Public Health Classics

This section looks back to some ground-breaking contributions to public health, reproducing them in their original form and adding a commentary on their significance from a modern-day perspective. David J. Apple reviews the late Sir Harold Ridley's invention of the intraocular lens as described in his 1952 paper, the original of which is reproduced by permission of *The Lancet*.

A pioneer in the quest to eradicate world blindness

David J. Apple[1]

The late Sir Harold Ridley, who died in 2001 shortly after receiving a knighthood in recognition of his pioneering work in the correction of cataract blindness, remains known almost exclusively for his invention of the intraocular lens and related innovative forays into various subspecialties of "high-tech" ophthalmology, which we now call biomedical engineering. Ridley implanted the first intraocular lens on 29 November 1949. This invention, whose description is reproduced here (*1*), has been of vast importance: over 50% of visual disability and blindness in the world — especially in the developing world — is caused by cataract (*2*).

I first met Harold Ridley in 1985, at a time when much of his work was still not accepted by many, including members of the academic medical establishment (*3*). Even his lens implant (*4*), unarguably one of the most important innovations in the history of ophthalmology and a huge blessing to society, was widely criticized. It was not until 1986 that he was elected a fellow of the prestigious Royal Society, and in 1989 he received an honorary degree from the Medical University of South Carolina; he was knighted in 2000, more than 50 years after his outstanding gift to humanity.

Sir Harold's series of contributions began during the Second World War. Indeed, his story represents one of the finest examples of efforts to apply knowledge acquired during a conflict to the development of technical innovations for the benefit of mankind. The Battle of Britain in the summer of 1940 was a horrific struggle, and Ridley's invention of the intraocular lens was based in part on his examinations of fighter pilots' eyes. In his very first publication on the topic in 1951 (*5*), Ridley wrote the following insightful statements that laid the foundation for his invention: "In the eye itself some information had been gained from war injuries, in which fragments of plastic material had been driven into the eye by an explosion or by the impact of a bullet on the Perspex (plastic) cover of an aircraft". It also marked a turning point in the development of some principles of prosthesis implantation: "Unless a sharp edge of the plastic material rests in contact with a sensitive and mobile portion of the eye the tissue reaction is insignificant".

There is absolutely no question as to Ridley being the sole inventor and first implanter of the intraocular lens. This is in sharp contrast to the vast majority of new drugs, devices and other therapeutic agents that have generally been invented or developed by several individuals or teams, often with controversy as to priority.

Unfortunately, there was a huge backlash against Sir Harold's invention and surgical procedure by his peers, especially from the academic establishment in his own country as well as in the USA. Until that time, eye surgeons had been taught to take things out of the eye (foreign bodies, inflammatory material, tumours, etc.), whereas Ridley's technique required a new thought pattern, namely the concept of putting something into the eye. His invention thus represented a radical paradigm shift, which was difficult for many to accept.

The early 1950s witnessed two other important scientific discoveries, the elucidation of the double helix structure of DNA by Watson & Crick in 1953 and the first successful initiation of a nuclear chain reaction by Enrico Fermi and colleagues in Chicago in the same year, which overshadowed the dissemination of information about Ridley's invention. However, in the fields of vision correction and blindness prevention, Ridley's invention has had a powerful influence on numerous patients' lives.

Ridley's invention of the intraocular lens was not only the introduction of a new and important adjunct to cataract surgery, in his own words "a cure of aphakia", but in reality represented a much broader and more significant innovation. In effect, he helped to pioneer the modern field of biomedical engineering, specifically the field of artificial device implantation, preceding by many years the introduction of all other major devices designed for tissue or organ replacement and implantation.

