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Stephen Birch, Stefan Listl

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The economics of oral health and health care

Stephen Birch[1,2] and Stefan Listl[3,4]

[1] Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, ON, Canada

[2] School of Community Based Medicine, University of Manchester, Manchester, UK

[3] Translational Health Economics Group, Department of Conservative Dentistry, Heidelberg University, Germany

[4] Munich Center for the Economics of Aging, MPI for Social Law and Social Policy, Munich, Germany

Abstract:

This paper describes the principles of economics and their application to oral health and health care. After illustrating the economic determinants of oral health, the demand for oral health care is discussed with particular reference to asymmetric information between patient and provider. The reasons for the market failure in (oral) health care and its implications for efficiency and equity are explained. Moreover, it is described how economic evaluation can be used to maximize oral health gains in scenarios of scarce resources. The behavioural aspects of patients´ demand for and dental professionals´ provision of oral health services are discussed. Finally, methods for an optimized planning of the dental workforce are discussed.

Keywords: Oral health production, scarce resources, asymmetric information, opportunity cost, equity, efficiency, economic evaluation, QATY, ICER, willingness-to-pay, provider payment, supplier-induced demand, dental insurance coverage, dental workforce.

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The economic problem: Getting the most out of our resources

Economics is concerned with maximising benefits from the resources available to us (the constrained maximisation problem) and is based on three fundamental principles; ***Scarcity***, ***choice*** and ***opportunity cost***. *Scarcity* occurs when the resources available to us (e.g., number of dentists) are less than the resources required for everything we would like to do (e.g., provide all effective care to everyone). So *choices* must be made about how to use available resources. Often these choices are difficult; should we use the funds for a more effective but more expensive restorative material to fill decayed teeth if this means that fewer teeth could be filled using available resources? Making more resources available for oral health care does not avoid choices having to be made about (1) redirecting additional resources from their current use in order to create the capacity to fill the same number of teeth and (2) making best use of these additional oral health care resources. *Opportunity cost* represents the basis for making these choices and is given by the highest valued alternative use of resources. Hence, we are only making best (most efficient) use of resources if the benefits generated from the way we *choose* to allocate *scarce resources* exceed the benefits that would be generated by using the same resources in other ways (i.e., the *opportunity cost*).

Health economics is concerned with applying these principles to problems of health and health care. However health and health care present particular challenges for the application of the economic principles because they have characteristics that make them different from standard goods and services that are bought and sold in private markets. This means problems of health and health care require particular attention from economists in order to consider the use of resources devoted to producing health care and improving oral health.

The production of health

Health is a source of value for an individual (i.e., along with other goods and services, it generates utility, or well-being, for the individual). However, health cannot be purchased directly. Instead it is ‘produced’ by the levels and combinations of factors that influence health and the risks of disease (i.e., health determinants). Some of these factors can be purchased directly (private goods such as toothbrushes, toothpaste, oral health care) while others may be in the form of a public good such as water fluoridation (or a public bad, such as air pollution). The individual may have little control over exposure to some of these determinants, either because of the characteristics of the individual (e.g., the individual has insufficient funds to purchase the private good) or the good (e.g., the individual cannot avoid exposure to a public good or bad).

Although health care is an important determinant of health (Gulliford, 2009), other factors also influence an individual's health, e.g., an individual's genes (De Coster et al., 2009), lifestyle e.g., smoking behaviour (Carr and Ebert, 2012) or participation in activities with risks for tooth trauma (Lahti et al., 2002, Schildknecht et al., 2012), diet (Burt and Pai, 2001) etc. as well as limitations placed on choices about many of these factors by the individual's income and wealth (e.g. Listl and Faggion Jr., 2012). This concept of multiple determinants of health is called the *health production function* (see e.g. Rosenzweig and Schultz, 1983). The relationship between a particular health determinant and health is often complex and conditional on the levels and mix of other health determinants. For example, the improvement in oral health (or reduction in risk to oral health) produced from scaling and polishing may depend on the environment in which an individual lives (the fluoride content of the water supply), lifestyle (smoking, types of foods and drinks consumed), the skill levels of the care provider etc. Economics provides a means of analysing the production of health while the estimation of health production functions (the mathematical relationship between health determinants and health outcomes) enables us to consider

1. The returns to investment in health determinants across a range of *different levels* of investment. For example, does the change in health produced from toothbrushing differ with brushing frequency (see e.g. Twetman, 2009)? This is similar to the dose-response relationship in clinical research.
2. Whether the returns to investment differ among a range of *different health determinants*. For example does investing resources in improving oral hygiene produce more health gain than investing the same amount of resources in water fluoridation (see e.g. Weintraub, 1998)?
3. Whether the return to investment in a particular health determinant is *conditional* on the levels of other health determinants. For example, is the level of caries prevention produced in response to a programme of water fluoridation conditional on the

socioeconomic circumstances of the population (see e.g. Birch, 1990, Glied and Neidell, 2010)?

