IOP MONITORING
Devices for continuous IOP monitoring move closer to clinical reality

by Dermot McGrath in Abu Dhabi

New devices that will allow researchers to perform temporary continuous intraocular pressure (IOP) monitoring of patients with glaucoma are slowly but surely making their way into clinical use and should prove a major advance on current methods of performing periodic IOP measurements during regular office hours, according to Georg Michelson MD.

Addressing delegates attending the World Ophthalmology Congress, Dr Michelson, Department of Ophthalmology at Friedrich-Alexander University Erlangen-Nurnberg, Germany, said that while many problems remain to be solved in the development of a continuous monitoring system for IOP, advances in materials and technology are bringing the prospect of such a device closer to clinical reality.

“As a clinical ophthalmologist it is necessary to be able to measure the intraocular pressure and we are continually on the lookout for a system that might allow us to achieve a continuous monitoring for IOP in the management of glaucoma. The fact is that continuous monitoring of IOP opens new perspectives in the management of glaucoma and will be an important tool in designing and evaluating therapy for glaucoma patients,” he said.

Dr Michelson noted that IOP is a dynamic physiologic parameter with regular circadian variations and unpredictable short-term and long-term fluctuations.

“IOP has a range of 0-70 mmHG and is not constant. There are fast changes of between one-per-second to one-per minute due to heart beat associated changes in choroidal blood volume, posture associated changes; blood pressure associated changes, and changes derived from the autonomic nerve system. There are also slow changes in aqueous humour production and outflow over a 24-hour period which impact on the IOP reading,” he said.

Three approaches In a literature review of continuous IOP measurement devices that are currently under development or already on the market, Dr Michelson cited three different approaches which have been tried with varying degrees of success.

The first device, an implantable telemetric pressure transducer system adapted to monitoring anterior chamber IOP, has been successfully tested in non-human primates by Crawford Downs et al of the Ocular Biomechanics Laboratory, Devers Eye Institute, Portland, Oregon, US.

The current version of the IOP telemetry implant is based on an existing, commercially available, battery-powered, implantable pressure monitor of proven design (T30F-13B; Konigsberg Instruments).

The researchers set out to conduct continuous IOP telemetry in three non-human primates to characterise IOP dynamics at multiple time scales for multiple 24-hour periods. Summarising the study outcomes, Dr Michelson said that IOP fluctuated as much as 10 mmHG from day to day and hour to hour and that snapshot IOP measurements were therefore inadequate to capture the true dynamic character of IOP over time. When IOP data were averaged across multiple 24-hour periods within animals, a weak nycthemeral (relating to the alternation of night and day) rhythm was present in the non-human primate, in which IOP tended to be highest at night. The authors concluded that IOP fluctuations of this frequency and magnitude may be an important yet unknown contributor to IOP-related glaucomatous damage.

The second device in the literature survey, a novel wireless ocular telemetry sensor (OTS) (Triggerfish, Sensimed AG), is already commercially available, said Dr Michelson. The Triggerfish Sensor is a soft hydrophilic single-use contact lens, containing passive and active strain gauges embedded in the silicone to monitor fluctuations in the diameter of the corneoscleral junction, which is directly correlated to fluctuations in IOP. The output signal is sent wirelessly to an antenna that is worn around the eye and is connected to a portable recorder through a thin flexible data cable.

In two studies of the Triggerfish sensor published to date, the device showed a good safety and tolerability profile, said Dr Michelson. But he said that more work needs to be done on the calibration and validation of such systems before they can become a routine part of glaucoma management.

“There are also open questions concerning the effect of nighttime changes in corneal thickness and ocular movements when using the device,” said Dr Michelson.

Another interesting approach perhaps more suited to longer continuous IOP monitoring is the technique devised by Walter, Schnakenberg and colleagues at the University of Cologne using a silicone IOL with a fully encapsulated IOP sensor.

In a study in 2000, the device was successfully implanted into enucleated pig eyes and into rabbit eyes in vivo. The in vivo and in vitro tests in both the rabbit and pig eyes demonstrated that the implanted system worked with the same precision as established techniques for IOP determination, said Dr Michelson.

“The device serves as a functioning model for the realisation of a telemetric IOP sensor for integration into an artificial IOL,” he said. Looking forward, Dr Michelson said that other promising devices under development include a fluid-filled catheter capable of conducting IOP to a transducer in the orbit, and a foldable IOL with integrated IOP sensor. He said, however, that some unsolved problems remain before these devices can take their place in daily clinical practice.