The Impact of Nomograms on Growth of the Refractive Practice

Software products provide time-saving nomograms for the many different ways that lasers are used.

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The cost of LASIK enhancements is not limited to the hard costs of a laser card and clinical chair time. Although not trivial, these fees are noted in the expense column and can be quantified. The larger cost of LASIK enhancements is reflected in a demoralized staff, the extra time it takes to counsel the patient, and most importantly, in decreased patient referrals.

In the current economic environment, competition for refractive surgery patients has become fierce, and LASIK is no longer the profit center it once was. Enhancement rates of 5% to 15%—once common—can make it unaffordable to offer refractive surgery at current surgical volumes.\(^1,2\) Moreover, today's patients are savvy and seek out centers that provide the desired outcome with one treatment.

It is currently possible to have a busy refractive surgery practice with enhancement rates approaching zero. Nomograms play a key role in achieving that goal. Consider two patients. Both work at the same company and had LASIK. “Tom” had surgery at practice A. After the first procedure, he had a small residual refractive error that required an enhancement, which achieved a good result. “Angela” had surgery at practice B and had a plano result with excellent vision after one procedure. From an ophthalmic perspective, both of these cases would be considered successful based on their final result. The patients’ perspectives, however, may differ. Tom and Angela are at an office party and are asked about LASIK. Angela says it was a “snap” and that she was back at work the following day. Tom says, “They missed with the first procedure. I had to take off work twice, and I took longer to heal. Although my vision is fine now, I am not sure I would have LASIK again.”

Will listeners have LASIK? If so, which center will they choose?

WHY NOMOGRAMS?
The need for nomograms has been apparent since excimer lasers were first approved by the FDA in 1996. Subtle differences among lasers, surgeons, and OR environments can lead to significant variability in outcomes. To compensate, surgeons often must input refractive data that differ from the refraction they want to treat. Nomograms are used to help the surgeon to determine the adjustments that are needed to obtain the desired outcome.

Nomogram development is mathematically demanding. Data must be accurate, properly grouped, and analyzed using valid algorithms that not only detect all of the factors that influence outcomes but also adjust for them. In addition, nomograms must be constantly updated, as lasers, surgeons, and techniques change over time.

In the past, the time and investment needed to develop surgeon-specific nomograms were generally considered prohibitive. Few surgeons attempted to create their own surgeon-specific nomograms. Instead, most borrowed nomograms from other surgeons or guessed what adjustments to make based on their recent results. Experience has shown that this approach is of limited benefit and rarely results in near-zero enhancement rates (Table 1).

NOMOGRAM DEVELOPMENT
Today, software products (some distributed by manufacturers) provide nomograms for the many different ways that lasers are used (eg, LASIK, PRK with or without mitomycin C, different treatment ranges, keratomes, optical zones, etc.). Nomogram software can actually save time in working up the patient and by helping to avoid enhancements (Figure 1). Web-based applications make it possible to access the software from anywhere with Internet access, and they pro-
vide other efficiencies, particularly in practices with multiple locations or an off-site laser center. With Internet-based applications, technicians can enter the preoperative information from the clinic, ophthalmologists can perform surgical planning from home, and the laser technician can open the plans and program the laser before the surgeon arrives at the laser center. These efficiencies save money.

Before 2003, surgeons wanting to develop nomograms had to collect data from their initial eyes and make adjustments once the results were known. This approach often took 1 to 3 months and led to high enhancement rates with new lasers. With modern nomogram software, surgeons can avoid the learning curve (and enhancements) that are associated with using a new laser. Software provides starting nomograms from a “library” of nomograms that have been developed over time. Web-based programs permit the pooling of outcomes data from many centers. These large data pools make it possible to detect variations among surgeons, lasers, techniques, and other factors and to develop average or starting nomograms for each approach. Surgeons trying a new laser can use these nomograms to generate very reliable surgical plans.

As early postoperative results begin to come in, the nomogram software evaluates them to determine what library nomogram would have best predicted the results to date. This “best-fit” algorithm allows the software to automatically use the new nomogram for subsequent plans. The best-fit algorithm runs continuously as new data are entered on a treatment-by-treatment basis. Over time, enough data are reported to generate a new nomogram for the individual surgeon. To be useful, the surgeon-specific nomogram must yield a statistical profile that outperforms the best-fit nomogram. This includes having an adequate range of treatments, a good mix of treatments for sphere and cylinder, and consistent outcomes. The successful development of surgeon-specific nomograms is usually possible with data on approximately 50 to 100 eyes. Once a surgeon-specific nomogram has been developed, subsequent data are used to refine it over time.