The health production function *describes* the relationship between health determinants and health outcomes, but it doesn't explain the particular levels of health determinants and why these differ between individuals and between populations. Grossman (1972) developed an economic model of individual health behaviour, or *demand for health*. Under the model, individual behaviour is determined by the balancing of the benefits and opportunity costs of health change. Benefits incorporate two components, consumption (the utility change from feeling healthier or less healthy) and investment (the utility change generated from the impact of health change on income earning capacity or the capacity to engage in leisure activities etc.). These benefits are measured by the individual's valuation of these 'consequences' of health change.

Similarly, opportunity costs are measured by the impact on the individual's well-being of what he has to forgo to achieve the health change. The benefits and/or opportunity costs of *the same health changes* may differ between individuals leading to them behaving differently. The health change could be associated with different impacts on earnings capacities. Glied and Neidell (2010) found that the impact of oral health status on earnings differs between women and men. The opportunity costs differ if what the individuals have to forgo differs (e.g., the costs of fluoridated toothpaste relative to income may differ considerably between industrialized and developing countries [Goldman et al., 2008]), or if the effect of this sacrifice on utility differs between individuals. Hence differences in health determinants between two individuals, such as smoking for example, need not be the result of a poor choice by the individual who smokes (Birch et al., 2005) even though health agencies, concerned with improving the health of populations might prefer that they make more healthy choices. Given the circumstances (or context) faced by the individual, choosing to smoke may represent optimal (i.e., utility maximising) albeit non-healthy behaviour (i.e., a lower demand for health) and public interventions aimed at improving health may thus be of limited effectiveness. The Grossman model provides a way of understanding individual behaviour and emphasises the need to design healthy public policies in ways that respond to the varying contexts and circumstances of individuals. In other words, if we want individuals to behave differently we need to find ways of ensuring individual well-being increases by behaving differently (Birch 1999).

The production of health care, derived demand and asymmetric information

Health care, like many other goods and services (but unlike health), can be purchased directly, either by patients or public agencies. However, unlike many other goods and services, health care is not a direct source of utility for an individual. Individuals prefer not to consume health care because it may involve pain, discomfort or inconvenience. Health care is consumed only for the expected impact on health status. Hence the demand of health care is *derived* from the net increase in utility arising from the expected health gain produced by health care after allowing for any reductions in utility associated with the process of treatment (pain, anxiety, side effects).

Individuals have limited knowledge pertaining what health care is required to achieve a desired health improvement. They seek the advice of health care professionals, with greater knowledge about the health care-health relationship, to determine what health gain can be expected from different treatment options. This *asymmetry of information* between the consumers and the providers of health care means that the demand for health care, although derived from the individual's expected health gain, is based on the advice and direction of health care providers[1]. The demand for health care is thus *induced* by the suppliers of care through their role as advisor, or agent, of the patient. Supplier induced demand is not a problem *per se* because we want individuals with health problems to seek the advice of health care professionals before determining what care to choose. However this means that the demand for health care cannot be determined solely by consumers. This represents the defining characteristic of health care that separates it from other goods and services. Providers of care therefore have a potential conflict of interest in advising patients, because providers also draw their incomes from providing care. As a result, the market for health care requires intervention if resources are to be used to maximise health gain.

[1] The expertise of the provider is however limited to this relationship with the individual having expertise in the association between health and well-being, i.e. whether the increase in health expected from a particular health care intervention generates a net increase in utility, and which treatment option produces the greatest expected increase in utility..

In an unregulated market any individual could set themselves up as an ‘expert’ in diagnosing an individual’s health problem, recommending a treatment and delivering that care. However, the potential adverse consequences of ‘rogue’ experts are profound (pain, suffering, disability or death). Supply is therefore organised through restrictions on market entry (licensure) to individuals with defined qualifications and professional codes of practice in order to protect the public interest. This simply limits supplier inducement to qualified practitioners. The demand for care remains influenced by supply and so market mechanisms fail to achieve the socially optimal allocation of health care resources. In particular, providers’ recommendations for care may partly reflect the expected workload (and hence income) expectations of providers. As a result the levels of services used need not reflect (only) patients’ needs for those services and supplier induced demand may lead to care being provided in ways that do not maximise health gain from available resources. Commissioning services by a third party such as a local health authority, is an attempt to limit the role of supplier inducement by funding service provision by providers based on the needs of the population being served (Whittaker and Birch 2012).

