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Innovations

2019


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Letter from leadership

Dear friends and colleagues,

Ophthalmology as a discipline is experiencing explosive innovation on many fronts, and OHSU Casey Eye Institute is at the forefront of some of the most exciting developments.

As a leader in informatics, advanced imaging and gene therapy, we're recognizing that we can assemble these amazing advancements to change the future of vision health in our state and beyond.

▶ We are proud to be a world-renowned academic eye center working to eliminate preventable blindness through research, education, innovative and community service.

Left to right: Dr. Michael Chaing, Dr. David Wilson, Dr. Andreas Lauer of OHSU Casey Eye Institute.

We have reached an intriguing historical intersection in ophthalmology where two influential factors, breakthrough technology and evolving health care economics, offer the opportunity for a philosophical shift in delivery of care from solely the individual to a population-based approach. Following this concept, what if we start judging our success based on the eye health of a population rather than tallying individual outcomes as a measure? For example, determining the percentage of the population that becomes legally blind from macular degeneration.

OHSU Casey Eye Institute is prepared for this moment of opportunity due to forward-thinking investment in technology and talent coupled with a clear mission to serve the people of Oregon as our state's only academic health center. We've begun taking some steps in this direction that have the potential to evolve into a comprehensive approach measurable on a statewide basis:

- We've partnered with about 70 organizations geographically distributed throughout our state for clinical outreach and screenings.
- We are training community providers, technicians and even volunteers to perform screenings in community locations, such as our volunteer-delivered screenings for about 8,000 preschool children each year.
- We've begun some programs delivered via telemedicine or the internet, such as diagnosing retinopathy of prematurity in neonatal units.

A critical goal is to increase access to eye health care. In our personal practices, there are numerous instances of irreversible vision loss that are a result of not having timely access to care. Though these programs are a start, we can also visualize an opportunity to shift to greater preventive care if we can screen target populations and identify issues before they become symptomatic. For example, one day we may have technicians based at local pharmacies or community centers who can use optical coherence tomography for screenings and send results to a central reading center at OHSU Casey Eye Institute to identify at-risk people for referral.

With a strong tradition of teamwork, diversity and interdisciplinary care, OHSU Casey Eye Institute is a natural environment for innovation. We are proud to share with you some highlights of the promising work that is transforming how we provide care to people affected by various eye diseases.

Sincerely,

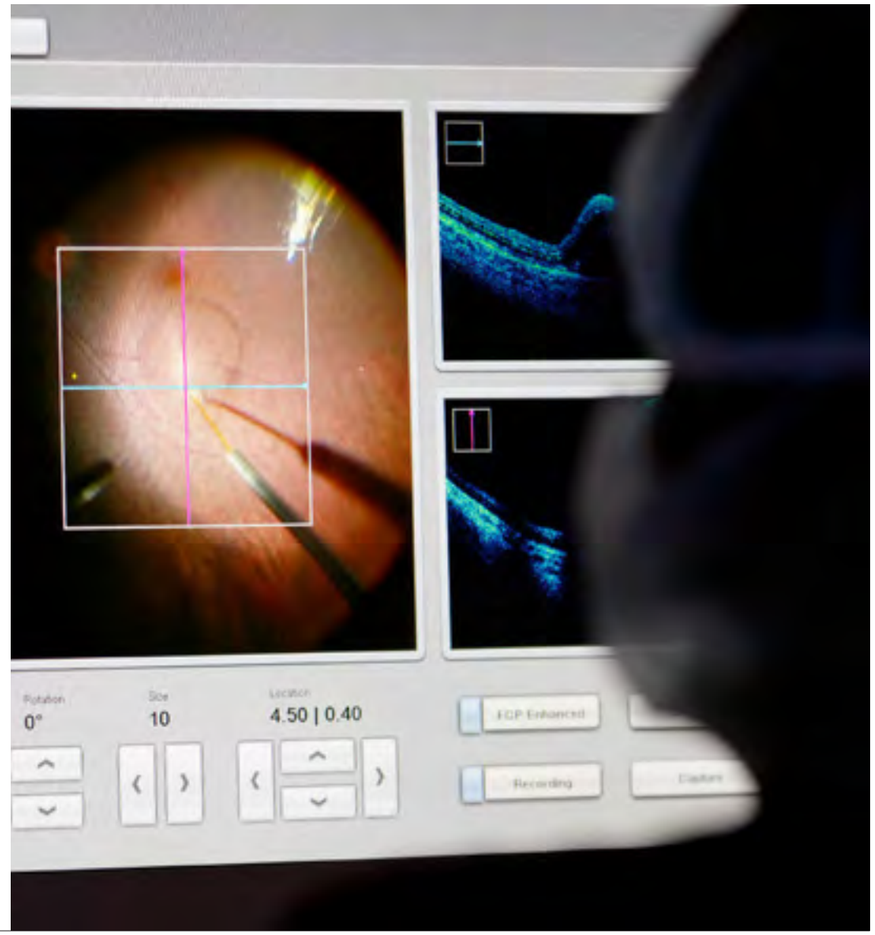
David. J. Wilson, M.D.
Professor and Paul H. Casey Chair,
Department of Ophthalmology
Director, Casey Eye Institute

