<table>
<thead>
<tr>
<th>Icare</th>
<th>APPLANATION</th>
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<tbody>
<tr>
<td>• No anesthesia</td>
<td>• Requires anesthesia</td>
</tr>
<tr>
<td>• No calibration</td>
<td>• Requires regular calibration</td>
</tr>
<tr>
<td>• Easy to use &gt; short learning curve</td>
<td>• Long learning curve</td>
</tr>
<tr>
<td>• Universal AA battery</td>
<td>• Exclusive battery</td>
</tr>
<tr>
<td>• Non-latex probes</td>
<td>• Latex tip covers</td>
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<tr>
<th>Icare</th>
<th>NON-CONTACT</th>
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<tbody>
<tr>
<td>• Very patient-friendly</td>
<td>• Unpleasant on patient</td>
</tr>
<tr>
<td>• Hygienic</td>
<td>• Cross-contamination risk</td>
</tr>
<tr>
<td>• Small; does not need space</td>
<td>• Requires space</td>
</tr>
<tr>
<td>• Hand-held &amp; portable</td>
<td>• Fixed location</td>
</tr>
<tr>
<td>• Low maintenance</td>
<td>• High maintenance costs &amp; efforts</td>
</tr>
<tr>
<td>• High accuracy</td>
<td>• Low accuracy</td>
</tr>
<tr>
<td>• Affordable</td>
<td>• High priced</td>
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<tr>
<th>Icare</th>
<th>DYNAMIC CONTOUR</th>
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<tbody>
<tr>
<td>• No anesthesia</td>
<td>• Requires anesthesia</td>
</tr>
<tr>
<td>• No calibration</td>
<td>• Requires calibration</td>
</tr>
<tr>
<td>• Universal battery</td>
<td>• Exclusive battery</td>
</tr>
<tr>
<td>• Sensor tip diameter less than 1 mm</td>
<td>• Sensor tip diameter 7 mm</td>
</tr>
<tr>
<td>• Up to three years warranty</td>
<td>• One year warranty</td>
</tr>
<tr>
<td>• Easy to use</td>
<td>• Difficult to use</td>
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FREQUENTLY ASKED QUESTIONS

IS THE ICARE® MEASUREMENT PAINLESS?
Measurement is painless, the light-weight probe touches the cornea momentarily and some patients don’t even notice the measurement.

IS IT POSSIBLE TO HURT THE EYE WITH ICARE®?
If the device is used according to the instructions given in user manual, the light-weight probe cannot cause any damage to the patient’s eye.

IS THE ICARE® MEASUREMENT RESULT ACCURATE?
Several independent studies prove the accuracy of Icare® readings. Extensive bench testing and clinical studies have also been performed to ensure the accuracy and repeatability of measurements.

WHY SIX MEASUREMENTS?
Six measurements are required to provide accurate measurement results by eliminating the variations caused by operator error and heartbeat.

DOES ICARE® TAKE INTO CONSIDERATION CCT?
Icare® tonometer is calibrated for average CCT just like the Goldmann tonometer.

CAN ICARE® BE USED WITH CONTACT LENSES?
Yes, but depending on the type of contacts the tonometer readings may be affected by the contact lens. Soft daily disposable lenses [and some soft 2-week or monthly lenses] affect the reading only slightly. Hard contact lenses have a significant effect on the reading and should not be worn when measuring the IOP with Icare® tonometer. For most accurate measurement results use of any contact lenses is not recommended.

CAN ICARE® BE USED AFTER EYE SURGERY?
Yes, but consider that some surgeries e.g. LASIK and similar surgeries may change the thickness of the cornea (thinner cornea => lower IOP)

CAN ICARE® BE USED WHEN THE EYE IS INFECTED?
Yes. Just remember that the probe used to measure the infected eye cannot be used again, even for measuring the non-infected eye of the same patient.

DOES THE CORNEAL SHAPE AND RADIUS INFLUENCE THE IOP READING TAKEN WITH ICARE®?
No. The area of contact is so small, that the measurement is not influenced by these aspects.

CAN ANESTHESIA STILL BE USED?
Icare is designed to be used without applying topical anesthetic. For most accurate measurements, we recommend not to apply topical anesthetic when measuring with Icare tonometer. It is possible to measure anesthetized eye but the readings may be affected by the swelling caused by topical anesthetic.

IS IT POSSIBLE TO LOAD THE PROBE WRONG WAY?
No, it’s not possible to load the probe wrong way. The mechanical design of the probe and probe base makes it impossible to insert the probe incorrectly.

CAN I RE-USE THE PROBES?
Icare® tonometer uses single-use disposable probes. Probes should never be cleaned or sterilized because the process and handling can damage the probe resulting in unreliable measurement results or even damage the tonometer. However, the same probe can be used for measuring the same patient within a reasonably short time period.

CAN THE SAME PROBE BE USED TO MEASURE BOTH EYES OF ONE PATIENT?
Yes, the same probe can be used to measure both eyes of one patient if the patient’s eyes are healthy. If the patient has infection in one eye or if there is any doubt that one eye may have a disease that can be transferred from eye to eye, the healthy eye should be measured first. A probe used to measure an infected eye should never be used to measure a healthy eye. If in doubt, always use a new probe.

HOW WILL PROBES BE DISPOSED OF?
Probes can be disposed of according to the hospital/clinic/practice standard regulations.

DOES ICARE® REQUIRE CALIBRATION?
Icare® tonometers do not require any maintenance calibration or regular service. The tonometers don’t have any parts that wear out, except for the probe base, which can become dusty or collect some particles that affect the probe movement. The probe base can be changed by the user as described in the user manual. The calibration can be checked if there’s doubt about the measurement results. In such case, you should contact your local distributor.

If the tonometer requires service, for example has been dropped to the floor, you should also contact your local distributor for further instructions.

HOW CAN I GET ICARE® LINK SOFTWARE?
Icare® LINK software can be downloaded from the Icare website. Icare® ONE or PRO device is needed when downloading the software. Installing automatically identifies device serial number and registers the tonometer with details given by the user.

IS ICARE® LINK SOFTWARE FREE OF CHARGE?
Yes, Icare® LINK is a free accessory software for Icare PRO and ONE tonometers.

HOW CAN I SEE THE EXACT MEASURING RESULTS FROM ICARE® ONE TONOMETER?
With Icare® LINK software the Icare® PRO user can see the exact measuring results from Icare® ONE. The Icare® ONE user can see the measuring result as range, measuring quality and date with time.

CAN I USE ICARE® LINK SOFTWARE WITH ICARE TAO11?
No, Icare® TAO11 model cannot be linked to Icare® LINK software. But any results can be manually fed to the LINK software.
A view of Icare®’s market conquest

Icare Finland’s Japanese representative M.E. Technica Co., Ltd. performed a questionnaire study on end user experiences with the Icare® tonometer. There were 58 respondents and the results are more than good.

M.E. Technica operates in Tokyo, Osaka and Sapporo specializing in import and sales of medical instruments. The full sales organization consists of 250 local distributors throughout.

Mr. Manabu Ohashi from M.E. Technica pointed out some experiences of the Icare story in Japan:

How and when did your cooperation with Icare Finland start?
- We got a letter and brochure from Icare® in April 2004. It didn’t take more than a minute for our president Mr. Sunny Hanawa to realize the unique features and high potential of the Icare® tonometer. Right away I sent an e-mail to Finland for more information. The reply came promptly before the end of the day. That was the beginning of our business cooperation.

How well did the Japanese market accept the products?
- The instrument was displayed at every Japanese congress we attended. We also ran an ongoing print campaign in magazines and journals along with making our own marketing materials such as manuals, posters and leaflets in order to overcome the language barrier. Our sales reps travelled all over Japan demonstrating the device. As we repeated the promotion the popularity of the Icare® tonometer steadily went up.

What is your main target group for the Icare® tonometer?
- Ophthalmologists.

What kind of feedback do you get from your target group?
- We have received hundreds of positive remarks, especially for the accuracy and easy use. Yet, we also get suggestions for some improvements. Desired features are: downward measuring, a table stand or a holder for the device, a better, less slippery grip etc.

Mr. Sunny Hanawa,
President of M.E. Technica

ICARE® user questionnaire results from Japan

<table>
<thead>
<tr>
<th>How long have you used Icare®?</th>
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<tbody>
<tr>
<td>Less than three months</td>
<td>14%</td>
</tr>
<tr>
<td>One year</td>
<td>2%</td>
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<tr>
<td>Over one year</td>
<td>84%</td>
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<tr>
<th>Was it easy to use?</th>
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<tbody>
<tr>
<td>No</td>
<td>7%</td>
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<tr>
<td>Yes</td>
<td>93%</td>
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<tr>
<th>Are you confident in the data?</th>
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<tbody>
<tr>
<td>No Reply</td>
<td>5%</td>
</tr>
<tr>
<td>No</td>
<td>0%</td>
</tr>
<tr>
<td>Neither yes or no</td>
<td>22%</td>
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<tr>
<td>Yes</td>
<td>73%</td>
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<tr>
<th>Does your staff (nurses etc) use it?</th>
<th></th>
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<tbody>
<tr>
<td>No reply</td>
<td>3%</td>
</tr>
<tr>
<td>Yes</td>
<td>44%</td>
</tr>
<tr>
<td>No</td>
<td>53%</td>
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<table>
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<tr>
<th>How many times do you use it per day?</th>
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<tr>
<td>Over 30</td>
<td>3%</td>
</tr>
<tr>
<td>Less than 3</td>
<td>41%</td>
</tr>
<tr>
<td>10–30</td>
<td>44%</td>
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<tr>
<td>3–10</td>
<td>12%</td>
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<tr>
<th>Is Icare® good for screening?</th>
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<tbody>
<tr>
<td>No reply</td>
<td>2%</td>
</tr>
<tr>
<td>Neither yes or no</td>
<td>15%</td>
</tr>
<tr>
<td>No</td>
<td>0%</td>
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<tr>
<td>Yes</td>
<td>83%</td>
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<table>
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<tr>
<th>Would you recommend Icare® to your colleagues?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Neither yes or no</td>
<td>3%</td>
</tr>
<tr>
<td>No</td>
<td>2%</td>
</tr>
<tr>
<td>Yes</td>
<td>95%</td>
</tr>
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</table>

95% of the users recommend Icare to their colleagues.
**Dr. Elie Dahan; potential to become the new standard**

The Icare® tonometer is in daily use at Dr. Elie Dahan’s practice. He not only prefers it to the more traditional instruments on his own patients, he also thinks eventually it could claim its place as the most popular method of measuring IOP worldwide.

After his graduation from the Technion Medical School in Haifa Dr. Dahan specialized in Ophthalmology in Israel and South Africa (1978-1983). During his 27 years in South Africa he served as the Head of the famous St. John Eye Hospital in Johannesburg and as a Senior Consultant/Lecturer in the Department of Ophthalmology at the University of Witwatersrand.

Having taken a special interest in Anterior Segment Surgery with emphasis on Cataract and Surgical Glaucoma, he made a breakthrough in Pediatric Cataract Surgery popularizing the use of Intraocular Lenses (IOL) on infants in the early 80’s. He also designed several advanced IOLs and surgical instruments.

In the early 90's Dr. Dahan was one of the first pioneers of the Non-Penetrating Glaucoma Surgery (NPGS) and developed a non-absorbable glaucoma implant for NPGS. In the beginning of the present decade he improved the Ex-PRESS miniature glaucoma device invented in Israel making its use grow exponentially worldwide.

**Professional authority on glaucoma treatment**

Dr. Dahan is known as the author of many scientific articles and text book chapters on Ophthalmology. According to him, measuring the IOP should be part of the normal health care routine for every 40+ year old person. For high-risk glaucoma patients the 24-hour IOP-progression follow-up should always be offered.

As the best features of the Icare® tonometer Dr. Dahan lists its repetitive accuracy, painlessness, speed and ease of use. He is very much looking forward to having downward measuring added to the capabilities of the device, as it would enable him to use it also on patients lying down after surgery.

Requiring no drops, neither specialized skills for its use the quick and painless Icare® tonometry should have an important role in national glaucoma screening programs, says Dr. Dahan. By early detection most patients’ eyesight can be saved, surgical operations done earlier and health care costs brought down - not to mention the blindness related suffering and anxiety that can be lifted off the individual patient’s life.

**Personal views on the future of the Icare®**

The Icare® tonometer definitely has the potential of becoming the most widely used instrument in tonometry, says Dr. Dahan. Technologically it represents the future while the competition is cumbersome.

**How long have you been using the Icare® rebound tonometer?**

I have been using the Icare® tonometer routinely for the last 5 years.

**What model have you been using?**

I own the 3 models but my favorite is the original one (TAO1) which I find the most ergonomic and user friendly. All the models are equally accurate.

**Do you use it as your routine every day tonometer?**

Definitely! I have the original Goldmann Tonometer on my Haag Streit Slit Lamp but I seldom use it during the day. I prefer by far the Icare® tonometer and so do my patients too!

**In which occasion do you counter check the measurement with the GAT?**

In patients where I suspect an abnormal corneal thickness, I compare the readings with those of the GAT. In these patients, I check the central corneal thickness and measure the IOP with the Icare® and the GAT.

**Do you sometimes use the Icare® tonometer with a drop of local anesthetic?**

In young patients or in anxious patients I routinely use a drop of local anesthetic to make the measurement totally unfelt. When the patient is accustomed to the measurement I ask if he wishes to have the measurement without the local anesthetic.

**What other advantages did you discover as you became a regular user of the Icare® tonometer?**

The GAT is far from being accurate and its results can be affected by the tears layer properties apart from calibration issues and examiner’s subjectivity. The GAT is dependent on the examiner’s subjective evaluation of the probe’s impact on the cornea. The Icare® tonometer gives a definite value every time it measures the IOP. When the measurements are inconsistent or bizarre, the examiner is warned that there is a problem. The problem can be due to misalignment or abnormal physical corneal properties. In other words, “strange readings” are a warning to the examiner that he must be more careful in the examination process.

Furthermore, the Icare® tonometer rarely underestimates IOP which is an advantage over the GAT that can underestimate or overestimate IOP reading according to the conditions. The Icare® IOP readings are not affected by the number of measurements whereas the GAT IOP readings decline somewhat as the measurements are repeated.
Glaucoma treatment as a lifetime dedication

Dr. André Mermoud is a widely respected ophthalmologist living and working in Lausanne, Switzerland. Just typing his name in the Google finder results in thousands of hits referring to his numerous scientific articles and publications as well as research programs and study teams to which he has contributed.

Dr. Mermoud, what is your line of specialization in ophthalmology? For the past 20 years my work has been focused on glaucoma surgery, particularly on new methods for safer surgery.

Where were you trained? I studied in Lausanne and obtained further experience working as a fellow in Cape Town, South Africa. I also worked in Los Angeles, California and spent some time in India.

In your opinion, what have been the most important developments in glaucoma treatment and diagnostics in the last decade? First and foremost I would name the NPGS, the Non-Penetrating glaucoma surgery, which has become a viable alternative to conventional trabeculectomy in glaucoma management because of its significantly fewer complications. Also the lowering of intraocular pressure with prostaglandin drops was a great contribution from a Swedish research group. In glaucoma diagnostics I would give significance to the development of new, patient friendly devices for measuring the intraocular pressure.

How did you first come in contact with the Icare tonometer? It was introduced to me during a glaucoma scientific meeting. I immediately liked the idea. After using the Icare® tonometer on some of my patients I liked it even more.

How would you describe the effect of this device on your daily patient work? Most importantly, it has enabled me to get a reliable IOP reading even with those non-compliant or very young patients, who always present a big challenge in determining their need for glaucoma treatment. Besides reliability I highly value the fact that the measuring is so easy on the patients: you don’t need to anesthetize their eyes and the whole procedure is over before they even realize what’s happening. Another important point is that the Icare® tonometer can be lent to a patient who needs frequent IOP checks during the day. Instructions on how to operate the device have never been a problem with the easy-to-use Icare® tool. I have two of them: one I use in my clinic, the other I keep lending to my patients.

How many cases of glaucoma do you treat annually? Do all your patients come from Switzerland? For about a year now I have had my own, private clinic in Lausanne, where I work with three other doctors. We have rooms & facilities for twenty patients and in our two operating theaters we perform an average of 1500–2000 operations per year. As a quick estimate I would say that perhaps one third of our patients come from outside of Switzerland.
NORTH AMERICA

Dr. Sanjay Asrani, MD, Duke Eye Center, Raleigh, NC, USA
“I feel that the Icare® is very easy to use and handle and so do my techni-
nicians. Most patients prefer Icare® because they do not need to get anesthetic eye drops and have realized that their dry eye does not get worse after the eye examination.

I find it correlates well with Goldmann as we have shown in the study published in Journal of Glaucoma Feb 2011. Other studies have also shown a good correlation.

I would absolutely recommend Icare® to my colleagues. Icare® tonometer is a great instrument.”

Dr. Jack M. Chapman, Jr., MD, USA
“Icare® is one of the best instruments I have purchased! It is easy to use, accurate & patients like it! It can be used over soft contact lenses. It works great with children and it is easy to transport. My techs love it!!!”

Dr. Christopher Lyons, MD Pediatric Ophthalmology, BC Children’s Hospital, Vancouver, Canada
“We have been very pleased with Icare® tonometer. This purchase has meant that much fewer children have needed to have examinations under anesthesia for intra-ocular pressure check, freeing much-needed operation time for other children.”

EUROPE

Prof. Dr. Em. Thierry Zeyen, MD, Belgium
“We use many tonometers in the University Hospital, Leuven, Belgium. From a user preference viewpoint Icare® rebound tonometer is the easiest to work with and its accuracy and precision are better than those of other tonometers compared to GAT.

We use Icare® tonometer already very much. For instance IOP measurement after a corneal transplantation can be made practically only with Icare® tonometer and IOP measurements of children are so fast and easy because anesthetics is not needed at all with Icare®.

Icare® has also introduced a new Icare® ONE for home monitoring of IOP which is great news and a tonometer that we glaucoma specialists need for our patients.”

Dr. Andre Mermoud, MD, Switzerland
“Most importantly, it has enabled me to get a reliable IOP reading even with those non-compliant or very young patients, who always present a big challenge in determining their need for glaucoma treatment. Besides reliability I highly value the fact that the measuring is so easy on the patients: you don’t need anesthesia and the whole procedure is over before they even realize what’s happening.”

Dr. Luke Clifford, Ophthalmologist Fellow in Paeds Ophthalmology, Addenbrookes Hospital, Cambridge, UK
“The Icare has revolutionised IOP measurements in pediatric ophthalmology making the process much easier and more accurate in the clinical setting.”

Dr. Robert Harvey, MD, UK
“The Icare® has found wide acceptance at our hospital amongst the nursing staff and the ophthalmologists. Patients prefer Icare® to Tono-
pen and the latter is now redundant. The nursing staff find Icare® easy to use. Training is easy and the digital readout gives reliable reproduc-
ible results.

Some patients for example children dislike eye drops, fortunately re-bound is so well tolerated anaesthetic drops are not required and the probe is barely noticed. Other patients are virtually impossible to appa-
nate by Goldmann tonometry because of blepharospasm or very small palpebral fissures. Even an experienced ophthalmologist may struggle yet with Icare® the IOPs are easier to obtain and also more accurate.”

