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By S. Eckermann

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THE UNIVERSITY OF NEW SOUTH WALES

Measuring performance consistent with evidence-based medicine in practice

Simon Eckermann, Flinders University

Abstract

It is generally recognised that measures of health care performance should reflect the value of quality of care, as well as the costs of quality of care. However, the specification of effects in performance measurement needs to be consistent with an appropriate underlying objective for such performance measures to be meaningful and create appropriate incentives for quality of care. An index has recently been proposed by a team from the Centre for Health Economics at the University of York (Dawson et al, 2005) to include health effects and other indicators of quality of care in measuring the performance of the UK National Health System (NHS). The implicit objective underlying this index of relative performance measurement is shown in this paper to be minimising average cost per unit effect (average cost-effectiveness). An objective of average cost-effectiveness for relative performance comparison has, however, been rejected in health technology assessment (HTA) for failing to reflect the incremental and patient specific nature of effects of health care. Under these characteristics, maximising net benefit has been established in HTA as a more appropriate objective. An alternative specification of effects under the net benefit correspondence theorem (Eckermann, 2004) is illustrated to allow efficiency measures consistent with maximising net benefit. Coverage and comparability conditions of this theorem are also shown to provide a robust theoretical framework to prevent measuring cost-shifting and cream-skimming as performance improvement.

Keywords: efficiency, quality of care; maximising net benefit

Simon Eckermann
A/Professor in Health Economics
Flinders Centre for Clinical Change and Health Care Research,
Repatriation General Hospital, Daw Park SA 5041, Australia
e-mail: simon.eckermann@flinders.edu.au

Introduction

It is generally recognised that it is desirable in measuring the performance of a health system to allow for the quality as well as the quantity of care within that system (Newhouse 1970; Harris 1978; Evans 1981; Newhouse 1994; Smith 2002; Eckermann 2004). A method has recently been proposed by a team from the Centre for Health Economics at the University of York to measure the output and performance of the NHS allowing for quality of care (Dawson et al., 2005). Central to their proposed method is a Laspeyre output index taking the form:

$$I_{yt}^{xq} = \frac{\sum_j x_{jt+1} \sum_k \pi_{kt} q_{kjt+1}}{\sum_j x_{jt} \sum_k \pi_{kt} q_{kjt}} \qquad (1)$$

where;

x_{jt} is the volume of output j in period t;

q_{kjt} is the amount of characteristic k produced by a unit of j and;

π_{kt} is the marginal value of outcome k.

In assessing the appropriateness of this proposed method for including quality, an important question to be addressed is "what implicit objective function underlies performance measurement using this index?"

What objective underlies the index of Dawson et al.(2005)?

In the simplest case of a single volume output (admissions say) and single effect (survival say), the value terms π_t in the numerator and denominator of (1) cancel, leaving the volume of output (x_t) multiplied by the amount of quality characteristic per output (q_t). This further simplifies to the amount of the quality characteristic observed, denoted by Q_t in the final expression of equation (2). For example, the number of admissions multiplied by survival rate per admission equals the number of survivors.

$$I_{yt}^{xq} = \frac{\pi_t x_{t+1} q_{t+1}}{\pi_t x_t q_t} = \frac{x_{t+1} q_{t+1}}{x_t q_t} = \frac{Q_{t+1}}{Q_t} \qquad (2)$$

Now, in measuring performance for the simplest case where inputs are represented by cost, a performance index based on the output index in (2) can be re-expressed as the ratio of average cost effectiveness ratios:

$$\frac{Q_{t+1}}{Q_t} / \frac{C_{t+1}}{C_t} = \frac{C_t}{Q_t} / \frac{C_{t+1}}{Q_{t+1}} \qquad (3)$$

Therefore, using the output index proposed by Dawson et al (2005) in performance measurement has, in the simplest case, an underlying objective function of minimising average cost per unit effect or average cost effectiveness.

Is average cost effectiveness an appropriate underlying objective for health care?

An underlying objective of average cost effectiveness has been widely rejected by health economists in comparing relative performance of alternative health care strategies as part of processes of health technology assessment. Health economists have rather advocated the reporting of incremental cost effectiveness ratios for consideration by decision makers against threshold values (Weinstein and Fineberg, 1980; Drummond et al. 1987, 1997) or, more recently, the equivalent but explicit objective of maximising net benefit (Claxton and Posnett, 1996; Stinnett and Mullahy, 1998). Formally, incremental net monetary benefit (INMB) over time is represented by the monetary value of incremental effects (ΔE) less incremental costs (ΔC):

$$INMB = k \times \Delta E - \Delta C \quad (4)$$

Where k is the monetary value per unit effect.