Andreas Lauer, M.D.
Professor and Thiele-Petti Chair,
Chairman, Department of Ophthalmology

Michael F. Chiang, M.D.
Knowles Professor,
Department of Ophthalmology
Associate Director, Casey Eye Institute

Pioneering a groundbreaking treatment

Leading the field in gene therapy



▶ Using a fine needle to inject a gene therapy vector underneath the retina of a patient with an inherited retinal dystrophy. The delicate procedure is guided by a state-of-the-art intraoperative OCT imaging system made possible by philanthropic support of OHSU Casey Eye Institute.

In 2018, OHSU Casey Eye Institute was one of the first three institutions in the country to administer the first federally approved gene therapy for retinal dystrophies. The Food and Drug Administration approved Luxturna™ (voretigene neparvovec-rzyl; Spark Therapeutics) in December 2017. OHSU Casey Eye Institute treated two patients with the new gene therapy in August and September 2018.

"This is a pivotal moment for our field; it's nothing short of historic," said Mark Pennesi, M.D., Ph.D., chief of the Ophthalmic Genetics division at OHSU Casey Eye Institute. "The first trial was incredibly exciting, but even more exciting is the potential to change the whole field of ophthalmology and genetic disease. This success represents the tip of the iceberg. There are over 250 different genes that can cause these types of diseases. The fact that gene therapy can work for one indicates that many more may be treatable. At OHSU Casey Eye Institute, we have eight additional gene therapies in clinical trials and more on the way."

OHSU Casey Eye Institute is conducting more ocular gene therapy trials than any other research center in the world. "We have been leaders in testing novel therapies for Usher syndrome, Stargardt disease, achromatopsia and X-linked retinitis pigmentosa," Pennesi said. "In the coming year, we also plan to participate in the first clinic trial to use gene editing."

Strong collection of resources to support gene therapy

Pennesi said a robust infrastructure in specialty personnel, advanced technology and surgical services is necessary to support gene therapy and its clinical trials. OHSU Casey Eye Institute is ideally positioned due to leadership's commitment to support research into rare conditions.

"Many centers don't have ophthalmic geneticists on staff, but here we have three," Pennesi said. "We also have a full-time genetic counselor and seven clinical trial coordinators. We have substantial, state-of-the-art diagnostic resources with trained technicians to measure whether a gene medication is working. But above all, we have a depth of collective experience among our retina surgeons working in a high-volume center."

Exciting implications for the field

The first approved gene therapy is specific for biallelic RPE65 mutation-associated retinal dystrophy in children and adults. In clinical trials, more than 90 percent of people improved their vision, with some moving from legally blind to not blind.

"Although gene therapy won't restore eye cells lost to disease, people who are treated in the early stages may look forward to a future without ever-diminishing eyesight," Pennesi said. "We are entering an era of new therapy for those who otherwise would become irreversibly blind. For the first time, we are offering hope for these patients and their families and improving quality of life."

Defining the future of eye care through informatics

Leading invention in AI, telemedicine and data analytics for ophthalmology

The frenetic pace of technology in the 21st century is changing medical practice, and OHSU Casey Eye Institute is an epicenter for inventing and integrating these new tools into ophthalmology.