There are different ways of producing health care and the challenge is to find the most efficient methods of production, i.e., those methods that maximise health gain from available health care resources. The methods of production determine the particular levels and mix of inputs and represent the health care production function (the mathematical relationship between health care inputs and health outcomes). This enables us to explore ways of increasing health gains through the use of different mixes of inputs (or substitution between inputs). For example, the production of primary oral health care services could be changed by deploying more dental therapists and dental hygienists and fewer dentists (Harris and Sun, 2012). The introduction of computer assisted design and manufacturing (CAD/CAM) in dentistry has reduced the amount of dental technician time in the manufacturing of dentures compared to traditional methods (van Noort, 2012). Decisions about the methods of service delivery must be informed by evidence of the outcomes and costs of the various ways of producing services and supported by policies that enable more efficient methods of service delivery to be used. For example, primary care dentists remain the point of entry for oral health care in some countries even though the only care received by a large proportion of patients is an oral screen and scale and polish (the regular examination). Allowing dental hygienists to provide this service independently would free up dentist time to focus on patients with greater needs while providing a lower cost option for patient examinations. This would increase access to examinations within the population. A recent report in the UK has called for changes to current regulations to allow dental hygienists to provide these services independently (Office of Fair Trading 2012).

Health care often involves episodes of care that are made up of a complex series of complementary services (e.g., prevention, treatment and rehabilitation). The health outcomes produced in each service element within the episode of care may not be additive. Instead the outcome from a given treatment procedure may depend on the quantity and type of prevention and or rehabilitation received. For example, the survival of a dental implant may depend on the level of professional oral hygiene instruction (Quirynen et al., 2002). Efficiency of services must therefore be evaluated in the context of the episode of care that a patient experiences as opposed to service elements that separate providers deliver.

The health care production function allows us to compare different methods of producing health care services in order to address the constrained maximisation problem. The estimation of production functions enables us to consider

1. The returns to investment in health care inputs across a range of *different levels* of investment. For example, does the change in oral health in a population produced from increasing dentist supply change with the baseline level of dentist supply? This is similar to the dose-response relationship in clinical research.

2. Whether the return to investment differs among a range of *different health care inputs*. For example does investing resources in training more dentists produce more oral health gain than investing the same amount of resources in training more dental hygienists?

3. Whether the return to investment in a particular health care input is *conditional* on the levels of other health determinants. For example, is the health gain from increasing the supply of dentists conditional on the supply of dental hygienists in the population?

Health care economics: The demand and supply of health care

Health *care* economics is concerned with the demand and supply of health care, including the behaviour of providers and consumers of health care, and the evaluation of health care services. It considers the impact on the health and well-being of individuals and populations of using available resources in alternative ways by comparing both the effects (outcomes) and costs of different health care interventions (economic evaluation). Such evaluations are, in isolation, descriptive information on the expected rate of return on additional investment (what extra outcome can be produced by investing more resources in this particular treatment?). In addition the opportunity cost of the additional investment (what has to be forgone in order to provide the additional investment required) determines whether this rate of return represents an efficient use of resources. Consideration must also be given to ensuring that services evaluated as being efficient will be produced by providers and consumed by patients in the way intended. Hence health care economics extends beyond the area of economic evaluation of health care interventions to incorporate the study of the behaviour of providers and consumers. For example there may be interest in introducing a new screening service (e.g. the use of salivary cytokines as a screening tool for oral squamous cell carcinoma; see Osman et al., 2012). Health care economics would involve *inter alia*

1. Estimating the additional costs and effects of the new service compared to existing practice

2. Calculating the expected rate of return on additional investment (additional effects divided by the additional costs)

3. Considering alternative ways of supporting the additional investment within the existing resource constraint and the forgone effects associated with taking the resources required from these other uses

4. Analysing the behaviour of patients and providers concerning who uses care and what care is delivered.

5. Modelling the required amount of care to be delivered and the required number and mix of providers to deliver the care.

Activities 1-3 represent the area of economic evaluation of health care programmes, 4 involves studying provider and patient behaviour (behavioural economics) while 5 concerns creating the optimal capacity to support the provision of the right amount of care to the right patients (service and workforce planning).

