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Irving Shapiro; Matthew D. Shapiro; David W. Wilcox

The American Economic Review, Vol. 89, No. 2, Papers and Proceedings of the One Hundred Eleventh Annual Meeting of the American Economic Association. (May, 1999), pp. 333-337.

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Quality Improvement in Health Care: A Framework for Price and Output Measurement

By IRVING SHAPIRO, MATTHEW D. SHAPIRO, AND DAVID W. WILCOX*

Health care is one of the most problematic areas of price and output measurement. This paper highlights several central and interacting aspects of health-care measurement. First, the decision of whether to have a treatment is based not on the flow utility of the treatment in any given period, but on the benefits that can be expected to accrue over a lifetime. Second, health care is subject to enormous ongoing technical change that both improves efficacy of treatment and can reduce patient burden. Technical change can interact with the durability of health care to affect not just the extent of treatment, but its timing within the course of a disease. Third, insurance, third-party payment, and managed care lead to a dearth of market-based price and quantity data for studying supply and demand and for quantifying price and quantity change. This paper presents a framework for studying how the demand for durable medical treatments is affected by changes in the technology of treatment. It then suggests how this framework can guide construction of price indexes for health care that take into account changes in the quality of treatment.

I. Framework for Assessing Cost and Benefits of Durable Medical Interventions

Medical problems often have long-lasting impacts on well-being. Likewise, treatment of

medical problems often have durable effects. It is well understood in the literature on evaluating the net benefits of medical care that these benefits must be accrued over time to appropriately evaluate the intervention. Figure 1 shows a stylized representation of the net benefits.¹ Age is measured on the horizontal axis. An index of well-being is measured on the vertical axis. The solid line shows well-being without treatment. The dashed line shows well-being with the treatment. The vertical line indicates the age of treatment, T . The area $B(T)$ indicates the cumulative difference between pre- and post-treatment well-being.

The benefits displayed in Figure 1 need to be balanced against the cost of treatment to determine the timing of a medical intervention. Denote the pecuniary cost of the treatment as P . Owing to the prevalence of third-party payment and insurance, the pecuniary dimension of cost typically weighs little in the decision to have a medical intervention. Denote the function mapping the actual unit cost of the treatment into the cost that bears on the decision to treat a patient as $X(P)$. The form of $X(P)$ will depend on parameters faced by the patient (e.g., co-payments) and on how costs are taken into account by health-care providers.

Additionally, there may be substantial non-pecuniary costs that are borne by the patient. These include pain, risk of side-effects, and a period of recovery from the intervention. Denote these as $C(T)$, where the dependence on the date of treatment can reflect the patient's preference for postponing an intervention.

The timing of the intervention (if any) will depend on integrating an expression such as

* Irving Shapiro: Phillips Eye Institute, Minneapolis, MN 55403; Matthew D. Shapiro: Department of Economics, University of Michigan, Ann Arbor MI 48109, and NBER; Wilcox: U.S. Department of the Treasury, Washington, DC 20220. The views expressed herein are not necessarily those of the U.S. Department of the Treasury or other members of its staff. Matthew Shapiro gratefully acknowledges the support of the NIA through the Michigan Exploratory Center on Aging. The authors benefited from discussion with Zvi Griliches during the early stages of this project and from comments by David Meltzer. The views expressed in this article are those of the authors alone and should not be attributed to any of the institutions with which they are affiliated.

¹ Such figures are common in the literature on valuing outcomes of medical interventions. See Marthe Gold et al. (1996) for a general discussion and Michael Drummond (1988) for an application to cataract treatment.

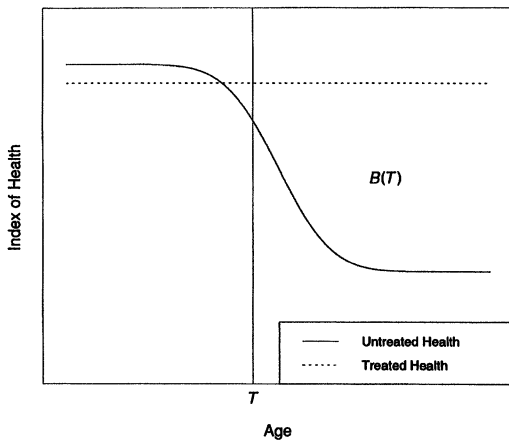


FIGURE 1. BENEFITS OF TREATMENT

$$V = B(T) - C(T) - X(P)$$

over possible realizations of health states and possible changes in the techniques of treatment.² There is uncertainty and heterogeneity for the course of the disease and for the outcome of the treatment given the state of the art of treatment. Moreover, given the rapid technical change, there is an incentive to defer interventions to take advantage of such improvements. As with all options, this uncertainty tends to defer the intervention. Therefore, the patient and health-care provider must make a forward-looking decision at each point in time. There is no necessary relationship between the timing of the intervention and the flow comparison of well-being with and without treatment. The intervention might take place before, at, or after the point where the pre- and post-treatment well-being lines cross in Figure 1, or perhaps it might never occur.