"The wealth of data and incredible advances in technology are changing the way we practice ophthalmology," said pediatric ophthalmologist Michael F. Chiang, M.D., a nationally-known medical informatics expert who trained as an engineer before earning his medical degree. "At OHSU Casey Eye Institute, we are among a handful of centers deeply investigating telemedicine, artificial intelligence and data analytics for ophthalmic care. We are ideally positioned to go from identifying a clinical need to researching a solution, proving it works, applying it to real-world care, influencing national best-practice guidelines, and integrating it into our educational curriculum."

Chiang was co-leader in a 2018 research study describing a novel artificial intelligence algorithm designed to diagnose retinopathy of prematurity (ROP), a leading cause of childhood blindness worldwide. The study showed that this artificial intelligence algorithm accurately diagnosed severe ROP in 91 percent of cases, which was better than a panel of leading experts, who were correct an average of 82 percent of the time.

"There's a huge shortage of ophthalmologists who are trained and willing to diagnose ROP. This creates enormous gaps in care, even in the U.S., and sadly leads to many undiagnosed children around the world," Chiang said. "Through deep learning, the algorithm uses the collective knowledge of ophthalmologists and creates a mathematical model that accurately diagnoses ROP from images. The implications are exciting, especially for rural and underserved areas."

Chiang heads the Oregon State Elks Center for Ophthalmic Informatics, the only such center in the country. He is principal investigator for a consortium of 12 academic institutions sharing the goal of developing better methods for diagnosing and treating ROP through computer-based image analysis, genetic analysis, and biomedical informatics analysis.

◀ Wide-angle retinal image from infant screened for retinopathy of prematurity (ROP). To diagnose ROP, artificial intelligence systems must first identify and segment retinal vessels.

An early investigator into telemedicine for ophthalmology, Chiang continues to position OHSU Casey Eye Institute as a leader in pushing the boundaries of telemedicine. He is involved in many studies funded by the National Institutes of Health regarding the use of electronic health record systems to improve the quality and efficiency of ophthalmic care, and he leads major American Academy of Ophthalmology initiatives involving registries, data analytics and big data.

"Having the technology is one thing but applying it to a particular disease is the challenging piece," Chiang said. "Our work at OHSU Casey Eye Institute illustrates the principles and creates a blueprint for application."

◀ Overlay shows retinal vessels identified by a fully-automated vessel segmentation system developed by OHSU Casey Eye Institute faculty and collaborators.

Outreach efforts to rural and underserved areas

◀ The Casey Community Outreach Program collaborates with partners to provide care to various disadvantaged populations, reaching over 8,500 community members with no other access to eye care. Through this program, OHSU Casey Eye Institute representatives have identified people with preventable and treatable conditions related to refractive error, diabetes, macular degeneration and glaucoma for referral, furthering our mission to end preventable blindness.

Global Opthalmology Meeting: July 19–20, 2019, Portland, OR

◀ The Global and Community Ophthalmology Meeting is a biennial forum hosted by OHSU Casey Eye Institute to bring together ophthalmologists, public health professionals and national and international thought leaders to investigate key topics influencing the front lines of eye care throughout our region and across the world. In 2019, we will investigate how new scientific evidence will reshape the future of community and global ophthalmology and how lessons learned abroad can be applied in our own backyard.
www.ohsucasey.com/globalmeeting