Economic evaluation of health care

Economic evaluation has been defined as “ensuring that the value of what is gained from an activity outweighs the value of what has to be sacrificed” (Williams 1983) reflecting the fundamental principles of scarcity, choice and opportunity cost. In order to determine whether the benefits produced by a particular programme exceed the opportunity costs of providing that programme a method of measuring and comparing outcomes is required. Because different health programmes are aimed at producing health gains in different patient groups, they often involve very different types of health gain. For example in oral health care some programmes may be aimed primarily at retaining and restoring teeth (restorative care) while others are aimed at improving function (orthodontics). Even among programmes aimed at achieving the same outcomes (e.g., composite versus amalgam tooth restoration), often the programmes differ in other important aspects of outcome (e.g., the appearance of the filled tooth). Hence economic evaluation involves comparing outcomes across different health programmes.

The approach to between-programme comparisons of outcomes adopted has involved a measurement tool that combines the expected period of health gain (quantity) with the expected improvement in health (quality) into a Quality-Adjusted Life Year (QALY), or, in the case of oral health programmes, a Quality Adjusted Tooth Year or QATY (Birch 1986). By basing the measurement of quality on patient (or public) preferences among different health outcomes, it is sometimes argued that the analysis will identify which programme maximises social well-being (i.e., by interpreting the QALY to be a measure of patient health related well-being). However the method of measuring QALYs separates quality and quantity of health into independent dimensions with quality scores for health states being multiplied by the number of years in each health state (Williams 1985, Birch 1986). But the assumption of separability implies that health states have values that are independent of the duration in that state as well as being independent of the states of health experienced prior to the current state and expected to follow the current state. It limits the impact of a particular state on the patient utility to be proportional to the amount of time spent in that state and prevents an individual from expressing a preference that doesn't fit this arbitrary model (Gafni and Birch 1993). Under such a model dental anaesthesia would be of little value to patients because the pain, suffering and anxiety relieved is for such a short duration that it would have a QATY value of close to zero. Yet as Gafni and Birch (1993) argue, many individuals express a strong preference for anaesthesia as expressed in their willingness to receive (and pay for) anaesthesia during dental procedures.

Other approaches have been developed for overcoming these limitations of the QALY model. The Healthy Year Equivalent (HYE) makes no assumptions about the separability of quantity and quality in patient preferences among health states (Gafni et al 1993, Gafni and Birch 1997). However this still assumes that the utility of health gains is independent of all other aspects of an individual's life. If utility maximisation is the objective, a more generic outcome measure is required in the form of 'willingness to pay' for the intervention. This allows for comparison between different types of health programmes, as well as between health and other programmes (Matthews et al 1999, Birch et al. 2004). Although the use of WTP has been criticised because of the influence of an individual's ability to pay (ATP) (e.g., income) on the individual's stated WTP, and hence may favour those with higher incomes, the same equity problem has been shown to apply to the methods used for measuring QALYs (Donaldson et al., 2002). Methods have been developed for addressing the adjusting stated WTP amounts for differences in ATP (see e.g. Donaldson et al. 1997).

Cost effectiveness analysis

Cost-Effectiveness Analysis (CEA) is the most common methodology of economic evaluation in health care, aimed at informing decision makers faced with maximising benefits from constrained resources (see e.g. Listl et al., 2010; Listl and Faggion Jr., 2010). It compares the difference in effects between a programme under consideration and the current way of serving the same patient population (incremental effects), and the difference in costs between the two programmes (incremental costs). Where incremental costs and incremental effects have different signs, the solution is trivial, e.g., the new programme costs more (i.e., reduces resources available for other unrelated programmes) and produces less effects than the current programme. In most cases, however, a new intervention involves incremental effects and incremental costs with the same sign, e.g., the intervention is more effective but costs more than the existing intervention. To provide the greater effects of the new treatment, the number of other unrelated treatments must be reduced to release resources to support the additional costs of the new treatment. Here the decision-maker looks to the economist for ‘inputs’ to the decision-making process – in particular decision rules for CEA.

The analytical tool of CEA is the incremental cost-effectiveness ratio (ICER), the incremental cost divided by the incremental effects. Maximum health gain from available resources is produced by selecting programmes in ascending order of ICER (i.e., project with lowest ICER first) until available resources are exhausted (Weinstein and Zeckhauser 1973). Because ICERs have not been estimated for all programmes delivered in health care systems, comprehensive ICER ‘league tables’ are not available and the rule cannot be followed. Instead a threshold ICER approach has been adopted under which programmes are selected if the ICER is less than or equal to λ, the ‘threshold’ ICER for efficient programmes. This threshold rule has provided the basis for economic evaluation guidelines in many jurisdictions aimed at maximizing health improvements from available resources (Gafni and Birch 2006).

