypertension. Hypertensive retinopathy goes through three stages, known as the vasoconstrictive, sclerotic, and exudative phases. During the vasoconstrictive phase, elevated pressures cause local autoregulatory mechanisms to narrow the retinal arteriole and vasospasm to reduce blood flow. The sclerotic phase consists of the layers of the endothelial wall thickening and degradation in the arteriolar worsening arteriolar narrowing. Subsequently, the exudative phase presents a disruption of the blood-brain barrier and leakage of plasma and blood causing retinal hemorrhages, ischemia, and the necrosis of smooth eye muscle. (Figure 22) (Kim, 2021)

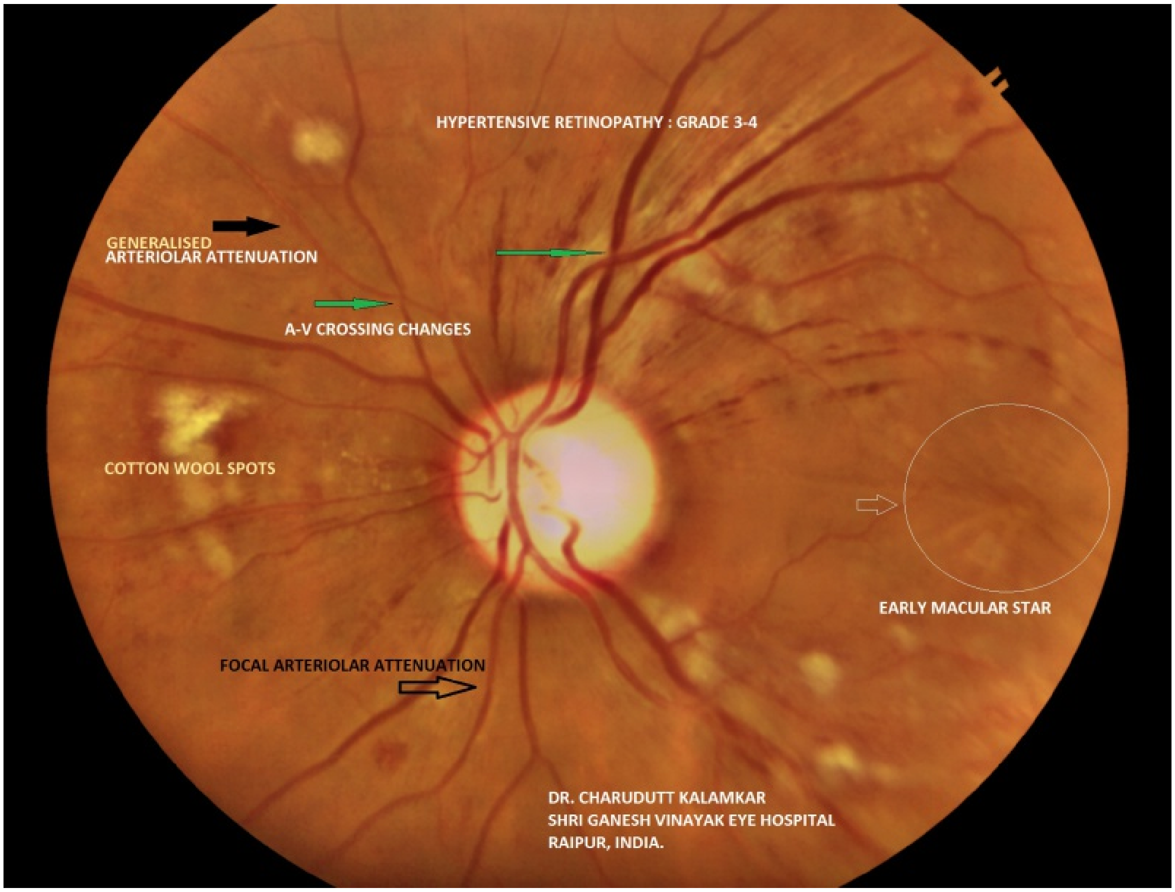

Figure 22: Retinal Scan of Eye with Hypertensive Retinopathy

Source: Kim, J. E. (2021, November 30). Hypertensive Retinopathy. American Academy of Ophthalmology. Retrieved March 1, 2022, from https://eyewiki.aao.org/Hypertensive_Retinopathy#cite_ref-:4_10-1