Dr. Attila Kiss, M Assistant Director of Emergency Department, St John Medical Center, USA
“I can tell you without a moments hesitation the Icare® is the only tonometer we will ever use. The Icare® is easy to use, simpler to learn and operate than anything we have used before. There is no finesse or learning curve. We have an EM residency and each year the new interns have to be trained in its use. This takes 5 minutes at most and operator error is taken out of the equation. We have used it on kids as well and they find it tickles and laugh during the experience! So glad I found it. I have no problem endorsing this product at all, I believe in it.”

Dr. Peter H. Galloway, MD, UK
“The simplicity of the Icare® lies in its ease of use as no eye drops are required; another key advantage is that it is clearly quicker to perform than Goldmann tonometry yet with a surprising degree of consistency with concurrent Goldmann measurements. The confounding factor of variable thickness of the fluorescein prisms on the Goldmann tonom-
etry is eliminated, and IOP measurements with the Icare® are generally tolerated exceptionally well.”

Dr. Jesper Skov, MD, Denmark
“I use Icare® for children and disabled people who are not able to be examined in the slitlamp, and I’m happy to say that IOP measurement with Icare® is extremely easy and reliable.”

Dr. Else Gade, MD, Odense UH, Denmark
“Icare® is very useful with children, patients in wheel chair and patients with allergic reactions. It is very quick to use. Sometimes it measures high pressures compared to GAT, but according to our experience we can trust it if it is low or normal. It is very useful with children, we wouldn’t live without it now.”

Dr. Jens Kratholm, MD, Norway
“We have had 5 Icare® tonometers since 2004. They are easy to use for me and all my assistants, easy on all kind of patients, especially with children and handicapped patients. We have never had any need for service for any of our six Icare® instruments.”

Dr. Frank Jenssen, MD, Norway
“Icare® has made the IOP monitoring by staff more predictable. Before it was difficult for nurses to get accurate readings with Goldmann. We had the very first Icare® in Norway now we have 3 Icare®s and our pediatric department is especially happy with it.”

Dr. Anu Vaajanen, MD, PhD, Tampere UH, Finland
“Icare® is reliable, simple and fast to use. Not requiring topical anesthesic eye drops makes it easy to measure IOP with Icare® in adults and even in poorly cooperating infants. It distinctly speeds up work in ophthalmological practice and facilitates the differential diagnostics of eye problems by general practitioners in public health centres. In addition, Icare® has proved eminently useful to medical students practising their ophthalmological skills for the first time. They quickly learn to use it, and they have rated it superior to other methods available.”

I use Icare® in my daily work at hospital. Its advantages are conspicuous in measuring postoperative IOP, especially after cornea transplantation surgery and in any situation in which the cornea is affected as for example in ulcerations and erosions. The device is small and easy to take to hospital ward consultations when IOP can be measured at the bedside. The ultimate success of the instrument will be guaranteed when it can be used to measure IOP in very ill, e.g. bedridden patients after severe trauma.

I have also successfully used a derivate of this device (TONOLAB) in my experimental ophthalmological studies (Vaaajanen et al. 2008). TONOLAB makes it possible to measure IOP rapidly even in awake laboratory animals such as widely used rodents. This is of great significance in antiglaucomatous drug development as an is well known to reduce IOP.

Dr. Joaquin Campos Lopez, MD, Portugal
“The Icare® tonometer has improved tremendously the way I handle my Glaucoma Patients. It is comfortable for the patients, accurate and easy to use.”

Dr. Kyriaki Evangelatou, MRCSEd, Pediatric Ophthalmologist at Pantheo Eye Center, Limassol, Cyprus
“Icare® is an excellent gadget! It is very easy to use on my young patients. Even with one reading, as long as you are vertically centered on the cornea, you have a good indication of where the pressure stands. I use it daily.”

Dr. Nikolay V. Strenev, MD, Russia
“I've been using Icare® for several years. I like it for its simplicity, safety and speed of measurement. What is important - you may use it in situations where all the other tonometers fail, e.g. nyctagmus.”

Dr. Mircea Varga, MD, Romania
“Icare® is very easy to use and useful. It’s very good for checking the IOP from children and people less co-operative and in fact for all people. Examination time is very short ~ it’s very nice device in altogether. Accuracy is enough; I haven’t discovered a big difference in GAT and Icare®. For 2-3 months I’ve used both Icare® and GAT to check the accuracy of Icare® and now I have enough trust for Icare®. I’ve had it for 1.5 years and I’m happy with it.”

Dr. Lilia Catrinu, MD, Romania
“Icare® is very easy to use. It is comfortable for the patients of all ages. It is portable and there is no need of drops and anesthesia. It makes IOP measuring of children easy. The measured values are close to the values by GAT. We have been using Icare® TAO1 for more than 5 years and we’re very satisfied with it.”

Dr. Miriam Golovachoca, MD, Georgia
“With great pleasure I would like to tell that Icare® is my ‘best friend’. We have already worked three years with it and it is very convenient in ambulatory work, especially with children and postoperative patients.”

Dr. Artashes Ziftyan, MD, Armenia
“Main benefit of Icare® tonometer is that we don’t need to use anesthesia. It is very easy to use, especially with children. We have replaced TonoPen with Icare®, which is now our main tonometer.”

Dr. Alessandra Del Longo, Ospedale Niguarda, Milan, Italy
“I’m a pediatric ophthalmologist that works in private and public sectors. I’ve used this instrument for about 4 years. It’s very easy to use in the daily work. Actually I never have the necessity to do any maintenance. Also good instrument in screening.”

Dr. Marco Mazza, Ospedale Niguarda, Milan, Italy
“I am a pediatric ophthalmologist and have used it for about 5 years. I am very happy for this tool that allows you to measure easily the intraocular pressure in children. I have not yet changed the batteries and never done any maintenance.”

Dr. Elisabeth Kerkhof, UMC Utrecht, Netherlands
“For me the Icare is an eye-opener! It is just fantastic. No droplets any more. Very friendly for children.”

AFRICA

Dr. Clive Novis, MD, South Africa
“I have been measuring IOP for the last 35 years. I have used many versions of the non-contact tonometers, the Goldmann, Tonopen, Perkins, and Schiotz. In the last few years I have changed to using the Icare®. I now have 4 Icare® tonometers [two in each practice]. I find that the Icare® tonometer is fast, efficient, reliable and accurate. In fact, I find it more precise than the Goldmann.”

Dr. Dupe Ademola Popoola, Univ. of Ilorin Teaching Hospital, Ilorin, Nigeria
“I found it comparable to the Perkins that I’ve used for 14 years. In addition more kids tolerated Icare use for IOP check compared to Perkins in the clinic setting.”

MIDDLE EAST

Dr. Elie Dahan, MD, Israel
“The Icare® is in daily use at Dr. Elie Dahan’s practice. He not only prefers it to the more traditional instruments on his own patients, he also thinks eventually it could claim its place as the most popular method of measuring IOP worldwide. As the best features of the Icare® tonometer Dr. Dahan lists its repetitive accuracy, painlessness, speed and ease of use.

Dr. Dawood Al-Rashed, MD, Head of Glaucoma and Cataract Dept., Al Safwa Hospital, Saudi-Arabia
“Icare® is easy to use, which is a great benefit in some patients, for example in children.”

AUSTRALIA

Dr. Frank J. Martin, Sydney Ophthalmic Surgeons, Australia
“The Icare tonometer has transformed the way we manage our post-operative pediatric cataract and glaucoma patients. The number of EUA’s has decreased dramatically and we now have an accurate way to monitor IOP in the clinic.”

Dr. Shanel Sharma, Eye & Laser Surgeons, Australia
“I have found the Icare tonometer an asset to my practice, particularly examining young children, as no anesthesia is required, and in adults who squeeze their eyes.”
www.eyeandlaser.com.au
"I am incredibly happy with Icare®. I find it to be very helpful in many situations. Many of our patients mention that they hate the air puff. It is actually a pain point that many people say they think about when visiting their optometrist.

Due to my work with Special Olympics Lions Clubs International Opening Eyes, I see many people with intellectual disabilities. It is the best way I find to get an accurate pressure on these patients. In addition, at each Opening Eyes event we find that all of our doctors really love it. It is easy to learn how to use it, it does not require drops and is not uncomfortable for the patient. For these reasons I certainly can recommend the Icare® tonometer as a great addition to any optometrist’s equipment.”

"I have never had such an enthusiastic response by patients to any other piece of equipment that I have purchased. No air puff (which we haven’t used in years) and no anesthetic need. The Icare® is accurate and easy to use. It has replaced the tonopen as a screening tool in our practice. Our staff liked it so much, we needed to buy a second one after the first month of having one. This is a true innovation in eye care.”

"The Icare® tonometer is a no-brainer for any busy practice. It is easy to use, patients love it and it streamlines the examination process since it doesn’t require topical anesthesia or NaFl dye use. In addition, I have found the Icare® to be more reliable and accurate compared to application tonometry when dealing with patients who have poor cooperation, deep set orbits, prominent brow or photophobia.”

"Since we’ve been using the Icare® we’ve found great efficiency and accuracy within our practice. Not only have patients expressed gratitude for this new device rather than having drops instilled in the eyes that burn or sting, we’ve found greater confidence and accuracy in our diagnosis because no previous drops are affecting the ocular surface. It also saves a significant amount of time per patient allowing us to see more patients and it provides consistent IOP measurements compared to the more cumbersome previous options. Finally new technology always impresses patients and especially when it’s an improvement in patient comfort compared to what they experienced in past examinations. Even our staff have migrated over to using the Icare® because it’s ease of use and great patient response.”

"The Icare® has quickly replaced my two tonopen as the portable tonometry of choice in my clinic. It is fast, requires no drops, and enables my staff to perform this on the front end of my exam rather than the back end, due to trauma to the cornea.”

"Thanks for getting us started on the new Icare® tonometer. With a large glaucoma practice base, both we and our patients benefit from equipment that is patient-friendly, accurate, and technician-easy. The new Icare® fills all the requirements. Patients love the no drops, I love the accuracy, and it makes accurate tonometry a technician delegated task, that is not only accurate, but highly repeatable, and easily portable. The efficiency adds to our bottom line. Clinicians in practices large and small will be thrilled with this advance. Thanks for bringing it to the USA!”

"The Icare® has been one of the best new technologies that we have added to our practice. It is extremely accurate and easy for our techs to use. We see a lot of children and they’re not scared or threatened by the testing and love that no drops are needed. I highly recommend this instrument for any Optometric practice.”

"We purchased our first Icare® in March of 2008, and we purchased a second within a month. We were previously using a Tonopen for screening IOP, but the Icare® has rendered the Tonopen useless in our office. It’s easy to use, reproducible, and requires no anesthetic, so we’re able to incorporate IOP screening into our pre-test without compromising the cornea in any way. This is truly a revolutionary product in eye care.”

"I’ve used it for three years more than 5 times per day with all the customer groups. Icare® is easy to learn to use. It is compact, non invasive and a user-friendly tool. I recommend Icare® to all my colleagues as well as to general practitioners!”

From scepticism to amazed acceptance

Two US specialists, who recently published the Clinical Guide to Ophthalmic Drugs, now recommend the Icare® tonometer to all their colleagues. Ron Melton, O.D. and Randall Thomas, O.D. have both replaced the use of all Air-Puff tonometers with the easy Icare® routine in their practices. We asked them: Why?

- After being introduced to the Icare® rebound technology, we finally find the Air-Puff tonometry quite obsolete, say Ron and Randall. Patients hate the trauma and its anticipation. And the measuring results are not that accurate, either.

- In the context of contact lens care we can also understand the patient’s annoyance with techniques requiring fluorescent dye and topical anesthetics. This is exactly why many doctors have continued using the dreaded Air-Puff over the years.

- Having heard of the new rebound technology in tonometers, we were very skeptical at first. But as soon as we had the Icare® tonometer performed on ourselves, our skepticism turned to amazed acceptance and we couldn’t wait to use it on our patients. It is indeed asymptomatic in virtually all instances and certainly atraumatic in all cases.

- Here’s the magic: the Icare® tonometry requires no topical anesthe-sia, no drops and no dye. The device itself is conveniently hand held and easy to use. It projects a tiny, blunt-tipped probe onto the corneal surface. As the probe rebounds off the cornea, onboard sensors measure the IOP. This procedure is barely or not at all perceived by the patient.

- Furthermore, the Icare® tonometer’s single-use, disposable probes ensure microbiological safety even in field situations. This technique is very fast and can be used on soft contact lenses, which may sometimes be helpful in keeping the receiving room patient flow dynamic.”
Red Bank Opticians, Blackpool, UK

Puff of air in the eyes is now not necessary.
We have the latest Icare® tonometer which takes the pressure readings without air or drops. It takes a more accurate reading due to the patient not jumping in surprise at the shock of the air. Most patients feel nothing. Call into the practice to see this revolutionary new equipment.

Richard Petrie Optometrist, Derby, UK

No more fondly remembered ‘puff of air’ test. We now use the "Icare® tonometer". A small disposable probe touches the cornea very lightly for a fraction of a second. The measurement is barely noticeable by the patient and therefore suitable even for sensitive patients.

Cary Optometric, Cary, NC, USA

The Icare®, A Kinder, Gentler Way To Measure IOP
I stopped using the dreaded "air-puff test" to measure IOP way back in 1999. While most patients preferred the Tonopen, some just couldn't stand the idea of anything touching their eye, even if they were numb. Others think any type of eye drop is torture. Fortunately, we now have the Icare® tonometer to measure IOP without shooting a puff of air into your eye or using numbing drops. Since I started using the Icare®, I haven't had any patients that couldn’t do it.

The EyeCare center, Beloit & Smith Center, KS, USA

No More Air Puff...Icare® New For Eye Pressures
No air puff. No eye drops. No anticipation. And best of all, no more startling shock. The air puff has finally been replaced by the Icare® tonometer. The Icare® is the newest and best technology in eye pressure measurement.

Park Slope Eye, Brooklyn, NY, USA

That dang air puff
At Park Slope Eye we have a better way to determine patients’ IOP. We have a special device from Finland that gives just as accurate IOP readings as Goldmann tonometry. It’s very fast, painless, and requires no drops. A few seconds after I explain it to patients, the machine has already measured the IOP three times in each eye!

Plaza Lane Optometry, Santa Cruz, CA, USA

We’re proud to introduce the new Icare® "puff-less" eye pressure test to the delight of our patients.
We know you’ve always hated the anticipation and sensation of the dreaded air puff. Now we no longer need it. Our new test is very quick and easy. It requires no topical anesthesia, no drops and no dye. Patients are telling us that they much prefer Icare® to the “puff”.

Perspective Eyecare, Belleville, MI, USA

We NO longer use the “PUFF OF AIR” instrument for testing pressure of the eye.
This IOP test is used to detect glaucoma and has revolutionized early detection and control, by making the IOP measuring routine quick and effortless. This device makes measuring intraocular pressure a more pleasant experience.

New Tampa Walmart Vision Center, Tampa, FL, USA

Introducing our new non-invasive, high tech Icare®
Although our “air puff” test is quite gentle many patients still find the experience a bit unpleasant. That’s why we’ve added the new Icare® tonometer which takes the same reading without an air puff at all!!!

Russell Eyecare & Associates, St. Joseph, MN, USA

NO Air Puff. NO Air Puff?
Our office does not use the air puff, or the ‘yellow drops’ to check IOP! We use a newer technology called Icare®. This small instrument is easier on you, our patient! IOP readings are also more accurate than the standard air puff method.

Parker Family Vision Center, Ardmore, OK, USA

Checking Pressure without the puff of air or drops
We use a newer technology called No more air puff, no more drops... when patients go the eye doctor one of the number one complaints of the visit is that air puff machine. We don’t like the air puff either, so our technology is different, we can measure your IOP without that annoying puff of air by using the new Icare® tonometer. This revolutionary equipment uses state of the art technology to accurately check your pressure without the puff of air or any eye drops.

Insight Eye Care - Vision Source, St. Cloud, Paynesville & Becker, MN, USA

No more air puff!
We are always trying to make sure our patients do not experience any discomfort during an exam, so we are using new technology to measure IOP. The new instrument is an Icare® tonometer. It is quick and causes no discomfort when checking pressures. Our patients are thrilled that they no longer need to have the air puff!

Dr. Joel P. Ways, Sharon, PA, USA

We now have the Icare® tonometer - No More Air Puff!

OceanEye, Summerville, SC, USA

No Air or Drops
One of the most dreaded procedures when visiting an OD seems to be that puff of air into the eyes to check for elevated IOP. The anticipation is torture for most patients, and for that and other reasons, Ocean Eye has chosen to never use that method. Until recently, Ocean Eye has used other, more precise methods, such as the GAT and Pen-like Dialton. To some, these procedures have been perceived as a little invasive to the eye and still require eye drops. Therefore, Ocean Eye has gone a step further and in most cases, is now using what is called the Icare® tonometer.

Martin Eyecare, Greenville, MI, USA

Will I have air puffed in my eyes?
No, Dr. Martin has replaced the old ‘puff of air test’ with an instrument with new technology called the Icare® tonometer. This instrument checks the pressure of your eyes without the use of air or drops!

Karthik Netralaya, Bangalore, India

Several tonometers including Goldman’s, Keeler’s contact, Icare® rebound tonometer etc are available and are routinely used in the OPD and Glaucoma clinic at Kartik Netralaya. The Icare® tonometer does not need any anesthetic drops or dye, and is very popular amongst our doctors & patients.
Dr. Sergei Astakhov, St. Petersburg Medical University (Pavlov), department of ophthalmology, St. Petersburg, Russia
"More easy than Goldmann tonometry, more precise than Maklakov tonometry."

Dr. C. Bennebroek, UMC Utrecht, Netherlands
"I have been using the Icare® Pro for 1.5 years with high satisfaction. An increasing population of young children, handicapped children/grownups, or adults with spastic orbicular reactions to conventional tonometry can now be measured and followed up with reliable results. This equipment appears to be very patient-friendly and efficient in use."

Dr. N.E. Schali-Delfos, Leiden University Medical Center, Leiden, Netherlands
"It's great. Children that were not measurable without anesthesia now have their IOP measured before they know anything has happened. It would be a great idea if a jingle could be played to distract them even more."

Dr. Leo Seo Wei, Dr Leo Adult & Paediatric Eye Specialist Pte Ltd., Singapore
"I was already very satisfied with using Icare. Now it is even better with Icare® Pro because I can measure IOP efficiently even when the baby is lying down. Very user friendly!"

Dr. Adrian Smedowski, MD, Poland
"Icare® PRO can really help to improve every ophthalmologist’s practice. The measurement takes less than 1 minute and requires no anesthesia. It is really helpful in cases of non compliant patient and children, can also be used in the operative unit on supine patients."
Eye care greetings from East Melbourne

Richard Lindsay & Associates is recognized as one of the leading specialist contact lens practices in Australia. Since 1997, the beginning of its business, the practice has been located at 376 Albert Street in East Melbourne, an area where it still remains the only one of its kind.

“Our typical clientele consists of unusual contact lens patients”, says Practice Manager Adriana Warren, who particularly enjoys running the practice at Richard Lindsay & Associates because of just that.

