

Accurate Tonometry: Is Help on the Way?

Not today.

BY DAN EISENBERG, MD

The simple answer is that help is not on the way for accurate tonometry anytime soon. There is no shortage of technology or of the will to invent, but the forces against change have, to date, been insurmountable. This article details the various obstacles that appear to be halting progress.

WHY DO WE NEED MORE ACCURATE TONOMETRY?

The Goldmann applanation tonometer (GAT) is considered accurate, highly reliable, and simple to use. Moreover, this instrument is extremely well established in clinical use and research. Every article that I have reviewed on the topic of tonometry includes the cliché that the GAT is the gold standard. Nearly every review and discussion of tonometry includes the statement as well. It is typically declared as a fact beyond question. Why, then, should we abandon the gold standard? I could not argue with that, were it true.

The amount of literature detailing the failings of the GAT is just as extensive as the literature extolling it. I will not revisit all the known instances when the GAT fails to obtain a correct pressure or to obtain any pressure at all, but I will note that to accept this tonometer as a standard of any type requires a total disregard for its proven failings. Really, how can we accept the GAT as a standard when it is accurate only some of the time and only when the right conditions and restrictions are met? As an aside, gold is not really a standard, either, because it is a commodity with a value that fluctuates at market price.

THE HISTORICAL ARGUMENT

In the historical argument, new research must use the GAT to be consistent with prior literature that used this tonometer. This circular thinking precludes any change ever, because old literature cannot be altered. It also assumes that new technology can never produce new information. What is the purpose of research if we cannot learn anything new?

THE COMPARISON ARGUMENT

New tonometers must agree with the GAT to check the accuracy of the readings. In addition to the assumptions of the historical stance, the comparison argument assumes that the GAT is ideal, so any new tonometer must produce similar results. Why would anyone develop a new tonometer if this were true? The need to compare everything to the GAT is completely illogical, yet it appears to be mandatory by consensus. It is certainly a major hindrance of technological innovation.

Maurice Langham, a tonometry researcher and the inventor of the Langham pneumatonometer, among other things, once told me that he had to include a Goldmann setting on his tonometer so that clinicians could compare his tonometer's readings with those from their GAT to convince them that his instrument was accurate. It did not matter that the literature showed pneumatonometry to be much closer than Goldmann applanation tonometry to true IOP, as measured by manometry¹; they did not trust any instrument that deviated from the Goldmann. No tonometer is an acceptable control for another tonometer: without a true reference standard, manometric IOP, it is impossible to determine the accuracy of one instrument versus another, because the errors of both are either contrasting or compensating while the true pressure remains unknown.

THE NOSTALGIA ARGUMENT

We are human, so we generally like to do what we have always done. It is familiar, comfortable, and less stressful than change. Like the comparison argument, the nostalgia argument precludes all new instruments. It also assumes that what we have done has done well by our patients. The literature suggests this may not be true. Elevated IOP is routinely missed in patients with thin corneas. Eyes with a keratoprosthesis are at very high risk of blindness from glaucoma, because the GAT cannot

measure their IOP. The GAT also fails in children and in eyes with corneal scarring or nystagmus. Our nostalgia appears to be paired with a fair amount of amnesia.

THE SIMPLICITY ARGUMENT

Many eye care practitioners like the GAT, because it works via gravity and it is easy to understand the mechanism and principles. Instruments like the pneumatonometer (model 50; Reichert), Tono-Pen XL (Reichert), Pascal Dynamic Contour Tonometer (Ziemer Ophthalmic Systems), and Ocular Response Analyzer (Reichert) are much more complicated, so it is harder to grasp the mechanics and theory behind them. Most of us likely do not understand our cell phones, but we have no trouble accepting and using them. Nevertheless, we are wary of sophisticated tonometers.

Albert Einstein said, "It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience." The GAT satisfies the first section but fails the latter.

THE ECONOMIC ARGUMENT

The economic argument is the strongest in favor of keeping the GAT. All of the high-tech instruments are much more expensive to purchase and maintain than a GAT. The driving force of the GAT is gravity, and gravity is free. The GAT complements the slit lamp we practitioners already own. If we are only concerned about economics and need the most accuracy per dollar spent, the GAT is the clear winner. If we can loosen our budgets in favor of greater accuracy and, in many cases, freedom from the slit lamp, we can do much better with the newer instruments.

CONCLUSION

The dogma that the GAT is the gold standard remains the single greatest hindrance to the development and dissemination of new, more accurate tonometers. I cannot explain why eye care practitioners as a group continue to prefer 60-year-old technology and to reject decades of literature demonstrating its flaws. ■

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1. Eisenberg DL, Sherman BG, McKeown CA, Schuman JS. Tonometry in adults and children. A manometric evaluation of pneumatonometry, applanation, and TonoPen in vitro and in vivo. *Ophthalmology*. 1998;105(7):1173-1181.