Maximising net benefit, unlike minimising average cost per unit effect, reflects the incremental nature of costs and effect relative to alternative treatment (even if doing nothing) and the specific (non-tradable) nature of health effects to the population treated. Under these characteristics, a lower average cost effectiveness ratio is not always preferred to a higher average cost effectiveness ratio[1], however, a higher net benefit is preferred to a lower net benefit (Eckermann 2004: 134-139). To illustrate, consider a simple example where for one activity and one effect (survival) we compare average cost effectiveness and net benefit across time.

A simple illustrative example

Let the survival rate (adjusted for differences in patient population risk factors and mortality beyond separation) improve from 90% to 95% over time, while the real cost per admission (adjusted for risk factors at admission and costs beyond separation) increases from \$900 to \$1000. Further, assume the value of avoiding a death is \$100,000.

Therefore, net monetary benefit per admission increases over time by \$4,900 (\$100,000×0.05-100). However, in measuring performance based on average cost effectiveness there would be a 5.55% increase in effect (0.95/.90), an 11.11% increase in costs (1000/900) and hence a net reduction in performance of 5.55%. While net

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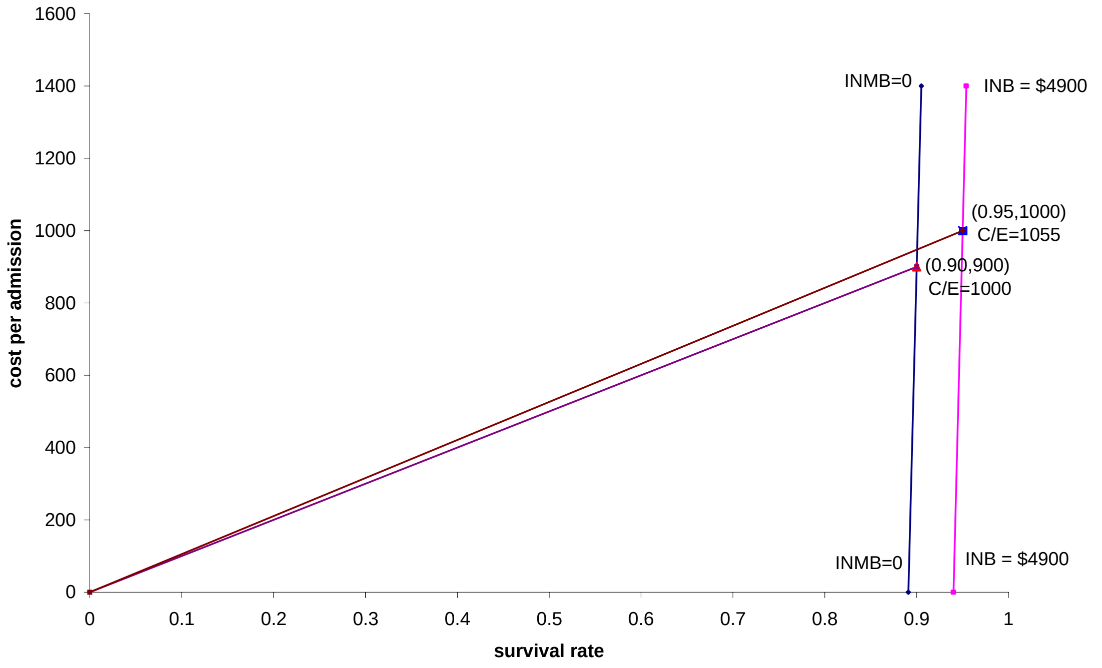
[1] The specific nature of health effects to a population implies that a lower ratio of incremental cost per unit incremental effect would also not always be preferred to a higher ratio.

benefit has increased over time, performance measurement based on the index of Dawson (2005) is measured as having decreased. This is made graphically clear in figure 1, where:

1. Average cost per unit effect (slope of ray from origin) increases and hence performance measurement under the index of Dawson et al (2005) falls, but;
2. Measuring incremental net monetary benefit relative to the initial period, the later periods cost and effect lies on a line representing a $4900 higher net benefit, reflecting the greater value of a 5% higher survival rate than the $100 greater cost in the later period.