“Every day is different at RL & A and presents new challenges because of the incredible diversity of patients referred to us. We see conditions such as keratoconus, irregular corneal grafts, failed refractive surgery, paediatric aphakia, high astigmatism, high ametropia, anisometropia, corneal scarring and ocular trauma on a daily basis.”

The founder of the practice, Richard Lindsay, is internationally renowned as an expert in the field of contact lenses. He has been a Visiting Lecturer at both the University of Melbourne and the University of New South Wales, published over 30 papers on the subject in scientific and clinical papers and written chapters for many text books.

Altogether nine people work at RL & A. Besides the day-to-day running of the business Adriana Warren and her staff do “a little bit of everything” to keep things flowing smoothly. They perform various eye sight tests on clients, measure their IOP, handle contact lens fittings and teach patients to use and take care of their contact lenses. Some days can get rather hectic.

“One of the procedures that was holding us back on busy days, was measuring IOP with our old tonometer”, says Adriana. “Even though not all of our clients are glaucoma patients, many of them belong to a high risk category. So we need to check eye pressures about fifteen times or more on an average day. The Non Contact Tonometer/Pachometer we previously used was fixed in one room and could not be moved.”

“Less than half a year ago, after hearing about the Icare® tonometer from a representative of Designs for Vision, we sold the non contact tonometer and purchased our own Icare®. It has brought a significant change into our daily routines. We particularly value its advantages from the patient point of view, as most of them really hated the “puff” and seem to find the rebound method much less intrusive.”

“From our business point of view the Icare® tonometer helps us keep up with the patient flow and saves space, because it is portable and can be used in all of the consulting rooms. It is also very convenient for children and people with limited mobility. And we find it rather cost-effective”, Adriana adds.

“The fact that the invention comes from Finland, was news to us. Well done and thanks for a very good product.”
Dr. Kirsten Baggesen, MD, Denmark
“The Icare® ONE tonometer is a valuable new member of the Icare® family and with the LINK software the measurements are easily transferred to the computer in the clinic.

The families who have tried the home-measurements are satisfied, and find the tonometer easy to use, even on children. For the children, the procedure of IOP measurement is more relaxed, as it is mom or dad who takes care of it, at the right moment at home.

For some families the possibility of having measurements several times a day in a week, reassures their feeling of full control of the IOP. For the ophthalmologist the precise results are a well-documented background for making a decision for treatment, whether it is a case of congenital glaucoma or high IOP following congenital anterior chamber malformations ie cataract.”

Dr. Ivanescu Augustin, MD, Romania
“I like the product; I use it for all the patients. My patients use Icare® ONE; it is convenient that we can make measurements in different conditions and out of clinic and we’re able to harvest long time data of results. It is easy to use, my nurses do the measurements which saves a lot of time for me. We plan to give up the non-contact measurements since they are very uncomfortable for the patients. We trust the Icare® results; we have compared the results with applanation and we’ve found out they correlate well.”
With the pocket tonometer on Tour:
IOP simple self check

The portable Icare® ONE tonometer allows glaucoma patients a comfortable IOP self check at home. The prominent opera tenor Fernando del Valle also uses the practical and easy to use device.

It is easy to overlook the eye problems of the internationally acclaimed tenor Fernando del Valle from New Orleans: He has been diagnosed with glaucoma and macular edema. His IOP is elevated and problematic. However Del Valle is able to manage his day in spite of his glaucoma with the help of the compact, portable and practical Icare® ONE self check tonometer.

The so called rebound technology employs a miniscule probe which contacts the cornea for a split second and measures the IOP via a magnetic field impulse. The measurement is so gentle and rapid that it is faster than a blink reflex. The device is very easy to use even for a novice and can be used without any problems. It is comparable in terms of ease of use to a blood sugar measuring device for diabetes patients. The home measurements are seen as an expansion of the control checks carried out by the eye doctor.

Fernando del Valle was also able to use the tonometer without any problems after a short training. As it fits into even the smallest of handbags, the tenor can also carry out his self-checks at any time, anywhere while on tour: He does this 3 times daily (in the morning at midday to noon) in order to optimize his therapy and just before he goes to bed. He can also if necessary measure during the night. The IOP of the opera singer fluctuates quite dramatically and often the highest values are reached during the night.

A sterile packed single use probe is inserted into the tonometer before each measurement. To measure, the user, like del Valle, holds the tonometer centrally in front of his eye, ideally at a distance of 4-8mm from the cornea. The measurement is started by pressing the measure button. The result is displayed as a range (e.g. 18-20 mm HG), this design feature avoids unnecessary concern where small changes in pressure are detected.

“Prevention is best, control is second best”, the Tenor explains, as a diabetic sufferer he has increased risks from glaucoma. He was first diagnosed as having elevated IOP when he got an eye exam following intense head aches and light sensitivity. The pathology was already well advanced. He advises everyone over 40 to get regular IOP checks, as elevated IOP is often noticed when it is too late - this is often with fatal consequences. The elevated IOP leads to optic nerve death, which in turn results in field loss and eventual blindness.

The tenor’s IOP has normalized now following several operations and the appropriate therapy. The regular IOP measurements help him and his eye doctor to optimize his treatment. This gives the singer a sense of security and provides a control for the fluctuating pressure. Medication can be prescribed according to his needs. Should the IOP go above 40 mm HG then the tenor needs to put “emergency drops” into his eyes.

The measurement results from Icare® ONE can be transmitted to the doctor’s office using a special software. Eventual error measurements are easy to identify. What is convincing for the doctor is that the results of the Icare® ONE tonometer correlate to the Goldmann Applanation tonometer (1).

Del Valle lives a more relaxed life these days thanks to his Icare® ONE and in spite of the silent threat of blindness. “Before, when I suspected an increase in IOP I had to go to the emergency room. Today I can make a precise control at the push of the button.”

Shared tonometer by Glaucoma Patient Society

Icare® interviewed Marja Kalvia, a Glaucoma Patient who is the spokesperson of the Finnish Glaucoma Association in the greater Helsinki area. She has been using the Icare® ONE tonometer for about one year now.

Marja, you are one of the many people in Finland to have experience with the Icare® ONE self measuring tonometer. Is it your personal tonometer?
Actually the tonometer belongs to our Association. Originally I was asked to test it in order to be able to instruct our members on how to use it. Now I am no longer the only one using it.

Do you find it easy to use? How long did it take to learn the procedure?
Most people, I among them, learn to use this tonometer after just one try.

How often do you control your IOP? How has the Icare® ONE tonometer changed the frequency of your IOP controls?
Before this possibility of having the self measuring tonometer at hand I used to go to the eye clinic for controls two or three times per year. Obviously now I can check my IOP even between those official controls and see what my real IOP level is and if there are peaks.

In your opinion, how has the self measuring possibility made a difference in how your glaucoma is advancing? How has the treatment of your glaucoma changed?
I have been under such close control and active care for so many years, that I really cannot find any great changes either way. However, it has been important to be able to verify that in my case a certain type of pain I occasionally experience is in fact always associated with an increase in my IOP.

What effects - if any - have you noticed in the quality of your life and the way you feel?
As far as only the glaucoma is concerned, surely the possibility to be aware of the changes in my IOP has helped - especially because I now know better in what kind of circumstances the pressure tends to increase.

You are the spokesperson of the Finnish Glaucoma Association in the greater Helsinki area. What would you say is the role of the Association in the life of a glaucoma patient and in the surrounding society?
In the six years that I have held this position our Association has focused on lobbying in the patients’ best interest and urging to help the progress of glaucoma care in general. There are several issues concerning the individual glaucoma patient: the so-called care guarantee and the service coupon system sound good but have not improved the situation from the patients’ point of view. Glaucoma is an illness that requires long term monitoring and treatment. The University Eye Clinic is still not able to follow through and offer all local patients the care they need. That is why the patients need a voice that speaks for them. Our role in the society is also important in spreading glaucoma knowledge and information on the risks it poses for the patient. Particularly the aging people are a group difficult to reach with the right information at the right time.
Peace of mind from knowing the IOP

Trevor Nightingale had what can only be described as a ‘happy accident’ when he sat on his glasses and broke them. Understandably, he was annoyed with himself at the time because he had to go to the optician to get some new ones and that would entail some inconvenience and expense.

However, his accident turned out to be a piece of great good fortune because his optician had just taken delivery of a new eye pressure machine, which he was keen to start using with patients, and when he examined Trevor he found that unexpectedly at the age of 31, Trevor had the first stages of glaucoma. Trevor had not noticed anything amiss. He thought that there might be a halo effect around lights but he had not experienced any pain or discomfort so he had happily ignored these symptoms.

Trevor was referred to the local hospital, James Cook University Hospital in Middlesbrough, where he was found to have open eye glaucoma. Trevor was naturally rather shocked but he was actually really fortunate. Because his condition was diagnosed early he has lost a little vision in the left eye and next to nothing in the right eye. His condition is controlled with drops, firstly with Timolol and then after six or seven years he changed to Xalacom. He puts the drops in once a night and has no side effects. Trevor’s eye pressure is now acceptable at about 17mm of mercury in each eye and he has a check-up with his eye specialist every six months.

Trevor says, ‘Everything was going fairly smoothly when I noticed news about the Finnish company Icare® and their Icare® ONE device for home testing of IOP levels. I have had glaucoma for about ten years now and I have learned to manage the condition successfully but when something new was offered that I felt would be helpful, I was keen to try it. Once I had set up the unit and got used to it, I found it easy to use. I was reassured when I went to the opticians and found that they had a unit which enabled them to test my eye pressure and their results were the same as mine. I could then feel confident that I was getting it right.

Trevor explains, “When I saw my eye specialist she was very interested, because she just sees me once every six months and if she wanted to get the same number of readings that I take she would have to see me repeatedly 4 or 5 times through the day, and that is clearly impossible. I now keep a daily diary and my pressure readings have dropped further so I am very happy with my situation now. It is never good to find that you have any medical condition that you had not noticed and it is a relief to feel that you are in control and able to monitor your condition yourself.”
The Icare® advantage in pediatric ophthalmology
by Dr. Kirsten Lau Baggesen, Denmark

Glaucoma has always been a major risk in many pediatric ophthalmic patients. Although congenital glaucoma is rare, with only a few new cases annually diagnosed in Denmark, the ophthalmologist still has to measure IOP as a routine when examining most pediatric patients.

High intraocular pressure is considered one of the greatest risk factors in different conditions, such as congenital infantile cataracts, uveitis combined with juvenile idiopathic arthritis and many other syndromes involving eyes, especially following traumas.

In children as well as in the adult patient, it is important to trace high intraocular pressure early, before any permanent damage to the vision has occurred. Because the eyeball of a child is soft, increased pressure inside it will cause the eye to grow in size. This may result in a life-long visual handicap, which is not always treatable with glasses.

There are many different methods to diagnose the damage already occurred in small children. You can look for hippsker stria in the cornea, look for changes in the child’s appearance or see changes in the nerve-head. And of course, first and foremost, the IOP should always be measured.

Children cannot be expected to be very cooperative in complicated procedures involving their eyes. Therefore, when the traditional methods are used, it is often necessary to have the child undergo general anaesthesia. With the Icare® tonometer it will be so much easier. As a general rule, just following the next simple steps will make the measuring a full success with the little patient:

1. Show the child how the device is used by measuring the IOP on a teddy-bear or a doll
2. Let the child feel how absolutely harmless the device is by measuring the pressure on the child’s hand
3. Touch the child’s forehead with the device to let him/her get used to the close contact
4. When the child is feeling safe, secure and relaxed, continue to measure the IOP.

After this the IOP can be measured every three or six months depending on the risk level of each individual child. With children between 3 to 24 months of age as well as with children older than four years you will most likely find the follow-ups relatively easy. However, as it is commonly known, children between two and four years of age are generally not very cooperative at all. So, even the quick and easy routine may not give you a 100% guarantee against the occasional tantrum. Don’t let yourself be discouraged if that happens.

The use of Icare® tonometer on high risk pediatric ophthalmic patients doesn’t remove the need of general anaesthesia altogether, but it definitely diminishes the number of times it is needed, thus offering a great advantage to the young patient and his/her already distressed family.
IOP measured by the parents

Sarah Smale is six years old. In most ways she is like any other girl of her age. She is bright, outgoing and very happy. She loves to dress in pink & purple and laughs easily. However, Sarah’s daily life is a bit more complicated than usual. She has a rare eye condition called aphakic glaucoma, which is difficult to manage.

This story started on the 24th of November in 2008, when Sarah’s mother Angela Smale contacted Icare USA. She wanted to know whether it would be possible to buy an Icare® tonometer for private use on her daughter, whose eye pressure needs constant monitoring.

Angela was well aware that the device is not intended for domestic use. But as one of the few parents already trusted to use a Tonopen at home as part of her daughter’s weekly care, she was not prepared to accept no for an answer. Having had the opportunity to compare the Icare® tonometer to a Tonopen during one of Sarah’s frequent visits to the Duke University Eye Center in North Carolina, she knew what she wanted.

The following day Icare USA received a touching plea and recommendation from Duke University’s Professor of Ophthalmology Sharon Freedman, the specialist whom Sarah and her parents regularly traveled to see all the way from Washington state where they lived. In her letter professor Freedman explained why she thought it would be important for the Smales to have the Icare® tonometer at home:

“Sarah was born with congenital cataracts (cloudy lenses) in both eyes, in addition to small eyes and small corneas. She had the cataracts removed as an infant in order to clear the visual axis and to allow sight to develop in her eyes. Unfortunately, she developed glaucoma soon thereafter: As an attempt to control the glaucoma, she underwent additional surgery in one eye. The outcome was not a success, and she actually lost all sight in that eye.

Since that time Sarah has vision remaining in only one eye, which also still has glaucoma. To save the optic nerve and whatever is left of her vision she will someday need surgery to lower the pressure in that eye. But as the surgery has its substantial risks, for the time being we are keen to optimize her several medications to maintain the lowest possible eye pressure throughout the day and night.

Sarah’s parents have been using a Tonopen to check her pressures at home. Having tried the Icare® tonometer in my pediatric glaucoma clinic, I know how well it functions and how easily “natural” pressures are obtained without anesthetics. Also, as the measuring is very quick, even young children can keep their eyes open long enough. This way the true pressure is less likely to be altered by unintentional squeezing while holding the eyelids apart.

For these reasons I find that the Icare® tonometer would be an invaluable tool in the hands of Sarah’s parents, allowing them to monitor her pressures at various times as well as allowing me to get the best understanding of how her pressures change along with different medications and their administration or at different times of the day and night. With this tool we hope to be able to preserve her optic nerve and her precious vision as long as possible.”

Sarah’s story impressed Icare USA. Professor Freedman had explicitly stated that Sarah’s parents were quite competent to safely operate the Icare® tonometer on their daughter.

In only a few days everything was set. Professor Freedman as Sarah’s physician would prescribe the easy-to-use “no drops” tonometer for Sarah’s IOP monitoring at home. Icare® Finland would follow the case closely in order to get useful information on what features our future private customers mostly value in the Icare® tonometer.

At that time we were already preparing to launch our new product variant, which has been specially developed for self measuring and domestic use. With that we hope to be able to help many more families like the Smales and to make glaucoma monitoring at home a common routine for all patients who need it.

Icare® Finland wishes little Sarah the best possible IOP results with the Icare® tonometer. We are truly sorry it doesn’t come in pink just yet.

“I am fortunate to be one of very few parents trusted to test their child’s IOP at home. My husband and I love the Icare® tonometer’s ease of use. From a parent’s perspective it’s important to be able to get a measurement without the anesthetic drops, which are known to pose significant risks with improper use”, says Sarah’s mother Angela Smale.
Sarah’s story: Looking forward to what tomorrow brings

In our last story we met Sarah Smale, a little girl from Washington State, USA. She developed aphakic glaucoma as a tiny baby after having congenital cataracts removed from both eyes. She also lost sight in one of her eyes. Because Sarah’s glaucoma is hard to manage, last spring her family got a prescription for an Icare® tonometer to be used at home to help monitor daily fluctuations in her eye pressure, and to guide her medication regimen and overall glaucoma management.

Sarah is now 7 years old, a bright 1st grade student who enthusiastically attends several extracurricular activities such as Kempo Karate, horseback riding and swimming. Her mother Angela Smale is pleased to tell that she is just getting ready to test for the purple belt in Kempo. At school Sarah is well above her grade level in all areas of academics - reading, writing, spelling and mathematics. Reading about science topics, particularly space exploration, weather and paleontology, is one of her favorite pastimes along with coloring, crafts and inventing games.

Recent operation brought changes. Starting school is obviously a big change in any child’s life. But what else is new with the Smales? Sarah had a Baerveldt Glaucoma Drainage Device implanted in her right eye last spring, along with surgical removal of her vitreous gel and widening of her pupil. There was a suture holding the stent closed for approximately 6 weeks post-operatively, to allow the eye to heal before the implant started to work. According to Angela Smale the Icare® tonometer was instrumental in managing Sarah’s eye pressure after the surgery while waiting for the stent to open up.

For the first three weeks Sarah’s IOP was checked twice a day and the readings sent to Dr. Sharon Freedman at the Duke Eye Center. She would then adjust the medications as needed. In the mornings Sarah would get pressure readings as high as 40. The Icare® was used right before her eye drops every morning and evening in order to know exactly the moment when the stent opened. This was important, because the pressure dropped to 4 when that happened. Glaucoma medication at such a time could have caused the eye pressure to go even lower, significantly increasing the risk of retinal detachment and visual loss.

As soon as the suture had dissolved and the stent opened, Dr. Freedman was notified of the Icare® readings by SMS. The family had traveled back to North Carolina for easy access to Duke when the tube opened. Dr. Freedman arranged to meet Sarah immediately to ensure that her eye looked good internally, which it did.

Seeing better is an extra bonus. The Icare® tonometer has been an amazing tool for fine-tuning Sarah’s medication needs after the surgery. Now she only gets one drop of Timolol, 0.25 % every 2 days, at bedtime, and she is doing very well with it. One of the unexpected consequences of the surgery is that her vision seems to have improved a bit. She can now read paperback chapter books without the use of a magnifier, and is quicker to recognize and see small things in her surroundings, says Angela.

Sarah is totally blind in her left eye, so she has no binocular vision. This affects her judgment of distances and steps. She still also has nystagmus (shaky eye) in her right eye, so when she is tired, her eye shakes more, and her vision decreases. Therefore her physical play skills are not as good as they could be at her age, for example catching a ball is difficult for her. The good news is that her schedule no longer revolves around what eye drops she needs, so she is more available for socializing and after school activities.

How is Sarah dealing with all this? According to Angela, Sarah is very open to talking about her eyes. She usually tells people that her left eye is her fake eye, and her right eye is her small eye, with glaucoma. When she goes to hospital for an exam under anesthesia, she says she is going for a ‘hospital nap’. She loves going to hospital, and looks forward to her appointments with Dr. Freedman. She also has pet names for her eye drops and tonometers; for example, ‘Timmy’ is the Timolol eye drop, and ‘Cary’ is the Icare® tonometer. Everyone at home agrees that Cary cares a lot. This term at school Sarah is going to help with a presentation to her class about how eyes work, and how her eyes are different from her friends’ eyes. The class will also discuss how the other children can help her, like offering to hold her hand when going down steps with no railing, or arranging a place to meet her in the playground at lunchtime, so Sarah doesn’t have to go searching for her friends.