In addition to implantation of "standard" intraocular lenses intended to replace the opaque, diseased cataractous human lens and thus cure aphakia, this procedure has opened up a flood of new possibilities to implant highly specialized lenses and biodevices for specific clinical purposes. In effect, Sir Harold opened the lock to the previously inaccessible capsular bag, the membrane-like scaffolding composed of a portion of the outer capsule of the patient's lens that is not removed at surgery but is left in place. The capsule's structure is such that it can wrap around the implanted prosthetic device. Its presence provides a base for a wide array of modern vision-enhancing innovations such as accommodative lenses and mulitifocal and paediatric intraocular lenses. Ridley's invention has provided us with the necessary platform to carry out such procedures.

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Intraocular lenses have benefited over 50 million cataract patients worldwide: over 6 million such lenses are now implanted annually. Unfortunately, penetration of the technique into the developing world has been slow, delayed largely by financial and logistic reasons as well as lingering poor acceptance by many of our specialty's leaders. An important turning point was a World Health Organization meeting in Geneva in 1990, in which I had the privilege of participating (*6*). We established minimum criteria for intraocular lens quality, discussed various cost issues, and provided much needed support to enhance the acceptance of implants worldwide.

As the procedure is gradually implemented on a more widespread basis, satisfied patients will increase the demand for it: the number of implantations is estimated to more than double by the year 2020. This is a very positive occurrence because, as the underprivileged world population increases and as populations age, the incidence of disabling cataracts will rapidly increase. Almost all of us will develop cataracts if we live long enough.

Sir Harold's practical invention symbolized the beginning of an era that we now term the golden age of ophthalmology and the visual sciences (*7*), characterized by the almost complete closure of institutes for the blind, the substantial decrease in the number of blinded eyes submitted to anatomic pathology laboratories like the one I have directed since the 1970s, and our markedly increased ability to treat and manage eyes injured by various types of disease or trauma — eyes that would surely have been lost before our modern high-tech era.

Apart from the intraocular lens, Sir Harold made several other valuable discoveries, each one of which would represent the work of a lifetime for many of us in the fields of medical and surgical ophthalmology and the visual sciences. His original ideas in technology included his use of television in ophthalmology (*8*), as well as studies that formed the base for such highly complex devices as the laser scanning ophthalmoscope and confocal microscopy. He also set the stage for major changes in the finances of medicine. The intraocular lens represented a product to sell commercially and — with related and complementary commercial ventures — it participated in the influx of changes going on in our specialty today, in essence a huge ophthalmic industry (*9*).

Sir Harold Ridley had a special interest in the field of tropical ophthalmology. His lifelong work in Africa began in the 1940s. In 1993, when I began to prepare his biography, he said to me: "I hope you will not forget to mention the active work we undertook in tropical countries almost every year, for very few did this sort of thing at that time". His efforts in tropical ophthalmology are little known even today, except to small numbers of highly specialized experts in this subspecialty. During wartime service in Ghana, Ridley immersed himself in clinical studies on what he determined to be the most important blinding diseases afflicting the underprivileged areas in which he found himself. His work on onchocerciasis, resulting in the publication of his classic monograph in 1945 (*10*), ranks among the most important of his other contributions. Knowledge revealed by Ridley has been quietly passed on to today's highly dedicated workers located in many developing countries. Projects based on his principles and discoveries are carried out worldwide with gusto, often with the support of WHO's blindness prevention projects.

Ridley also developed a keen interest in treating patients, especially children under eight years of age, with Vitamin A in order to combat xerophthalmia. He applied this treatment on a small scale (but with great success) during his wartime period in Ghana. He did not publish results regarding this condition, but he spoke of it often and emphasized it in his private writings and notes for his biography. His accomplishments in this field were a source of great pride to him. In some conversations he would speak of these efforts with much more enthusiasm than he accorded to the intraocular lens. Most readers will be very surprised to learn that Sir Harold was an early advocate of a therapeutic mode we often consider to be "modern", namely the application of various multivitamin therapies, especially in tropical countries (*11*).

With the support of Sir Harold's family, I am working as his official biographer on a full-length biography — an effort which I hope will establish definitively his incredible legacy to mankind. ■

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