Figure 1: Comparing perfromance with average cost effectiveness and incremental net benefit (k =$100000 / life saved)



Performance measurement with the proposed index method of Dawson et al.(2005) represents an underlying objective of minimising average cost per unit effect which unlike the maximisation of net benefit established in HTA, does not recognise the incremental and specific nature of effects in patients treated. If performance measures are to be consistent with health technology assessment and support evidence-based medicine in practice then the objective underlying performance measurement should be consistent with maximising net benefit, rather than minimising average cost per unit effect.

Efficiency measurement consistent with maximising net benefit

The net benefit correspondence theorem (Eckermann, 2004:77-99) provides a method for ratio measures of performance consistent with an underlying objective of maximising net benefit. This theorem states that there is a one to one ordinal and cardinal correspondence between maximising net benefit per service, and minimising costs per service plus effects valued as in net benefit, but framed as disutility rates (mortality, morbidity, life years or QALYS lost), where the following conditions are satisfied:

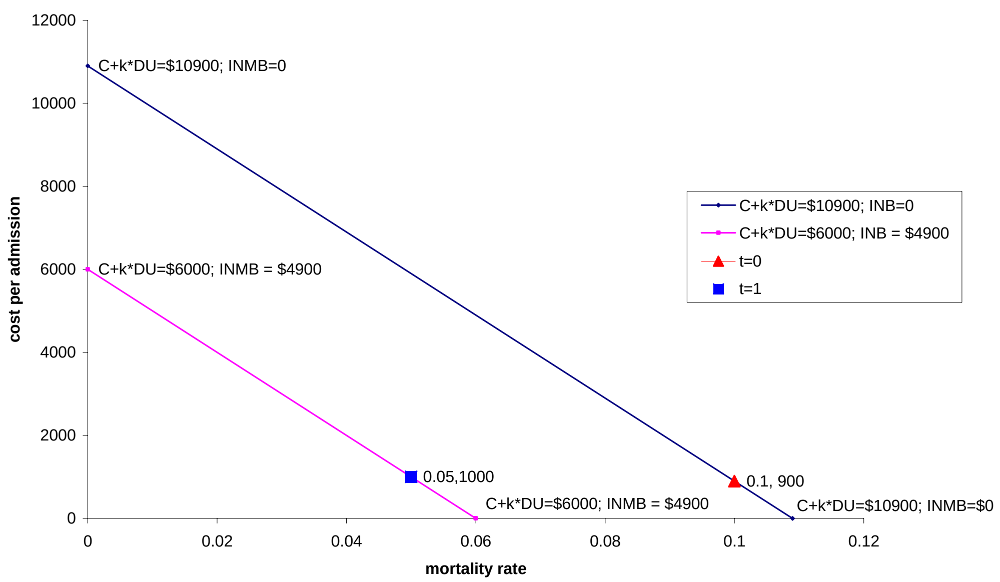
(i) measured disutility rates covers effects of care (coverage condition);

(ii) differences in risk factors at point of admission are adjusted for (comparison condition).

This correspondence allows relative performance over time to be simply measured by comparing the costs plus value of effects framed from a disutility perspective (mortality, morbidity, functional limitation, life years or QALYs lost) at each time period. A lower value corresponds with higher net benefit and hence better performance.

Applying the correspondence to measuring performance over time for our simple illustrative example, the survival rate increased from 90% to 95% implying the mortality rate reduced form 10% to 5%, while costs per admission increased from $900 to $1000. Cost plus value of disutility is therefore initially $10,900 (0.1×100000+900), reducing to $6,000 (0.05×100000+1000). This reduction in the cost plus value of disutility of $4900 corresponds to an increase in net benefit of $4900. This is illustrated in figure 2 on the cost-disutility plane.

Figure 2: Applying the net benefit correspondence theorem for radial measurement of perfromance consistent with maximsing net benefit (NB) in the cost-disutility plane



In figure 2 the increase in net monetary benefit and net effectiveness benefit are represented by the distance closer to the origin of the later periods net benefit line, measured on the vertical and horizontal axes, respectively. That is, the improvement in net monetary benefit of $4,900 per patient on the vertical axis, at a value of effects of $100,000 per survivor, can be expressed as an equivalent improvement in survival (net effect benefit) of 4.9% on the horizontal axis.

In considering relative performance on the cost-disutility plane, equi-proportional contraction to the origin (reducing costs and disutility by the same proportion) unambiguously increases net benefit. Hence, radial properties are present in comparison of net benefit on the cost-disutility plane and ratio measures of performance consistent with maximising net benefit can be constructed.

