# Ensuring Connectivity for Reliable Home Monitoring of Age-Related Macular Degeneration

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**Patients with age-related macular degeneration (AMD) are at a high risk for vision loss. However, new wireless technology can aid the preservation of eyesight. Using cellular technology provided by Telenor Connextion, Notal Vision has recently enhanced its ForeseeHome AMD Monitor, the first FDA cleared telemedicine device for monitoring the vision of patients with AMD. Equipped with psychophysical testing and wireless communication, the ForeseeHome operates as a home-based monitoring technology capable of saving one's eyesight.**

Age-related macular degeneration (AMD) is a retinal disease that affects the vision of an estimated 30 million patients worldwide. The disease occurs in two main forms: a dry form which is usually asymptomatic and non-threatening to vision and a more virulent wet form that can rapidly lead to permanent loss of vision and blindness. Patients with dry AMD are considered to be at high risk for conversion to the wet form. Vision loss can occur within a few weeks.

Unfortunately, patients in the early stages are usually asymptomatic, and unaware that they have developed wet AMD until they experience vision loss. The key to early detection and treatment of wet AMD is frequent monitoring. Given that daily visits to the doctor's office are impractical, today's patients can rely on home monitoring technology and telemedicine to provide a convenient and affordable solution, resulting in early detection and prevention of vision loss.

Notal Vision [1] recently began utilizing cellular technology provided by Telenor Connexion [2] to enhance its ForeseeHome AMD Monitor. The ForeseeHome is the first FDA cleared telemedicine device for monitoring the vision of patients with Age-Related Macular Degeneration (AMD). As with many other diseases, early detection and treatment is the key to saving one's vision.

To provide a sensitive and reliable test for patients with AMD, Notal Vision developed preferential hyperacuity perimetry (PHP), which is implemented as a psychophysical test in the ForeseeHome AMD Monitor.

**PHP Technology**
PHP takes advantage of hyperacuity, a sensitive visual function that enables a person to perceive the relative location of objects in space, such as a misalignment of a dot within a dotted line.

During a PHP test, stimuli are successively flashed in various locations of the visual

field. A typical stimulus consists of a series of dots, the majority of which are aligned with respect to each other. A few dots are misaligned, creating the perception of a wave or distortion in an otherwise straight line (Figure 1). The brief presentation ensures that cortical completion is not engaged, and that fixation is maintained during the entire presentation of each stimulus. The presentation of the signal is triggered when the patient is fixating on the center of the screen. The patient's task is to mark the location where the distortion was perceived. When the stimulus is projected on an unhealthy area of the retina, the patient may perceive two or more distortions on the line: one corresponding to the artificial wave and the other corresponding to the patient’s pathological distortion.

**Figure 1: PHP test**

According to the preferential looking principle, the visual attention of a subject is automatically attracted to the more prominent source when presented with several stimuli. Consequently, if the pathological distortion is larger than the artificial wave, the patient is likely to ignore the artificial wave and mark only the location of the pathological distortion. The preferential looking principle is employed not only to localize pathological distortions, but also to quantify their perceived size.

Based on the PHP quantification capabilities, Notal Vision designed a test with various amplitudes of artificial distortions that maximally distinguishes between dry AMD patients and newly diagnosed wet AMD patients. Numerous evaluations have demonstrated the technology’s ability to provide early detection of changes occurring within a patient’s vision, often before the patient is even aware.

**The ForeseeHome AMD Monitor**

**Figure 2: The ForeseeHome AMD monitor**

The ForeseeHome AMD monitor (Figure 2) is designed as a closed viewer for single eye examination. A set of lenses embedded within the viewer ensures that the test is viewed as if projected from infinity. As a result, a patient with good distance vision sees the test in maximal focus. The patient starts the test by inserting his or her head within the viewer. A pair of infrared sensors located in the walls of the viewer detects the position of the head relative to the hood, and ensures that the test is not played until the head is correctly positioned. The tested eye may be alternated from left to right by half cycle rotation of the viewer.

Patients are instructed to test their prescribed eye(s) daily, and their responses are automatically transmitted to the Notal Vision Data Monitoring Center (DMC) at the end of each test. The wireless communication technology facilitates fast and reliable transmission of data which is then made available to the physician through a secure website. Tests are continuously compared to a normative database threshold. When a statistically significant change of test patterns is detected, the DMC alerts the clinic and the patient to schedule a prompt clinical examination.

In addition to monitoring test scores, the frequency of use is also tracked. To encourage patients to test at an adequate frequency (one that will allow timely detection in a conversion event), the DMC will contact the patient if no results are received for seven consecutive days.

**Wireless Communication**

Until recently, transmission of test results from patients to the DMC was done via telephone landlines. The dramatic reduction in the cost of cellular communication has allowed Notal Vision to upgrade the ForeseeHome AMD Monitor into an embedded wireless device, providing its customers with a range of usability advantages. Telenor Connexion, a premium service provider for M2M communications, will be providing the wireless communication services for this technology.

The wireless service data is securely routed from the ForeseeHome AMD monitor via the embedded SIM through the cellular network into the Telenor Connexion M2M platform by way of SS7/GRX links. The M2M platform then routes the data through a secure VPN back to Notal Vision’s Data Monitoring Center (DMC). An alert is sent to both the doctor and the patient if any statistically significant change in the data is detected. Data related to the performance of the connectivity itself can be easily accessed by Notal Vision through the Telenor Connexion Service Portal /API. Such access ensures a stable and reliable service, while allowing traceability of a specific embedded SIM if needed.

The introduction of wireless services offers many advantages to ForeseeHome customers. In fact, cellular technology has considerably reduced the number of technical problems that the company encountered in the past, mostly due to improper connection of the landline modem to the telephone line. The process of setting up a home system is made easier by having wireless modems installed in the device before it arrives. A great benefit of a wireless device is that it does not occupy the telephone line while transmitting, greatly facilitating support via a telephone. Wireless devices also release users from annoying cables, having to

reconfigure device settings (change access phone number) and facilitating portability. With cellular communication, patients can use their device outdoors or in places without landline availability, thus increasing the adherence of daily use. Another advantage of wireless technology is the faster baud rate, which allows shorter communication sessions and a faster upgrade process if needed.

Overall, the ForeseeHome represents an exciting advancement in eye care. As the aging population increases, new advancements in home-based monitoring technology in the ophthalmic sector are likely to continue.

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