Calculating the ICER produces an *average* cost per additional unit outcome (or inverse of the average rate of return on additional investment). But programmes are not divisible into individual units of outcome (perfect divisibility). Moreover, the ICER implies that the rate of return on additional investment is constant (constant returns to scale). But the outcome from providing a particular orthodontic procedure for example may depend on the number of orthodontic procedures already provided, because the need for (and hence expected gain from) the procedure reduces as more patients are treated. So the conditions required for the CEA to result in an efficient allocation of health care resources do not hold. A manager must purchase an entire Digital Volume Tomography (DVT) machine, it is not divisible into chunks to fit whatever budget the decision-maker might have, it is “all or nothing”. Some programmes may not be divisible because of political or ethical constraints, e.g., it is unlikely that a decision-maker could introduce a programme with a capacity to screen only 50% of children at risks.

Similarly, increasing investment in a particular programme may not produce proportionally equal increases in outcomes as programme coverage expands to lesser need/severity groups. So the additional outcomes produced from investing resources in a programme may diminish with the scale of the programme. Even if the programme under evaluation does exhibit constant returns to scale, the opportunity cost is likely to have non-constant returns. The increased resource requirements for the new programme mean the decision maker has to 'dig deeper' into his existing budget to fund it. After resources from the least productive current programme have been exhausted a decision-maker must look to other more productive programmes meaning that the opportunity cost of the programme per unit expansion increases with the size of the programme.

Because decision-makers face choices between programmes of different sizes and the opportunity costs of programmes depend crucially on programme size, the new programme and the current programme for the same patients are not directly comparable. Comparisons of ICERs across programmes ignore problems introduced by the different sizes of programmes and so do not compare like with like. Each programme produces a quantity of health gain and the average price per unit health gain may vary with by programme size. Consequently the ICER threshold is not sufficient to maximize health effects from available resources and the strategy of selecting the programme with the lowest cost-effectiveness ratio cannot be justified on the basis of efficiency in resource allocation (Doubillet et al 1986). Moreover, the threshold ICER value required to make decisions that produce the maximization of health gains from available resources cannot be determined because information on the incremental costs and effects of *all* possible programmes is not available and hence the opportunity cost of the least efficient programme currently funded cannot be determined. Instead decision makers have adopted arbitrary thresholds that bear no relation to maximising health gain (Birch and Gafni 2006). This has led Drummond (2012) to note that "the impact of economic evaluation on the allocation of healthcare resources is hard to ascertain".

Extending economic evaluation to identify efficiency improvements

For an intervention to represent an efficient use of resources the additional effects it generates must exceed the effects forgone from the most productive alternative use of the same resources. Hence efficiency cannot be established only by reference to the resources required and outcomes produced by a particular intervention. Information on alternative uses of those resources is also needed and so efficiency is context specific (Birch and Gafni 2003). Even where incremental costs and effects of an intervention are identical in different settings, it does not mean the efficiency of that intervention is the same in all settings (Birch and Gafni 2002).

If economics is to inform decision-makers about the efficiency of investments, CEA and the use of ICERs are insufficient. Mathematical approaches to constrained maximization such as integer programming (IP), solve the decision-maker's problem and are the only universal approach to ranking programmes according to efficiency under a resource constraint (Drummond 1980). The key requirement of the IP approach is that the specification of the problem (i.e., objective function and constraints) must accurately reflect the decision-makers problem setting (See Tianviwat et al., 2009 for a recent application of this approach to delivering primary dental care to schoolchildren).

The substantial data requirements of the IP approach, specifically the incremental costs and effects of all programmes together with the resources available for investment, may be difficult to satisfy. However they reflect the complex nature of the decision-maker's problem. Birch and Gafni (1992) present a practical alternative which satisfies a modified objective of an unambiguous increase in health improvements from available resources (i.e., an objective of improving as opposed to maximising, efficiency). This requires the health improvements of the proposed programme be compared with the health improvements produced by that combination of programmes that have to be given up to generate sufficient funds for the proposed programme. Only where the health improvements of the proposed programme exceed the health improvements of the combination of programmes to be given up does the new technology represent an improvement in the efficiency of resource utilization. The approach does not rely on an arbitrarily determined ICER threshold value to ascertain the efficiency of the programme, nor is it dependent on unrealistic assumptions about perfect divisibility and constant returns to scale. Instead, the source of additional resource requirements is identified and the implications of cancelling programs to generate these resources form part of the analysis. Iterative application of this efficiency-*improving* approach would eventually lead to efficiency *maximisation* as opportunities to further improve efficiency are exhausted.