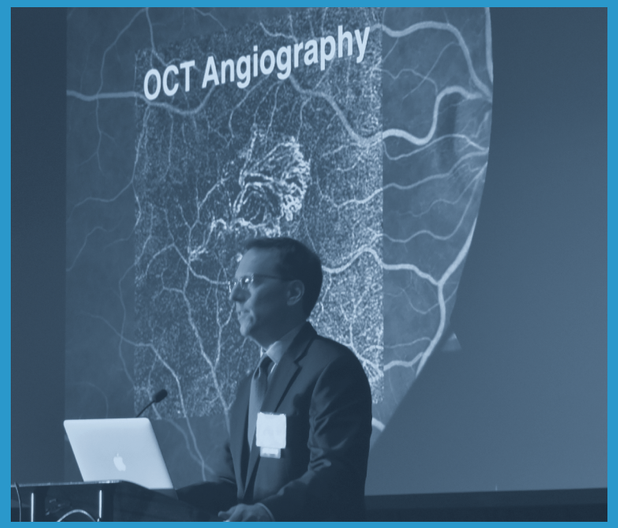
Casey physician helms VISION 2020 USA

▶ Currently serving as national chairman of VISION 2020 USA, OHSU Casey Eye Institute's Mitchell V. Brinks M.D., M.P.H. directs U.S. national policy and advocacy efforts of a consortium of organizations striving to prevent blindness and elevate eye health to a national priority for the year 2020. VISION 2020 USA will work with the U.S. Surgeon General to initiate a national *Call to Action* as a launching point for this endeavor. Priority initiatives include coordinating federal programs, modernizing population eye health data, standardizing integration into health insurance, and readying the U.S. to take advantage of tele-ophthalmology.

VISION 2020
THE RIGHT TO SIGHT

International Ocular Circulation Society (IOCS) Meeting: Aug. 10, 2019, Portland, OR

▶ The International Ocular Circulation Society (IOCS) was recently co-founded by David Huang, M.D. and Yali Jia, Ph.D. of OHSU Casey Eye Institute, and a group of international leaders. The inaugural meeting in Portland will bring together experts from around the world to present cutting-edge research on the imaging and measurement of ocular blood flow, ocular vascular anatomy and physiology, and the roles of ocular circulation in ocular and systemic diseases. The meeting will feature Casey's pioneering work on optical coherence tomographic angiography (OCTA) and its use in the diagnosis management of many eye diseases.



Physical expansion doubles capacity with new building

◀ The new Elks Children's Eye Clinic facility, a 60,000-square-foot building adjacent to OHSU Casey Eye Institute, will provide more space for some of Casey's crucial programs, including the Ophthalmic Genetics Center, the Wold Macular Degeneration Center and the Elks Children's Eye Clinic pediatric service. With this new facility, we will expand clinical trial capacity for gene therapy to accommodate the expected tripling of patient volumes, grow research and clinical trials for AMD, and serve as a statewide hub for pediatric eye care programs, including telemedicine for retinopathy of prematurity, pediatric vision screening and treatment of inherited eye disease. The facility is scheduled to open in 2020.

Macular Degeneration and Vision Expo for the community

◀ For 11 years, OHSU Casey Eye Institute's Macular Degeneration Center and Vision Rehabilitation Center has hosted a free, one-day program in Portland for community members with macular degeneration and other conditions that impair eyesight, attracting as many as 900 attendees annually. The expo features presentations by OHSU Casey Eye Institute faculty on the latest advances in macular degeneration research and treatment, small group sessions on adjusting to vision loss, and exhibits of community services, optical aids and assistive technology.

New frontiers of imaging for eye diseases

Leading advancement in OCT angiography

OHSU Casey Eye Institute is at the forefront of noninvasive imaging technology to detect vascular changes that may allow for treatment to prevent permanent vision loss from several eye diseases. Not only is OHSU Casey Eye Institute blazing a trail in how to use optical coherence tomographic angiography (OCTA) clinically, but we are also continually improving the capabilities of the technology.

A world-recognized leader in OCT structural and angiographic imaging, David Huang, M.D., Ph.D. runs the Center for Ophthalmic Optics and Lasers, or COOL Lab, at OHSU Casey Eye Institute. With his team, Huang is currently pioneering new applications of this extraordinary technology, including creating high-speed prototypes, novel signal and image processing, and piloting clinical studies utilizing OCTA in diagnosing and monitoring several critical eye diseases.

"OCT angiography is so relevant to eye health because all of the leading causes of blindness, including age-related macular degeneration, diabetic retinopathy and glaucoma, involve changes in retinal, choroidal and optic nerve circulation," Huang said. "I believe OCT angiography will become just as important a tool as structural OCT. For example, conventional imaging techniques cannot detect choroidal neovascularization until it becomes exudative, turning AMD into the wet form. But with OCTA, we can detect these precursor lesions and potentially identify eyes that would benefit from prophylactic treatment."

Huang and his team are also studying OCTA's effectiveness in the early detection of neovascularization in diabetic retinopathy. The ability of OCTA to make a big clinical impact depends on further enhancing the efficiency and reliability of the imaging technology and algorithms, according to Huang.

