I can vividly recall a weekend in the early 1970s when I attended my first national ophthalmology meeting. I was in my residency at the University of Wisconsin and had the opportunity to go to the annual spring meeting of the Chicago Ophthalmologic Society. I remember hearing the speakers during the retinal section of the conference describing the new and exciting innovation in their subspecialty, the pars plana vitrectomy. The anterior segment authorities spoke excitedly about the intraocular lens, a radical new solution to the optical problems associated with aphakia. The first soft contact lens had been recently approved for general use, and there were glowing reports about its successful application in previously contact lens–intolerant patients. By that stage of my training, I had already decided on a career as a pediatric ophthalmologist. So it was with great anticipation that I awaited the section of the program devoted to strabismus. The moderator of those lectures began with an acknowledgment of the great advances that had been made in other areas of ophthalmology, and continued with, “Actually, we are not doing anything differently in the treatment of strabismus than we were 50 years ago.” In spite of (or perhaps inspired by) those remarks, I did indeed become a pediatric ophthalmologist.

During the quarter of a century that has elapsed since that May weekend in the 1970s, there have unquestionably been some notable advances in pediatric ophthalmology. Certainly the routine use of adjustable sutures for treating adult strabismus, the advent of botulinum toxin A for select forms of strabismus, and new understanding of orbital anatomy (eg, orbital pulleys) represent a few of the important milestones in the history of the management of strabismus in the last millennium. The application of intraocular lens implantation in children and advances in preventing and treating retinopathy of prematurity (ROP) represent similar landmarks for other areas within pediatric ophthalmology. But despite these important achievements, the field of pediatric ophthalmology has not experienced the same dramatic advances that have become almost commonplace for ophthalmology in general. However, as we cross the threshold into the new millennium, the future seems abundant with promise. In her novel The Spirit Catches You and You Fall Down, Anne Fadiman wrote

I have always felt that the action most worth watching is not at the center of things but where edges meet. I like shorelines, weather fronts, international borders. There are interesting frictions and incongruities in these places, and often, if you stand at the point of tangency, you can see both sides better than if you are in the middle of either one.

In that spirit, the field of pediatric ophthalmology and strabismus is a truly exciting place in which to be engaged as the 20th century rubs shoulders with the 21st. The knowledge we have gained in the last quarter of the 20th century is the soil in which the accomplishments of the future will grow.

If knowledge is power, it is because power is instrumental in helping one influence the future. Although it would take a prophet of biblical proportions to fore-
see the future of pediatric ophthalmology and strabismus during the entire next millennium, a more manage-able task is to speculate on changes that will occur in pediatric ophthalmology and strabismus in the next 20 to 30 years. That is the goal of this report. To assist me in generating these ruminations, I in-voked the wise counsel of some noted authorities in our subspecialty, who are acknowledged at the end of the article.

To predict the future of pediatric ophthalmology and strabismus most accurately, one needs to understand the current situation in the clearest light and proceed with the hope that we will have the collective wisdom to fashion a future based on real need. Currently, in the United States alone, there are approximately 60 million children younger than 15 years who compose about 20% of the nation’s population. It is estimated that more than 95% of the 4 million children entering first grade each year have never seen an eye doctor. This is in part due to the shameful fact that children constitute a disproportionately large share of those without access to health care in this, the wealthiest country ever, at the end of this “American Century”; more than 15% of American children (>11 million) do not have health insurance coverage. That inequity is in part a result of an equal shame—the fact that the United States is one of the only major Western nations without universal health care.

Winston Churchill said, “Americans are wonderful people in that they always find the right answer after they have tried every wrong answer first.” There are those who believe we are starting to see early signs of the demise of the national experiment known as managed care. Both corporate America and the public are disenchanted with it, albeit for different reasons. But a clear vision of what will replace it remains obscure. However, the needs of children are currently prominent on the radar screens of politicians and the public. As such, I imagine there will be a national agenda to provide universal health care to all children in the United States before there will be similar benefits provided for people of all ages. But why has the current situation been a reality up until now? As H. L. Mencken said, “When they say ‘it’s not about money’ it’s about money.”

The cost of providing health care coverage to all children can best be appreciated when viewed in a historical perspective. The creation of Medicare in the 1960s expanded insurance coverage to 32 million people, and the number of children in this country today is almost double that. Medicare is a major component of the federal budget. Consequently, an important aspect of my vision for the future is that bona fide breakthroughs will occur that will improve the quality of care yet will contain cost.