In comparisons across time, performance indices consistent with maximising net benefit are simply constructed in the case of a single activity and single effect (e.g. mortality) as a Laspeyre[2] index of the form:

$$I_t^{cxd} = \frac{C_t / x_t + k_t d_t / x_t}{C_{t+1} / x_{t+1} + k_t d_{jt+1} / x_{t+1}} \qquad (5)$$

where

x_t is the volume of output (admissions) in period t;

d_t is the measured effect framed as a disutility event (e.g. mortality) in period t;

k_t is the marginal value of the measured effect in period t;

C_t is the cost in period t.

Applying this index to our simple example, a productivity index set to 100 at the initial period increases to 181.67 (10,900/6000×100) in the later period. An index based on the net benefit correspondence theorem would therefore estimate an 81.67% improvement in performance, reflecting the value of halving the mortality rate while increasing cost per admission by $100. This compares with a 5.55% fall in

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[2] To avoid potential biases from change in relative prices over time, a Fischer index constructed as the geometric mean of a Laspeyre index using initial period value weights (k_t) and a Paasche index using later period weights (k_{t+1}) might ideally be used, rather than the Laspeyre index implicit in equations 1 and 4.

performance measured under the method proposed by Dawson et al.(2005), reflecting a higher average cost effectiveness ratio.

More generally, the linear nature of the net benefit statistic enables the performance index with single outcome in equation (5) to be simply extended to a multiple (j) effect case, as identified in Eckermann (2004: 208-210) and shown in equation (6)[3].

$$I_t^{xcd} = \frac{C_t / x_t + \sum_j k_{jt} d_{jt} / x_t}{C_{t+1} / x_{t+1} + \sum_j k_{jt} d_{jt+1} / x_{t+1}} \qquad (6)$$

Correspondence conditions and avoiding perverse incentives

The net benefit correspondence theorem allows efficiency measurement consistent with maximising net benefit with a simple transformation where effects are framed from a disutility rather than utility bearing perspective and relative performance is compared in the cost-disutility plane. Hence, where data on costs and effects of care are available this correspondence provides an alternative specification to current methods such as that of Dawson et al (2005), which unlike these methods allows efficiency measurement consistent with maximising net benefit.

The coverage and comparison conditions of the net benefit correspondence theorem also, however, provide a theoretical framework to prevent cost-shifting and cream skimming being measured or interpreted as performance improvement. To illustrate the robustness of this framework, consider what is required to avoid cream- skimming

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[3] Aggregation across activities akin to that in equation (1) can also be simply undertaken by summing across numerator and denominator arguments, or by weighting relative performance using standardised industry cost shares to avoid the Fox (1999) aggregation paradox, as illustrated in Eckermann (2004: 35-37).

and cost-shifting being measured as performance improvement and hence perverse incentives being created by performance measures.

Incentives to choose patients with lower expected costs and higher expected effects (cream-skim) will be created by performance measures unless differences in expected cost and effects of care present at point of admission are adjusted for. Adjustment of costs and effects for patient risk factors at point of admission are, however, also required to satisfy the common comparison condition. In our simple example the adjustment of the rates of costs and effects per admission for predictive patient risk factors satisfies the common comparator condition and prevents incentives for cream-skimming. However, if risk adjustment was not undertaken and hence the common comparison condition were not satisfied, relative performance measures would include and hence create incentives for, cream skimming. Therefore, in general, satisfying the common comparator condition is necessary and sufficient to prevent cream skimming being measured as performance improvement.

Similarly, unless effects beyond separation are adjusted for in performance measurement, incentives are created for practices such as early release of sick patients, with expected negative effects on health outcomes and consequent expected increase in health care use post-discharge (cost-shifting). However, allowing for such effects beyond point of separation is also required to satisfy the coverage condition. In our simple example, including mortality and costs per patient to a common time point post admission prevents cost and effect shifting being measured as performance improvement and satisfies the coverage condition. However, if actual or expected effects beyond point of separation were not included, performance measurement should be qualified by performance measurement including, and hence creating incentives for cost and effect shifting. In general, satisfying the coverage condition is necessary and sufficient to prevent incentives for cost and effect shifting.

Satisfying coverage and correspondence conditions are necessary and sufficient to prevent incentives for cost-shifting and cream skimming, and would be required to prevent these incentives whatever framework is proposed (Eckermann 2004:119-145). The comparator and coverage conditions therefore create an explicit theoretical framework for performance measurement, which identifies conditions under which cost-shifting and cream-skimming are avoided and qualifies analysis when these conditions are not satisfied.

