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PARTIALLY WRONG? PARTIAL EQUILIBRIUM AND THE ECONOMIC ANALYSIS OF PUBLIC HEALTH EMERGENCIES OF INTERNATIONAL CONCERN

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SUMMARY

We argue that traditional health economic analysis is ill-equipped to estimate the cost effectiveness and cost benefit of interventions that aim at controlling and/or preventing public health emergencies of international concern (such as pandemic influenza or severe acute respiratory syndrome). The implicit assumption of partial equilibrium within both the health sector itself and – if a wider perspective is adopted – the economy as a whole would be violated by such emergencies. We propose an alternative, with the specific aim of accounting for the behavioural changes and capacity problems that are expected to occur when such an outbreak strikes. Copyright © 2008 John Wiley & Sons, Ltd.

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INTRODUCTION

Guidelines for the economic evaluation of health-care interventions (i.e. cost-effectiveness, cost-utility and cost-benefit analysis) often have statements indicating that all 'relevant' costs and benefits should be taken into account and that these should be estimated by their opportunity costs (Weinstein *et al.*, 1996; Hjelmgren *et al.*, 2001). However, what these opportunity costs are in practice remains a moot point, and what costs and benefits are relevant would be expected to vary by disease and intervention. For instance, in the UK guidelines (National Institute for Health and Clinical Excellence (NICE), 2004),

> [paragraph 5.6.1.2, page 25]: Given the perspective in the reference case, it is appropriate for the financial costs relevant to the NHS/PSS to be used as the basis of costing, even though these may not always reflect the full social opportunity cost of a given resource, and
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> [paragraph 5.6.2.1, page 25]: Although not part of the reference case, there will be occasions where non-NHS/PSS costs will be differentially affected by the technologies under comparison. In these situations, the Institute should be made aware of the implications of taking a broader perspective on

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costs for the decision about cost effectiveness. When non-reference case analyses include these broader costs, explicit methods of valuation are required. In all cases, these costs should be reported separately from NHS/PSS costs.

As in the NICE guidelines, most guidelines stress the importance of direct health-care costs to express a health-care system or payer's viewpoint (Hjelmgren *et al*., 2001). In doing so, the use of salaries, tariffs, charges, market prices and DRG-based hospital costs as an approximation to opportunity costs is widely accepted as standard practice for costing (Commonwealth Department of Health and Ageing, 2002; National Institute for Health and Clinical Excellence (NICE), 2004; Canadian Agency for Drugs and Technologies in Health, 2006; College voor Zorgverzekeringen, 2006). The Dutch guidelines is one of the few to state that both direct and indirect costs within and outside of health care need to be taken into account in the reference case, but that (College voor Zorgverzekeringen, 2006 [Directive 5, p. 8, translated]), 'The indirect costs within the health-care sector that are not related to the specific treatment, should not be taken into account.'

In most guidelines, however, indirect time costs (productive and/or non-productive time) are acceptable only if included as an optional – clearly separable – part of the analysis (insofar they are not already included as quality-adjusted life year (QALY) losses in the denominator of the cost-effectiveness ratio), and here there is debate over which method for estimating these costs should be used (e.g. human capital versus friction cost method) (Koopmanschap *et al*., 1995; Weinstein *et al*., 1997; Hjelmgren *et al*., 2001).

Health economic evaluation as generally practiced is a *partial equilibrium* analysis (Olsen and Smith, 2001). Although any change in activity (such as investing in a health programme) will generate ripples throughout the health-care sector as well as the wider economy, the analyst effectively seals off part of the economy (when adopting a societal perspective) or part of the health-care sector (when adopting a health-care payer's or sector's perspective) by invoking 'ceteris paribus'. This approach is often defended on the basis that a change in an individual's health status has only a small impact beyond the costs and benefits incurred by that individual, their health-care provider, insurer, employer, family and friends (i.e. people and instances considered 'relevant' in traditional health economic evaluation). Costs resulting from the patient's illness, but incurred by other third parties (e.g. opportunity costs caused by a reduction in demand for certain services outside the health sector or a decrease in health-care services capacity), are assumed to be small and are, therefore, typically ignored. Similarly, a change in health-care resource allocation for a single health-care intervention is usually assumed to have little impact on economic activities outside the health-care sector.

This discussion paper explains that this assumption of partial equilibrium in both health sector and wider economy is violated by a certain class of health problem, namely public health emergencies of international concern. The paper defines what is meant by such emergencies (or 'outbreaks' in short here), explores the application of traditional analysis in this context and then presents the case for a wider assessment.

