EDISON

Edison Explains

Retinal implants

How have retinal implants evolved and which companies are developing them?

How have retinal prosthesis evolved?

Stimulating nerves at the back of the eye to recover lost vision has captured the imagination of doctors and scientists since the earliest days of electrification. Experiments using electricity on nerves in blinded eyes began as early as the 18th century.

In the 1960s, devices were developed that stimulated the visual cortex with electrical signals translated from a camera on a pair of glasses. However, visual cortex devices were rudimentary and involved dangerous brain surgery.

It was only when microelectronic technology improved that devices implanted into the retina of the eye began to evolve. Retinal implants for the two most common causes of blindness, macular degeneration (MD) and retinitis pigmentosa (RP), then began to be developed.

Today's retinal implants actively stimulate nerves at the back of the eye to mimic rudimentary vision.

What are retinitis pigmentosa and macular degeneration?

RP is a group of rare genetic deficiencies that lead to a breakdown of retinal cells, resulting in vision loss.

RP damages retinal photoreceptor cells at the back of the eye (the retina) that convert light into electrical signals. Specifically, it first disrupts the rod photoreceptors, generally located on the periphery of the retina. It can then progress to the central 'macula' of the retina, where photoreceptive cone cells reside.

There is no cure for RP and doctors have had little success in slowing the disease. For many years, high doses of Vitamin A palmitate and other supplements have been the only available treatment to slow the rate of progression. Gene therapy is also under active investigation.

Age-related MD (AMD) refers a disease that damages retinal cells contained in the macula, leading to central vision loss.

Damage can be caused by irregular blood vessels in the macula that leak or break (wet AMD). Alternatively, yellow lipids and fatty protein deposits under the macula can cause dry AMD. Wet AMD can be treated and stabilised in most cases through ongoing anti-VEGF therapy, but there is no cure for dry AMD.

Both diseases share the impairment of light-sensitive cells in the retina, but not the nerves that communicate electrical signals to the brain.

Intact optic nerves allow an implant to be placed in the eye and for the relayed visual information to be communicated to the visual cortex.

How many people are affected by RP and MD?

RP is a rare or orphan disease that affects around one in every 3000–5000 people. Those who suffer from late-stage RP are often legally blind, but the degree and speed of the disease is highly variable.

Relatively few patients go completely blind; instead, they retain a very small visual field within the central portion of their vision. The size of the retained field commonly falls under the 20-degree diameter that defines legal blindness.

Late-stage MD creates a blind spot in centre of a patient's vision and is around six times more common than late-stage RP.

Edison Insight

'While competing retinal implants generally target rare conditions involving near-total blindness, Pixium Vision's Prima seeks to address initially a larger unmet market indication, patients with advanced dry age-related macular degeneration (AMD). A pivotal EU study is planned to start in H219. We view the current target AMD treatment population for Prima as about 73,200 patients in Europe and 46,500 in the US.' Pooya Hemani, Edison healthcare analyst

What types of retinal prosthesis are available?

Retinal prostheses tend to be either epi-retinal or sub-retinal.

Sub-retinal implants are surgically attached under the retina and epi-retinal implants place the electrode array on the surface of the retina.

In both cases, the retinal prosthesis contains electrodes that aim to produce and mimic the electrical signals normally

broadcast by damaged photoreceptors or other mid-stream retinal cells that take part in visual processing (eg bipolar cells).

Both types of implants require some communication between the electrodes interfacing with the retina, and a set of specialised glasses (containing a camera) worn by the patient that records and transmits visual information. Currently marketed implants (such as Second Sight's Argus II) require trans-scleral wires and cables to be surgically implanted and used for this communication.

Which companies are involved in retinal prostheses?

Second Sight was one of the first companies to develop a retinal prosthesis. Its Argus II was approved in 2011 for the EU and 2013 in the US for humanitarian use.

The device is an epi-retinal implant secured around the eyeball with a scleral band. Retina Implant had its sub-retinal implant, Alpha IMS, approved in 2013 for the European market, but does not appear to be actively marketing it.

Elsewhere, Pixium Vision is developing its sub-retinal Prima product to treat advanced cases of dry AMD. The company recently announced positive data for its five-patient EU feasibility study at six months post implantation. All patients experienced light perception in areas where no central vision remained prior to implantation. The company plans to start a CE mark-enabling EU pivotal study in H219.

On the more novel side, Gensight Biologics is attempting to introduce light-sensitive proteins to the retina via genetic manipulation. The treatment allows the proteins to penetrate the neurons of the optic nerve and a pair of glasses is used to concentrate the light to those cells. Its research is still in its early stages.