Volume 13 • Number 2 • 2010
VALUE IN HEALTH

Understanding the Medical and Nonmedical Value of Diagnostic Testing

David W. Lee, PhD,[1] Peter J. Neumann, ScD,[2] John A. Rizzo, PhD[3]

[1]GE Healthcare, Waukesha, WI, USA; [2]Center for the Evaluation of Value and Risk in Health, Institute for Clinical Research and Health Policy Studies, Tufts University School of Medicine, Boston, MA, USA; [3]Professor of Economics and Preventive Medicine; Director, The Center for Health Services & Outcomes Research, State University of New York at Stony Brook, Stony Brook, NY, USA

ABSTRACT

Objectives: To develop a framework for defining the potential value of diagnostic testing, and discuss its implications for the health-care delivery system.

Methods: We reviewed the conceptual and empirical literature related to the valuing of diagnostic tests, and used this information to create a framework for characterizing their value. We then made inferences about the impact of this framework on health insurance coverage, health technology assessment, physician–patient relationships, and public health policy.

Results: Three dimensions can effectively classify the potential value created by diagnostic tests: 1) medical value (impact on treatment decisions); 2) planning value (affect on patients' ability to make better life decisions); and 3) psychic value (how test information affects patients' sense of self). This comprehensive framework for valuing diagnostics suggests that existing health technology assessments may systematically under- or overvalue diagnostics, leading to potentially incorrect conclusions about cost-effectiveness. Further, failure to account for all value dimensions may lead to distorted payments under a value-based health-care system.

Conclusions: The potential value created by medical diagnostics incorporates medical value as well as value associated with well-being and planning. Consideration of all three dimensions has important implications for technology assessment and value-based payment.

Keywords: cost-effectiveness analysis, health-care decision-makers, health economics methods, value of information, willingness to pay.

Introduction

Health policy experts have called for a "value-based" US health-care system in which providers would compete for patients on the basis of price and quality, and payments would be based on value provided rather than costs [1]. Although the impact of such a system is uncertain, some have suggested that it could reduce overall US health expenditures by as much as 30% without adversely affecting medical outcomes [2]. Others note that value-based approaches could encourage employees to choose healthier lifestyles, higher-quality providers, and more effective treatments [3]. They may also help to rationalize drug benefits [4] and enhance patients' compliance with chronic medications [5]. As one observer recently noted, " 'value-based' is the preferred health care prefix of our era [6]."

The success of a value-based system hinges on valid definitions and measures of value across the spectrum of health-care services. This has largely been taken for granted, but there is not yet a shared meaning of "value" or systems in place capable of measuring it. Consider, for example, the current debate over advanced diagnostic imaging. Physicians cite new imaging techniques as an example of truly essential medical innovation [7,8]; however, some policymakers have questioned its value [9,10], and rapid growth in spending for diagnostic services in the Medicare program has led to congressionally mandated reimbursement cuts [11]. This disconnection between those convinced of imaging's value and those questioning it underscores the challenges of implementing a US value-based health-care system.

For surgical or pharmacological treatments, the concept of value is relatively straightforward. Life expectancy and quality of life have been measured—albeit with some controversy—using standard health technology assessment techniques [12]. But as Fryback and Thornbury have noted, these value measurement techniques are more difficult to apply to diagnostics because their clinical impact depends upon the sequelae of clinical interventions. In other words, diagnostics affect treatment decisions, and treatment decisions affect outcomes [13]. Asch et al. further observed that clinical impact alone is an insufficient measure of value for diagnostics because diagnostics also have the potential to affect patients' sense of psychic value whether or not they affect treatment [14]. For example, a diagnostic test for dementia may have relatively little impact on treatment or outcomes, but may have a substantial effect on the patient's psychic value.