Technical change in the medical treatment can have several effects. First, the dotted line will shift upward with improved outcomes, or downward if they worsen. Second, technical change can affect both pecuniary and nonpecuniary costs in either direction. Assuming that technical change increases the value of

treatment, V , the presumption is that more treatment will occur. The increase in treatment can take the form of more patients being treated and the treatment occurring earlier in the course of disease.

Our work shows how technical change has increased the treatment of cataract (see Shapiro et al., 1998). A cataract operation that once required a hospital stay of up to a week is now a brief outpatient procedure. Subsequent recovery from the operation is much faster. Postoperative results have dramatically improved, and complication rates have declined. Intraocular lenses have replaced cumbersome cataract spectacles or contact lenses. These changes have led to a substantial increase in the rate of cataract extraction. In just the past two decades, the rate of cataract surgery among individuals in the United States over 65 years old has increased by almost a factor of four.

The operation is being carried out much earlier in the course of the disease. Prior to the widespread use of intraocular lenses (before the 1980's), it was uncommon to do a cataract operation when the better eye had fairly good visual acuity. Currently, visual acuity in the better eye is 20/60 or better in the majority of cases (see Shapiro et al., 1998 table 3). Consequently, the flow benefit at the point of the typical operation is substantially less than it was prior to the widespread use of intraocular lenses. In the era when the operation was postponed until visual impairment was significant, the immediate benefit of the operation was much higher. But as the analysis underlying Figure 1 makes clear, this comparison is very misleading. For some patients, having the operation avoids a potentially long period of progressively worsening vision until they would have become candidates for surgery under the criterion for the earlier techniques.

There are many other examples where technical change, interacted with the dynamics of disease, has affected the timing of medical interventions. Angioplasty and joint replacement have seen substantial improvements in techniques, resulting both in more interventions and interventions earlier in the course of disease.

The increased incidence of treatment that can occur when the patient burden from the procedure falls may not always be beneficial.

² See David Meltzer (1998) for a closely related discussion that highlights some of the difficulties of such calculations.

Laparoscopic removal of gall bladders allows for much more rapid recovery than the traditional operation. Michael Chernew et al. (1997) suggest that this decline in patient burden has led to some operations that proved unnecessary.

II. Lessons for Price and Output Measurement

The analysis of the previous section can be used as an organizing framework for measurement. In this section, we will briefly discuss the importance of defining the good to be quantified in the context of health care. We will then discuss how changes in the net benefits from health-care interventions might be measured in order to make adjustments for quality.

Implicit in the discussion of the previous section is the definition of the health-care good as the treatment of a particular disease or condition. While this is a quite natural way to measure health care, until recently this thinking was not reflected in official statistics. Instead, the price indexes for health care in the Bureau of Labor Statistics's (BLS) producer price index (PPI) and consumer price index (CPI) were constructed by measuring the cost of fixed bundles of inputs. Cutler et al. (1998) and Shapiro et al. (1998) show how this approach can, for the examples of heart attack and cataract, substantially misrepresent actual price change. In the case of cataract, the traditional BLS approach implies a price increase of almost 10 percent per year for the 1969–1994 period. Taking into account the substantial fall in inputs required for the treatment cuts the rate of price increase by more than half.

The BLS has made substantial progress toward moving away from pricing inputs toward pricing treatments.³ In much of the PPI for hospital services and, more recently, in a fraction of the CPI, the BLS samples hospital bills for a fixed diagnosis and then each month reprices the items on the bills. By moving to pricing bills for a diagnosis, the BLS has made a major step toward defining the health-care good as the treatment of a disease. The pro-

cedure of repricing a fixed bill, rather than drawing a new bill each month for a fixed diagnosis, does have the drawback of potentially missing changes in quality or price that occur when the means of treatment for a diagnosis change. The pricing protocol calls for adjusting the bills when changes occur, but it remains to be seen how effective this procedure is in practice. At last report, no such adjustments have been made.

Pricing the treatment will provide a unit value index P . Absent any change in quality of the treatment, this could be a direct input into a price index.⁴ But as emphasized in the previous section, the benefit provided by a treatment changes over time owing to changes in the outcome and patient burden. To control for change in quality, it is necessary to measure the net benefit, $B(T) - C(T)$, and adjust the change in unit cost P for increases or decreases in the net benefit of the treatment. We consider several methods for evaluating the net benefits.

1. *Willingness To Pay: Direct Evidence.*—

To the economist, the most compelling evidence about the value of a service is actual willingness to pay. With health care, such data are very hard to come by. With insurance and third-party payment, the consumer faces little, if any, of the unit price P . Even when there is some variation in the price faced, estimates of the net benefit, $B(T) - C(T)$, would be confused with the function X relating the unit cost to actual price borne by the consumers. Moreover, in the United States, to the extent that there is variation in $X(P)$ cross-sectionally, it is likely to be systematically correlated with nonrandom characteristics, such as insurance coverage.

For cataract, we are aware, however, of one study on the cross-sectional willingness to pay, based on patients in Canada and Europe who had the option of queuing for surgery at public clinics or paying for an operation at a private

³ See Dennis Fixler and Mitchell Ginsburg (1998) for the PPI and Ina Kay Ford and Daniel Ginsburg (1998) for the CPI.