Better quality of life for the whole family. The huge reduction in the number of Sarah’s eye drops and medicines has made a big difference in the Smale family life. After spending a significant amount of time per day managing eye drops, Angela has been able to stop carrying the drops around with her. Better yet, Sarah no longer needs drops administered by the staff at school. The frequency of using the Icare® tonometer varies according to how stable Sarah’s eye pressure is, and whether there are any medication changes. Right now it is used every 2 to 3 days, to make sure that the recent change in Timolol dosage is keeping her eye pressure between 13 and 17 – her ideal target pressure. It is difficult to describe the peace of mind that comes from knowing how different medicines affect Sarah’s IOP, to be able to measure the effects of increasing medication when her glaucoma is out of control, and also to measure the effects of reducing medication as her eye adjusts to the glaucoma drainage implant. One glaucoma eye drop once every 2 days is not a usual prescription, and this frequency and timing is a direct result of having the Icare® tonometer at home, says Angela. Sarah still has glaucoma, but it is controlled for now. With the combination of her glaucoma drainage implant and the Icare®, we hope to stay away from further glaucoma surgery for the next ten years.

Angela: A thought to share. As a parent, knowing Sarah’s IOP fluctuation pattern, how physical exercise affects her IOP, how crying affects it, etc. makes me feel somewhat in control, and it relieves a lot of the stress associated with her condition. I update Dr. Freedman regularly with Sarah’s IOP numbers, and I feel like a partner in Sarah’s care, says Angela. It would be great if all parents in a situation like ours could spend a couple of weeks mapping out their child’s diurnal IOP curves, getting the pressure in the middle of the night [once or twice] first thing in the morning, at different times of the day, and at bedtime. I am sure there are children whose IOP is in the high normal range at the doctor’s office during the day, but spikes into the high 20s or low 30s every night. Treatment plans could be more targeted for the children this way. I’m very excited about the home-use tonometer for this purpose. Children going through a drainage implant surgery could really benefit from more frequent data regarding their IOP. Not every family with a child who has glaucoma needs an Icare® at home, some children go years managing with eye drops alone and no surgery, but the many families with children who have uncontrolled glaucoma, or are nearing surgery, or are uncooperative in a doctor’s office could definitely benefit hugely, Angela continues. I would love to help set up a ‘lending library’ of a few Icare® tonometers exclusively for use by parents of children with refractory [uncontrolled] glaucoma. It would be a lot of work for those involved, but what a great way to get better management of pediatric glaucoma through data.

“The Icare® tonometer has been an amazing tool for fine tuning Sarah’s medication needs after the surgery.”

-Angela Smale, Sarah’s mother
Medical emergency highlights lack of important diagnostic devices
Walter McLean faced a real problem when he needed urgent emergency treatment. Many of us dream about living on a beautiful, peaceful island away from the crowds and the pressure of city living. Indeed, it can be lovely but there are occasions when it is more than just inconvenient.

Walter McLean, who lives on the beautiful island of Islay, home of many famous distilleries, discovered just how difficult it can be when he needed emergency medical treatment that was not easily available.

"I had been seeing my GP about severe headaches", says Walter. "My GP diagnosed "cluster headaches", a type of migraine and he tried to arrange a CT brain scan as an outpatient. Then one day I suddenly developed a really intense headache. I felt as if a brick had landed on my head and I felt nauseous. My right vision was fuzzy. I called my GP who thought I had a subarachnoid haemorrhage, perhaps an aneurysm had burst. Islay is cut off from the Scottish mainland and advanced hospital facilities so we had a problem."

Mr McLean's GP said that he should be admitted immediately to hospital by air ambulance. When he arrived, he was rushed into casualty. The doctors and nurses quickly assessed him and agreed that he probably had a brain haemorrhage. He was then rushed to X-Ray for an emergency CT scan. Surprisingly, the result was normal. It was now impossible for Mr McLean to get home and he was still in agony so he was admitted onto a medical ward. The doctors said that sometimes a haemorrhage takes time to show up so he had a further brain scan two days later and a lumbar puncture. All the results were still normal so he was discharged and advised to take paracetamol and come back if there was any further problem. None of the doctors appeared to be concerned about his blurred vision.

"I was admitted as an emergency for a second time because of another severe headache", explains Walter McLean. "This time, to make matters worse, the weather was really foul with a 60 knot cross wind so helicopters could not fly. A brave pilot agreed to take me by fixed wing plane performing at its 'operational limit'. The cross wind meant that the plane had to take off sideways. This was very scary, especially as I was so unwell, with a severe headache and nausea. My GP gave me morphine to help me to cope with the flight."

After admission to the same hospital in the West of Scotland Mr McLean had another brain scan and unbelievably, that was also normal despite the agony he was in.

"The doctors seemed puzzled about my crashing headache and nausea but were happy with the head scans," continues Mr McLean. "Now I had trouble seeing out of my left eye. I saw a total of 13 doctors, including GPs and hospital physicians and A & E consultants. Then a FY1 junior doctor noticed that one of my pupils seemed large and fixed. She suggested that the ophthalmologists should review as perhaps the problem was acute glaucoma."

Within 30 minutes the diagnosis was confirmed in the eye department. Mr McLean had bilateral acute angle closure glaucoma with very high pressure in both eyes. Thirty minutes later, after the eye consultant put a drip into him, the pain vanished. The relief was unbelievable as the eye pressure came down. The original attack was on the right eye and then the left eye had followed suit ten days later. It seems that the doctors had missed the diagnostic sign of a fixed mid-dilated pupil and in any case they were unable to measure intracocular pressure.

"My ophthalmologist said I was very lucky not to be permanently blind in both eyes," says Walter McLean. "Fortunately, he was able to make small holes in the coloured iris of each eye, using laser to prevent the build-up of fluid and pressure in the future. Since then, I have been completely free of headaches and don't need any on-going treatment for glaucoma now. I have learnt that most doctors find it hard to examine and diagnose eye conditions. My ophthalmologist said acute glaucoma is often misdiagnosed as migraine because the symptoms are so similar [headache, blurred vision with nausea or vomiting]."

"The equipment optometrists and ophthalmologists use to measure eye pressure is very sophisticated", says consultant ophthalmologist Dr Robert Harvey. "But there is a device made by icare in Finland that makes eye pressure measurement quick and simple even by non-experts. It would be a great asset in hospital A & E departments and larger GP departments."

The icare tonometer is available worldwide with approx costs of £2800 plus vat but as Walter McLean points out "I wish there had been an icare device on my island of Islay. It could have spared me 2 emergency air ambulance flights. If the hospital that treated me had the device, it would have saved me from numerous costly investigations, including the repeated CT scans and that would also have been less of a cost for the NHS."
No fuss

You don’t have to make a big fuss about the IOP check. The procedure is over before even the most nervous of patients has time to get into a nervous state.

In many Skandinavian eye clinics the Icare® tonometer has already been in active use for several years. We talked to two ophthalmic nurses from Sweden about their experiences with it. Hélène Eriksson works at the Karlstad Hospital Eye Clinic. Anita Östberg is her colleague from the Ophthalmic Department of the Lund University Hospital.

Hélène Eriksson’s work shifts are alternated between the Karlstad Hospital Eye Clinic’s surgery and the operating theatre. She has been using the Icare® tonometer as part of her daily routine since 2005.

Before that time the Karlstad Hospital relied on other types of tonometers. In most cases an applanation tonometer was used. If for some reason the patient was not able to cooperate, the IOP reading would be taken with a portable tonometer, which was difficult to set up.

According to Hélène some of her patients, particularly children, used to be afraid of the tonometry procedure and disliked the anesthesia drops. The Icare® tonometer has brought a positive change to all this. Now that there is no need for anesthesia, the patients are more relaxed about having their IOP measured. Also the non-compliant, immobile patients or very recently operated eyes present no problem.

Most patients tolerate the touch of the light weight probe very well – it hardly makes them blink. And because the device is portable and its set up takes practically no time at all, you don’t have to make a big fuss about the IOP check. The procedure is over before even the most nervous of patients has time to get into a nervous state.

At the Karlstad Hospital patients very often have their IOP checked with the Icare® tonometer by one of the ophthalmic nurses, but the device is also in regular use at the ophthalmologists’ consultation rooms.

Anita Östberg works at the Ophthalmic Department of the Lund University Hospital as an ophthalmic nurse and orthoptist. About six months ago she was appointed as the head nurse of the Open Care unit. Anita’s professional background is very solid. Except for her orthoptic patients, the last twenty years of her daily practice has mostly been focused on intraocular photography, a procedure where the patient’s intraocular pressure often needs to be controlled, too.

The Lund University Hospital bought the first Icare® tonometer in 2006. Unfortunately, at that time the nurses were not provided any information on how to operate the device. So, initially the Icare® tonometer was left lying in its box for 1.5 years.

When finally a presentation on the use and advantages of the new device was organized in 2008, everyone immediately understood how the new method would make IOP measuring far quicker and easier in comparison to the old applanation tonometer (AT) that they had mostly used until then.

Anita especially values the Icare® tonometer’s ease of use when working with children. Regular IOP check-ups are needed if, for example, the little patient has glaucoma. These children are often frightened of the anesthetic drops and the big applanation tonometer. It is also difficult to have them sit still for any length of time. For them the quick, hardly noticeable touch of the light weight probe is ideal. The whole thing is over before they know it.

According to Anita, another patient group that really benefits from having their IOP measured with the Icare® tonometer is the majority of elderly people, often immobile in wheelchairs. When using an applanation tonometer you need extra personnel to help press the patient’s head against the headrest in order to get a reading.

With the Icare® any nurse can handle the measuring alone.

Anita also prefers to use the Icare® tonometer whenever the patient is seemingly worried about the IOP measuring. With the hand held, light weight device that requires no pre-measurement drops, it is easy to lower the patient’s anxiety level and get the job done in a calm, relaxed way.

Even some really challenging situations can be resolved with the rebound method. Anita tells about her 40 year old patient with a cornea (re)transplant. He had a massive epithelial defect on his donor cornea and therefore the applanation tonometer gave nothing but a blurred image. With the Icare® tonometer it was possible to get a reliable IOP reading from that eye.

At the Ophthalmic Department of the Lund University Hospital both doctors and nurses measure the patients’ IOP. Most patients, who make their appointments with the nurses, come in for regular glaucoma checks. All the nurses fill in a computerized daily journal on their appointments stating whether they used AT or Icare® tonometry. Personally Anita really prefers the Icare® because of its lightness and ease of use.
Glaucoma is the most important cause of irreversible blindness in the world and elevated intraocular pressure is the most important risk factor to develop the disease.

With glaucoma, the optic nerve is slowly damaged and this is often undetected for many years. Vision loss from glaucoma cannot be recovered but progression of this illness can be slowed down or halted by early diagnosis, treatment, and monitoring. The new tonometer of Icare Finland enables the easy measurement of intraocular pressure at home. The tonometers of Finnish Icare Finland Oy, specializing in the development and manufacturing of tonometers, are based on a rebound technique developed by Doctor Antti Kontiola. The technique allows the measurement of intraocular pressure quickly, gently and accurately without having to anesthetize the eye.

- The contact of the very light probe with the cornea is so fast you can't even feel it, says Doctor Thierry Zeyen, a Belgian professor specialized in the treatment of glaucoma and a visiting professor in Tays Central Hospital’s eye ward in Tampere. Doctor Zeyen has used and studied the tonometers of Icare since 2008 and written articles on the subject for several esteemed medical journals.

- According to our research, the measurements of the Icare tonometer are very close to the approved standard, meaning that they are highly reproducible and accurate. The method is also very suitable for children, who usually hate getting anesthetic eye drops, as well as for people who cannot use traditional methods reliably, such as patients with cornea transplants. The device is light, transportable and user friendly, he says.

Controlling intraocular pressure with home measuring The device, originally designed for general practitioners, soon made its way to opticians’, ophthalmologists’ and even veterinarians’ offices due to its ease of use and patient-friendliness. The newest device is the Icare ONE designed for use at home to measure intraocular pressure quickly, painlessly and accurately on a daily basis.

- We’re interested in a home tonometer because the intraocular pressure varies within a day and from one day to the other. Measurements taken at the office of the ophthalmologists are only snapshots. Glaucoma is commonly treated with daily eye-drops to lower the intraocular pressure, but adherence to treatment is often unsatisfactory. According to surveys, as much as 70% of patients don’t use their eye-drops as regularly as they should except for the weeks preceding the visit to the ophthalmologist. Therefore the intraocular pressure measurements during office visits are often normal even if the vision of the patient has deteriorated in between. Home tonometers allow patients to monitor their intraocular pressure daily or several times per day. This provides useful information to the ophthalmologist and will also contribute to a better adherence to treatment. When patients with glaucoma take their medication according to instructions, progression of the disease can be slowed down or stopped, Doctor Zeyen summarizes.

Glaucoma – the subtle thief of vision Elevated intraocular pressure is the most important risk factor to develop glaucoma and the only one we can modify by treatment. Other risk factors to develop glaucoma include heredity, age, myopia, African ethnicity, a thin cornea and vascular diseases. However, glaucoma is not the same as elevated intraocular pressure; it is a chronic illness of the optic nerve, causing a slow deterioration of optic nerve cells with gradual defects in the visual field. One of 40 adults older than 40 years has glaucoma, although loss of visual function is often asymmetrical. Glaucoma is subtle because the elevated intraocular pressure damages the optic nerve slowly, mostly without causing any pain or symptoms to the patient until late in the disease when visual impairment arises.

- It may take years to diagnose glaucoma because, as vision deteriorates, the brain adapts and fills in the gaps in the visual field. Even in developed countries, half of glaucoma cases are undiagnosed. Doctor Zeyen notes. Glaucoma may develop even with intraocular pressures within the normal range [normal tension glaucoma]. On the other hand, patients with intraocular pressures above the normal range [ocular hypertension] have an increased risk for developing glaucoma, but many of them will not develop the disease. Therefore, measuring the intraocular pressure alone is insufficient to detect glaucoma.

- In order to detect glaucoma in time, we also need to examine the optic nerve and the visual field. If glaucoma is detected early, treatment is often more efficient and visual impairment can be prevented in most cases.

EA | Dr. Zeyen has no financial interest in any of the items discussed.
AIDE–VISION, Asbl is a non-profit eye care organization based in Goma, Eastern Democratic Republic of Congo. The organization is interested in general eye care including eye health and vision. It was founded in 2007, but the clinical activities started in January 2011, says Ophthalmologist Dr. Jason Pithuwa, who trained at the Eye Department of KCMC Moshi and is now personally involved in managing the organization in Goma.

Goma is the main town of the North Kivu province, inhabited by about a million people. There is a variety of health care services available, but not much in eye care. Only one hospital and one private clinic have an active eye department. Thus the Aide–Vision clinic is the third eye care clinic in Goma.

Glaucoma, the second most important cause of blindness worldwide, has never been seriously evaluated locally. Lack of awareness complicates the treatment of glaucoma in Congo. As a reaction to the call of the World Glaucoma Association, Aide–Vision organized local activities to improve the people’s awareness on glaucoma during the World Glaucoma Week 2011. The theme of the year is: “Don’t lose sight of your family”.

How did you get people to have their IOP checked?

The objective was to reach the people of Goma by using the media to invite them to a screening event. There were banners along the main roads of Goma with a short message on glaucoma. Local radio stations broadcasted a glaucoma message and invitation for eight days in both French and Swahili.

The same message was made into a TV-spot with explanatory pictures to accompany it. Two local TV stations aired it at the same time with the radio campaign. Also two radio stations interviewed Dr. Aldy Kavuo, a final year Resident and glaucoma researcher from Kinshasa.
Three days with 4% glaucoma turn up

The screening event took place in March and went on for three days, from the 9th to 11th. The first day was spent at a diabetic center where patients go for their blood glucose checkups on regular basis and get their medications at an affordable price. The center also gives health education and social support to the patients.

This provided a good opportunity to screen the patients and talk to them about glaucoma and other diabetes related eye problems. All patients with IOP 22 mm Hg or more were given an appointment to attend the Aide–Vision Eye Clinic free of charge for a complete ocular examination.

The next two days the screening was done at the Aide–Vision eye clinic, where more patients were seen. They were explained the risks of glaucoma and the importance of screening to prevent blindness. As a result of these activities thousands of people learned about glaucoma, including those who did not come for the screening. Many people called and passed by the clinic to ask questions and get more information after they had heard or seen the campaign.

A total of 749 people were screened. Higher than normal IOPs were found in 17% of the recorded results and the presence of glaucoma was obvious in 4% of the cases. Dr. Pithuma finds it very encouraging to have been able to spot patients who had no previous diagnosis and whose vision can still be preserved with treatment.

There is a long way to go

During the screening the question of the target group was raised. The invitation was actually aimed at people aged 40 or more. It was, however, decided that anyone who showed up should be received, irrespective of age. On the second day a 17 year old boy wanted to have his eyes checked “just out of curiosity”. He had the highest IOP of the day, already causing severe changes in both eyes. He was immediately started on treatment.

There was also a glaucoma patient, who had been diagnosed over five years ago. He had refused surgery and therefore been put on Timolol 0.5% eye drops, which he was told to use for the rest of his life. Having soon finished the drops given to him at the hospital, he had been buying a “dawa ya macho” (eye medicine in Swahili) without prescription at a nearby pharmacy. No wonder his condition had deteriorated, for four years he had been dropping Dexamethasone 0.02% twice daily in his eyes.

These two cases point out, that there is still a long way to go to raise the level of glaucoma awareness in the area in order to alleviate the magnitude of sight loss due to glaucoma.

Many thanks to those who made it happen

The whole campaign and screening were organized by volunteers who received no financial compensation for their work. The campaign was sponsored by the local Lions’ Club members as individuals (17.4%), the local Datco company (4.6%) and internal contributions by Aide-Vision members and staff (78%).

Dr. Pithuma wants to extend his thanks to Icare® Finland for the donation of a TAO1i rebound tonometer, which made the IOP screening possible. Special thanks are also addressed to the World Glaucoma Association for having been the instigator in the campaign.
Icare® Finland, Pfizer and the Association of Glaucoma Patients of the greater Helsinki area have collaborated in organizing a series of public functions under the title “eye-to-eye facts on glaucoma” in order to deliver up-to-date information and offer free IOP screening for people who feel they need it. These functions have been a big success and we would like to share the idea with all our partners and clients.

Despite the rainy, cold and dark autumn day a crowd had gathered at the auditorium of the Lau-rea College in Tikkurila near the capitol of Finland, Helsinki. People were queuing to have their IOP measured. There were three nursing students who have had a “crash course” on how to use the Icare® tonometer just the day before.

Everything went smoothly, the nursing students handled their tonometers as if they had always used them and the queue moved fast. People were overheard asking: “Was that it?” It was hard for them to believe the measuring could be over before they hardly noticed it.

Over a cup of coffee there was a possibility to get acquainted with the various activities of the Glaucoma Patients’ Association and fill in an application to become a member.

In his presentation the visiting lecturer, ophthalmologist, docent Marko Määttä from the Helsinki University Hospital focused strongly on the risk factors of glaucoma and the importance of early diagnosis. He talked about the five phases in which the advancing of the disease can be classified, emphasizing the fact that damages cannot be repaired, only prevented.