This article has several objectives that contribute to the literature on the value of diagnostic tests. First, it seeks to highlight the potential value of diagnostic testing for medical decision-making. Second, the particular dimension of value on which we focus is the value of diagnostic testing in resolving patients' uncertainty about their medical conditions. This dimension of value—what we term the "value of knowing"—has been largely ignored in the cost-benefit literature. But it is important to recognize this dimension of value, both for more accurate economic evaluations of health-care treatments and technologies, and for appropriate design of health insurance policies. A third aim is to discuss the implications of this framework for policymaking, health technology assessment, optimal insurance design, the physician–patient relationship, and public health policy. Finally, we explore the obstacles to measuring the value of diagnostics, and offer some possible strategies for overcoming them.

Defining Value for Diagnostics

Conceptually, a diagnostic test can be defined as an information-gathering exercise in health-care delivery. This can range from a simple clinical assessment (e.g., observation, palpitation, blood

Address correspondence to: David W. Lee, GE Healthcare—Health Economics and Outcomes Research, 3000 N Grandview Boulevard, W-460, Waukesha, WI 53188-1696, USA. E-mail: david.w.lee@ge.com
10.1111/j.1524-4733.2009.00597.x

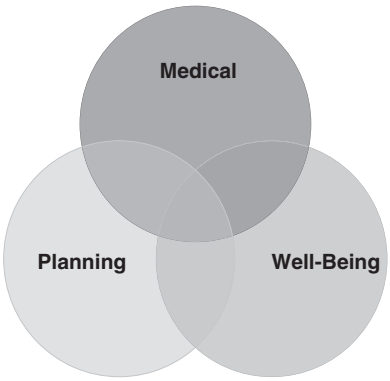

Figure 1 Dimensions of diagnostic value.

pressure check) to an advanced in vitro or sophisticated diagnostic imaging study. Regardless of type, diagnostics have the potential to create value along three dimensions (Fig. 1).

Medical Value

Medical value reflects a diagnostic's ability to inform clinical treatment. Examples include complete blood counts to detect disease; mammograms to detect breast cancer; x-rays to diagnose pneumonia; or magnetic resonance imaging to inform musculoskeletal surgical decisions. The medical value of diagnostics is typically evaluated using standard cost-effectiveness analysis methods when the diagnosis–treatment link is direct; however, patient preferences for treatment may not be well captured. A patient who knows she is at risk for dementia may forego a life-extending treatment with associated mortality or morbidity risks because she may not want to trade off high-quality current years for low-quality future years.

Planning Value

Planning value refers to a diagnostic test's ability to inform patients' about choices on reproduction, work, retirement, long-term health, financial plans, and so on. Research has suggested, for example, that many people would want to know early in life if there were a gene that predicted whether they would eventually contract Alzheimer's disease, even in the absence of preventative measures or treatment for the disease. On average, respondents to one survey stated that they would be willing to pay several hundred dollars for such a genetic test. When asked what they would do with the test information, respondents pointed to planning; for example, they would "sign advance directives, spend more time with family, get their finances in order, and/or buy long-term care insurance [15]."

Imagine a genetic test that could determine with certainty whether one will eventually contract Huntington's disease. From a medical treatment perspective, this test has little value because it does not affect treatment, but nevertheless, it could be highly valued by a patient concerned about childbearing if she is at risk for the disease based on family history. Even in the absence of formal tests, clinicians and genetic counselors may use their knowledge of genetics and epidemiology to help concerned families gauge their chances of contracting a disease and to plan accordingly.

Psychic Value

Psychic value captures how diagnostics can directly change patients' sense of satisfaction, and may yield either positive (good news) or negative (bad news) value [14]. Although perhaps the least-studied dimension of value, it could also be the most important, especially for certain medical conditions where treatment is unavailable or ineffective but knowledge of the disease can have a profound impact on one's sense of psychic value. Consider a patient with lower back pain who is extremely concerned that the pain may be indicative of a serious health-care condition, like cancer. Although the medical value of advanced imaging for initial, acute lower back pain is negligible [16], such a test may have a very large psychic value for the patient.

