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Incorporating Equity–Efficiency Interactions in Cost-Effectiveness Analysis—Three Approaches Applied to Breast Cancer Control

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ABSTRACT

Background: The past decade, medical technology assessment focused on cost-effectiveness analysis, yet there is an increasing need to consider equity implications of health interventions as well. This article addresses three equity–efficiency trade-off methods proposed in the literature. Moreover, it demonstrates their impact on cost-effectiveness analyses in current breast cancer control options for women of different age groups.
Methods: We adapted an existing breast cancer model to estimate cost-effectiveness and equity effects of breast cancer interventions. We applied three methods to quantify the equity–efficiency trade-offs: 1) targeting specific groups, comparing disparities at baseline and in different intervention scenarios; 2) equity weighting, valuing low and high health gains differently; and 3) multicriteria decision analysis, weighing multiple equity and efficiency criteria. We compared the resulting composite league tables of all approaches.
Results: The approaches show that a comprehensive breast cancer program, including screening, for women below 75 years of age was most attractive in both the group targeting approach and the equity weighting approach. Such control programs would reduce disparities with 56% and at €1908 per equity quality-adjusted life-year gained. In the multicriteria approach, a comprehensive treatment program for women below 75 years of age and treatment in stage III breast cancer were most attractive, with both an 82% selection probability, followed by screening programs for the two age groups.
Conclusion: In the three equity weighing approaches, targeting women below 75 years of age was more cost-effective and led to more equitable distributions of health. This likely is similar in other fatal diseases with similar age distributions. The approaches may lead to different outcomes in nonfatal disease.
Keywords: breast cancer, equity–efficiency trade-off, health economics methods, Markov model.

Introduction

The distribution of the disease burden [1,2] and treatment benefits [3,4] are frequently an area of health economics research. In breast cancer, control studies reveal differences in disease burden by race [2], urbanization [5], socioeconomic status [6], and insurance status [7]. These studies typically report disparities in incidence, prevalence, stage distribution, and disease mortality. In some studies, differences in quality-adjusted life expectancy are calculated [8]. One may distinguish three ways of equity reporting [9].

First, one may observe differences in health outcomes, such as life expectancy, quality of life, and incidence of a condition. Second, disparities may be reported in the provision of health care with those with a more severe condition receiving less, i.e., vertical equity. Third, inequities may be related to dissimilar use of health care for individuals with the same health, i.e., horizontal equity [9]. These three types of equity are interrelated, as utilization of health care is related to health outcomes, and both are related to difference in access. In all cases, inequalities may be reduced through the provision of additional health care to underprivileged groups, for example, by differential reimbursement of health packages [10].

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Descriptive and distinct information about health disparities and cost-effectiveness estimates in relation to health interventions may be available and may give insight. Yet, due to the descriptive nature, its use in health policy, addressing equity and efficiency, is limited. Such a broad approach to evidence-based priority setting in health programming would use efficiency information on available strategies, as well as their potential for reducing existing disparities. Without this, reduction of inequalities as a policy goal remains a matter of intuition and debate, rather than of systematic evaluation. If so, still, interventions may have differential effects on the distribution of health depending on the way health inequalities are actually defined, measured, and addressed.

Methodological studies on the use of equity considerations in cost-effectiveness analysis and its effect on health inequalities are reported [11–15]. Nevertheless, comparisons of the impact of these methods in economic evaluation have, so far, not been done, and any application in breast cancer control is absent. We distinguished three different methods that can be potentially beneficial in priority setting: targeting specific groups, equity weighting [13], and multicriteria decision analysis [11,16].

The aim of the article is to show the potential and the impact of these approaches in the use of cost-effectiveness analysis, e.g., by government agencies responsible for the selection of health benefit packages. Such processes may have yet to become more explicit, transparent, and thorough if equity implications are to be considered similarly as and parallel to cost-effectiveness analyses. Our perspective is societal and governmental, given the nature of any operational equity–efficiency approach.

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We explain three approaches in the method section and relate them to the underlying theory. Subsequently, we demonstrate their application in cost-effectiveness analyses, aiming at a rank order of optional interventions. We apply the equity-incorporating approaches for breast cancer control evaluations using an existing breast cancer life table model [17], addressing the existing controversy in breast cancer control options by age groups. Differentiating breast cancer control options by age is subject to debate [18–20].

Methods

We first describe three equitability approaches; subsequently, we summarize the use and application of the existing World Health Organization (WHO) breast cancer model and the combined equity and cost-effectiveness analysis.

