Measuring the Impact of Glaucoma and the Value of Treatment

A primer on value-based medicine.

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Ophthalmology is fortunate to have Drs. Melissa and Gary Brown, who have dedicated their careers to figuring out value-based medicine. Most of us believe that what we do as physicians has great value, but how do we show or measure that value? Medicare reform bills currently before Congress are considering performance, value, and cost as metrics by which to change the Medicare payment system. Congress wants to know more than just the cost of a procedure; government leaders also want to know the evidence-based medicine behind what they are paying for and how it affects patients' quality of life. The foundation for this new system will be modeled on VBM, meaning reimbursement will no longer be based on simple fee for service but instead tied to quality of life and cost-effectiveness. How do you figure out a system in which the patient, payor, and physician determine the respective value of what they receive, pay for, and perform? How do you relate that value to the overall practice of medicine? Read on, and find out in the first of three articles written by the experts in the field of VBM. Looks like fee for service will be on life support, and then someone will pull the plug; of course, there will be exceptions for those with means.

—Ronald L. Fellman, MD, section editor

A Value-Based Medicine (VBM; Center for Value-Based Medicine) model for assessing the comparative effectiveness and cost-effectiveness of glaucoma therapy was presented at the American Academy of Ophthalmology Annual Meeting in New Orleans in 2013.[1] The model demonstrated that glaucoma therapy provides great benefit to patients by maintaining their vision, thus considerably improving their quality of life.[1] Glaucoma therapy was also noted to be highly cost-effective, yielding a large financial return on investment (ROI) to patients and insurers and increasing the overall wealth of the nation.

Although the concepts of VBM are intuitive, initially, the terminology can be foreign. To help clinicians grasp these concepts, *Glaucoma Today*'s "Landmark Studies" column will feature a three-part series to augment readers' understanding of the glaucoma model and the changes that will surely occur across medicine over the coming decade. The first article in this series provides an overview of the VBM model and primarily addresses patient value gain, a parameter defined in this article. The second installment will focus on health care costs, and the third will discuss a cost-utility model that demonstrates the considerable patient and financial value conferred by glaucoma interventions.

THE NEED FOR VBM ANALYSIS

Comparative Effectiveness Review No. 59 from the Agency for Healthcare Research and Quality did not find evidence that screening for open-angle glaucoma decreased vision impairment.[2] Comparative Effectiveness Review No. 60 on glaucoma therapy stated, "Although it is logical to presume that slowing glaucoma damage would lead to preservation of vision-related quality of life and reduction in visual impairment, this link has not been demonstrated in the research literature."[3]

Because such a statement in a report sponsored by a government agency could affect decisions regarding the allocation of medical resources, and because we feared a

repeat of the 1986 scenario in which Medicare officials considered stopping payment for glaucoma interventions, we performed a VBM cost-utility analysis comparing glaucoma therapy to no therapy. Our analysis used the best available evidence-based data and a transparent model that is logical to providers, patients, and decision makers.

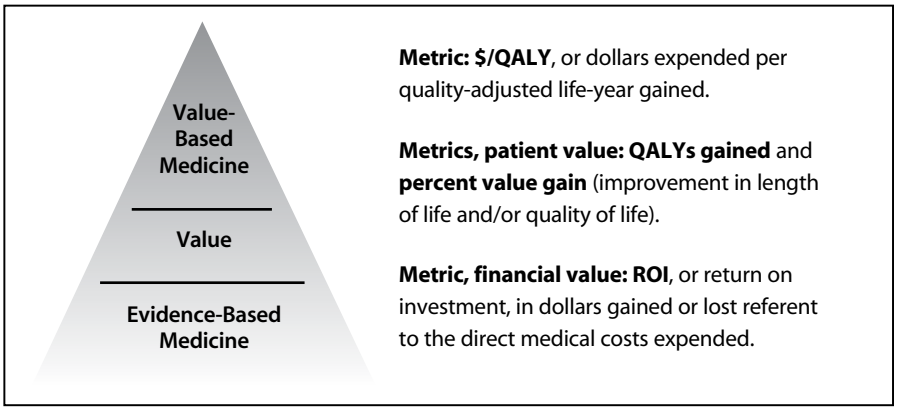

Figure. VBM triangle. Patient preferences (utilities) quantifying the quality of life associated with a health state are added to the best evidence-based medicine data to objectively measure patient value gain. Societal cost data are also integrated to quantify financial value, including the dollars gained from the therapy. Patient and financial value are combined at the top to assess the dollars expended for, and generated by, the patient value gained.[8]

EVIDENCE-BASED MEDICINE

Evidence-based medicine is the practice of medicine based upon the highest level of evidence. There are five levels of interventional evidence (Table 1).[4] VBM analyses typically incorporate the highest level of evidence available when evaluating an intervention, preferably level 1 interventional evidence.