WHAT ARE PUBLIC HEALTH EMERGENCIES OF INTERNATIONAL CONCERN?

The World Health Organization (WHO)'s definition of public health emergencies of international concern involves five criteria (based on an understanding of what the disease is as well as its context) (Hardiman and Adreano, 2006): (1) unknown or unusual illness, (2) serious health impact when acquired, (3) risk of international disease spread, (4) risk of interference with international travel or trade and (5) need for international assistance to assess the event or to implement adequate control measures. This definition primarily applies to infectious diseases (although the WHO acknowledges that these emergencies could arise from non-infectious causes, such as a tsunami), as do some of the arguments we develop below. Potentially lethal emerging infections, such as severe acute respiratory syndrome (SARS) or pandemic influenza, provide well-known examples.

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WHY THE STANDARD APPROACH MAY NOT SUFFICE?

Infectious disease emergencies of international concern typically have wide impacts on the health service (above and beyond those parts of the health service concerned with treating the cases and halting the outbreak) and the economy as a whole. That is, they may violate the assumptions of partial equilibrium, irrespective of whether a health sector or societal perspective is adopted. When shifts in the prevalence of health problems cause the (temporary or long run) impairment of health system functioning, then this will affect patients who do not have the disease in question as well as those who do. Under these circumstances, there is clearly a need for health economic evaluations to recognize this impairment, as the opportunity cost of the disease in question includes the reduction in services offered to other patients. For example, during an influenza pandemic, doctors, hospitals and mortuaries would be stretched over their maximum capacity to cope with the sudden increase in demand. Governments may be able to partially offset such sudden surges in demand by implementing emergency procedures through which temporary health-care units could be installed (although surge capacity is unlikely to be sufficient during a pandemic) (Menon *et al*., 2005; Itzwerth *et al*., 2006; Schull *et al*., 2006). Nonetheless, the traditional approach to estimating opportunity cost would multiply caseload by cost per case (with average cost per case typically estimated in the absence of an outbreak, often based on the average charges for a clinical case). We argue that such an approach would be wrong in this case because substantial opportunity costs would be ignored.

Additionally, the presence of a health threat can influence the general expectations and behaviour of consumers and investors and, therefore, have an impact far beyond the direct reduction in productivity from sick patients (Sadique *et al*., 2007). For instance, for SARS, it has been observed that by far the largest economic impact occurred by reduced (local and international) travel and reduced engagement in non-vital consumption activities (e.g. restaurants and bars) as well as postponement of consumption of other goods (i.e. mostly durable goods) (Keogh-Brown and Smith, in press). Although there is room for modified travel and communication strategies, much travel cannot be postponed (commuting being the most obvious), and e-mail and conference calls are increasingly considered suboptimal in many business environments (see, for instance, (Egan, 2007)).

Hence, we argue that ignoring consumers' and investors' adaptation to public health emergencies would undermine the utility of economic analysis in this context (for an illustration of these effects in plausible pandemic influenza scenarios for the UK, see Keogh-Brown *et al*., in revision).

A BROADER 'LESS PARTIAL' FRAMEWORK

Estimating the opportunity cost of an epidemic

A sudden increase in patients with a severe disease (for ease of argument, we will use pandemic influenza as an example) is likely to have an impact on prioritization in various health-care settings. Health-care workers would be expected to have less time, on average, per patient and may not be able to treat, accommodate, nurture or counsel all patients presenting (i.e. those with and those without flu) as required. Trivial treatments and much elective surgery would be postponed, partly to free up capacity, partly to try and avoid unnecessary contact of other (often elderly and vulnerable) patients with influenza cases in the health-care environment and partly because health-care workers themselves are most likely to be exposed and, therefore, absent from work (exacerbating the capacity problem). One could speculate that the health-care workers who continue to work, work longer hours, or that retired health-care workers might help out. However, these emergencies have the ability to make up to 50% of the population seriously ill in a matter of months. It seems highly unlikely that such spontaneous adaptive behaviour would solve, under each plausible outbreak scenario, the capacity problems that would arise.