Because the prevalence of glaucoma increases with age, it is most important for everyone to look out for it and have regular eye examinations after the age of 50. Statistically the amount of glaucoma patients can be expected to grow along with the aging of the population. In Finland the amount of 65-year old people is estimated to increase 64% in the next 20 years. The good news is, of course, that the treatment of glaucoma has greatly improved in the last decade and more innovative medications and surgical treatments are being developed all the time.

After the lecture the audience had a chance to ask questions and discuss with Marko Määttä. The interest on the subject was really great and time flew so quickly that the evening seemed almost too short in the end. Everyone took home a brochure of the Glaucoma Patients’ Association and their personal IOP reading written on a patient card to show at the next eye examination.
Active teamwork to raise awareness on health issues

Glaucoma is one of the treacherous health risks that people need to be more aware of. This is why Icare® Finland has actively teamed up with other companies in an effort to reach out to those who may be part of a risk group without realizing it. Participation in Pfizer Finland’s “Healthiest people in the world by 2015” challenge tour in May 2010 was a success.

In 2008 Pfizer Finland launched their project “Healthiest people in the world by 2015”. For the past two years Icare® has been one of the many partners touring Finland with Pfizer’s health education trailer aiming to wake people up to living a healthier life and to make health risks such as the metabolic syndrome, COPD and glaucoma more visible.

Between the 8th and 15th of May 2010 the trailer visited six Finnish cities offering the public free health tests, information and a possibility to taste various health focused products. People were actually standing in a queue to measure their IOP, lung capacity, body mass index, fist pressing power and to see a simulated photo of themselves after ten years of smoking.

An average of 300 people had their IOP measured at each stop. There was a great deal of positive feedback from the public and a general feeling of keen interest. More young people showed up than the year before.

“To sum it up in a nutshell; people nowadays value all health related information and are very open to taking advice on how to improve their life and future prospects. Obviously we take a great responsibility in giving that advice and must be careful in referring them to seek further help if needed. The idea to have free tests sponsored by companies instead of tax payers seemed especially gratifying to many of our tour visitors”, says Kirsi Järvinen from Icare® Finland.

Glaucoma is a common interest for Icare® and Pfizer, and this collaboration has proved effective in reaching an important target audience, the general public, to update their knowledge on glaucoma and the necessity of its early detection and control. As a result of this year’s tour several cases of acutely high IOP were discovered. There were also patients already on glaucoma medication, who were advised to see their ophthalmologist as soon as possible.

Particularly the new self-measuring Icare® ONE tonometer proved to be an item of utmost interest. As one of the visitors said: “Even though I see my doctor regularly, it has never been possible for me to know how my IOP varies from day to day.”
ICARE® STUDY - ICARE® AT NON-OPHTHALMIC DEPARTMENT, CAN THE ICARE REBOUND TONOMETER BE SAFELY USED BY GENERAL A&E DOCTORS AND OR NURSES TO MEASURE IOP IN NON-OPHTHALMIC CASUALTY DEPARTMENTS?

Dr R. Harvey, et al. Department of Ophthalmology, Royal Alexandra Hospital, Paisley UK. The authors have no proprietary or commercial interest in Icare.

Introduction:
Primary angle closure glaucoma often presents to main A&E doctors and may be misdiagnosed. A barrier to making the correct and rapid diagnosis is that intraocular pressure measurement by the “gold standard” of Goldmann tonometry is difficult to master by general A&E doctors.

Purpose:
The Icare rebound tonometer (IRT), manufactured by Icare Finland, offers a method of easily and quickly measuring IOP. Training is rapid, taking just 25 minutes unlike Goldmann application tonometry (GAT) where training takes days or weeks. The IRT measurements are rapid, reproducible and reliable. Topical anaesthetic is not required and IRT is surprisingly well tolerated by patients. Our study shows after training most new users find the procedure simple and after testing 5 subjects in their “novice period” most users feel competent and can be trusted. We have compared the accuracy of Icare against the generally accepted gold standard of Goldmann tonometry. Many previous studies compare how IRT measurement differ from GAT supposing that one may always read higher than the other. We have attempted to determine the clinical significance of the differences in results between GAT and IRT measurement and how this might help predict the risk of glaucoma. We have found the GAT - IRT difference reveals new and useful information. All IOP measurements are indirect. GAT is a static test whereas IRT is a rebound test. Eyes with higher IOPs give a greater rebound. Differences in corneal elasticity/rigidity and hysteresis also have an effect on the amount of rebound.

Methods:
A&E study carried out in a busy general A&E department during normal office hours by doctors and nurses. Their results were compared with staff from the Eye department. All staff undertook a short course of training in Icare tonometry. Their results were compared with experienced ophthalmologists or ophthalmic nurses. The time taken to train and accuracy of results obtained were compared and analysed by Student’s t-test. The 22 patients used were volunteers (with no known eye pathology) and written informed consent. Patient received topical anaesthetic with proxymetacaine only if they had pressure measurements by both Icare and Goldmann techniques.

Results:
TRAINING STUDY
All 20 medical and nursing staff were volunteers who were taught in small groups of 4. 4 separate staff categories: Ophthalmologist n=5, Non-oph doctor n=5, ophthalmic nurse n=5, Non-ophth nurse n=5. Short talk on theory (15 minutes). Then demonstrate on one volunteer. Then all volunteers check each other plus the teacher. (20 minutes) Average time to learn technique was 7 minutes per individual. This compares with weeks of supervised training for very junior ophthalmologist in GAT. All results agreed within 2 mm of mercury.

Discussion:
The digital readout enables the novice to quickly refine technique and gain confidence. GAT though accurate and fast in experienced hands may trap the novice. Icare rebound tonometry therefore has considerable advantages in measuring IOP: IRT may be more reliable than GAT when measuring IOP by relatively inexperienced technicians. This applies to a general A&E department without any fully eye trained staff and in the community as in a glaucoma screening program. There are some situations where IRT is superior to GAT even for experienced ophthalmologists: patients with very deep set eyes, blepharospasm and or small palpebral fissures due to congenital blepharophimosis. The IRT probe has a tiny profile in comparison with a Goldmann prism and is well tolerated. Patients with irregular corneas due to scarring have irregular mires on GAT. IRT has limited use in the operating theatre because the Icare device requires the subject to be upright: if the probe is triggered when tilted downwards or upwards its velocity is affected by gravity leading to an error message. Repeated IRT measurement has no discernable effect on IOP measurements. This is an advantage to GAT where repeated measurements have a massaging effect on the globe which increases aqueous outflow. Measuring IOP by the Icare device is different to GAT measurements because the device requires a minimum of 6 probe rebounds. The device firmware averages the 4 most consistent readings giving a P value. If the P value suboptimal the a further set of 6 measurements is taken. Up to 3 sets of readings may be taken. Experienced operators need fewer sets of readings.
PREDICTIVE VALUE STUDY We measured the IOPs in 100 consecutive patients in the setting of a busy glaucoma clinic (= 200 eyes but only right eyes were analysed) and found no consistent difference between GAT and IRT before stratifying patients into those with POAG or OHT. Our overall results are in accordance with other investigators. IRT does not provide identical values to GAT because the physics of measurement are different. IRT is dynamic whereas GAT is a relatively static test. The 95% limit of agreement between the two methods of tonometry were calculated by the Bland-Altman method. The mean (M) and standard deviation (SD) of the difference in IOP between GAT and ICT (GAT-IRT) were calculated. The 95% confidence limits of agreement are shown below. We stratified the results by assigning patients into 3 groups: definite glaucoma (glaucomatous optic neuropathy + field defect), borderline glaucoma and ocular hypertension (normal discs and fields). Interestingly it seems a positive GAT-IRT value is a predictor for glaucoma. We hypothesise this may be because a thicker or more rigid cornea confers greater rebound.

THE EUROPEAN WORKING TIMES DIRECTIVE is making the provision of ophthalmic on-call service increasingly difficult across Europe. This small study shows the Icare device may be useful in avoiding needless referrals. Rapid IOP measurement may help diagnose subacute (but still potentially sight threatening) primary angle closure glaucoma. The Icare device is easy to use and measurements taken by novice hands are probably more reliable with IRT than GAT. This device offers further possibilities e.g. a useful tool within a national glaucoma screening program.

![Graph showing practice time and time directly supervised](image)

**Readings**

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**95% confidence limits**

POAG  
Borderline PACG  
OHT

**PREFERENCES**


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COMPARISON OF THE NEW REBOUND TONOMETER WITH GOLDMANN APPLANATION TONOMETER IN A CLINICAL SETTING

Acta Ophthalmologica 2013: Kyoung Nam Kim, Jin Wook Jeoung, Ki Ho Park, Min Kyu Yang and Dong Myung Kim

PURPOSE: To evaluate the clinical usefulness of a new rebound tonometer, iCare PRO (iCare PRO), by comparison with Goldmann applanation tonometry (GAT) in a study on patients with glaucoma.

METHODS: One hundred and seventy-two eyes of 86 subjects were enrolled in this study. All of the subjects were examined with an autorefractometer, iCare PRO, slit-lamp biomicroscope, GAT, ultrasound A-scan and pachymeter. Three intraocular pressure (IOP) measurements were obtained by iCare PRO and GAT. The intraobserver reliabilities were established by calculating the interclass correlation coefficients. The Bland–Altman plot was used to compare the iCare PRO and GAT.

RESULTS: There was a good correlation between the IOP measurement by GAT and that by iCare PRO (r = 0.6956, p < 0.001). The intraclass correlation coefficients of iCare PRO and GAT were 0.778 and 0.955, respectively. The IOP differences between iCare PRO and GAT (mean: 1.92 mmHg; SD: 3.29 mmHg; 95% limit of agreement: 4.52 to 8.37 mmHg) did not vary over the wide range of central corneal thickness (p = 0.498), age (p = 0.248), axial length (p = 0.277) or spherical equivalent (p = 0.075).

CONCLUSIONS: Although IOP with iCare PRO was higher than that with GAT, especially at lower GAT IOP value, iCare PRO was found to be a reliable method and showed a good correlation with GAT. The IOP difference between iCare PRO and GAT was not affected by the central corneal thickness, age, axial length or spherical equivalent. iCare PRO can be expected not only to be a good screening tool but also to be a good substitute for GAT.

THE USE OF THE ICARE® TONOMETER REDUCED THE NEED FOR ANESTHESIA TO MEASURE INTRAOCULAR PRESSURE IN CHILDREN

J AAPOS 2012;-:1-3: Florin Grigorian, MD, A. Paula Grigorian, MD, and Scott E. Olitsky, MD

PURPOSE: To determine whether the introduction of iCare rebound tonometry in a pediatric ophthalmology clinic resulted in fewer examinations under anesthesia to evaluate children with glaucoma.

METHODS: The medical records of consecutive glaucoma patients who were retrospectively reviewed. The number of examinations under anesthesia (EUAs) and office visits that included measurement of intraocular pressure (IOP) were compared for three periods relative to introduction of the iCare (iCare Finland Oy, Helsinki, Finland) rebound tonometer into our clinical practice: before device introduction, learning/transition period, and routine use.

RESULTS: A total of 87 subjects were included: 48 subjects met inclusion criteria for the first period; 58 patients met inclusion criteria for the third period (some subjects straddled all three periods). The average patient age for the first period was 4.2 years and 4.9 years (P 5 0.3) for the third period. The number of EUAs performed before the introduction of the iCare was 55 and after the introduction of the iCare was 18 (P<0.001). The number of office visits at which IOP was measured increased from 34 to 151 (P<0.001). Data from the transition period suggest a trend and a short learning period.

CONCLUSIONS: The use of iCare tonometry decreased the need for EUAs to evaluate children with glaucoma and significantly increased successful IOP measurement in clinic.

THE IMPACT OF CORNEAL EDEMA ON INTRAOCULAR PRESSURE MEASUREMENTS USING GOLDMANN APPLANATION TONOMETRY, TONO-PEN XL, ICARE®, AND ORA: AN IN VITRO MODEL

J Glaucoma 2012: Matthias Neuberger, MD, Philip Maier, MD, Daniel Boehringer, MD, Thomas Reinhard, MD, and Jens F. Jordan, MD

PURPOSE: Among other corneal biomechanical properties, Goldmann applanation tonometry (GAT) has been shown to depend on corneal edema. New tonometry devices have been designed, such as the Tono-Pen XL, iCare, and ocular response analyzer (ORA), to measure the intraocular pressure (IOP) accurately. This study aims to investigate the influence of corneal edema on the accuracy of these IOP-measuring devices in an in vitro model.

METHODS: A model of an artificial anterior chamber was developed using angle and axial length or spherical equivalent. Icare PRO can be expected not only to be a good screening tool but also to be a good substitute for GAT.

RESULTS: The mean CCT increased from 616.1±29.6 mm to 626.9±36.1 mm. At 10mm Hg, GAT yielded a higher IOP than those manometrically adjusted (10.4±3.3mm Hg); at all other ICP levels, GAT yielded lower ICP levels than those adjusted. The Tono-Pen XL and iCare showed the greatest difference at 10mm Hg, with the Tono-Pen XL yielding a value of 14.0±4.0mm Hg and the iCare yielding a value of 12.5±2.6mm Hg. All other results of the 2 devices fell within a range of ±2mm Hg from the adjusted ICP. The ORA provided accurate results only at “physiological” ICP levels with a maximum difference of 2.6mm Hg at 30mm Hg. At higher ICP levels, corneal hysteresis decreased significantly with increasing ICP. None of the measurement devices revealed a statistically relevant dependence on CCT in this experimental setting.

CONCLUSIONS: The Tono-Pen XL and the iCare yielded the most accurate ICP values across all the adjusted ICP values. This may be because of their relatively small contact area with the cornea and, consequently, greater independence from corneal biomechanical properties. The ORA yielded accurate measurement results only at physiological ICP levels. As anticipated, GAT underestimated ICP. The Tono-Pen XL and the iCare should therefore be used to determine IOP in patients suffering from corneal edema, such as bullous keratopathy or Fuchs endothelial dystrophy.
AIM/BACKGROUND: To compare intraocular pressure (IOP) measurements obtained by rebound tonometry (icare PRO tonometer), application tonometry (Goldmann and Perkins tonometry), and dynamic contour tonometry in the upright and the supine positions, and to investigate the influence of axial length and central corneal thickness.

METHODS: Ninety-nine right eyes of 99 patients with glaucoma or suspect for glaucoma, admitted to our department between November 2010 and January 2011 to obtain an IOP profile including supine measurements, were included in our study. IOP measurements were obtained in an upright position using an Icare PRO rebound (RTPRO), a Goldmann application (GAT), and a Pascal dynamic contour tonometer (DCT). In the supine position, IOP measurements were taken using the RTPRO and a Perkins handheld application tonometer (PAT). The means and SDs for all tonometers were compared. Agreement between the tonometers was calculated using the Bland-Altman method.

RESULTS: The mean IOPs obtained in the upright position were 17.7±8.0mm Hg (RTPRO), 17.6±7.8mm Hg (GAT), and 19.9±6.6mm Hg (DCT). Correlation analysis of these data indicated a good correlation between IOP readings obtained using RTPRO and GAT (r=0.951; P<0.001), and RTPRO and DCT (r=0.897; P<0.001). Bland-Altman analysis revealed mean differences (bias) between RTPRO and GAT, and between RTPRO and DCT of 0.1mm Hg and 1.8mm Hg, with 95% limits of agreement of 3.6 to 3.8mm Hg and 7.3 to 3.6mm Hg, respectively. In the supine position, the mean IOPs were 19.2±6.4mm Hg using the RTPRO and 19.6±6.2mm Hg using the PAT.

CONCLUSIONS: Measurements obtained with the RTPRO, either in the upright or in the supine position, show good correlation and agreement with those provided by application and dynamic contour tonometry. The study was registered with the DRKS (German Clinical Trials Register; http://www.germanctr.de; DRKS00000581).

PURPOSE: To examine the ease of use of the new rebound tonometer Icare-ONE for measuring intraocular pressure (IOP) and to compare its readings to those provided by the rebound tonometer Icare-PRO and Goldmann application tonometer (GAT).

METHODS: 150 patients were included in this study. 82 were healthy controls and 68 have a diagnosis of glaucoma/ocular hypertension. Three measurements were made using Icare-One by trained patients themselves and 1 measurement were performed using Icare-PRO by a glaucoma specialist. The order of use of the tonometers was randomized. Clinical data were collected to analyze the difficulty of the technique.

RESULTS: Mean IOP was 16.8+/−5.2, 16.9+/−5.0 and 16.8+/−5.1 mmHg for each measurement with Icare-One, 16.4+/−3.5 with Icare-PRO and 16.3+/−3.7 mmHg with GAT. Statistical differences were not found between the average of IOP measurements taken with Icare-ONE and Icare-PRO tonometers (p=0.30), although Icare-One shows a tendency to overestimate at higher values and to underestimate at the lower values of IOP compared with Icare-PRO (β=0.624, p<0.001). Similar results were found when compare Icare-One with GAT (β=0.563, p<0.001). Excellent agreement were found between Icare-PRO and GAT (mean IOP difference 0.1 mmHg, p=0.614; β=0.150, p=0.157). An influence of age, diagnosis, number of medications used and education level was found on the difficulty of use of Icare-One.

CONCLUSIONS: Icare-ONE may be considered as a useful option for the monitoring of IOP, and can be used for most of the patients after a short training. Icare-PRO shows an excellent agreement with GAT.

THE IOP FLUCTUATES

IOP is not constant during the 24 hours. There are short term fluctuations in both normal and glaucomatous eyes: CIRCADIAN

WHY MONITORING IOP?

Wilensky JT(1). 50% of pressure spikes > 22mmHg POAG pts were out of 8 a.m - 5 pm
Hughes E (2). The peak IOP during 24-h monitoring was on average 4.9 mmHg higher than peak in the clinic
This resulted in a change of clinical manage ment in 79.3%patients. There are patients erroneously considered well controlled

(1) Wilensky JT Diurnal variations in IOP. Trans Am Ophthal 1991;89:757
PURPOSE: To compare Icare OnE tonometry by clinic examiner and parent/guardian to Goldmann applanation in children with known/suspected glaucoma; to evaluate the trend in intraocular pressure (IOP) with 4 repeated measurements using Icare OnE; and to evaluate the feasibility of instructing parents on the use of the Icare OnE device in the clinic setting.

DESIGN: Nonrandomized, prospective clinical study.

METHODS: Patients with known or suspected glaucoma were recruited from the Duke pediatric glaucoma clinic. Parent(s) of all subjects gave informed consent (and children gave assent) for participation in this research study. IOP was measured using Icare OnE by clinic examiner and parent/guardian, then using Goldmann applanation (masked physician). Each parent/guardian completed an ease-of-use survey.

RESULTS: Sixty eyes (60 children) were included. Absolute value of mean IOP difference (Icare OnE clinic examiner vs Goldmann applanation) was 3.3 ± 4.0 mm Hg (P < .001). Icare OnE IOP by clinic examiner was within 3 mm Hg of Goldmann applanation in 68% (n = 41 eyes). In eyes with >3 mm Hg difference, Icare OnE was higher than Goldmann applanation in 84%. IOP demonstrated a statistically significant downward trend with repeated sequential measurements with Icare OnE (P = .0053, r2 = 0.9894). All parents accomplished Icare OnE tonometry on at least 1 eye; 98% reported it was “easy to learn to use.”

