One important outcome of the Ocular Hypertension Treatment Study (OHTS) and the European Glaucoma Prevention Study (EGPS) was the development of risk calculators to help predict the likelihood of an individual with elevated intraocular pressure (IOP) to develop glaucomatous optic nerve and/or visual field damage. These risk calculators are available online at http://www.deverseye.org/grc_web and http://ohts.wustl.edu/risk/; a practitioner enters a patient’s age, IOP, central corneal thickness, cup-to-disc ratio, and visual field pattern SD and derives a 5-year risk of that patient’s developing glaucoma.

The 5-year percentage risk of developing glaucoma is useful but in a typical clinical setting, it may not be the most important information that can be derived from a risk calculator. A common clinical situation in our practice is a new patient who is an untreated glaucoma suspect by virtue of family history, optic disc appearance, visual field abnormality, thin cornea, or elevated IOP. The resident or fellow recommends observation without treatment. We ask our trainee “Given what you see today, at what IOP today would you have recommended IOP lowering?” or “If the patient were to come back in 6 or 12 months, all other things being unchanged, how much higher would the IOP have to be for you to initiate treatment?”

We call this IOP level the “threshold to treat” and define it as the IOP at which the eye care practitioner and the patient conclude that the benefits of IOP lowering exceed the downside. The threshold to treat is dependent upon the level of risk that the patient and doctor are willing to tolerate in the absence of treatment.

We have previously studied the level of risk that ophthalmologists tolerate in the observation of untreated patients with ocular hypertension. Using simulated case scenarios consistent with the population of the OHTS, we determined that the average treatment threshold for 56 glaucoma specialists was a 23% chance of developing glaucoma over a 5-year period when they did not have the results of a risk calculator and 17% when they provided with the risk calculator before making their decision. We also assessed the behavior of comprehensive ophthalmologists without glaucoma subspecialty training and determined the average risk threshold for treating a younger group and an older group of patients. The calculated risk threshold for glaucoma-trained physicians was 22% without a risk calculator and 17% with a risk calculator and that for nonglaucoma-trained physicians was 16% without a risk calculator and 13% with a risk calculator. The risk threshold was lower (greater likelihood of treating) in 40- to 50-year-olds than in 70- to 80-year-olds.

One can use one of the currently available risk calculators to determine the IOP for an individual patient with ocular hypertension (or who is a glaucoma suspect with unremarkable IOP) at which a certain 5-year risk occurs. However, this requires a time-consuming trial and error process in which one plugs an IOP into the calculator, determines the risk, and then tries again with another IOP until the desired risk of conversion is reached. For instance, suppose a 65-year-old patient has an IOP of 18, 17, and 19 mm Hg in his right eye over 3 visits, a cup-to-disc ratio of 0.8, a mean central corneal thickness of 570 μm, a pattern SD of 1.6 dB, and the physician had a threshold of 25% 5-year risk of conversion for recommending treatment. One could guess that an IOP of 22 mm Hg might yield 20% risk and plug 22 mm Hg into the OHTS risk calculator along with the other parameters and find that the risk was 14.7%. One could then try a higher IOP, let us say 26 mm Hg, and find that the risk was 20.4%. Eventually one could determine the IOP at which the risk was 25%.

To facilitate the task of determining at what IOP a given 5-year risk of developing glaucoma occurs, we utilized the same statistical principle behind the current risk calculators but made IOP the dependent variable and the 5-year risk an independent variable (Fig. 1). We used the hazard ratios and population average values from the combined OHTS/EGPS analysis to calculate coefficients for each of the risk factors identified in those studies: age, cup-to-disc ratio, visual field pattern SD, and central corneal thickness. If the practitioner and the patient have an idea of the 5-year risk of developing glaucoma that they are willing to tolerate without treatment, this modification allows a rapid answer to the question “at what IOP should treatment be started?”

This “threshold to treat” calculator has the same shortcomings as the calculators that now exist, including lack of applicability to patients with characteristics different from the OHTS and EGPS study populations, ignoring some of the beneficial and adverse outcomes of the disease and its treatment, and a fixed time frame of 5 years. Furthermore, there may be other, as yet unidentified, risk factors that were not evaluated in the OHTS and EGPS but could increase the accuracy of a risk calculator. Finally, one should always recognize that static measurements of IOP, even if repeated, do not capture short-term fluctuation or peak IOP, which might be important in the decision to initiate treatment.

Although a practitioner may choose to select the same level of risk for all patients when calculating a threshold to treat, it is more likely that he/she, in consultation with the...
patient, will customize the level of risk. Perhaps most obviously, as demonstrated in previous work, the younger the patient, the lower the threshold for treatment is likely to be. The “threshold to treat” calculator can be applied to patients whose intraocular pressure is <22 mm Hg, as no IOP measurement is entered into the calculator, with the caveat that this is not strictly evidence-based. Furthermore, a resultant threshold to treat of <22 mm Hg must be treated cautiously as the OHTS risk calculator was derived only from eyes with IOPs of 22 mm Hg or greater.

We hope that the “threshold to treat” calculator, available at http://oil.wilmer.jhu.edu/threshold, can provide information complementary to the traditional OHTS risk calculators, that will prove useful in patient care.

FIGURE 1. In the Ocular Hypertension Treatment Study (OHTS) risk estimator, intraocular pressure is an independent variable and risk of developing glaucoma is the dependent variable. In the Threshold to treat estimator, the tolerated risk of developing glaucoma is an independent variable and the intraocular pressure is the dependent variable.

REFERENCES