The treatment for hypertensive retinopathy is predictably focused on reducing the patient's blood pressure. It is important to treat swiftly, as timely evaluation and management of the disease are key to reducing ocular and systemic damage. (Kim, 2021)

Closing

The eye reveals an immense amount of information to an eye trained to find it. It is the only organ that is completely visible without making an incision or otherwise probing within the body. This gives an optometrist an unparalleled window into not only a person's vision but their health. The eye as an organ is not unlike any other organ within the body, it shows clear signs of issue and deterioration alongside the body with many systemic diseases. The ability of an optometrist to see the vasculature and all functioning units of the eye is among the most important advantages the translucent nature of the eye provides. The vasculature within the eye is easily damaged and presents instances of disease in some cases before other signs or symptoms appear. Other signs of ocular decline can also provide indications of disease states, as described previously. Consequently, this increases the capabilities of an optometrist as a general health care professional.

An appropriate way to walk through the intricacies of the eye that an optometrist can comprehend is by layering the views an optometrist is provided. With the naked eye the pupil, iris, sclera, and corneal layers are able to be examined. Asymmetry between the two eyes, blood or fluid accumulation within the aqueous humor, and exposed blood vessel damage are among the most alarming signs that are visible upon initial observation. A further inspection into the inside of the eye with tools such as an ophthalmoscope reveals even more information, allowing doctors to evaluate the vitreous humor, retina, and other components within the interior of the eye. The functioning units of the interior can present as spotted, deteriorated, or otherwise damaged when affected by the disease. Finally, the new and developing technologies for optometric uses provide unparalleled insight into the function and state of all components of the eye. Technologies such as the retinal camera, corneal topography, optical coherence tomography, and the optomap retinal exam provide increasing levels of detail for the optometrist to analyze. These different levels of assessment and analysis allow for the discovery of increasingly hidden health concerns.

The first level of evaluation for an optometrist is of course, with the naked eye. The amount of issues an optometrist can identify without tools is great, though greater diagnostic capabilities come with the use of technologies.

One of the more direct signs that something is erroneous with a patient is blood or inflamed blood vessels visible within the front of the eye. As a result of a blunt force injury to the eye tearing the iris or pupil, an acute hyphema can occur. This often requires further diagnosis and treatment from a health care professional. However, other, more obscure issues may also be to blame. In some cases, both diabetic and hypertensive retinopathy can be seen in the front of the eye. Though further testing and diagnosis will be required, the abnormal blood vessels that are visible would be an alarming sign to an optometrist to evaluate the issue further. The ability to recognize and eventually diagnose this is a vitally important, and underrepresented, role of an optometrist. Due to the typical lack of side effects of both of these potentially fatal systemic diseases, the presentation of the disease in the eye allows an optometrist to potentially help someone get the life-saving medical care they need. This aspect of optometric care will be further elaborated upon later.

Asymmetry in the eyes is also clear at first glance, but a trained eye would be required to analyze the depth of the issue. The most common cause of asymmetrical eyes is amblyopia or lazy eye. Though this seems to be a fairly typical issue, once further evaluated it proves complex. The brain, in conjunction with the eyes, is actively shutting down an organ in an attempt to work around a lack of vision. The brain and eyes are crucially interconnected, and any issue with the brain is likely to affect the eyes and eyesight. This may present as asymmetry, as the brain focuses to use one eye for whatever reason or issue there is, it diverts resources from the other. The brain essentially choosing for itself to maim or kill a functioning bodily organ is unlike anything seen elsewhere within the body. The identification and treatment of amblyopia, or other asymmetrical issues, is important for optometrists, but the underlying cause and effect of the ailment are very unusual and not discussed enough. There are also a number of brain issues that could cause the decline of vision, many of which would be clearly presented at first glance. Any tumor, aneurysm, build-up of pressure, or other damage that occurs to the occipital lobe, the portion of the brain that controls vision, or nerves that carry visual signals from the eye to the lobe, will inevitably affect vision. This deterioration of vision would be clear to the patient, as well as to any optometrist. Any rapid vision decline would be cause for alarm to any optometrist, and if no issues are immediately evident, it is likely a scan or further evaluation from a medical professional would be recommended.