CONCLUSION: Icare OnE tonometry appears accurate and well-tolerated compared to Goldmann applanation, and holds promise for clinic and home tonometry in children. IOP trends downward with successive measurements using Icare OnE, demonstrating a possible effect from presumed patient relaxation.

QUOTES FROM THE FULL STUDY

“A recent study demonstrated good correlation of Icare ONE to Goldmann applanation tonometry in the adult population.”

“There was a good linear correlation between Icare ONE IOP measured by the parent and by the examiner (R2 = 0.95) and between Icare ONE and Goldmann applanation tonometry.”

“The relationship of certain ocular characteristics with the magnitude of difference between IOP by Icare ONE vs Goldmann applanation tonometry was assessed using a Fisher exact test. None of the following variables was found to be statistically significantly associated with a clinically significant (3 mm Hg) difference between Icare ONE and Goldmann applanation IOP readings: visual acuity, nystagmus, strabismus, corneal abnormalities, CCT, number of prior glaucoma surgeries (data not shown).”

“53 of 54 parents (98%) “agreed” or “strongly agreed” that the Icare ONE was “easy to learn how to use.” Fifty-two of 54 parents (96%) reported that they would feel comfortable using Icare ONE to obtain IOP on their child at home. Forty of 51 parents (78%) rated the Icare ONE equally or better tolerated than Goldmann applanation for checking the IOP in their children (3 parents did not answer the question).”

“Although Goldmann applanation tonometry was used as the “gold standard” in this study, it is not clear that this is the most accurate way to measure IOP in children. There is evidence to suggest that applanation underestimates the true IOP in children.”

“The ease with which parents are able to use the device, and its correlation to Goldmann applanation, make the Icare ONE promising for home tonometry in children. One of the goals of home tonometry is to identify IOP fluctuations that are not identified during standard clinic hours. Icare ONE may be useful as a screening tool to capture such fluctuations and to identify those patients requiring more careful monitoring.”
HOME TONOMETRY FOR MANAGEMENT OF PEDIATRIC GLAUCOMA
Meghan S. Flemmons, Ya-Chuan Hsiao, Jacqueline Dzau, Sanjay Asrani, Sarah Jones and Sharon S. Freedman

PURPOSE: To use Icare rebound tonometry in the home setting for documentation of diurnal intraocular pressure (IOP) fluctuations in children.

Design Nonrandomized, prospective clinical study.

METHODS: Pediatric ophthalmology clinic patients were recruited between October 2009 and February 2010 who were able to cooperate with IOP measurement by Icare rebound tonometry and whose caregiver was willing and able to obtain Icare measurements at home. The child’s IOP was measured first by Icare tonometry followed by a second method (Goldmann applanation [GAT]). The caregiver was instructed on the use of the Icare tonometer. The subject’s IOP was measured by the caregiver at home at designated time periods for at least 2 consecutive days.

RESULTS: Seventeen children (17 eyes) with known or suspected glaucoma and 11 normal children were included. Excellent reliability was obtained by caregivers in 70% of Icare measurements. Mean difference between Icare and GAT in clinic was 2.0-4.0 mm Hg, P = .08. Daily IOP fluctuation occurred in both subjects with glaucoma and normal subjects. In children with known or suspected glaucoma, relative peak and trough IOPs occurred in the early morning (45%) and late evening (43.5%), respectively. Comparison of the peak IOP measured at home vs in the clinic was >6 mmHg in 5 of 16 subjects (31%) and affected glaucoma management in several subjects.

CONCLUSIONS: In selected children with glaucoma, home tonometry by Icare rebound tonometry was reliable, easily performed by caregivers, and well tolerated, and offered IOP information valuable in clinical management.
EVALUATION OF THE I CARE® REBOUND TONOMETER AS A HOME INTRAOCULAR PRESSURE MONITORING DEVICE

J Glaucoma 2010; Sanjay Asrani, MD, Ashmita Chatterjee, BSc, David K. Wallace, MD, MPH, Cecilia Santiago-Turla, MD, and Sandra Stinnett, DrPH

PURPOSE: (a) To investigate whether the Icare rebound tonometer can provide accurate measurements of intraocular pressure (IOP) in the hands of an inexperienced user compared with Icare measurements and Goldmann tonometry by a trained technician and (b) to assess the intrauser reproducibility of IOP measurements and the learning curve among patients using the Icare rebound tonometer.

METHODS: A trained technician used the Icare rebound tonometer to measure the IOP of the right eye of 100 glaucoma patients. The technician then instructed each patient on use of the Icare tonometer. Each patient then measured his/her own pressure using the Icare tonometer. Finally, a different technician, who was masked to both of the earlier readings, measured IOP by Goldmann applanation tonometry. Thirty patients repeated the Icare measurement 3 times (once every 5 min) 20 minutes after the initial IOP measurement.

RESULTS: Of the 100 patients, 82 of patient Icare and the technician Icare readings were within 3mm Hg of each other, and 75 of the patient Icare and Goldmann applanation tonometry measurements were within 3mm Hg of each other. Intraclass correlations between self-administered Icare measurements 1and 2, 1 and 3, and 2 and 3 were 0.69, 0.71 and 0.81, respectively.

CONCLUSION: In this study, the Icare rebound tonometer was accurate and reliable in the hands of patients. Patients can easily learn to self-administer this test, possibly allowing for home monitoring of IOP.

QUOTES FROM THE FULL STUDY

“Raised intraocular pressure (IOP) is known to be a major risk factor for glaucoma development and progression. IOP measurements during the office hours have been shown to incorrectly identify IOP peaks and its range. Recently some studies have shown that short-term IOP fluctuations and intervisit IOP variations are prognostic factors for glaucoma progression. However, data on IOP fluctuations are limited owing to the impractical nature of measuring IOP in the office over several hours or days. A home tonometer would provide these data and could aid in the management of individual patients.”

“The measurements taken with the Icare tonometer by both experienced and inexperienced technicians were comparable with GAT measurements.”

“Ninetyfour percent of the participants agreed or strongly agreed that they learned to use the Icare tonometer quickly, and 93% agreed or strongly agreed that the instrument was simple and easy to use.

The gentle learning curve implies that minimal time is required for training patients in the use of the Icare instrument. The strong intraclass correlation between attempts 2 and 3 indicates a high degree of reproducibility in Icare tonometer IOP measurements in the hands of the patient. In this study, 82% of the Icare readings of the patient’s measurement versus that of the trained technician were within ± 3mm Hg. Meanwhile, 75% of the patient Icare measurement and the technician Goldmann measurement readings were within 3mm Hg of each other. The above rate of agreement implies that Icare can be used by patients to accurately measure their IOP at home.”

“The IOP measurements with Icare taken from the central cornea were similar to those obtained from the peripheral cornea.”

“However, as the same patient uses the probe for home tonometry, this cost may be minimized, as it is possible to store the probe aseptically in the original capped container.”
“There are many benefits of home monitoring. IOP data on a patient are typically collected for 2 to 4 seconds at a time, 3 to 5 times a year owing to the need for instruments that can be used by trained ophthalmic personnel and thus limited to those in physician offices. This leads to very limited IOP data available to eye physicians for the management of a chronic condition, such as glaucoma. Future advances in therapy and the better understanding of the role of IOP fluctuations may be possible with the availability of additional IOP data in the patient’s own environment. This advance may be similar to the advent of home glucose monitoring devices for the management of diabetes.”

“In conclusion, IOP readings provided by the Icare tonometer are both reliable and reproducible. Its recent US FDA approval, its gentle learning curve and the absence of need for an anesthetic make it ideal for use by the patient. Thus, the Icare tonometer has the potential of providing IOP data in the patient’s home environment, and may be of particular value for those patients requiring aggressive monitoring of IOP.”

APPLICATION OF THE ICARE® REBOUND TONOMETER IN HEALTHY INFANTS

J Glaucoma 2010; Anna Lundvall, MD, PhD, Helena Svedberg, MD, and Enping Chen, MD, PhD

PURPOSE: To study the tolerability of the Icare rebound tonometer (RBT) and to establish reference values of the intraocular pressure (IOP) in healthy infants.

PARTICIPANTS AND METHODS: Forty-six children were recruited. In 6 infants aged 3 to 18 months, it was not possible to conduct the examination. Five children refused all cooperation. In 1 child, only 1 reading was obtained. In 1, partly uncooperative infant, the difference between the highest and the lowest reading exceeded 3mm Hg (a difference of 7mm Hg). These 7 infants were excluded. Totally 39 children, 22 girls and 17 boys, aged 1 month to 36 months were included in the study. The mean age was 14±9 months [mean ± standard deviation (SD)]. One randomly selected eye of each child was examined with the Icare RBT. Three consecutive readings were made. In 10 children, IOP measurements were conducted twice with an interval of 10 to 30 minutes by 2 different ophthalmologists.

RESULTS: The mean IOP value of the 39 infants was 11.82±2.67mm Hg. The median value was 10mm Hg with a range of 7.3 to 17.0mm Hg. In 10 children, the IOP was determined by 2 examiners. The results were virtually identical with differences of 0 to 1mm Hg in 9 out of 10 children. The mean difference between Examiner 1 and Examiner 2 (0.77mm Hg) was not statistically significant (P>0.20). The examinations were very well tolerated, and no child showed any signs of discomfort during or after the examination.

CONCLUSIONS: The hand-held RBT in the present study is easy to use, it does not require topical anesthesia and it is very well tolerated by cooperative infants. However, 7 out of 46 infants refused cooperation.

QUOTES FROM THE FULL STUDY

“Childhood glaucoma is a rare but serious condition often leading to visual impairment and even blindness. Diagnosis is important, as treatment can prevent visual handicap.”

“Tonometry is a cornerstone of the diagnosis and in the management of glaucoma.”

“However, infants are not cooperative and intraocular pressure (IOP) measurement with the Goldmann tonometer is not possible.”

“General anesthesia is a risk for the patient and is resource demanding and may affect the IOP.”

“Topical anesthesia that often causes discomfort.”

“In school children, measurement of IOP with the Icare rebound tonometer (RBT) is a highly reproducible method showing high intraobserver and interobserver correlation.”

“The examinations were very well tolerated by the cooperative infants and none of these children showed any signs of discomfort.”
COMPARISON OF ICARE® REBOUND TONOMETER WITH NONCONTACT TONOMETER IN HEALTHY CHILDREN

J Glaucoma 2010; Mitsuyo Kageyama, MD, Kazuyuki Hirooka, MD, Tetsuya Baba, MD, and Fumio Shiraga, MD

PURPOSE: To evaluate the effectiveness of using a noncontact tonometer (NCT) versus a rebound tonometer (Icare) when measuring the intraocular pressure (IOP) in healthy children.

DESIGN: Prospective observational study.

METHODS: A total of 180 (96 males and 84 females) healthy children, aged 6 months to 15 years, were recruited. IOPs were measured using both the NCT and Icare devices in the absence of anesthesia. A successful outcome was defined as the measurement of the IOP in both eyes. The McNemar test for comparing correlated proportions was used to analyze the Icare and NCT data.

RESULTS: Although the IOP was successfully measured in 160 children (88.9%) when using Icare, we were only able to successfully measure 130 children (72.2%) when using NCT. Below the age of 6 years, measurement of the IOP using Icare was better tolerated as compared with the NCT (McNemar test; P<0.001). The mean differences (95% limits of agreement) for the IOP readings between Icare and NCT in right and left eyes were 0.90±6.40 and 1.18±6.19mm Hg, respectively.

CONCLUSIONS: IOP measurements performed using Icare are better tolerated in the pediatric population, as compared with measurements using NCT, especially in children below the age of 6 years.

QUOTES FROM THE FULL STUDY

“Although accurate and consistent intraocular pressure (IOP) measurements in children are difficult to obtain, they are of extreme clinical importance when trying to diagnose and manage pediatric glaucoma. The widely accepted Goldmann applanation tonometry (GAT) is the standard for IOP measurements in adults. However, measuring IOP with conventional contact tonometers can be difficult in young patients owing to their lack of cooperation. To obtain sufficient cooperation during IOP measurements in pediatric patients, the use of anesthesia is often required. Unfortunately, currently used volatile anesthetic agents cause airway irritation, especially when they are used for inhalation induction of anesthesia. When dealing with children up to 3 years of age, IOP readings generally require either the assistance of other individuals or the use of general anesthesia. Therefore, there is a need for a rapid, accurate, highly reproducible, and easy to use tonometer that makes it possible to perform IOP measurements in children.”

“Use of this tonometric method is advantageous in that the instrument is easy to use and affordable, along with the fact that the procedure can be quickly performed. Perhaps the most important advantage is that this method does not require local anesthesia.”

“Although the IOP was successfully measured in 160 children (88.9%) when using Icare, we were only able to successfully measure 130 children (72.2%) when using NCT. The youngest subject successfully measured with Icare was 6-months-old, whereas the youngest one tested when using NCT was 2-years-old. Below the age of 6 years, IOP measurements performed when using Icare were better tolerated as compared with those made when using NCT.”
This study proposes to evaluate the level of accuracy of intraocular pressure (IOP) measurements of a second generation rebound tonometer (IOPen), taking as references the Goldmann Applanation Tonometer (GAT) and the Icare rebound tonometer. The right eyes of 101 consecutive clinical patients were assessed with the three tonometers. The IOPen and Icare measurements were taken by two different optometrists and the GAT by an ophthalmologist. In this study, statistically significant differences were found when comparing the IOPen tonometer with the other two tonometers (p < 0.001). The IOPen underestimated the IOP value when compared to the GAT and the Icare (mean differences were 2.94 ± 4.65 mmHg and 3.20 ± 4.72 mmHg (mean ± S.D.), respectively). The frequency distribution of differences demonstrated that in more than 55% of measurements the IOP readings differed by more than 3 mmHg between the IOPen and the GAT. Based on the present population study, these results suggest that IOPen measurements should be interpreted with caution.

**Figure 1.** Plots of difference vs mean of IOP values obtained with IOPen, Icare and GAT. (The solid line represents the mean bias, the small dashed lines represent 95% limits of agreement and the large dashed line represents the linear regression).

**QUOTES FROM THE FULL STUDY**

“Taking these results all together, we conclude that for the majority of patients within a normal range of IOP values, Icare is able to measure this parameter with an absolute bias less than 1 mmHg, which is clinically acceptable for a screening method. On the other hand, IOPen can only obtain clinically comparable results to GAT in less than half the cases.”

“This study showed that Icare could be used as a screening instrument for IOP evaluation, but IOPen must be used with extreme caution, since it underestimated IOP values to a clinically significant degree in more than half the population studied.”
COMPARISON BETWEEN INTRAOCULAR PRESSURE MEASUREMENTS WITH ICARE® REBOUND TONOMETRY AND TONOPEN XL TONOMETRY IN PREMATURE INFANTS

A.H. Haus, C. Jonescu-Cuypers, B. Seitz, B. Kaesmann-Kellner

PURPOSE: To evaluate and compare the reliability and repeatability of intraocular pressure (IOP) measurements using the new Icare rebound tonometer (ICT) and the Tonopen XL Tonometer (TP) in premature infants.

METHODS: 69 premature infants aged 25 to 35 (mean 28.4) weeks were examined in their 40th week of gestation (SD=10 weeks) during the screening for retinopathy of prematurity. 142 eyes of 71 infants were measured by ICT (three measurements per eye), 56 eyes of 28 infants by ICT and TP (three measurements per eye and per method). Because of known impact of anesthetic eyedrops on IOP, we first performed ICT measurements, followed by TP in local anesthesia (Proxymetacain-HCl 0.5%-eye drops). TP was performed three minutes after eye drop application. A linear regression model correlated the deviations of ICT and TP (SPSS 15.0).

RESULTS: Mean IOP was 9 mmHg for ICT (SD 2.2 mmHg) and 16 mmHg for TP (SD 4.4 mmHg). IOP measurements were found to read significantly higher with TP compared to ICT (p<0.01).

CONCLUSIONS: IOP values are significantly lower evaluated by ICT than by TP. Thus ICT seem to better reflect the known infant IOP. Tonopen measurements are probably falsely elevated due to defense and discomfort reactions of the premature baby to the anaesthetic eye drop instillation and bigger size of eyelid opening width due to the larger applanation area of the Tonopen.

“Glaucoma is a major cause of blindness in Western countries. Intraocular pressure (IOP) is the most important risk factor for developing glaucoma. The major risk factors for progression of glaucoma include increased IOP levels and possibly increased IOP fluctuation. Tonometry remains the cornerstone of clinical management and followup of glaucoma.”
The aim of this study was to compare the intraocular pressure (IOP) results measured by the Icare rebound tonometer with those obtained by the Goldmann applanation tonometer (GAT) over a wide range of IOP values. Furthermore, the comfort level of the Icare measurement was evaluated.

**METHOD:** The study included 75 eyes of 75 patients. The patients were divided into three groups (7–15 mmHg n=25, 16–22 mmHg n=25, 23–60 mmHg n=25). The measurements were taken by two independent observers in a masked fashion. All patients were asked about discomfort during the Icare measurement. To establish the agreement between the two devices, a Bland-Altman analysis was performed.

**RESULTS:** Overall, the 95% confidence interval of the differences between the two devices was −8.67 to 10.25 mmHg and in 62.7%, the Icare measurement was within ±3 mmHg of the GAT measurements. The distribution of the differences in IOP was similar, from 7–22 mmHg. In the higher IOP range (23–60 mmHg), however, the deviation was almost twice as large. The measurement with the Icare tonometer was well tolerated; 100% of the patients denied any discomfort.

**CONCLUSIONS:** The Icare tonometer is a mobile alternative to GAT in a low to moderate IOP range, but our findings show

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**QUOTES FROM THE FULL STUDY**

“The Icare might be useful in disabled patients, e.g., in old peoples homes, in rural areas and an alternative to GAT, when a mobile tonometer is needed. It is easy to use and very well tolerated by the patients. It can also be helpful for patients who are difficult to measure with GAT, due to blepharospasm during the GAT measurement, or for patients who should be measured without the need to apply any eye drops.”

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**FIGURE 1** IOP-correlation between Icare (y-axis) and GAT (x-axis) for all 75 patients in all three pressure groups. Regression line R² value is 0.757

**FIGURE 2** Bland-Altman analysis shows the bias between the two measurements. The black line represents the mean difference and the red line the 95% limits of agreement of the Icare and the GAT measurements
FIGURE 1. A and B, Bland-Altman plots presenting the differences in IOP (IcareGAT), as a function of IOP measured with GAT for left eyes [A] and right eyes [B].

PURPOSE: To compare a new method of intraocular pressure (IOP) measurement, using the Icare tonometer, with Goldmann applanation tonometry (GAT).

PATIENTS AND METHODS: Two observers obtained IOP readings in 292 eyes (143 right and 149 left) of 153 subjects, using the Icare without topical anesthetic. A GAT reading was subsequently obtained by a consultant ophthalmologist, without the knowledge of the Icare readings. Central corneal thickness (CCT) was obtained on all eyes with ultrasound pachymetry. Patient comfort after IOP measurement was assessed in a consecutive subset of patients.