Maximizing health improvements from available resources may be one of several objectives that decision-makers face. Political considerations associated with providing equal access to services and providing greater priority to health improvements of specific population groups may be important goals. However multiple objectives and constraints do not reduce the importance of adopting a constrained maximization model as the basis for analysis. Whatever goals are identified must be pursued efficiently in order to avoid wasting resources (Williams and Cookson 2000). The explicit identification of each objective and constraint enables the full range of policy concerns to be incorporated systematically into the analysis. Hence, the complex objectives faced by decision-makers, far from limiting the role of economic analysis, represent precisely the challenges that the economic model of constrained maximization is intended to accommodate.

Understanding patient and provider behaviour

Health problems can be caused by low income, and health problems can lead to reductions in income as they can restrict normal activities. As a result, an individual's need for health care is greatest when his ability to pay for health care is lowest and populations with greater needs will tend to have lower capacity to care for needs – what has been referred to as the *inverse care law* (Hart, 1971). To allocate health care resources in ways that maximize health gain, we need to understand what determines this mismatch between use of and needs for care and evaluate methods for planning and allocating resources in accordance with relative needs for care. Health economics addresses this 'conundrum' by analysing alternative approaches for funding service provision, allocating resources for the capacity to care and managing performance. Government intervention in response to market failure does not mean that resources will necessarily be allocated efficiently. The threat of 'government failure' to maximize health gain is similar to the threat of market failure to maximize health gain. Hence health care economics involves the development and evaluation of methods used in planning for and allocation of health care resources in the absence of the market.

For example public funding for oral health care, aimed at reducing or removing the price of care paid by patients, has been used in many jurisdictions as a means of improving access to care among the population and hence increasing the efficiency of resource use. Yet despite many years of public funding, inequalities in oral health remain (see e.g. Listl, 2011; Listl, 2012a; Listl and Faggion Jr, 2012; Listl, 2012b). This policy failure arises from the simple models of access to care that underlay the public funding models of care in which access to care is implicitly viewed as being determined by the cost of care to the patient at the point of service delivery (ie the patient charge).

Understanding the determinants of using care

Andersen et al. (1968) presented a model for understanding differences in the use of care within a population. These were categorised broadly into need, predisposing, enabling and system factors. Predisposing factors relate to individual characteristics, such as the individual's education that might be associated with a greater probability of use other things equal, because of greater understanding of symptoms. Enabling factors relate to individual characteristics that may support or constrain the individual using care (such as the individual's income, as a means of paying for care and the costs associated with travelling to care providers) while system level factors relate to the way care delivery is organised in a population (e.g., geographic distribution, appointment and referral systems etc). Removing the cost of care at point of service delivery will not lead to care being used in accordance with need if the system, predisposing or other enabling factors remain unequal in the population. Hence policies aimed at overcoming market failure need to embrace a broader perspective on the determinants of use.

McIntyre et al. (2009) present a framework in which access to care is determined by three broad dimensions, affordability (the full costs to the patient of receiving care in relation to the patients ability to meet those costs), availability (the location, time and eligibility criteria for using care) and acceptability (the way care is delivered). Under this framework, care remains inaccessible, even when it is free to the patient, if the care does not satisfy patient expectations and constraints concerning where and when the care is offered, how the care is delivered and the costs to the patient of attending the care facility. If those with greatest need for care also have greatest challenges of affordability, availability and acceptability then subsidising the cost of care at the point of delivery will simply increase government expenditure on health care without affecting the distribution of care. Instead those already using care receive a transfer of wealth from the government, as they now pay less out of pocket for the care they receive, while care remains inaccessible to those with greatest needs. This suggests that the models of care to be used in planning service provision need to reflect the perspectives of those with needs for care at least as much as those delivering the care.

Understanding the delivery of care: Paying providers

If resources are to be used in ways that maximize health gain we must ensure that policies are developed to support providers delivering care in these ways. If provider incomes do not respond to the level and mix of needs being served why would we expect providers to behave in ways which do reflect the levels and mix of needs? There are three broad approaches used for paying health care providers (or 'incentivising' health care delivery). Health economics provides a 'toolbox' for analysing these approaches in the context of the goals of the health care system in which providers work.