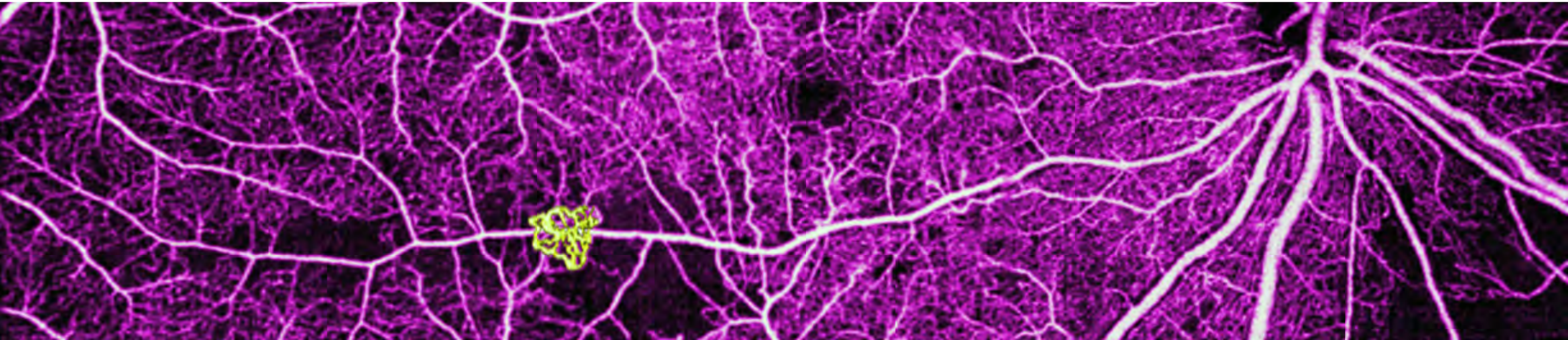
"There are a lot of nuances in getting a clean OCTA image," Huang said. "Our lab is improving the technology's ability to accurately determine capillary density in different layers of the retina using methods that can resolve the four retinal vascular plexuses. We have also developed ways to cancel out artifacts caused by signal strength variation and eye motion."

Ongoing potential for other OCT innovations

The COOL Lab is also pursuing research in other novel OCT technologies and new

COOL Lab

David Huang, M.D., Ph.D. runs the Center for Ophthalmic Optics and Lasers, or COOL Lab, at OHSU Casey Eye Institute with a team of top scientists from around the world who have been perfecting OCTA technology and investigating multiple clinical applications. This team includes Yali Jia, Ph.D., who has received international recognition for several contributions to OCTA technology. The COOL Lab is supported by four NEI grants to develop OCTA technology for applications in age-related macular degeneration, diabetic retinopathy, glaucoma and anterior eye diseases.



▼ Early detection of retinal neovascularization in diabetic retinopathy using wide-field OCTA (6x16-mm),

clinical applications. These include the use of nanoparticles as OCT contrast agents, OCT elastography in measuring corneal mechanical properties, Doppler OCT to measure retinal blood flow, directional OCT to measure tissue composition, ray tracing on OCT images to calculate visual optics, and artificial intelligence to detect and classify corneal and retinal pathologies. Huang expects significant advances to continue for the foreseeable future. “OCTA is the new frontier in OCT research,” Huang said, “but it is not the last frontier.”