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The above delays to treatment would not be valued within a 'standard' economic evaluation, when partial equilibrium is assumed within the health-care sector as traditionally prescribed. However, these postponements do represent an opportunity cost for the patients involved. These losses could be valued using utility scores for ill-health states over the extended duration of non-treatment. Losses in QALYs from postponement of treatment can be derived based on such utility scores, combined with estimates of the extent by which postponement of treatment for different illnesses would occur under various epidemiological scenarios. To estimate this potential 'capacity gap', patterns of demand for health-care services (e.g. seasonal hospital bed use) are needed, along with their cost functions (e.g. at what level of increased hospital bed demand would a new ward or hospital be needed?) and estimates of the demand during an outbreak. Costs can also be attributed to such QALY losses based on the principle of an explicit willingness to pay criterion for a QALY gained (or existing ceiling ratio (e.g. €40 000 per QALY gained), which could be deduced from past decisions) (George *et al.*, 2001; Devlin and Parkin, 2004; Smith and Richardson, 2005). In a pandemic situation (when equilibrium would be disturbed), the product of this willingness to pay per QALY gained and the QALY loss of postponing treatment for particular patients for a given period of time (for instance, based on information from waiting lists) would represent the opportunity costs of postponing particular interventions over that time period. This also implies that a 'breakpoint' would exist at which the opportunity cost of not treating existing health problems is greater than the benefit from treating flu cases. In the pre-pandemic situation, the optimal level of additional capacity can thus be determined as a function of where this breakpoint would be for various scenarios and their likelihood of occurring.

Health economic evaluation as it is practiced today would ignore these aspects. The incidence of infection and the severity of associated disease caused by outbreaks may be such that ignoring these aspects produces misleading results when assessing the cost effectiveness of interventions to avoid or mitigate them.

Incorporating the consequences of modified risk perceptions and behaviour

Illness has an indirect impact on productivity through absenteeism and may well result in other non-health-care expenses to patients, their employers and insurers. These would normally be accounted for to some extent in a standard economic analysis from the societal perspective. However, public health emergencies of international concern may also lead to risk-modifying behaviour (as observed for SARS (Sadique *et al.*, 2007)). Risk perceptions and associated risk-modifying behaviour influence consumption and investments and the economic impact of an outbreak, in and outside the health-care sector (Keogh-Brown and Smith, in press). In addition, the response to the epidemic at the individual and governmental levels results in increased absenteeism beyond what would be expected from illness itself. For instance, increased absenteeism may be expected due to risk avoidance behaviour (prophylactic absenteeism) or through closure of educational facilities. These different consequences should be integrated in appropriate models that aim at estimating the cost-effectiveness of interventions to control and prevent disruptive outbreaks. To achieve this, changes in behaviour and their economic consequences should be studied by assessing revealed behavioural changes (and the associated economic impact) during past disruptive outbreaks (Keogh-Brown and Smith, in press) and stated behaviour and risk perceptions from surveys (de Zwart *et al.*, 2006; Smith, 2006; Sadique *et al.*, 2007). Using such information, along with broad macroeconomic data (e.g. input–output tables and social accounting matrices), the shocks to the economy of various outbreak scenarios can be estimated by macroeconomic modelling (e.g. with a computable general equilibrium model (Smith *et al.*, 2005; Keogh-Brown *et al.*, in revision) or a G-cubed model (Lee and McKibben, 2004)). These macroeconomic models could thus provide the societal costs of various outbreak scenarios, as predicted by epidemiological models. Such costs could be estimated on a global scale, or more specifically per country, or per group of countries (e.g. EU15, EU27, OECD) depending on which level of societal perspective is deemed

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relevant for policy makers. Cascade effects resulting from health shocks can thus be estimated across sectors and economies.

CONCLUSION

We argue that traditional health economic analysis is ill-equipped to estimate the cost effectiveness and cost benefit of interventions that aim at controlling and/or preventing public health emergencies of international concern (such as pandemic influenza). The implicit assumption of partial equilibrium within both the health sector itself and – if a wider perspective is adopted – the economy as a whole would be violated by such emergencies. We propose an alternative, with the specific aim of accounting for behavioural changes and capacity problems that occur when such an outbreak strikes and far-reaching control measures are taken. The problems we identified are indicative of the limitations inherent to the very foundation of cost-benefit analysis (and arguably cost-effectiveness analysis). Indeed, cost-benefit analysis, as a local solution within a partial equilibrium model, assumes flexibility in all commodities (which is violated when resources are incapacitated in the short run) and relies on remaining within the neighbourhood of the current equilibrium state. The sheer scale and the range of an emergency of international concern would perturb the general equilibrium. Since traditional health economic forms of evaluation are being used to inform decisions about controlling and preparing for these emergencies, they do not appear to be fit for purpose.

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