Conclusion

In conclusion, while including quality aspects of care in measuring the performance of the health care system is important, the specification of quality in performance measures should be consistent with an appropriate underlying objective. Performance measurement with the method proposed by Dawson et al (2005) for specifying and valuing quality has been demonstrated in this paper to be consistent with an objective of minimising average cost per unit effect (average cost effectiveness). An underlying objective of average cost effectiveness in relative performance measurement is, however, problematic in health care in failing to reflect the incremental and patient specific, non tradeable nature of effects. These characteristics have lead to an objective of net benefit maximisation being preferred to minimising average cost per unit effect (average cost effectiveness) in comparing the relative performance in processes of health technology assessment, underlying evidence based medicine.

Application of the net benefit correspondence theorem to performance measurement in the cost disutility plane has been shown to allow the preferred objective of maximising net benefit in efficiency measures of health system performance over time. Satisfying correspondence conditions of this theorem have also been shown to be necessary and sufficient to avoid the measurement of cost-shifting and cream-skimming as improved performance, providing a robust theoretical framework absent with alternative methods.

Application of the net benefit correspondence theorem to health system performance measurement over time in the cost-disutility plane is therefore suggested to offers two distinct advantages over the method proposed by Dawson et al. (2005):
(i) efficiency measurement consistent with net benefit maximisation underlying evidence-based medicine, rather than average cost effectiveness and;
(ii) correspondence conditions of comparison and coverage provide a robust theoretical framework to avoid measurement of cream-skimming and cost-shifting, respectively, as improvement in performance.

The correspondence theorem also offers advantages when applied in comparing the relative performance of multiple strategies in health technology assessment or the relative efficiency of health care providers. In health technology assessment radial properties present in the cost-disutility plane offer distinct advantages in construction of efficiency frontiers over that in the incremental cost effectiveness plane, where they are absent, as shown by Eckermann, Briggs and Willan (2006). In comparison of providers, construction of frontiers in the cost-disutility plane enable policy makers to decompose economic efficiency consistent with maximising net benefit into sources of technical, allocative and scale efficiency, as illustrated by Eckermann (2004:77-99) in comparing hospital performance.

References:

Dawson D. Gravelle H., O'Mahony M,, Street A., Weale M., Castell A., Jacobs R. et al. (2005) Developing New approaches to Measuring NHS Outputs and Activity: Final Report. CHE Research Paper 6. http://www.york.ac.uk/inst/che/publications/rp.htm

Drummond M.F., O'Brien B.J., Stoddard G.L. and Torrance G.W. (1997). Methods for Economic Evaluation of Health Care Programmes. 2nd ed. Oxford UK: Oxford University Press.

Eckermann S, 2004. Hospital Performance Including Quality: Creating Economic Incentives Consistent with Evidence-Based Medicine. Ph.D. Dissertation, University of New South Wales. http://www.library.unsw.edu.au/~thesis/adt-NUN/public/adt-NUN20051018.135506/.

Eckermann S, Briggs A, Willan A. (2006). Health Technology Assessment in the Cost-Disutility Plane. CAER 2006 Working Paper no 5. http://www.caer.unsw.edu.au/CAER_WP_series.html

Evans R.G, 1981. Incomplete Vertical Integration: The Distinctive Structure of the Health Care Industry. In: Health, economics and Health Economics, J. Van der Gaag and M. Perlman (Eds.), Amsterdam, North Holland, 329--354.

Fox K.J. (1999). Efficiency at different levels of aggregation: public vs. private sector firms. Economics Letters 65:173-76.

Harris J.E, 1977. The Internal organization of hospitals: some economic implications. The Bell Journal of Economics 8, 467--482.

Newhouse J, 1994. Frontier Estimation: How useful a tool for health economics? Journal Of Health Economics 13, 317--322.

Newhouse J, 1970. Towards a Theory of Non-Profit Institutions: An Economic Model of a Hospital. American Economic Review 60(1), 64--74.

Smith P, 2002. Measuring health system performance. European Journal of Health Economics 3, 145--148.

Stinnett A.A. and Mullahy J. (1998). Net Health Benefits: a new framework for the analysis of uncertainty in cost effectiveness analysis. Medical Decision Making 18 (2 suppl.): S65-S80.

Weinstein M.C. and Fineberg H.V. (1980). Clinical Decision Analysis. W.B. Saunders: Philadelphia.