Importantly, nomogram development occurs automatically as data are entered. The user provides the data, and the software does the rest.

| TABLE 1. CONSIDERATIONS AND BENEFITS OF IMPLEMENTING NOMOGRAMS IN A REFRACTIVE PRACTICE |
|----------------------------------------|----------------|---------------|----------------|----------------|----------------|
| Task                                  | No Nomogram Software | Nomogram Software | Performed by | Difference | Impact | Comment |
| Surgical planning                      | N/A | 2 minutes per eye | Technician | 2 minutes | Minor | Requires competent, reliable technician |
| Generate surgical plan                 | 5-15 minutes | 1 minute per eye | Surgeon | Approximately 10 minutes per eye | Significant | Accuracy improved, errors reduced, can be performed from remote offices or home |
| Laser room operations                  | Manual chart delivery | Records available online | Laser technician | No time difference | Significant | Permits laser to be set up in advance |
| Enter treatment into nomogram software | N/A | 1 minute per eye | Laser technician | No time difference | None | Saves time when entering postoperative data |
| Postoperative data entry              | N/A | 1 minute per eye | Technician | 1 minute | Minor | One exam required per eye |
| Enhancements                           | 5%-10% | 0%-1% | Entire clinic | Practice growth, increased profitsa | Very significant | Enhancement rates based on internal surveys of surgeons using SurgVision DataLink products (Scottsdale, AZ) |

*Enhancement costs include the hard costs of performing the procedure, added exam time, increased medicolegal liability, decreased patient referrals, and a negative impact on staff morale.
**NOMOGRAM IMPLEMENTATION**

Nomograms can save time, and with a little planning and organization, they are not difficult to implement. Because nomograms are based on prior data, it is necessary to enter postoperative data into the nomogram software. This process can be automated in centers using electronic medical records via software interfaces that transfer data from the electronic medical records system to the nomogram software. In practices that use paper charts, forms are used to capture the required data during the examination. Entering data from the paper forms into the software takes very little time, and it is a simple and cost-effective approach.

Using nomogram software need not disrupt the clinic’s operations. Prior to surgery, preoperative data must be entered so the surgeon can generate surgical plans. The ophthalmologists can make these plans much faster using nomogram software versus paper nomograms or freehand calculations. The laser technician enters treatment records into the nomogram software as the treatments are performed. Postoperative data are collected when the patient returns for the follow-up examination.

**ANCILLARY BENEFITS TO THE PRACTICE**

As anyone who has attempted to calculate clinical outcomes knows, data analysis can be tedious and time consuming. In addition to reducing enhancement rates, commercial nomogram software applications automate outcomes analysis. Reports are available online and are e-mailed to surgeons and clinical administrators.

**Outcomes reports are used in many ways, including research, marketing, evaluation of results with new technology, comparison of clinical person-
Prospective patients often feel reassured when they know their surgeon tracks outcomes and can provide realistic predictions of results based on his or her own data. LEGAL CONSIDERATIONS

Current nomogram software programs comply with patient-confidentiality laws and use encryption technology to protect health information. Nevertheless, it is a worthwhile precaution to include an authorization in the patient’s Health Insurance Portability and Accountability Act consent that allows clinical outcomes to be compiled and used for nomogram development and outcomes analysis. Although the need for an enhancement per se is not generally grounds for malpractice suits, most refractive malpractice cases involve patients for whom an enhancement was necessary. Enhancements risk other complications, and reducing or eliminating retreatments can decrease a surgeon’s overall risk of medicolegal liability.

LIMITATIONS

Nomograms give surgeons the ability to predict outcomes more accurately. They do not overcome other limitations of laser refractive surgery, such as equipment failures, laser programming errors, dry eyes, flap-related complications, and postoperative keratoconus (ectasia). They also do not prevent the disappointments that come from poor patient selection, such as operating on an eye that exceeds the reasonable refractive range of laser treatments. Nor do nomograms remove the need for a surgeon. Because subtle considerations for visual function become part of the surgical planning process, nomograms increase the surgeon’s control over refractive outcomes.

THE FUTURE

Modern nomogram software improves surgical outcomes and decreases the need for enhancements to achieve the targeted result. Fewer retreatments not only drive practice development and improve the staff’s morale, but they also make refractive surgery safer for patients. With current software and laser technologies, enhancement rates are less than 1% in many practices. At some point, nomograms may become incorporated into excimer laser platforms without the requirement for human intervention.

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Figure 1. Surgical plan printout from current-day nomogram software. Information about the patient, the planned surgery, and the nomogram adjustments is provided. Note that the plan provides information about prior results for similar cases, which allows the surgeon to adjust the targeted outcome according to the patient’s visual needs. Because the software is Internet based, laser technicians can access the surgical plan information and program the laser before the surgeon arrives at the laser center, thus saving time.