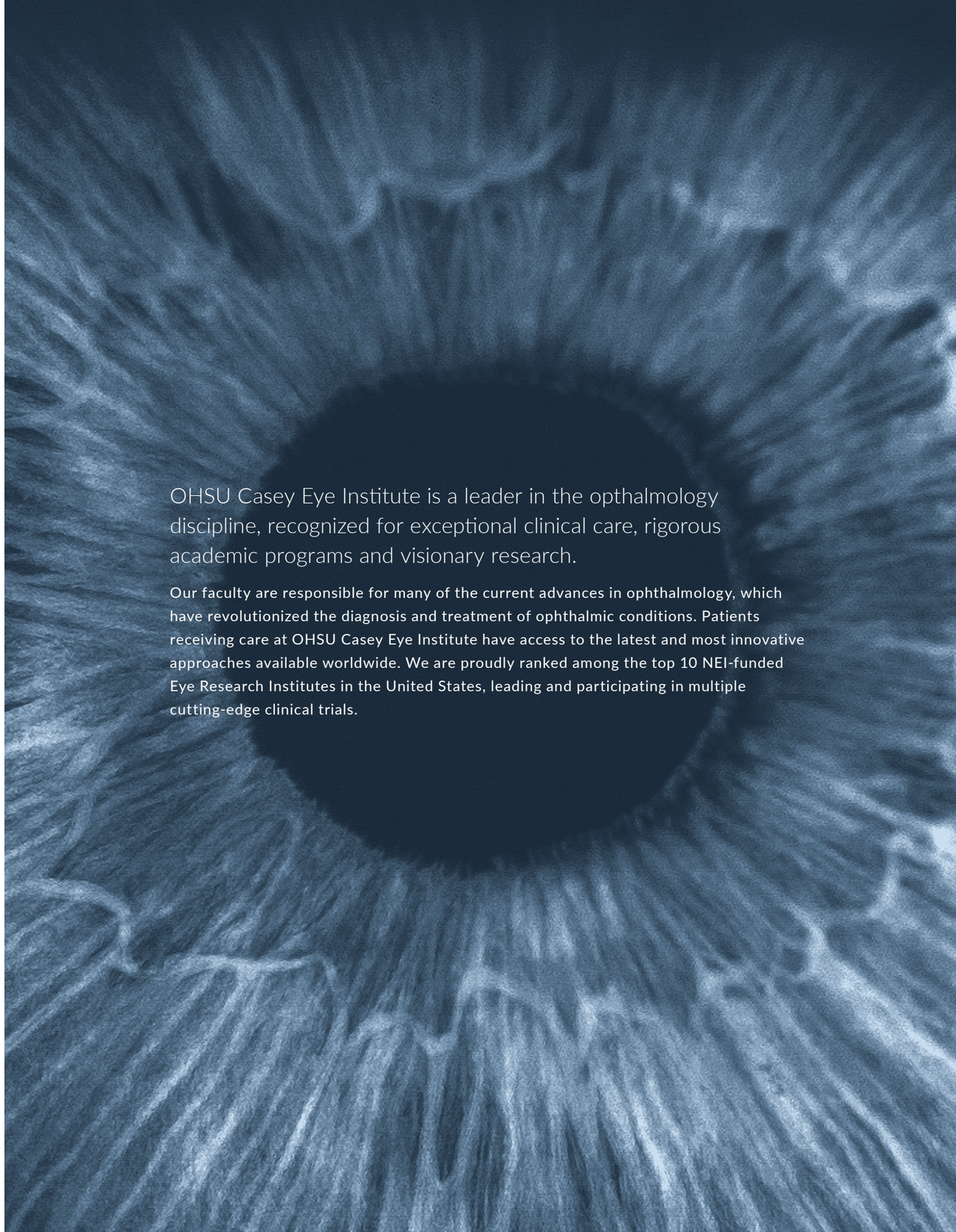
Unique climate for innovation

From Huang’s perspective, the COOL Lab at OHSU Casey Eye Institute is a leading international contributor to research and applications of OCTA because it bridges the technology to clinical use, supported by an institutional culture conducive for collaboration.

“At OHSU Casey Eye Institute, we tailor engineering innovations to have maximal clinical impact,” Huang said. “This is a special environment where engineers, scientists and clinicians work closely together. Not all labs have those resources. We can go from basic technology development to translational research to directly relevant clinical studies. This degree of vertical integration is special in any discipline.”

Co-founder of transformative technology

As a Ph.D. student at Massachusetts Institute of Technology, Casey Eye Institute’s David Huang, M.D., Ph.D. was the co-inventor of optical coherence tomography (OCT) technology, the most commonly used ophthalmic diagnostic technology worldwide, with an estimated 30 million OCT imaging procedures performed every year. “OCT imaging succeeded beyond even what we anticipated in 1991,” Huang said. “I am pleased to see how the technology has evolved over the past 27 years. The No. 1 application now is for aged-related macular degeneration. OCT use continues to grow rapidly in ophthalmology and other medical specialties.”



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