RESULTS: The intraclass correlation coefficient between the 2 modalities of IOP measurement was r=0.95 for the right and r=0.93 for the left eye. The mean difference (Icare-GAT) between the IOP measured by the 2 methods was 0.4mm Hg in the right eye (SD 3.0, 95% confidence interval 5.5 to 6.3), and 0.8mm Hg in the left eye (SD 3.0, confidence interval 4.7 to 6.2). GAT measurements did not vary with CCT [correlation coefficient=0.09 (P=0.25) right and 0.14 (P=0.09) left eyes]. However, IOP measured with Icare tonometry increased with increasing CCT [correlation coefficient=0.16 (P=0.05) right and 0.21 (P=0.01) left eyes]. For every 100-mm increase in CCT, the difference (Icare-GAT) increased by 1mm Hg. Of the 38 consecutive patients surveyed, 28 (73.7%) rated the Icare more comfortable than GAT, with only 2 (5.3%) rating it less comfortable (P<0.001).

CONCLUSIONS: There is good correlation between the 2 methods of IOP measurement, even at extremes of IOP. The Icare instrument was easy to use and recorded rapid and consistent readings with minimal training. It seems to be more comfortable than GAT and obviates the need for topical anesthesia.

QUOTES FROM THE FULL STUDY

“Accurate and consistent measurement of intraocular pressure (IOP) remains a key factor in the diagnosis and management of glaucoma.”

“In circumstances (such as within the emergency department) in which identification of either very low or high pressures can have significant management implications, accessibility to a simple reliable instrument is valuable.”

“Use of the device is simple and can be rapidly taught. It may have a role in the setting of community screening.”

“There was a high degree of correlation between the 2 methods. The Icare GAT difference did not change significantly throughout the study, suggesting no significant learning effect associated with the Icare.”

“The mean response score for subjective patient comfort of IOP measurement method was 2.03 (ie, in favor of Icare). This was a significant result.”

“Our results demonstrate that the Icare tonometer is in close agreement with the GAT, in the majority of patients. Furthermore, the Icare was consistently able to identify cases in which the IOP was well outside what is considered normal. However, it does appear that the Icare overestimates the GAT in the lower IOP ranges and underestimates in the higher ranges. Despite this, these discrepancies are small and may not be clinically significant, especially if the instrument is used for screening purposes.”

“Our results using the Icare are more favorable compared to studies comparing other portable tonometers with the GAT.”

“In conclusion, the Icare seems to record accurate readings in most situations when compared with GAT. It is easy to use, requires little training, does not require the use of topical anesthetic, and is very well tolerated by patients. It may be of particular benefit in community screening programs, inpatient settings, and emergency departments in which the routine and accurate use of the GAT may be unrealistic. The Icare may also be useful in obtaining IOP measurement in children or patients in which Goldmann applanation is technically challenging.”

www.icaretonometer.com
REPRODUCIBILITY AND TOLERABILITY OF THE ICARE® REBOUND TONOMETER IN SCHOOL CHILDREN

J Glaucoma 2007; Afsun Sahin, MD, Hikmet Basmak, MD, Leyla Niyaz, MD, and Nilgun Yildirim, MD

PURPOSE: To establish the intraobserver and interobserver reliability of the rebound tonometer (RBT) in healthy schoolchildren and to test patient tolerance in an unanesthetized eye.

SUBJECTS AND METHODS: To examine the reproducibility of the RBT, 2 experienced ophthalmologists undertook 3 consecutive intraocular pressure (IOP) measurements with the RBT without an anesthetic in 304 eyes of 152 healthy schoolchildren. Any pain or discomfort experienced by the children was recorded. Intraobserver and interobserver reliabilities were established by calculating correlation coefficients (r).

RESULTS: Of the 152 patients, 78 (51.3%) were males and 74 (48.7%) were females. The mean patient age was 11.2±2.6 years (range: 7 to 15 y). Mean IOP values obtained by examiners 1 and 2 were 16.48±2.82mm Hg and 17.27±3.27mm Hg for the right eyes and 17.15±3.36mm Hg and 17.06±3.21mm Hg for the left eyes. Intraobserver correlation coefficients for examiner 1 were 0.970 for the right eyes and 0.974 for the left eyes. For examiner 2, intraobserver correlation coefficients were 0.963 for the right eyes and 0.970 for the left eyes. The interobserver correlation coefficients were 0.798 for the right eyes and 0.858 for the left eyes (all P<0.0001). With the RBT, 98.6% of the subjects felt no pain and/or discomfort.

CONCLUSIONS: Measurement of IOP with the RBT is a highly reproducible method in schoolchildren showing high intraobserver and interobserver correlation and it seems to be very comfortable when performing IOP measurements in schoolchildren without an anesthetic.

“Our study indicates that RBT provides highly reproducible readings when used in schoolchildren without an anesthetic, showing high intraobserver and interobserver correlation coefficients.”

“In general practice, IOP measurement is sometimes very difficult in young children. They often lack cooperation and they do not want topical anesthetics to be instilled for Goldmann applanation tonometry. In our study, the measurements made without anesthetics were well tolerated and it was possible to obtain IOP readings for both eyes in all children. Currently, the main advantage of the RBT is that measurements can be taken without the need for topical anesthesia and with minimum discomfort. Kontiola and Puska16 established the degree of tolerance of RBT and Pulsair 3000 (Keeler Ltd, Windsor, UK) on nonanesthetized corneas of adult patients. They concluded that measurement of IOP with the RBT without an anesthetic is a rapid and welltolerated procedure. These results are also similar to our study.”

“In conclusion, the RBT offers highly reproducible IOP measurements in schoolchildren without an anesthetic. The impact on the eye is so gentle that in a majority of the cases it does not even cause an eyeblinking reflex. Thus, it should be a method for IOP measurement in schoolchildren that is rapid, reliable, operator independent, and has low variability.”

QUOTES FROM THE FULL STUDY

“Tonometry still remains the cornerstone of both the diagnosis and management of glaucoma because high intraocular pressure (IOP) is the main risk factor for the development and progression of glaucoma.”

“The main advantages of this tonometric method are that the instrument is quick, easy to use, and affordable; above all, topical anesthesia is not required. Moreover, a slit lamp is not required, general anesthesia or sedation is not required; and the rapid measurement enables measuring IOP in noncompliant individuals, especially in children. Taken together, the RBT seems to be suitable in the pediatric population.”

“The RBT was well tolerated without an anesthetic (Table 3). Of the patients who completed the questionnaire, 93.4% (n=142) did not feel any pain and/or discomfort (P>0.05). No child reported more than slight discomfort with the procedure.”
**PURPOSE:** To determine the agreement between the measurement of intraocular pressure (IOP) by the rebound tonometer (RBT) and by the Goldmann applanation tonometer (GAT) and to find out the effect of central corneal thickness (CCT) values on IOP measurements in glaucoma patients.

**METHODS:** IOP was measured with the RBT and GAT, respectively, in 61 eyes of 61 glaucoma patients. CCT was measured using an ultrasonic pachymeter after all IOP determinations had been made. The mean IOP measurement by the RBT was compared with the measurement by the GAT, by Student’s t-test. Bland–Altman analysis was performed to assess the clinical agreement between the two methods. The effect of CCT on measured IOP was explored by linear regression analysis.

**RESULTS:** The mean patient age was 56.7 ± 21.1 years (range: 30–80 years). There were 32 (52.46%) women and 29 (47.54%) men in the study group. The mean IOP readings were 18.7 ± 4.7 mmHg using the RBT, and 18.2 ± 3.49 mmHg using the GAT. The difference was not statistically significant (mean difference ± 0.4 ± 2.55, P = 0.2). A frequency distribution of the differences demonstrated that in more than 80% of cases the IOP readings differed by <2.3 mmHg between the RBT and GAT. There was a strong correlation between the RBT and GAT readings (r = 0.852, P < 0.0001). The IOP measurements with the two methods were correlated with CCT (r = 0.40, P = 0.02 for the RBT and r = 0.48, P < 0.0001 for the GAT). The IOP increased 1.1 mmHg and 8 mmHg for every 100-mm increase in CCT for the GAT and RBT, respectively.

**CONCLUSION:** The RBT slightly overestimated the IOP value by 0.43 mmHg on average when compared with the GAT. Nevertheless, the RBT readings appeared to be more affected by the various thicknesses of different corneas when compared with those obtained using the GAT.

**QUOTES FROM THE FULL STUDY**

“It is well known that elevated intraocular pressure (IOP) is the main risk factor for the development and progression of glaucoma. IOP measurement is an essential factor in making glaucoma diagnosis and in the assessment of the efficacy of the management.”

“Subjects were given topical anaesthesia (Alcaine, Alcon, Ft. Worth, TX, USA) bilaterally before the IOP and CCT measurements.”

“There was a strong correlation between the RBT and GAT readings (r = 0.852, P < 0.0001).”
Currently, the main advantage of the RBT is that the IOP measurements can be taken without the need for topical anaesthesia even in paediatric population. Also, the RBT has disposable tips. This could be an advantage in situations involving a high risk of cross-barrier infection.

In conclusion, the reliability of the RBT is quite high and it can be a useful alternative for measuring IOP.

“Currently, the main advantage of the RBT is that the IOP measurements can be taken without the need for topical anaesthesia even in paediatric population. Also, the RBT has disposable tips. This could be an advantage in situations involving a high risk of cross-barrier infection.”

“In conclusion, the reliability of the RBT is quite high and it can be a useful alternative for measuring IOP.”
PURPOSE: To compare the intraocular pressure (IOP) measurements obtained with the rebound tonometer (RT) and the Goldmann handheld tonometer (GT) in normal and altered corneas.

METHODS: A total of 208 normal corneas and 50 corneas with pathologies were included in this prospective study. All measurements were randomly obtained by 1 observer. The medians and interquartile range (IR) for both tonometers were compared. The median differences were assessed in IOP groups. Agreement between the tonometers was calculated using the Bland–Altman method.

RESULTS: The median IOP in all eyes was 17 mmHg (IR, 13–22 mmHg) with the RT and 16 mmHg (IR, 13–21 mmHg) with the GT (P < 0.001). The correlation was excellent between tonometers ($r^2 = 0.86$; $P < 0.001$). The minimal differences between the two were obtained from 10 to 20 mm Hg (GT). The Bland–Altman scatterplot obtained good agreement between the instruments. In normal corneas, the median difference was #2 mm Hg in 77.4% of cases. In the altered corneas, the median difference was #2 mm Hg in 73% of cases ($P = 0.21$ compared with the normal group). In 10% and 2% of cases, the IOP could not be measured using the GT and RT, respectively.

CONCLUSIONS: The results were similar for both tonometers. In the altered corneas, the IOP could be difficult to obtain with the GT because of distorted half-circles. The 1-mm-diameter disposable RT tip facilitated obtaining measurements without anesthetic drops, which avoids infections. The RT could be useful in routine clinical settings when measuring IOP in corneas with pathologies.

QUOTES FROM THE FULL STUDY

“Elevated intraocular pressure (IOP) is a major risk factor for glaucoma, which causes visual impairment and blindness in millions of patients worldwide.”

“This RT has been used with good results in experimental models of glaucoma for noninvasive IOP measurements in animals.”

“Advantages of RT are that it is easy to measure IOP in an unanesthetized eye, the round tip minimizes the risk of corneal injury from the impact of the probe, and the tip is disposable, eliminating the risk of microbiologic contamination. Finally, the RT tip has a 1-mm-diameter plastic cover; thus, the IOP measurement is less affected by corneal irregularities.”

“In 5 eyes (4 cases of PKP and 1 case of band keratopathy), it was impossible to obtain a measurement using the GT because of highly distorted half-circles.”

“The device had high reproducibility for measuring IOP in humans.”

“In conclusion, the IOP readings obtained with the RT were similar to those obtained with the GT in normal corneas and those with pathologies after PKP. Thus, this finding suggests that the RT is a useful tonometer for routine clinical use in cases with corneal pathologies. The 1-mm-diameter disposable tip of the RT facilitates IOP measurements without anesthetic drops, thus avoiding corneal infections, and could be used in corneas with keratoconus, ulcers, edema, or graft rejection after PKP.”
PURPOSE: To evaluate the reliability and repeatability of intraocular pressure (IOP) measurements using a new rebound tonometer.

METHODS: Intraocular pressure was measured in 42 healthy human eyes of subjects aged 18–30 years (mean ± standard deviation [SD] 21.5 ± 3.2 years) using the Icare Rebound and Goldmann tonometers in two separate sessions.

RESULTS: Intraocular pressure measurements were found to read slightly, but not significantly, higher with the Icare tonometer compared with the Goldmann instrument in both sessions (first session: mean bias ± SD + 0.50 ± 2.33 mmHg; second session: mean bias ± SD + 0.52 ± 1.92 mmHg). Limits of agreement between repeated readings were ± 5.11 mmHg for measurements taken with the Icare tonometer, compared with ± 3.15 mmHg for measurements taken with the Goldmann method.

CONCLUSION: Measurement of IOP in normal, healthy subjects using the Icare rebound tonometer produced a small, statistically insignificant, positive bias when compared with the Goldmann tonometer. Intersessional repeatability of IOP taken with the Icare is poorer than that of IOP taken with the Goldmann tonometer, but is comparable with that of other non-Goldman-type tonometers currently available.

"Due to the obvious limitations in human investigation, however, this study quantified the accuracy and repeatability of Icare IOP measurements by comparing them with those taken by the current clinical gold standard, namely, Goldmann applanation tonometry. Further, the disposable Tonosafe probe was selected as it has been shown that, of all the currently used disposable Goldmann probes, Tonosafe produces the least variation in IOP measurements (Bhatnagar & Gupta 2003). The Icare tonometer, on average, overestimated IOP by 0.51 mmHg. This overestimation, however, was neither clinically or statistically significant when compared with previously reported intrasubject variations of Goldmann-type tonometers (4 mmHg; Phelps & Phelps 1976)."

"In conclusion, IOP readings taken with the Icare Rebound tonometer show a slight positive bias, which is neither clinically or statistically significant in this normal, healthy cohort. The repeatability of the instrument is poorer than that of the Goldmann tonometer, but better than that found with certain other commercially available tonometers. Given that it has advantages over other tonometers because it is quick to use, portable, lightweight and does not require corneal anaesthesia, the Icare represents a valuable addition to the raft of tonometers currently available to the ophthalmologist, optometrist and researcher. Further, its potential advantages in paediatric, geriatric and domiciliary care may prove invaluable."
PURPOSE: To compare central and peripheral intraocular pressure (IOP) readings obtained with rebound tonometry.

METHODS: Intraocular pressure was measured on the right eye of 153 patients (65 males, 88 females), aged from 21 to 85 years (mean ± S.D., 55.5 ± 15.2 years) with the Icare rebound tonometer at centre, and 2 mm from the limbus (in the nasal and temporal regions along the 0–180° corneal meridian).

RESULTS: Intraocular pressure values obtained with the Icare were 14.9 ± 2.8; 14.1 ± 2.5 and 14.5 ± 2.7 mmHg at centre, nasal and temporal corneal locations, respectively. On average, nasal and temporal IOP readings were 0.75 and 0.37 mmHg lower than the central reading (p < 0.05 and p > 0.05, respectively). A highly significant correlation was found between central and peripheral measurements in nasal (r² = 0.905; p < 0.001) and temporal (r² = 0.879; p < 0.001) regions along the horizontal meridian. Almost 80% of patients presented nasal IOP values within ±1 mmHg of the central value.

CONCLUSIONS: Intraocular pressure values measured with the Icare rebound tonometer on the nasal corneal region is slightly lower on average and highly correlated with IOP values recorded at corneal centre. Both nasal and temporal readings are in good agreement with central IOP, and could be used to obtain a reliable estimate of rebound IOP in corneas where central readings cannot be taken.

QUOTES FROM THE FULL STUDY

“The assessment of intraocular pressure (IOP) is still of major importance in glaucoma diagnosis and follow-up.”

“Comparisons of Icare with dynamic contour tonometer also displayed an excellent agreement (Martinez-de-la-Casa et al., 2006b).”

“As a consequence, an additional benefit of the Icare is the possibility of taking measurements at different corneal locations easily, using only a small part of the cornea. This could be of great clinical interest when reliable measurements could not be taken from the central part of the cornea using applanation tonometers because of the presence of corneal ulcer, corneal distortion or previous refractive surgical procedure.”

“In summary, we have found in the present study that in normal healthy eyes peripheral readings taken with the Icare rebound tonometer were in high agreement with central ones. While temporal readings have been widely suggested in the literature as an alternative to central ones our results show that with the Icare, both nasal and temporal IOP readings can be used as an alternative to central readings. In a high proportion of patients differences between central and peripheral readings were within an interval of ±1 mmHg. These results apply to normal subjects.”
The aim of this study was to evaluate the accuracy of measurement of intraocular pressure (IOP) using a new induction/impact rebound tonometer (icare) in comparison with the Goldmann applanation tonometer (AT). The left eyes of 46 university students were assessed with the two tonometers, with induction tonometry being performed first. The icare was handled by an optometrist and the Goldmann tonometer by an ophthalmologist. In this study, statistically significant differences were found when comparing the icare rebound tonometer with applanation tonometry (AT) (p < 0.05). The mean difference between the two tonometers was 1.34 ± 2.03 mmHg (mean ± S.D.) and the 95% limits of agreement were ±3.98 mmHg. A frequency distribution of the differences demonstrated that in more than 80% of cases the IOP readings differed by <3 mmHg between the icare and the AT. In the present population the icare overestimates the IOP value by 1.34 mmHg on average when compared with Goldmann tonometer. Nevertheless, the icare tonometer may be helpful as a screening tool when Goldmann applanation tonometry is not applicable or not recommended, as it is able to estimate IOP within a range of ±3.00 mmHg in more than 80% of the population.

**QUOTES FROM THE FULL STUDY**

“IOP measurement is an essential factor in glaucoma diagnosis, and in assessment of the efficacy of glaucoma treatments. In Europe, with the exception of Ireland, Netherlands and UK, it is forbidden for optometrists to use anaesthetic agents.”

“This method has an enormous advantage over Goldmann tonometry because it is measuring IOP in a non-anaesthetized eye with a very simple device.”

“There is a need for a low-cost, accurate and easy-to-use tonometer that allows measurements to be made in people with special needs, like persons confined to bed or in the pediatric population.”

**AGE DIFFERENCES IN CENTRAL AND PERIPHERAL INTRA-OCULAR PRESSURE USING A REBOUND TONOMETER**


**AIM:** To evaluate the influence of age on the measurements and relationships among central and peripheral IOP readings taken with a rebound tonometer.

**METHODS:** The intraocular pressures were assessed using the icare rebound tonometer (Tiotat Oy, Helsinki, Finland) on the right eye of two-hundred and seventeen patients (88 males, 129 females), aged 18 to 85 years (mean ± SD, 45.9±19.8 years), at the center and at 2 mm from the nasal and temporal limbus along the horizontal meridian. Three age groups were established as being less than 30 years old (n=75), from 31 to 60 years old (n=77) and above 60 years old (n=65).

**RESULTS:** There was a high correlation between central and peripheral IOP readings, with central reading being higher than peripheral ones. The higher IOP values were found within the younger group for the central location. Subjects within the older group (above 60 years of age) presented significantly lower temporal IOP readings than the remaining two groups (p<0.001), while no significant differences were found among groups at central and nasal locations (p=0.099 and p=0.225, respectively). There was a significant decrease in nasal and temporal IOP readings as the age increased (p=0.011 and p=0.006, respectively).