There are 2 areas in which we are palpably close to realizing such advances, both of which involve the early detection of disease or risk for disease through screening. Imagine the utility of being able to identify the large percentage of infants who have no ocular abnormality and little risk for developing one. Society could then devote its resources to the much smaller number who are at greater risk. Instruments for screening the ocular media of newborns for structural or optical abnormalities will play an important role in this regard. Perhaps they will be some variant of today’s photographic screening devices. The other sphere in which the future is almost on us is that of genetic screening, either prenatally or in the neonate, for genetically influenced disorders that may be present at birth or will develop in childhood. This, along with gene therapy, will allow us to concentrate our attention and resources where they are most needed. Better understanding of homebox or “controlling” genes, and their interplay with environment—the interaction between nature and nurture—will be influential in understanding and preventing common disorders such as myopia and strabismus. Thus, I envision that all infants will be screened for important ocular disorders in a manner that will become become as routine as certain immunizations. Identification of individuals at high risk for developing ocular disorders in the future will facilitate treatment inter-
terventions as soon as a disorder becomes clinically evident or, in some situations, prophylactically. The information revolution, using the model of telemedicine, can make these screening modalities available to children in the most remote regions of the world.

But screening and early diagnosis will only help us sharpen our focus by identifying who needs specialized attention. Important advances will occur in the diagnosis and treatment of pediatric ocular disease. Currently there is still a crucial need for an accurate, practical, office-based method to assess visual acuity in preverbal children. Our current armamentarium includes fixation preference testing with or without an induced tropia (too many false positives for detecting amblyopia), forms of preferential looking such as Teller Acuity Cards (underestimates or overestimates acuity in different circumstances), or the sweep visually evoked potential (not readily available and costly). I predict this need will be met in the next 20 to 30 years. Once amblyopia is diagnosed, we are still treating it essentially the same way as we did more than 50 years ago. Better understanding of the neurophysiological basis of amblyopia should give rise to improved treatment modalities. Elucida-
tion of the molecular mechanism of neural cell functioning and identification of specific neural trans-mitters will lead to drugs that can overcome suppression and treat am-blyopia. Insight into the behavior of genes to trigger and regulate cells to regenerate and replace lost connec-tions will help recover the lost binocularity that occurs with strabismus. Functional imaging holds promise for providing a view into the neural processes underlying amblyopia and abnormal sensory adapta-
tions. These tools will all help us open the mysterious black box behind strabismus.

As with many fields in medicine, I predict improvements in the management of strabismus will occur incrementally. The aforementioned developments that will provide early detection should lead to earlier treatment, thus preventing or minimizing the devastating effects of abnormal sensory adaptations, in-
cluding amblyopia. Undoubtedly refractive surgery will play a role in the management of anisometropia and perhaps accommodative strabismus in the future. Hopefully this will not occur before we have sufficient understanding of the factors regulating changes in the refractive state with growth, and thus can avoid the long-term adverse effects of refractive surgery in children. Alternatively, and probably in the more distant future, insight into factors affecting refractive changes in children may spawn gene-based or pharmacologic therapies that may prevent the development of refractive problems before they develop. Similarly, pharmacologic agents that stimulate or block convergence or divergence can be anticipated. Perhaps these may include new delivery systems such as implanted time-release pellets.

But until we have found effective means to prevent strabismus by eliminating the underlying cause, surgery will probably remain at the forefront in its treatment. With respect to that intervention, I predict some important advances in the next 20 to 30 years. Presently strabismus surgery is typically formula-based, with the main input being prism diopters of misalignment, and the main output being millimeters of surgery. We need better understanding of what other variables should go into the equation. Whether it ought to include parameters of muscle stiffness and generated force, size of the globe, position of the eyes under anesthesia, and other orbital tissue factors will be clarified in the next quarter of a century and our “formulas” modified accordingly. Computer modeling of strabismus will probably evolve to a new level of utility, allowing the clinician to simply enter criteria obtained as part of the patient’s examination and be provided with a sound surgical plan. With the current trend for earlier surgery for infantile strabismus, we are in desperate need of a more accurate means to measure the angle of misalignment in infants than is now available. The Hirschberg and Krimsky tests are too inaccurate for reliable use. Probably some form of photographic analysis will be the first step, with the addition of digital technology to aid in interpretation later.

These developments will affect the planning of surgery. There will also be improvements in surgical technique. The application of adjustable-suture surgery is limited by the age and cooperation of the patient. I envision synthetic suture materials that would respond (enlarge or contract) to some remotely applied external stimulus, thus extending the benefits of suture adjustment after surgery to patients of all ages and degrees of cooperation.

We can also hope for advances in the field of adult strabismus. As the management of retinal detachments with encircling elements becomes employed less frequently, the post–scleral buckle adherence syndrome will vanish. Similarly, as more cataract surgery is performed with topical anesthesia, the post–cataract surgery myopathy syndrome will disappear. Also, I predict the development of topically applied drugs that will prevent the devastating effects of the fat adherence syndrome that can occur after orbital trauma or strabismus surgery.

As our knowledge of the control mechanisms behind the development of strabismus expands, including the role of vergence adaptation, muscle length adaptation, and sensory factors, we will probably develop methods to correct or prevent strabismus by nonsurgical means.