Differences in the relative importance of these three dimensions depend on the perspective of the affected party. For example, medical value is likely to be more heavily weighted by physicians based on their training, role in health-care decision-making, and the fact that they do not directly benefit financially from the pure value of knowing. Nevertheless, physicians would not be expected to completely ignore the value of knowing when they act as the patient's agent. In contrast, the patient is more likely to weigh the value of knowing and planning relatively more heavily than the physician. Finally, payers are likely to place the most weight on medical value and the least weight on planning or psychic value because, beyond the general need to keep customers satisfied with their health plan benefits, they receive little or no benefit from these nonmedical value dimensions.

Asch et al. provided perhaps the first conceptual treatment of the psychic value associated with diagnostics, which he coined "knowing for knowing's sake [14]." Asch et al. highlighted the importance of different psychological impacts associated with receiving equal amounts of good or bad news from a diagnostic test. Although traditional economic theory would suggest that patients apply the same value to equal increments of good and bad news, behavioral economics incorporates the well-documented phenomenon that patients are loss averse—they need to be compensated more for bad news than they are willing to pay for good news [17].

Recently, two of this article's authors built on this fundamental insight to create a more general conceptual model for measuring the psychic value of diagnostics, and used it to help explain patients' test-taking behavior [18]. The results of that analysis revealed that the pure value of knowing from diagnostic testing depends on test accuracy, pretest disease risk, the patient's discount rate, time to disease onset, the degree of a patient's worry about disease onset, and the patient's aversion to receiving bad news (loss aversion). As derived from that study, the pure value of knowing increases (testing becomes more likely) under certain conditions.

When tests are more accurate. The model predicted that less accurate tests would have lower value, especially when resolving inaccuracy is difficult or expensive. This result aligns with empirical research showing that patients place higher value on more accurate genetic tests for Alzheimer's disease [15], cancer [19], and Down's syndrome [20]. Not all empirical evidence, however, shows that accurate tests are more highly valued. Providing patients with information about test accuracy was shown to have no impact on willingness to pay for prostate cancer screening [21] or whole-body PET scans for cancer [22].

When pretest expectation of bad news is low or the bad news is not catastrophic or occurs far into the future. Consistent with findings in both cognitive science and behavioral economics, this result implies that patients value a diagnostic test most when the chances and consequences of a bad outcome are relatively small. In other words, patients tend to prefer tests that rule out rare

conditions, relatively benign diseases, or conditions that would not occur until far into the future.

When patients do not worry as much about the onset of future disease. Other things equal, patients who worry about a test result value it less because of the unpleasant prospects of having to "live with the disease." Rather than undergoing diagnostic testing to confirm or deny the presence of a disease, worried patients would prefer to remain ignorant by choosing not to be tested. Consistent with this prediction, surveys on genetic testing for Alzheimer's reveal that more than two-thirds of those respondents who say they would not choose to undergo the test cite concern over "living with the burden of the disease [15]."

Because psychic value is intangible and not observable in market exchange, this research points to methods for valuing intangible assets or public goods to quantify psychic value. Alternative analytical approaches for measuring psychic value include efforts to assess the value of knowing on quality of life, revealed preference approaches based on consumer and insurer purchases of diagnostic tests, and contingent valuation or "willingness to pay." Among these approaches, the contingent valuation technique has been identified as a potentially useful method for measuring the value of diagnostics [23]. The advantage of contingent valuation is that it captures not only the benefits from good news via willingness to pay for the test result, but also the harm from bad news via willingness to accept the loss from an unfavorable test outcome. By collecting both willingness to pay and willingness to accept measures, the contingent valuation method allows for a more comprehensive, albeit imperfect, assessment of value [24].

Practical Impact?

Diagnostic testing has the potential to create value in all three dimensions described earlier—medical, planning, and psychic value—but the distribution of value across these dimensions will vary from test to test. For example, the medical value of a diagnostic for diseases where treatment options are limited, such as Huntington's disease or Alzheimer's disease, is likely to be small relative to the value it creates for planning or patients' sense of psychic value. At the other extreme, the value from an x-ray to diagnose a fracture is likely to have high medical value, but little impact on patients' sense of psychic value. Although contingent valuation methods could apply to all diagnostic tests, it may be prudent to reserve them for those tests where the nonmedical value is likely to be substantial and missed by traditional technology assessment methods.

