

Author Response: Effect of Intraocular Pressure on the Bayesian Estimation of Rates of Visual Field Progression in Glaucoma

The stated aims of our study¹ were to present a simple Bayesian method for estimating visual field progression whose working may be appreciated by a nonspecialist reader, and to examine the influence of prior distributions that account for a major risk factor for progression, whether or not intraocular pressure (IOP) was treated (not, however, the influence of IOP per se). Our prior distributions that described the expected distribution of progression rates were taken from the Canadian Glaucoma Study (treated IOP) and the Early Manifest Glaucoma Trial (EMGT, untreated IOP). Although the choice of prior did alter the performance of our estimator, we assessed this alteration to be modest. Medeiros suggests that our study fails to show an effect of IOP, and that this is because of the widely different populations used for the priors and that IOP was not considered as a continuous variable.²

Absolute IOP undoubtedly is a risk factor for progression, particularly when extremes of IOP are considered. It was not the aim of our study to analyze this, however. A key aspect of our report was the presentation of two variants of a Bayesian analysis differing by a single risk factor, so the influence of this factor could be assessed readily. In contrast, most previous work has presented a single Bayesian approach and shown it is less variable than a non-Bayesian (for example, ordinary least squares) comparator—a finding confirmed in our report.

Our study found a significant influence of whether IOP treatment was considered in our Bayesian estimator, contrary to Medeiros' suggestion. We assessed this influence to be modest, however. We accept that the two studies from which we derived our priors had differences, although both investigated the same type of glaucoma (high-tension, primary open angle glaucoma) and had similar pretreatment IOP values (mean of 24.7 mm Hg and median of 25.0 mm Hg for the EMGT³ and the Canadian Glaucoma Study,⁴ respectively). Note: Median IOPs were not reported in the EMGT, nor means in the Canadian Glaucoma Study, and so comparisons are necessarily only approximate. For the EMGT data, IOP is for the high-tension glaucoma group only (i.e., low-tension glaucoma and exfoliation glaucoma excluded, as done in our study).

In any commercial implementation of a Bayesian progression estimator, the prior also almost certainly will be derived from a population different from that to which the estimator is applied. This is not inherently a problem. An analogous situation exists for normative databases currently used in perimeters and imaging devices, which retain utility despite differences between the population on which the database was developed and the patients to whom the database ultimately is applied. Bayesian estimators similarly must be robust to the precise form of the prior, and our results provide some reassurance that modest mismatches between the prior and the population being analyzed do not affect results profoundly.

Deriving the prior from the same tightly specified class of patients to whom the Bayesian estimator then is applied—as done in some previous work—runs the risk of overestimating the benefits of Bayesian estimators. In a clinical setting, or in a research setting where an estimator is applied prospectively rather than retrospectively, the prior distribution of progression rates likely will not be known with any certainty.

The ready availability of computationally advanced statistical packages that can be applied largely as a “black box” makes it increasingly difficult for the nonspecialist to grasp fundamental concepts regarding some recent procedures, including certain implementations of Bayesian analysis. We feel a straightforward presentation of the fundamental principles of Bayesian analysis, written particularly with nonspecialist readers in mind, is timely given recent appearances of Bayesian analyses of progression in the literature. We hope our article also will allow such readers to grasp the benefits and limitations of Bayesian methods for assessing progression, and to interpret such analyses appropriately should they eventually be incorporated in clinical devices. We believe our method may be more readily grasped by nonspecialists as its workings closely mirror the most common way Bayes theorem is expressed mathematically.

It would be of great interest to take our analysis and that of Medeiros, and apply them to a third, independent data set so that the relative influences of IOP treatment and absolute IOP might be compared appropriately. We would welcome the opportunity to collaborate on such an investigation.

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