The next quarter of a century also holds great promise for pediatric ophthalmology outside the area of strabismus. In addition to the aforementioned advances in gene-based therapies for monogenic diseases, and better profiling of risk for disease based on genotype, I predict gene therapy will prevent the occurrence of many hereditary ocular disorders and thus obviate later treatment. Until such time, intraocular lens technology will progress, grounded in an understanding of factors affecting refractive changes, to permit safe and predictable intraocular lens implantation in infants. Despite the gains we have made in the prevention and treatment of ROP, this devastating disorder is still one of the leading causes of blindness in children and its prevention has been elusive. More than 25 years ago, as a fellow in pediatric ophthalmology investigating ROP, I observed that the vascular pattern seen on retinal flat mounts of regressing ROP mimics the vasculogenesis that normally occurs in animals born in the immature state (such as marsupials). Is ROP a functional adaptation to premature exposure to the extrauterine environment? Certainly the future must hold an answer to the question of prevention of this disease.

The next quarter of a century promises to bring dramatic changes in education in pediatric ophthalmology, the dissemination of information, and research. The future will probably be characterized by an increased symbiosis among pediatric ophthalmologists, clinicians in other disciplines, and basic scientists. As such, fellowship training will move out of its present tightly defined container and provide more cross-disciplinary opportunities. Also, digital technology and the Internet promise to revolutionize the distribution of knowledge. Only within the past few years has the ability to send high-quality digital images and video recordings instantaneously (at no per-use cost) to a limitless number of recipients been available to anyone with a computer and a modem. This is particularly important for conveying information about eye movement disorders for which the dynamic aspect of videography adds a valuable component for the viewer. The Internet will permit easy access to consultation with experts worldwide, and probably allow for remote examinations by geographically distant experts teaming up with local paramedical personnel. In the past several years there has been an explosion of medical journals that have put their entire contents online, including the official journal of The American Association for Pediatric Ophthalmology and Strabismus. On-line journals provide the opportunity to include video segments as “illustrations,” thus greatly aiding authors’ abilities to describe surgical techniques and motility disorders in scientific publications. The Internet also poses a mixed bless-
ing with respect to patient education. By now, probably all clinicians regularly interact with patients who gain a substantial amount of medical information on the Internet, and perhaps used it to help decide on which physician to consult. Good information and misinformation have equal billing on the World Wide Web in its current form. This poses both opportunities and challenges for ethical and honest clinicians and researchers that will need to be sorted out in the near future. Finally, I imagine pediatric ophthalmology as a subspecialty taking giant steps toward further collaboration in clinical trials. Multi-centered clinical trials are crucial for pediatric ophthalmology for several reasons. By their very nature, studies of strabismic disorders need long-term follow-up to produce meaningful results. Patients with strabismus are sufficiently heterogeneous that few individual clinicians have access to a sufficiently large patient population to conduct many of the studies that need to be completed. The Pediatric Eye Disease Investigator Group (PEDIG) is an example of a recent model that allows for a large number of investigators, perhaps each contributing a small number of patients, to collaborate on important studies. This model will greatly facilitate high-quality scientific research to address many questions.

In his book *Art and Physics*, Leonard Shlain, MD, outlines an intriguing dissimilarity between the manner in which Western and Eastern thought conceives of time. In Western thought, the past is considered to be behind us and can only be seen if we turn around to view where we have been; we live in the present and face the future. Eastern philosophy likens time to a river with humankind facing downriver viewing the past. The future approaches from behind and the present is only seen out of the corner of the eye. As I contemplate the future of pediatric ophthalmology and strabismus in the next millennium, regardless of whether that future is behind me or in front of me, I imagine it to be rich and exciting!

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**A look at the past . . .**

The subject of diabetes following trauma has recently assumed a considerable importance in its relations to the matter of accident insurance, as well as in general interest. The following is a case in point:

P.E., æt. sixteen, a mason’s apprentice, fell from a considerable height and was found unconscious and bleeding from the mouth and nose. In a week the patient recovered consciousness, to find that he could not see with the right eye. After six weeks the patient was able to leave his bed, but later, his general condition not improving sufficiently to allow him to return to work, a benefit society to which he belonged insisted on a thorough examination, and he was found to have diabetes. Examination revealed in the right eye pallor of the optic disc with narrowing of the arteries; in the left eye slight pallor of the disc. About the disc in each eye were numbers of white and grayish spots. The right pupil was dilated and irresponsible, and $V=p.1$. The left eye had normal vision.

The atrophy of the right optic nerve was thought to be due to a fracture through the right optic foramen, and the fundus picture in the left was attributed to a possible hemorrhage in the sheath of the optic nerve, causing pallor of the disc without interfering with the function of the nerve.