Salary-based payments: Under salary, provider earnings respond to the amount of time devoted to providing care, but not to the type of patient served, how they are served, the number of patients served or the outcomes achieved. So there is no financial incentive to give priority to patients according to their needs or to maintain high levels of productivity (hence rewarding "on-the-job leisure", Robinson, 2001). Salary-based approaches provide funders with an effective form of controlling cost per provider (through salary controls) but controlling total costs may remain elusive if funders respond to apparent shortages of providers indicated by problems of access (e.g. waiting times) but caused by low productivity, by increasing the number of providers beyond the efficient level (i.e., that associated with a productive workforce) and hence increase total costs. Expenditure is the product of the number of providers and the mean level of salary. It does not relate to the size of the population being served or the needs for care within the population.

Fee-for-service payments: Under fee-for-service (FFS) provider earnings respond to the quantity and mix of services delivered, thus providing strong incentives to increase service productivity. Provider income does not respond to the type of patient served, the number of patients served or the outcomes achieved. So providers paid FFS have no financial incentive to give priority to patients according to their needs or to expand their patient lists. In this way it provides an incentive for over-treatment (Birch, 1988) and distorts the level and mix of service provided among patient groups with different levels and forms of coverage (Birch 1988, Chalkley and Tilley 2006) This suggests that the extent to which patients are able to bear the costs of treatment may constrain the FFS provider's ability to expand services, but it doesn't distinguish between services on the basis of patient need for the services. Cost control is a major problem under FFS because total expenditure is the product of the number of providers and the mean number of services per provider (adjusted for the mix of services). As with salary based payments, total expenditure does not relate to the size of the population being served or the needs for care within the population.

Capitation: Under capitation provider earnings respond to the quantity and type of patients being served thus providing incentives to expand patient lists and serve higher needs patients. It represents a payment for taking responsibility for an individual's health care needs by paying a predefined amount per period for each enrolled patient independent of whether or not the patient receives any care, or the type of care received. Provider income increases with the number of registered patients but decreases with treatment intensity provided. Ellis and McGuire (1996) argue that the disadvantages of capitation are that providers can increase incomes by selecting patients with low treatment needs (a *selection effect*), decreasing the number of services per patient (a *moral hazard effect*), and by narrowing the scope of provided services (a *practice style effect*). Needs-based (or risk-based) capitation fees which relate the capitation fee to the expected needs of the patient reduce selection effects while patient choice among providers can act as a constraint on moral hazard with patients dissatisfied with access to their dentist or the care received when accessed can move (together with their capitation fee), to another dentist. Failure to provide patient choice (by for example allowing providers to collude about closing patient rosters) would leave patients exposed to moral hazard. Cost control is less of a problem under capitation because total expenditure is the product of the patient population covered and the mean capitation fee per patient. Hence it relates directly to the size of the population being served and the needs for care within the population. Dentists choosing to serve larger and higher needs populations will receive higher earnings. It therefore provides a more appropriate basis for aligning the objectives of the system (meeting the needs of the populations) with the rewards for providers.

Under any payment system performance appraisal of providers remains important. Payment mechanisms represent methods of allocating resources between providers. Although capitation methods are more consistent with the goals of maximising health gains from available resources, they do not determine how those resources are actually used. Hence, monitoring and surveillance remain essential elements of ensuring appropriate resource use.

Planning the capacity to care

When dental care provision is organized by public authorities, decisions have to be made about the appropriate capacity for providing care. In markets for many other goods and services this capacity emerges from the interaction of supply and demand. However planning the capacity for health care faces two major challenges

1. The absence of an independent demand curve means there is no interaction between supply and demand

2. The providers of care are often highly qualified individuals requiring investments in long periods of education and training so decisions on the number of providers to produce have long lead times and long-lasting consequences.

We argued above that in order to maximise health gains decisions about what services to provide are determined in relation to the needs of the population being served as opposed to the preferences of those providing services. As a result, decisions about the size and mix of the health care workforce must be linked directly to decisions about the levels and mix of services required to maximise health gain. In practice there has been little if any integration of workforce planning with service planning. In this section we identify the problems arising from current methods of health workforce planning and present an approach for integrating workforce and service planning based on population needs for care.