The net psychic value of a test may also be positive or negative, and will vary from patient to patient. Individual patients value good and bad news differently, have different degrees of loss aversion over bad test outcomes, and have varying degrees of worry about disease onset—each of which factors into their individual valuation calculus. For example, one study found that 7% of patients did not seek colorectal cancer screening because of fear of learning that they might have cancer [25].

The extent to which diagnostics affect patient psychic value also raises the possibility that diagnostics could be characterized, in some cases, as therapeutics. If a patient is anxious over the possibility that she may have HIV, Alzheimer's disease, or some other condition (the "worried well"), should he/she be prescribed an anxiolytic or a diagnostic test?

Policy Implications

Accounting for the value of diagnostic testing has potentially important implications for evaluating and financing medical treatments and technologies, physician–patient relationships, and public health policy. In this section, we elaborate on each of these issues.

Technology Assessment

Incorporating the psychic value of diagnostic tests into health technology assessments could significantly impact the estimated benefits of these technologies, and consequently the allocation of health-care resources. To the extent that diagnostic testing confers positive value, incorporating it into formal technology assessments would generally improve the cost-effectiveness of care that includes diagnostic tests. (To the extent that it confers negative value, cost-effectiveness, of course, would worsen.) From the standpoint of the efficient allocation of resources, moving toward more cost-effective interventions and away from cost-ineffective interventions would be highly desirable.

Yet, despite its potential importance, the value of knowing has typically not been included in economic evaluations of medical treatments and technologies, for several reasons. First, in some cases, the value of knowing may simply be too small to have a meaningful effect on technology assessments. For instance, Hirth and colleagues report that willingness to pay for diagnostic certainty was low for peptic ulcer disease [26]. In all likelihood, however, there are many instances where the value of knowing is much higher. Rizzo and Lee found, for example, that the value of knowing is substantial for highly accurate tests that can rule out the presence of serious illnesses having a low probability of occurrence [18]. An example would be imaging studies to rule out spinal cancer in patients with back pain. To be sure, the low probability of spinal cancer argues against imaging to rule out cancer; however, a full assessment of the test should incorporate its value to the consumer, which includes the value of diagnostic certainty.

Measurement issues present another barrier to using the value of knowing in technology assessments. Discrete choice experiments will be useful in helping to isolate the value of knowing versus the value of health gain from treatments. Nevertheless, obtaining accurate and reliable willingness to pay and willingness to accept measures is challenging, as incentives to misrepresent preferences, difficulty in placing dollar values on risks to life, and other potential sources of bias are well known [23,24]. Moreover, the value of knowing is likely to be quite disease-specific, and to depend on test cost, accuracy, and patient's preferences. Obtaining such information will be expensive and time consuming, but the same could also be said for efforts to estimate quality of life. Failure to develop and implement more accurate assessments of the value of knowing runs the risk of under- or overstating the worth of diagnostic tests, both from the patient and societal perspectives.

Payers may also be resistant to considering the value of knowing when making decisions about which treatments to include in benefit packages. Market competition should provide incentives for payers to meet the demands of their clients who do value "knowing for knowing's sake." But it may be difficult for individual patients to quantify the value of knowing. Only more and better evidence on the value of knowing, as well as better patient education, can hope to overcome this informational deficiency.

Optimal Insurance Design

Economic efficiency would require setting diagnostic payment such that marginal benefit equals marginal cost; however, benefit should be defined broadly to include medical, planning, and psychic value benefits. Alternatively, society may not wish to pay

for the full, nonmedical value of diagnostics. Instead, a system of cost sharing tied to the nonmedical value of the diagnostic could be employed. The result might be a value-based tiering system for diagnostic tests similar to one proposed for pharmaceuticals [4].

For payers who rely on technology assessment, this approach to understanding the value of diagnostic testing offers new insights into how to accurately assess the cost-effectiveness of treatments and, ultimately, how to design insurance plans. But even the traditional approach to health-care technology assessment of comparing procedure costs to medical benefits has been employed only to a limited degree to diagnostics [27], and has excluded the potential nonmedical value of diagnostics altogether. This omission could be particularly important in evaluating screening programs because even a very small nonmedical benefit summed over the vast majority of patients whose screening test is negative could significantly impact whether the screening technology is cost effective.