⁴ Of course, it could not be a direct input into a demand system, owing to the weak relationship between unit value and the pecuniary cost born by the consumer, denoted by the function X . This function is not relevant, however, for measuring the price and quantity of medical services actually provided.

clinic. About one-fifth of the sample elected to pay privately (roughly \$1,000) to accelerate surgery, typically by half a year to a year (see Gerald Anderson et al., 1997).⁵ Evidence such as this provides a quite direct means of valuing the first slice of the integral of net benefits depicted in Figure 1.

2. *Survey Evidence from Patients.*—Surveys of patients can provide a much broader database than actual data on willingness to pay. These data will be subject to the standard objections concerning the incentives to give meaningful answers and the ability of subjects to conjecture about decisions they might make. Nonetheless, they form the basis for a substantial literature on valuing outcomes. There are two broad approaches to valuing outcomes. *Contingent valuation*, which has been applied in many areas in addition to health, asks for survey respondents to value hypothetical outcomes. *Quality-adjusted life years*, which are widely used in studying the cost-effectiveness of health care, are based on respondents balancing a shorter lifetime in perfect health versus a longer lifetime with a health problem. Both of these approaches have substantial difficulties, leading to apparently inconsistent valuations and valuations that are not robust to changes in the framing of the question, and so on. Nonetheless, owing to the scarcity of actual data on willingness to pay, there appears to be little alternative to the survey-based approach.

3. *Expert Knowledge.*—Even with a well-developed database of patient valuations of health states, there remains a substantial role for researchers and experts in valuing changes in quality of health care. In particular, patient valuations of health states need to be combined with estimates of objective efficacy of treatment.

4. *Uncertainty and Heterogeneity.*—This combining of patient assessment of the value of outcomes and expert assessment of the effects of treatments must take into account the hetero-

geneity and uncertainty of both the outcome of the treatment and the progress of the disease absent treatment. The case of cataract is instructive. As noted above, the improvements in treatment have led to cataracts being removed much earlier in the course of the disease, when symptoms are relatively minor. For some patients, the cataract would progress to create more substantial vision problems. For others, its symptoms would have remained relatively minor. The benefit $B(T)$ for these groups of patients would be quite different. Even if the course of disease for a particular patient is difficult to predict, estimates of the average benefit should take into account the distribution of the course of disease in the population.

For cataract, the rates of complication are quite low, and the postoperative results are relatively predictable. Hence, most of the uncertainty in calculating the benefits arises from the untreated state. For other diseases, such as cancer, the uncertainty is greater with respect to the outcomes of treatment. For many diseases (e.g., stroke, heart attack, hypertension, depression), the uncertainty and heterogeneity are substantial for both the treated and untreated states.

III. Recommendations and Conclusions

We conclude by recommending how the statistical agencies might apply the framework discussed in this paper to the practice of price measurement. The Bureau of Labor Statistics should continue its progress toward considering the treatment of a diagnosis as the good to be priced, instead of its historical practice of pricing fixed bundles of inputs. In implementing this procedure, the BLS should rapidly incorporate changes in treatments that it prices. These changes in treatments should be reflected in the level of the price index.

The statistical agencies, in cooperation with researchers and health professionals, need to develop standard metrics for adjusting the price of treatments for changes in quality. The BLS already cooperates with hospital administrators in selecting and pricing bills for treatments, and in quantifying the amount actually received after discounts provided to third-party payers. The BLS also assists in identifying sampled bills where the treatment has changed and making

⁵ Apparently, quality of treatment at the public clinics matches that at the private ones, although their level of amenities (beyond the queue) probably differ.

adjustments. We recommend that knowledgeable health-care professionals assist in identifying when such changes have occurred and making any adjustments.

More broadly, the statistical community needs to launch an effort to create a widely accepted database of values of health-care outcomes that could be used to adjust prices of treatments when their outcomes change. Rather than attempt to make these adjustments from scratch on a diagnosis-by-diagnosis basis, we suggest the following two-stage approach. First, standard values should be assessed for broad dimensions of impairments (low vision and blindness, loss of hearing, pain, impaired mobility, etc.) as well as mortality. These values would provide a metric for the net benefits, $B(T) - C(T)$. Since these values are presumably time-invariant, this first stage would only need to be carried out once, although it might be revisited periodically. Second, specialized panels should then provide the clinical assessment of how new treatments affect outcomes along these broad dimensions. These assessments would correspond to the pre- and post-treatment health states depicted in Figure 1. These assessments should not be expressed simply as expected values, but as a set of possibilities, with probabilities assigned to different paths of outcomes. This second stage would need to be an ongoing process with expert panels monitoring changes in treatment and issuing the assessments of changes in outcomes. Finally, the statistical agencies would then use the expert assessments of outcomes from the second stage and the agreed-upon values from the first stage to calculate how new treatments change expected net benefits. This procedure would provide for consistency across types of diagnosis. While such adjustments would be controversial and subject to uncertainty, such drawbacks should not serve as an excuse for ignoring quality change in health care.

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