**CONCLUSION:** Older patients displayed lower IOP values than the middle-aged and younger patients in the temporal peripheral location. A negative correlation between age and IOP by rebound tonometry was found in the corneal periphery but not in its center.
PURPOSE: To compare the intraocular pressure (IOP) readings taken with the new Icare tonometer and with the Goldmann applanation tonometer (GAT) and to evaluate the influence of central corneal thickness (CCT) on the IOP measurements.

PATIENTS AND METHODS: One eye of 178 consecutive patients with primary open-angle glaucoma underwent ultrasonic CCT measurement, followed by IOP evaluation with the GAT and with the Icare tonometer. The deviation of Icare readings from GAT values, corrected according to the Doughty and Zaman formula, was calculated and correlated to CCT by a linear regression model. The agreement between the 2 devices was assessed by use of the Bland-Altman method.

RESULTS: The average CCT was 552±39 μm. The mean IOP and the mean corrected IOP with GAT were 19.4±5.4 mm Hg, and 18.5±5.7 mm Hg, respectively. The mean Icare IOP reading was 18.4±5.2 mm Hg. The deviations of Icare readings from corrected GAT values were highly correlated with CCT values (r=0.63, P<0.01). Linear regression analysis showed that a CCT change of 10 mm resulted in an Icare reading deviation of 0.7 mm Hg. The Bland-Altman scatter-plot showed a reasonable agreement between the 2 tonometers.

CONCLUSIONS: The Icare tonometer can be useful in a routine clinical setting. The IOP readings are quite in accordance with those obtained by GAT. The measurements seemed to be influenced by CCT variations, and thus pachymetry should always be taken into consideration.

COMPARISON OF Icare Tonometer with Goldmann Applanation Tonometer in Glaucoma Patients

J Glaucoma 2006; Paolo Brusini, MD, Maria Letizia Salvetat, MD, Marco Zeppieri, MD, Claudia Tosoni, MD, and Lucia Parisi

“Glucoma is a major cause of blindness in the Western countries. It is well known that the major risk factors in the progression of glaucoma include increased intraocular pressure (IOP) levels and increased variation in IOP. Although the role of IOP in glaucoma is not fully understood, lowering it may halt or delay the progression of the disease.”

**FIGURE 1.** Correlation between CCT and the deviation of the Icare measurements from the corrected GAT values

**FIGURE 2.** Bland-Altman analysis showing the distribution of differences in IOP (Icare tonometer value minus GAT value, mm Hg) (y-axis) and the mean IOP value of the tonometers (x-axis) for each eye measured.

“...the advantages this device offers in comparison to other methods include the following: the device is small, lightweight, and portable; a slit lamp is not required; it is easy to use; IOP is taken with the patient in a comfortable sitting position; an anesthetic or sedation is not required; and the rapid measurement enables monitoring in noncompliant individuals. In conclusion, the IOP readings obtained with the new Icare tonometer have shown a reasonable concordance with IOP readings obtained by GAT in our sample study, suggesting that Icare can be considered an appropriate tonometry method for routine clinical use. Because this tonometer can be used without an anesthetic, similarly to noncontact tonometry, it may also offer a possible affordable alternative for family doctors and optometrists.”
TELEMEDICINE-FRIENDLY, PORTABLE TONOMETERS: AN EVALUATION FOR INTRACULAR PRESSURE SCREENING

Clinical and Experimental Ophthalmology 2006; Sajeesh Kumar PhD, Catherine Middlemiss MBBS, Max Bulsara PhD, Antonio Guibilato FRANZCO, William Morgan FRANZCO PhD, Mei-Ling Tay-Kearney FRANZCO, Ian J Constable AO FRANZCO and Kanagasingam Yogesan PhD

PURPOSE: To evaluate the intraocular pressure (IOP) readings from two portable, telemedicine-friendly tonometers for suitability in glaucoma screening.

METHODS: 213 eyes of 107 consenting patients attending an eye clinic were tested with an i-care tonometer and a Pulsair-Easy Eye puff-air tonometer. Gold standard IOP was measured with a Goldmann applanation tonometer (GAT). Effect of central corneal thickness, anterior chamber depth and refractive errors on IOP measurements were also analysed.

RESULTS: The mean difference of IOP by GAT and both the portable tonometers was ±2.2 mmHg. The analysis indicates minimal difference between IOP readings of both the portable tonometers. The mean difference between two consecutive readings by i-care was 0.01 mmHg. Using 21 mmHg as a threshold for suspected glaucoma, both the portable digital tonometers reported a sensitivity of 38% and specificity of >95%. In the subjects studied, central corneal thickness had statistically significant influence on IOP measurements while refractive errors and anterior chamber depth had no significant influence on IOP measurements with any tonometry.

CONCLUSION: The IOP readings by both portable tonometers are comparable and were within clinically acceptable range from GAT. These portable tonometers are useful tools for IOP screening.

QUOTES FROM THE FULL STUDY

“Glaucoma is a major cause of blindness and is often associated with an increase in intraocular pressure (IOP). Widespread screening is critical for early diagnosis, treatment and limiting the incidence of glaucoma-associated blindness. Meanwhile, individuals living in rural or remote areas have limited access to glaucoma tests. However, recent advances in compact, portable, easy-to-use, automated ophthalmic diagnostic devices and escalating spread of Internet-based telecommunications offer novel opportunities for telemedicine-based glaucoma screening and monitoring. Semiskilled, rural, ancillary health care workers could easily be trained to connect these devices to a teleophthalmology system, perform screenings and send the results electronically to specialists in urban centres for second opinion and management.”

COMPARISON OF REBOUND TONOMETRY WITH GODMANN APPLATION TONOMETRY AND CORRELATION WITH CENTRAL CORNEAL THICKNESS

British Journal of Ophthalmology; Milko E. Iliev, MD, David Goldblum, MD, Konstantinos Katsoulis, MD, Christoph Amstutz, MD, Beatrice Frueh, MD

AIMS: Rebound tonometry (RT) is performed without anaesthesia with a hand-held device. Primary aim was to co RT with Goldman applanation tonometry (GAT) and to correlate with central corneal thickness (CCT). Secondary was to prove tolerability and practicability of RT under “study conditions” and “routine practice conditions”.

METHODS: In group 1 (52 eyes/28 patients), all measurements were taken by the same physician, in the same room and order: non-contact optical pachymetry, RT, slit lamp inspection, GAT. Patients were questioned for discomfort or pain. In group 2 (49 eyes/27 patients), tonometry was performed by three other physicians during routine examinations.

RESULTS: RT was well tolerated and safe. IOP ranged between 6 and 48mmHg. No different trends were found between the groups. RT tended to give slightly higher readings: n=101, mean difference 1.0±2.17mmHg; 84.1% of RT readings within ±3mmHg of GAT; 95% confidence interval in the Bland-Altman analysis –3.2 to +5.2mmHg. Both RT and GA showed a weak positive correlation with CCT (r2 0.028 and 0.025, respectively).

CONCLUSIONS: RT can be considered a reliable alternative for clinical screening and in cases where positioning of the head at the slit lamp is impossible or topical preparations are to be avoided.
PURPOSE: To evaluate the intraocular pressure (IOP) readings from two portable, telemedicine-friendly tonometers for suitability in glaucoma screening.

METHODS: 213 eyes of 107 consenting patients attending an eye clinic were tested with an I-care tonometer and a Pulsair-Easy Eye puff-air tonometer. Gold standard IOP was measured with a Goldmann applanation tonometer (GAT). Effect of central corneal thickness, anterior chamber depth and refractive errors on IOP measurements were also analysed.

RESULTS: The mean difference of IOP by GAT and both the portable tonometers was ±2.2 mmHg. The analysis indicates minimal difference between IOP readings of both the portable tonometers. The mean difference between two consecutive readings by I-care was 0.01 mmHg. Using 21 mmHg as a threshold for suspected glaucoma, both the portable digital tonometers reported a sensitivity of 38% and specificity of >95%. In the subjects studied, central corneal thickness had statistically significant influence on IOP measurements while refractive errors and anterior chamber depth had no significant influence on IOP measurements with any tonometry.

CONCLUSION: The IOP readings by both portable tonometers are comparable and were within clinically acceptable range from GAT. These portable tonometers are useful tools for IOP screening.
PURPOSE: To assess the agreement between Icare rebound tonometer and Goldmann applanation tonometer in the hands of experienced and inexperienced tonometrists.

PATIENTS AND METHODS: Two tonometrists, experienced with both Goldmann applanation tonometry (GAT) and Icare tonometry (ICT) measured intraocular pressure (IOP), in a masked fashion, in 100 patients. In another series of 58 patients, ICT was performed by an inexperienced tonometrist and GAT by an experienced tonometrist.

RESULTS: In approximately 80% of patients, the difference in IOP between GAT and ICT was ±2mmHg in group 1 and ±3mmHg in group 2. The 95% limits of agreement were 4.0–4.4mmHg in group 1 and 6.0–5.0mmHg in group 2.

CONCLUSION: ICT compares reasonably with GAT, in both experienced and inexperienced hands. Its ease of use, portability, and sterility make it an attractive tonometer. Its degree of accuracy in inexperienced hands would make it a useful instrument for health care workers with limited ophthalmic experience.

QUOTES FROM THE FULL STUDY

“This does not require topical anaesthesia, minimises corneal injury, and there is no risk of cross infection. It is potentially easier to use than GAT, and it was our impression, based on clinical experience, that it not only provides accurate IOP recordings, but that it can be accurately employed by inexperienced tonometrists.”

“In summary, ICT compares reasonably with GAT, in both experienced and inexperienced hands. Its ease of use, portability, and sterility make it an attractive tonometer.”

“ICT in our study compares favourably. Also, its degree of accuracy in inexperienced hands would make it a useful instrument for health care workers with limited ophthalmic experience. It could be usefully employed in a number of settings, including optometric practice, general practice, and in the Emergency Department.”

FIGURE 2 Plots of difference vs mean IOP values obtained with GAT by experienced and ICT by inexperienced tonometrists.
Three portable tonometers, the TGDc-01, the Icare and the Tonopen XL, were compared with each other and to Goldmann applanation tonometry in a large group of healthy subjects and patients with ocular hypertension or glaucoma (n = 103). Measurements performed with the Icare and the Tonopen XL were in good agreement with that of the Goldmann tonometer. Intraocular pressure (IOP) values measured with the TGDc-01 were significantly lower and showed more variability. The 95% limits of agreement (portable tonometer – Goldmann) were −17 to +10 mmHg for the TGDc-01, −6 to +7 mmHg for the Icare and −6 to +8 mmHg for the Tonopen. Corneal thickness could not explain the differences between an IOP measured with the portable tonometers and an IOP measured with the Goldmann tonometer. Patient comfort was slightly higher for Icare when compared with the Tonopen.

QUOTES FROM THE FULL STUDY

“Glaucoma is a chronic disease that may cause irreversible blindness. Despite all the research that has been conducted and all the new developments, tonometry remains the cornerstone of both the diagnosis and management of glaucoma.”

“Measurements performed with the Tonopen XL and the Icare tonometer were in good agreement with that of the Goldmann tonometer.”

“Differences in corneal thickness might explain differences between an IOP measured with Goldmann applanation tonometry and an IOP measured using other techniques.”

“Patient comfort was slightly higher for Icare when compared with the Tonopen XL, and, unlike the Tonopen XL, Icare measurements can be performed without anaesthesia.”
Traditionally, intraocular pressure (IOP) has been measured by application of the cornea, using a topical anaesthetic, or by non-contact tonometry (NCT), using a puff of air on to the cornea. Recently a new type of contact tonometer has been made available: the Icare is a rebound tonometer that does not require the use of an anaesthetic. Rebound or dynamic tonometry is based on making a moving object collide with the eye, and the motion parameters of the object are monitored following contact. Measuring the IOP in a domiciliary environment can be difficult; it was therefore decided to compare this new instrument with the two tonometers most commonly used by domiciliary companies – the Tonopen and the Pulsair. These instruments are used since they allow IOP measurements to be obtained in an objective manner, as does the Icare. Instruments such as the Perkins, which require a subjective assessment, are less common in domiciliary practice.

QUOTES FROM THE FULL STUDY

“In addition to the reliability indication, the instrument will interrupt the reading if the probe does not hit the cornea at the correct speed or from the correct distance. Two beeps will be heard, and an error code will be displayed. The seven error codes are listed in the instruction manual; eg E01: the probe did not move."

“Error codes are rarely displayed when an experienced practitioner uses the instrument."

“The success rate for the Icare overall was 94.34%."

“There were no cases where either the Pulsair or Tonopen succeeded and the Icare failed, but there were 159 eyes for the Pulsair where the Icare obtained a successful reading and the Pulsair did not, and for the Tonopen there were 105 eyes where the Icare was successful but the Tonopen was not."

“In one case where a measurement was not possible with the Tonopen but was obtained with the Icare, the patient was referred with raised IOP. This was a patient in whom visual field analysis and detailed ophthalmoscopy were not possible due to an inability to cooperate because of dementia, and, without the Icare, the IOP would not have been obtained either. This fact alone is perhaps an indication that the Icare tonometer is highly suitable for domiciliary work."

“In the case of four eyes, corneal scarring prevented a measurement with the Tonopen, but not with the Icare."

“The Icare does not rely as heavily on patient compliance or understanding, and so, it can be used more successfully than the Pulsair for those house-bound patients who have dementia."

“In two cases of Parkinson’s disease, where it was not possible to obtain a reading with the Pulsair because of tremor, a reliable result was obtained with the Icare."

“Four of the Pulsair failures were patients who were registered blind, and so could not fixate at all. The IOPs of these patients were measured successfully with the Icare. There were two cases of irregular cornea due to scarring with which the Pulsair failed to obtain a measurement and the Icare succeeded."

“It is therefore shown that a greater number of successful tonometry readings were obtained with the Icare than with either the Pulsair or the Tonopen."

FIGURE 1. Bland & Altman plot showing Tonopen/Icare results for the right eye.

FIGURE 2. Bland & Altman plot showing Pulsair/Icare results for the left eye.

FIGURE 3. Bland & Altman plot showing Tonopen/Icare results for the right eye.

FIGURE 4. Bland & Altman plot showing Pulsair/Icare results for the left eye.
The Icare was considered by all of the optometrists involved in this clinical trial to be easier to use than either the Tonopen or the Pulsair.

The Icare combines the good points of both instruments. There is no requirement for drops to be instilled, and yet it is small, light-weight and easily portable.

No negative points were found on using the Icare; the disposable probes cost much the same as the Tonopen tips, and, since no minims of topical anaesthetic are needed, it will be cheaper to use in the long term. The purchase price of the Icare is similar to that of the Tonopen, much less than the Pulsair, and it does not require expensive servicing and regular calibration, since the manufacturers claim that the microchip technology that operates it is extremely accurate.

Nevertheless, these results show that, overall, the patients’ experience was that the Icare was a more comfortable instrument with which to have IOP measured than either the Pulsair or Tonopen.

When using the Icare tonometer, it is possible to obtain IOP readings for patients where both Pulsair and Tonopen fail, particularly when examining elderly patients who have dementia, who make up a large proportion of the patient base serviced by a domiciliary company. It is also easy to transport, which is important for domiciliary work.

The Icare is very easy to use since less patient cooperation is required than when using either the Pulsair or the Tonopen.

Patients find that when an Icare tonometer is used IOP measurement is far less uncomfortable than when using either a Pulsair or a Tonopen.

Healthcall Optical Services will be replacing Pulsairs and Tonopens with Icare tonometers when their existing equipment comes to the end of its useful life.
Type: TAO1i
The device conforms to CE regulations.
Dimensions: 13–32 mm x 45–80 mm x 230 mm
Weight: 195 g [without batteries], 250 g [4 x AA batteries]
Power supply: 4 x AA batteries
Measurement range: 7–50 mmHg
Display range: 0–99 mmHg
Accuracy: 95% tolerance interval relative to manometry: ± 1.2 (< 20 mmHg), ± 2.2 (≥ 20 mmHg)
Repeatability: (coefficient of variation) < 8%
Accuracy of display: 1

Display unit: mmHg
There are no electrical connections from the tonometer to the patient.

The device has B-type electric shock protection.

Operation environment
Temperature: +10 °C to +35 °C
Relative humidity: 30% to 90%
Atmospheric pressure: 800 hPa–1060 hPa

Storage environment
Temperature: -10 °C to +55 °C
Relative humidity: 10% to 95%
Atmospheric pressure: 700 hPa–1060 hPa

Transport environment
Temperature: -40 °C to +70 °C
Relative humidity: 10% to 95%
Atmospheric pressure: 500 hPa–1060 hPa

Type: ONE
The device conforms to CE regulations.
Dimensions: 110 mm x 80 mm x 30 mm
Weight: 190 g
Power supply: 2 x CR123 batteries
Measurement range: 5–50 mmHg
Display range: 5–50 mmHg
Accuracy: 95% tolerance interval relative to manometry: ± 1.2 (< 20 mmHg), ± 2.2 (≥ 20 mmHg)
Repeatability: (coefficient of variation) < 8%
Accuracy of display: Display is divided into 11 ranges:

5–7 mmHg
7–10 mmHg
10–14 mmHg
14–18 mmHg
18–21 mmHg
21–24 mmHg
24–27 mmHg
27–30 mmHg
30–35 mmHg
35–40 mmHg
40–50 mmHg

Display unit: mmHg
There are no electrical connections from the tonometer to the patient.

The device has BF-type electric shock protection.

Operation environment
Temperature: +10 °C to +35 °C
Relative humidity: 30% to 90%
Atmospheric pressure: 800 hPa–1060 hPa

Storage environment
Temperature: -10 °C to +55 °C
Relative humidity: 10% to 95%
Atmospheric pressure: 700 hPa–1060 hPa

Transport environment
Temperature: -40 °C to +70 °C
Relative humidity: 10% to 95%
Atmospheric pressure: 500 hPa–1060 hPa

Type: PRO
The device conforms to CE regulations.
Dimensions: 230 mm x 60 mm x 100 mm
Weight: 275 g
Power supply: rechargeable battery
Measurement range: 5–50 mmHg
Display range: 0–99 mmHg
Accuracy: 95% tolerance interval relative to manometry: ± 1.2 (< 20 mmHg), ± 2.2 (≥ 20 mmHg)
Repeatability: (coefficient of variation) < 8%
Accuracy of display: 0.1 mmHg

Display unit: mmHg
There are no electrical connections from the tonometer to the patient.

The device has BF-type electric shock protection.

Operation environment
Temperature: +10 °C to +35 °C
Relative humidity: 30% to 90%
Atmospheric pressure: 800 hPa–1060 hPa

Storage environment
Temperature: -10 °C to +55 °C
Relative humidity: 10% to 95%
Atmospheric pressure: 700 hPa–1060 hPa

Transport environment
Temperature: -40 °C to +70 °C
Relative humidity: 10% to 95%
Atmospheric pressure: 500 hPa–1060 hPa
Icare® TAO1i tonometer for quick, easy and painless IOP measurement by Ophthalmologists, Optometrists, Opticians, General Practitioners & Pharmacies.

One
Icare® ONE tonometer is for easy IOP self monitoring for Glaucoma Patients and Suspects.

Pro
Icare® PRO tonometer is the Ophthalmologist’s standard device for high accuracy clinical use.

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