Physician–Patient Relationships and Public Health Policy

Our results suggest that physicians should be mindful of how they communicate pretest probabilities and the consequences of positive findings, as both directly affect the value of knowing, and hence patients' willingness to undergo testing. On average, patients will be more likely to undergo testing when their perceived chances of a "bad" test result are low and their perceptions about the adverse consequences of such a result are relatively benign. Test accuracy, and the likelihood of false negatives and false positives, also bear on how patients value these tests and should also be communicated to them carefully.

Understanding the value of knowing also has implications for public health policy. For example, public health initiatives for mass screening may be able to achieve higher compliance rates by more accurately communicating pretest probabilities as well as information on the consequences of receiving a diagnosis of the disease. In particular, it is well known in the experimental psychology literature that people systematically overestimate the probability of rare but frightening events, such as earthquakes. This is also likely to be the case for dreaded diseases like cancer, especially rare but deadly forms of it. Furthermore, because the psychic value of a screening test is inversely related to the adverse consequences of detection, screening adherence rates have the potential to be improved if the real or perceived consequences of having the object disease are lower. As an example, our framework would suggest that development of improved HIV treatment would lead to increased screening. Overall, health education to assist the public in understanding pretest probabilities and health-care consequences associated with public health issues would be very valuable.

Finally, policymakers must be aware that tests that confer psychic value to the patient may also promote unhealthy lifestyles. For example, normal liver enzymes in a patient that abuses alcohol, normal cholesterol tests for an obese patient, and a clear chest x-ray in a smoker may provide incentives to continue to engage in unhealthy lifestyles.

Conclusions

There are many challenges in incorporating all dimensions of diagnostic value—medical, planning, and psychic value—into health-care technology assessments. Nevertheless, failure to do so runs the risk of biasing economic evaluations, leading to the misallocation of health-care resources. This problem will only become more widespread as the number of new diagnostic tests proliferates. Thus, it is now critical to consider strategies that promote more and better evidence on the value of knowing, and to use this information in health-care technology assessments. These strategies include promoting and financing research on the value of knowing, and educating government and payers that the value of knowing may really matter to patients.

In terms of research, more empirical evidence is needed. Such evidence may be obtained using a willingness to pay, willingness to accept framework, as outlined by Rizzo and Lee [18]. Ideally, this effort should be disease-specific, and should recognize consumer heterogeneity; that is, consumers will likely place differential value on "knowing for knowing's sake" because they differ in terms of their attitudes toward risk, time preference, the extent to which they will worry about adverse future outcomes, and other dimensions. Obviously, funding will be required to realize this research agenda. Given the public interest in quantifying this outcome, public funding sources may play a key initial role in helping to refine methodologies to ascertain evidence on the value of knowing and promoting initial surveys that are designed to assess the value of knowing for specific diseases and tests.

Psychic value from knowing may also be present in other types of medical services apart from diagnostic tests. For example, seeing a specialist may be reassuring even if it has no effect on treatment. Similarly, a placebo effect from a drug may confer psychic value although it does not improve medical outcomes.

Enabling the transformation to a broad value-based system will require well-grounded measurements of the value of all health-care services, including diagnostics. Building on the conceptual framework presented here, it should be possible to measure the value of diagnostics with better accuracy than current methods permit. Doing so can support more effective payment policies, technology assessments, clinical decisions, and public health campaigns.

Source of financial support: Research supported by GE Healthcare. Publication was not contingent on GE Healthcare's approval.