Levels of Interventional Evidence

Level 1 evidence, or that based upon randomized clinical trials, typically has a type 1 study error (α) of less than or equal to 0.05, meaning that the chance of selecting a false positive, such as a cure for a disease when it is not really a cure, is less than or equal to 5%. The type 2 study error (β), the false negative, associated with level 1 interventional evidence is typically less than or equal to 0.20, meaning that the chance of missing a cure for the disease when it really exists is less than or equal to 20%. Level 2 evidence includes that from a randomized clinical trial when the type 1 error is greater than 0.05 and/or the type 2 error is greater than 0.20.

TABLE 1. LEVELS OF INTERVENTIONAL EVIDENCE[4]

Level of Evidence	Descriptor
1	Randomized clinical trial with type 1 (α) error < 0.05 and type 2 (β) error < 0.20, or a meta-analysis
2	Randomized clinical trial with type 1 (α) error > 0.05 and type 2 (β) error > 0.20
3	Nonrandomized clinical trial
4	Case series
5	Case report

Power

The power of a trial, or its ability to detect a relationship, equals (1.0 - type 2 error). Thus, if the type 2 error is 0.20, the power of a trial to detect an effect is (1 - 0.20 =) 80%. A meta-analysis often combines two or more randomized clinical trials that are underpowered to provide level 1 evidence.

Knowing the power of a clinical trial is important when the trial is negative. For example, in a pilot study demonstrating level 2 interventional evidence, Bressler et al[5] found that patients with subfoveal choroidal neovascularization fared no better after scatter laser photocoagulation than those who did not receive treatment. Assuming 40% of patients without treatment developed severe vision loss (for $\alpha = 0.05$ and $\beta = 0.20$), 83 patients would be needed in each treatment arm to detect a 50% reduction in severe visual loss. With just 29 patients in the laser treatment arm and 26 in the no-treatment group, the negative result in this study could be related to the trial's small sample size.[4]

VALUE-BASED MEDICINE

VBM is the practice of medicine based upon a health care intervention's *patient value gain*, defined as improvement in the quality and/or length of life, and *financial value gain*, defined as cost-effectiveness and the financial ROI for the direct medical costs expended.[6-11] VBM incorporates patients' opinions on quality of life with the highest level of interventional evidence available (Figure). It then integrates all costs associated

with interventions into a metric that allows a comparison of glaucoma intervention and patient and financial values with those of interventions across ophthalmology and all specialties of medicine on the same scale.

PATIENT VALUE GAIN

Quality of Life

Although many metrics are available to measure quality of life, preference-based metrics, or utilities, are used in VBM analyses because they are readily applicable across all medical specialties. We prefer time tradeoff utility analysis due to its demonstrated validity[12] and reliability (reproducibility).[13,14] Utilities are often referred to as *patient preferences*, because a patient can prefer to trade something of value (time of life, money, etc.) to improve his or her health state or to trade nothing and remain in the same health state (having one or more diseases).[8]

With time tradeoff utility analysis, a patient is asked two questions:

1. How long do you expect you will live?
2. What is the maximum amount of that time, if any, you would be willing to trade for a cure for your glaucoma (or other disease) so that you could live for the remaining time without glaucoma (or other disease)?

The utility is calculated by subtracting the proportion of time traded from 1.0. For example, if a person is willing to trade a maximum of 5 of his or her 20 remaining years of life to be rid of glaucoma, the associated time tradeoff utility is (1.0 - 5/20 =) 0.75. Utility anchors are 1.00 (permanent perfect health) and 0.00 (death). The closer a utility is to 1.00, the better the health state is, whereas the closer the utility is to 0.00, the poorer the health state is.

TABLE 2. TIME TRADEOFF VISION UTILITIES

Vision in the Better-Seeing Eye (unless otherwise noted)	Time Tradeoff Utility
20/20 OU permanently	1.00
20/20 OU with an ocular disease	0.97
20/20	0.92
20/25	0.87
20/30	0.84
20/40	0.80
20/50	0.78
20/70	0.72
20/100	0.69
20/200	0.62
20/800 (CF)	0.52
HM - LP	0.35
NLP OU	0.26
Death	0.00

Abbreviations: OU, both eyes; CF, counts fingers; HM, hand motion; LP = light perception; NLP, no light perception.

Ophthalmic (Vision) Utilities

Ophthalmic utilities most closely correlate with BCVA in the better-seeing eye (Table 2).[6,15,16] It is noteworthy that a diagnosis of an ocular disease, such as glaucoma, in the presence of 20/20 bilateral visual acuity drops the utility 3%, from 1.00 to 0.97. This occurs due to the patient's worry about the future of his or her vision. Assuming that the development of end-stage bilateral glaucoma is associated with a visual acuity of 20/800,[17] the utility is 0.52. Thus, the overall quality of life is approximately 50% that of a person with normal ocular health and no vision problems.[6] The degree of vision loss in the better-seeing eye, rather than the underlying condition, appears to correlate most highly with the utility.[6,8]

Systemic Disease Utilities

Ophthalmic utilities are directly comparable with systemic utilities. Examples of systemic utilities are shown in Table 3.