Equity Approaches

Targeting specific groups. The first method we identified for the integration of distributive and economical impact of health interventions is simply targeting specific groups. This method shows how disparities between groups in breast cancer burden can be reduced through interventions in specific population subgroups, e.g., on the basis of insurance status [21]. The first step in the analysis is identical to the measurement of systematic differences by subgroups, usually defined by an indicator of social economic status. The second step involves selecting an intervention which addresses the difference between those specific subgroups. This means that it is necessary to determine what causes these differences in the first place and in which way they can best be diminished. One or more scenarios can then be constructed in which the targeted group of patients receives the intervention and the remaining group receives the usual level of care. The analyses show the potential improvement in health outcomes of groups of patients both in absolute (increase in health) and relative (reduction of inequalities) terms.

Equity weighing. Equity weighting [13] is based on the concept of the rank-dependent quality-adjusted life-year (QALY) model [12]. This method aggregates QALY gains from health interventions over a person's lifetime. In traditional health utility analyses, aggregation is straightforward, assigning equal valuation to each QALY gained. Nevertheless, policymakers may want to discriminate between various subgroups when choosing health interventions and may want to give more weight to health gains achieved in relative worse-off groups. Equity weighting quantifies these preferences by assessing the rank of the beneficiaries in the distribution of health. In this approach, the valuation of QALYs is nonlinear, which makes it possible to assign extra weight to the worst-off. The social value of a QALY profile (i.e., the distribution of health) is then given by:

$$\sum_{i=1}^{n} \pi_i U(q_i), \tag{1}$$

where π_i is the weight given to the QALY score q for individual i. The nonlinearity is shown by the function $U(q_i)$ instead of q_i. In this approach, the objective is to maximize Equation 1 instead of health as described in Equation 2 [13]:

$$\sum_{i=1}^{n} q_i \tag{2}$$

We assess the values of q_i in different scenarios and compare results with and without equity weighting, using both Equations 1 and 2. We use values of equity weights from the Dutch setting [13].

Multicriteria decision analysis. Multicriteria decision analysis reflects societal preferences for a number of characteristics of health programs in addition to cost-effectiveness, such as severity of the disease and the average age of the targeted population [11]. The full set of criteria [16,22,23] describes the most important aspects of a health intervention. The preferences of society are then measured through a conjoint analysis. First, respondents are simultaneously presented with two health interventions described by the full set of criteria, i.e., a profile. From these two interventions, they are asked to pick the most attractive one. A statistical analysis is then used to determine the relative importance of each criterion, reflected by a beta coefficient. Using these coefficients, the attractiveness of every intervention described by the full set of criteria can be calculated. The attractiveness of each profile is measured as the probability of selection. Using the probability of selection, different interventions can be ranked in a composite league table.

We will use criteria and coefficients from multicriteria investigation among Health Technology Assessment (HTA) policymakers [23]. The general regression equation is:

$$P = \frac{EXP\left(\beta_0 + \sum_{k=1}^{8} \beta_k \times X_k\right)}{1 + EXP\left(\beta_0 + \sum_{k=1}^{8} \beta_k \times X_k\right)}, \tag{3}$$

where β_0 is a constant, k indicates one of the eight dummy variables (i.e., six criteria of which two have three levels instead of two), and X_k indicates the score of the scenario on the dummy variable (i.e., either 0 or 1).

As discussed above, all three approaches deal with costs, effects, and equity in a different way. Some approaches describe equity implications more thoroughly than others. Although some use all cost-effectiveness data, others limit themselves in that regard. Yet all of them ultimately have the same goal: providing an informed equity–efficiency trade-off by ordering health interventions in a composite league table. Table 1 summarizes the way the three approaches incorporate the different aspects of health interventions. For illustrative purposes, a characterization of traditional health technology assessment is given as well.

Breast Cancer Model

We adapted an existing, standardized WHO method to arrive at comparative estimates in a broad cost-effective analysis to a multitude of interventions that is now under the name of the Choosing Interventions That Are Cost-Effective (CHOICE) program [27]. The existing breast cancer model based on this method [17] was adapted in such a way that it is suitable to incorporate the three equity approaches. The breast cancer model distinguishes four breast cancer stages defined according to the guideline definitions of the American Joint Committee on Cancer [24]. Breast cancer stages discern with regard to incidence, prevalence, case–fatality ratio, and health state valuation. We used age-specific epidemiological data for the European region from the Global Burden of Disease Studies [25]. Using age-adjusted data by breast cancer stage [17], we computed age and stage-specific prevalence, incidence, and mortality rates to estimate survival by disease stage. The age-adjusted estimates are provided in Table 2.

Cost estimates were also derived from the original study by Groot et al. We updated the cost prices to reflect 2007 prices by