References

1 Leavitt M. Leading the way: a conversation with HHS secretary Mike Leavitt. Interview by Leonard D. Schaeffer. Health Aff (Millwood) 2008;27:w52–9.
2 Garber A, Goldman DP, Jena AB. The promise of health care cost containment. Health Aff (Millwood) 2007;26:1545–7.
3 Lee PV, Hoo E. Beyond consumer-driven health care: purchasers' expectations of all plans. Health Aff (Millwood) 2006;25: w544–8.
4 Kleinke JD. Access versus excess: value-based cost sharing for prescription drugs. Health Aff (Millwood) 2004;23:34–47.
5 Chernew ME, Shah MR, Wegh A, et al. Impact of decreasing copayments on medication adherence within a disease management environment. Health Aff (Millwood) 2008;27:103–12.
6 Robinson JC. Slouching toward value-based health care. Health Aff (Millwood) 2008;27:11–12.
7 Looking back on the millennium in medicine. N Engl J Med 2000;342:42–9.
8 Fuchs VR, Sox HC Jr. Physicians' views of the relative importance of thirty medical innovations. Health Aff (Millwood) 2001;20:30–42.
9 Medicare Payment Advisory Commission. A Data Book: Healthcare Spending and the Medicare Program. June 2006.
10 Herb Kuhn (director, Center for Medicare Management, Centers for Medicare and Medicaid Services, U.S. Department of Health and Human Services). Statement on Payment for Imaging Services under the Medicare Physician Fee Schedule before The House Subcommittee on Health Committee on Energy and Commerce, July 18, 2006.

11 Moser JW. The deficit reduction act of 2005: policy, politics, and impact on radiologists. J Am Coll Radiol 2006;3:744–50.
12 Gold MR, Siegel JE, Russell LB, Weinstein MC. Cost-Effectiveness in Health and Medicine. New York: Oxford University Press, 1996.
13 Fryback DG, Thornbury JR. The efficacy of diagnostic imaging. Med Decis Making 1991;11:88–94.
14 Asch DA, Patton JP, Hershey JC. Knowing for the sake of knowing: the value of prognostic information. Med Decis Making 1990;10:47–57.
15 Neumann PJ, Hammitt JK, Mueller C, et al. Public attitudes about genetic testing for Alzheimer's disease. Health Aff (Millwood) 2001;20:252–64.
16 Jarvik JG, Deyo RA. Diagnostic evaluation of low back pain with emphasis on imaging. Ann Intern Med 2002;137:586–97.
17 Kahneman D, Tversky A. Prospect theory: an analysis of decision under risk. Econometrica 1979;47:263–91.
18 Rizzo JA, Lee DW. To test or not to test: what is the value of knowing? 30th Annual Meeting of the Society for Medical Decision Making, Philadelphia, PA; October 18, 2008.
19 Phillips KA, Van BS, Marshall D, et al. A review of studies examining stated preferences for cancer screening. Prev Chronic Dis 2006;3:A75.
20 Ryan M, Diack J, Watson V, Smith N. Rapid prenatal diagnostic testing for Down syndrome only or longer wait for full karyotype: the views of pregnant women. Prenat Diagn 2005;25:1206–11.
21 Yasunaga H. Willingness to pay for mass screening for prostate cancer: a contingent valuation survey. Int J Urol 2008;15:102–5.
22 Yasunaga H, Ide H, Imamura T, Ohe K. The measurement of willingness to pay for mass cancer screening with whole-body PET (positron emission tomography). Ann Nucl Med 2006;20:457–62.
23 Bayoumi AM. The measurement of contingent valuation for health economics. Pharmacoeconomics 2004;22:691–700.
24 Hanley N, Ryan M, Wright R. Estimating the monetary value of health care: lessons from environmental economics. Health Econ 2003;12:3–16.
25 Denberg TD, Melhado TV, Coombes JM, et al. Predictors of nonadherence to screening colonoscopy. J Gen Intern Med 2005;20:989–95.
26 Hirth RA, Bloom BS, Chernew ME, Fendrick AM. Patient, physician, and payer perceptions and misperceptions of willingness to pay for diagnostic certainty. Int J Technol Assess Health Care 2000;16:35–49.
27 Otero HJ, Rybicki FJ, Greenberg D, Neumann PJ. Twenty years of cost-effectiveness analysis in medical imaging: are we improving? Radiology 2008;249:917–25.