Visual Fields

To date, neither we nor other authors[18-21] have been able to convincingly demonstrate an association between mild to moderate visual field loss and a diminution in quality of life. Visual field loss, nonetheless, can be readily integrated into a VBM cost-utility model when that loss is definitively shown to decrease quality of life.

Total Patient Value Gain

Patient value gain is defined by an interventional improvement in the quality and/or length of life.[4] It is calculated by multiplying the utility gain by the number of years of interventional benefit. Because ophthalmic interventions rarely alter length of life, an improvement in quality of life is generally the relevant parameter used to quantify patient value gain.

The metrics for patient value gain include (1) quality-adjusted life year (QALY) and (2) percentage of patient

value gain. The QALY gain is calculated by the following formula: (utility gain) × (years of benefit) = QALY gain. For example, if an intervention prevents end-stage bilateral glaucoma (utility = 0.52) and allows a patient to maintain normal vision (utility = 0.97) for 8 years, the QALY gain is: (0.97 - 0.52) × 8 = 0.45 × 8 = 3.6 QALYs. To calculate the patient value gain, the QALYs accrued over time by a treated cohort and sham cohort are compared. Thus, if, over 20 years, the average person treated for glaucoma accrues 19.4 QALYs and the untreated person accrues 15.8 QALYs, the patient value gain from glaucoma therapy is: (19.4 - 15.8)/15.8 = 23%. For glaucoma therapy, the value gain is equivalent to the quality-of-life gain.

Discounting

All patient value final outcomes and costs are discounted, most typically at 3% annually.[8] Patient value gain is discounted because good health now is, theoretically, of greater value than good health in the future. Why? One reason is that good health now can be used to obtain financial resources that will compound over time. Similarly, a dollar now is worth more than a dollar in the future, because the former can be invested to compound and gain more dollars. Moreover, inflation decreases the future value of the dollar.

Standardization

VBM uses standardized cost-utility analysis to objectively measure patient and financial values. Although a number of excellent cost-utility (cost-effectiveness) analyses have dealt with glaucoma interventions, they are difficult to compare due to nonstandardized inputs.[22-24] Even one altered input can dramatically change an analysis, as evidenced by the fact that ophthalmologists underestimated the quality of life associated with macular degeneration, referent to patients with macular degeneration, by 96% to 750%.[25] We believe the utilities of patients who have lived with a disease should be the criterion, or gold standard, for the quality of life associated with that disease.

Cost-Utility Variables

The varying inputs for cost-utility analysis include different utility methodologies (time tradeoff, standard gamble, willingness-to-pay, multi-attribute, etc.), unlike utility respondents (patients, experts, physicians, administrators, caregivers, etc.), dissimilar cost bases (Medicare, commercial, blended, out-of-pocket, etc.), varying cost perspectives, discount rates, and others.[6] Researchers from the Center for Value-Based Medicine estimated that over 27 million different input variants can be integrated into a single cost-utility analysis.[26] Furthermore, Realini and Fechtner found that initial medical therapy for glaucoma can be undertaken in 56,000 different ways.[27] Thus, standardization is critical. With standardization, VBM cost-utility analysis can objectively measure which of the 56,000 possible initial medical therapies is the best by integrating clinical trial data and patient-based utilities to assess quality of life and quantify adverse events.[4] Once patient value gain is ascertained, the associated societal costs are added to evaluate which of the interventions that confer the same value is the least expensive. The patient value gain associated with an intervention

TABLE 3. SYSTEMIC TIME TRADEOFF UTILITIES

Disease	Time Tradeoff Utility[6]
Normal health	1.00
Systemic arterial hypertension, treated	0.98
AIDS, CD4 count 201-300	0.94
MI, mild	0.91
Diabetes mellitus	0.88
Angina, mild	0.88
Angina, moderate	0.83
MI, moderate	0.80
AIDS, CD4 count 0-50	0.79
Renal transplant	0.74
Cancer, breast, chemotherapy	0.74
Impotence and incontinence after TURP	0.60
Angina, severe	0.53
Renal disease, end-stage, home dialysis	0.49
MI, severe	0.30
Stroke, major	0.30
Death	0.00

Abbreviations: AIDS, acquired immunodeficiency syndrome; CD4, cluster of differentiation 4 (a glycoprotein found on the surface of T helper leukocytes); MI, myocardial infarction; TURP, transurethral resection of the prostate.

should always trump the associated costs.[8] Put another way, all patients deserve the interventions that confer the greatest patient value. Only when interventional patient values are the same should costs become a consideration.

FINANCIAL VALUE GAIN

The next article in this series will focus on financial value gain and cost-effectiveness. Additionally, we will discuss the novel concept of the financial ROI for the direct medical costs expended. William Nordhaus, an economist at Yale University, has suggested that 50% of the wealth created in the United States in the 20th century occurred secondary to medical advances.[28] Glaucoma therapy provides an excellent example of how the direct medical costs expended for therapy improve the wealth of the nation and provide a large financial gain to society, including patients and insurers. As Dr. George Beauchamp has stated, "Physicians are the producers of both patient and economic value."[29] ■

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