Symptoms of brain tumors, especially in children, can be entirely non-specific. (Peragallo, 2018) This lack of identification is a leading cause of why central nervous system tumors are the second leading cause of non-accidental death in the pediatric population. This also reduces the likelihood of a timely diagnosis unless all medical professionals serving the patient are capable and keenly aware, particularly the child's eye care provider. A significant portion of the brain is involved in vision, and brain tumors can distort, damage, and destroy portions of the brain involved in both the afferent and efferent visual pathways. (Peragallo, 2018) Due to the nature of brain tumors, specifically the lack of screening for pediatric cancers, it is the responsibility of both optometrists and ophthalmologists to become a makeshift first line of screening for this disease. The importance of an eye care specialist in assisting with the diagnosis of a brain tumor in children is highlighted by the fact that 46% of children diagnosed with a brain tumor were diagnosed with some form of vision loss. (Peragallo, 2018) A retrospective chart review of patients presenting to the emergency room who were eventually diagnosed with brain tumors showed vision loss or changes as the second most common symptom, behind headaches. (Peragallo, 2018) Brain cancer is one of, if not the most, dangerous type of cancer, largely in part to its lack of symptoms until late stages have begun. This dramatically increases the responsibility of an optometrist. To imagine a medical professional such as an optometrist as entirely single faceted has become obsolete thanks to the research and technologies of today. It could very well be an optometrist who suspects a patient may have a brain tumor during a routine eye exam and refers the patient to a doctor eventually leading to life-saving care.

Diabetic retinopathy is another example of an optometrist being provided the opportunity to screen patients for underlying issues or systemic diseases. Diabetic retinopathy is the world's leading cause of blindness for adults. As aforementioned, diabetic retinopathy occurs due to extensive damage done to the small blood vessels located in the retina by blood saturated with uncontrollably high blood glucose. Uncontrolled high blood glucose levels, or elevated A1C readings, are especially prevalent in patients with type one or type two diabetes who are medicinally noncompliant. It is also not unlikely to encounter a patient who is unaware they are diabetic, and therefore experience nearly constant elevated blood glucose levels. Therefore, particularly in patients who only visit doctors based on need rather than routine health checks and examinations, it is entirely possible for an optometrist to detect the signs of diabetic retinopathy in a patient who claims they have no knowledge of their disease state. Due to the now commonplace use of technologies such as the retinal camera, an optometrist would detect the presence of diabetic retinopathy during any routine eye checkup. Though it is presumably unlikely that an optometrist would be the first healthcare provider to detect diabetes in a patient, in some extreme cases it is very plausible. This further adds to the importance of an optometrist as a primary healthcare provider.

An important contributing factor to the role of an optometrist as a primary healthcare provider is the argument that some types of patients are particularly much more likely to visit their local optometrist than perhaps even a family doctor for a checkup. One of the most crucial components of any human's life is the ability to see. Many signs and symptoms of disease can be largely ignored or suppressed thanks to the use or misuse of drugs, or ignorance of the issue altogether. However, as soon as a patient's vision is impaired or declining, they are sure to visit their optometrist. It is important to note that it is likely they simply expect a new lens prescription from their eye care provider and not some life-altering news of a severe disease state that could be fatal and is sure to cost more than a routine eye check-up. Alongside this, no one fears bad news when they visit their optometrist the same way they might with a doctor visit. Visiting the doctor for certain demographics is sure to carry a negative connotation, whether that be bad news about their health or bad news about how much money will need to be spent to cure their current ailment. All of these things simply increase the importance of an optometrist to be able to detect and inform patients of any serious ailments. Optometrists are not typically thought of as primary health care providers, but this fact simply needs to change. Due to the increase in healthcare costs, increasing fear and mistrust of doctors and hospitals, especially during the current pandemic, and rapidly increasing capabilities of optometrists, it is time to give this subset of medical professionals the respect they deserve. Patients visit their optometrist due to eye problems but are often unaware of just how serious the underlying issues can be, and it is up to an attentive optometrist to detect potentially severe diseases that present themselves within the delicate organ that is the eye.

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