The 'inevitability' of workforce shortages

Although the number of practicing doctors per 1000 population in the UK increased by 42% over the first decade of the new millennium 23% in Australia 19% in New Zealand, 10% in USA and 9% in Canada, each country reports of serious shortages of doctors (OECD 2011) and concerns about the financial sustainability of health care systems when these substantial rates on increase in supply are insufficient. What explains this apparent never ending need for more health care given the changes occurring in population health and the delivery of health care? For example major improvements have occurred in both oral health (particularly among children), and dentist productivity (associated with changes in the way care is delivered) over the last quarter century of the last millennium (Birch and Maynard 1985). However dentist numbers continued to increase at rates faster than the increase in the size of the population (OECD 2009). Although one might have anticipated reductions in the average workload (and income) per dentist this ignores the 'rising expectations' in dentistry as reflected by, for example, the rapid expansion of orthodontics among children. Where did this 'expectation' come from? Mothers did not march on parliament demanding governments deal with the problem of children's 'bent' teeth. Nor were governments identifying children's 'bent' teeth being a threat to the economy, national security or general welfare. Instead, dentists, whose workloads were at risk as average needs per child fell and average productivity per dentist increased, took an interest in straightening children's teeth (for more on supplier induced demand in UK dentistry see Birch, 1988). This was not an unmet need governments *planned* to address as part of oral health policy. Instead, services expanded to meet the provider workload expectations during periods when needs for care were falling.

Because workforce planning methods do not respond to changes in the needs of the population or changes in productivity of providers serving those needs, the estimated required number of providers increases with the (age-adjusted) size of the population. As a result no attempt is made to integrate the needs of populations or the service requirements to meet those needs in determining the optimal supply of providers. Instead services respond to the workload preferences of providers. Using Evans' health care income expenditure identity' (Evans 1984), developments that offer the prospect of reductions in health care expenditures, such as reduced needs and improved productivity, involve reductions in the aggregate income of providers, either through the use of fee-for-service remuneration systems or threats to the current levels of non-fee for service remunerated positions. Providers may therefore respond to maintain workloads and protect incomes and positions by identifying other 'things to do' for patients – and creating illusions of necessity (Evans 1985).

Health workforce planning or 'demography gone wild'?

Estimating the future supply of providers involves quantifying the current stock of potential providers, future additions to and losses from that stock and the quantity of time for service production/delivery flowing from the stock (Birch et al. 2007). Aside from the careful identification and measurement of the determinants of these variables, estimating supply has provided few conceptual challenges.

Traditional methods for estimating future requirements for providers N_{t+1} have also been relatively straight forward, being determined by applying a provider-population ratio, (N/P)*, to the estimated future size of the population, P_{t+1}. With the future population size being exogenous, future requirements are 'controlled' through (N/P)*. In the simplest case the prevailing provider-population ratio is used and future requirements are driven entirely by the population size. Higher provider-population ratios may be used to respond to perceived shortages in providers (e.g., wait times), or aging populations, or to coincide with some external provider-population ratio (in other jurisdictions or based on international recommendations). Nevertheless, the required number of providers is a fixed proportion of the population size. Levels of health or sickness (and by implication levels of need for health care) are absent. Two populations identical in size, but with different health profiles, would have the same provider requirements. Similarly, requirements would be independent of changes in population health over time. Only reductions in population size or lower provider-population ratios would lead to reductions in requirements for providers. There is no evidence of either condition ever having occurred in health workforce planning. So, what gives rise to the requirement for providers is the amount of people not the amount of sickness.

The traditional approach also assumes that the required number of providers is directly related to the size of the population (used as a proxy for the need for care in a population) and that this relationship is constant over time and across communities. What providers do, how they do it and what they achieve by doing it, are implicitly assumed to be fixed. Under this approach the adoption of laser treatment and micro surgery in ophthalmology, although reducing the amount of time required by an ophthalmologist to provide treatment for patients with cataracts, does not affect the estimated required number of ophthalmologists.

So why do we observe persistent claims of provider shortages? Because health workforce planning has been performed in isolation of health service planning, providers and professional bodies can expand services in order to meet their workload preferences. As the new or expanded services become the norm, demand (as opposed to need) per capita grows and more providers are required to meet this expanded demand within a population increasing in size. So although we might expect provider-population ratios to fall over time as the average health of the population and productivity in health care increase, we observe the opposite.

An integrated approach to workforce planning

To avoid these problems the conceptual basis of health workforce planning can be expanded to recognise that (1) need for health care is determined by the health of the population not simply its size, (2) the requirement for providers is derived from the requirement for services and (3) neither of these relationships is constant over time (Birch et al. 2007). The 'simple' demographic model suggests

$$N_{t+1} = (N/P)^{*} \times P_{t+1}$$

Because there is no objective basis for the provider-population ratio, $(N/P)^{*}$, we break this down into its constituent parts so that

$$N_{t+1} = (N/Q)_{t+1} \times (Q/H)_{t+1} \times (H/P)_{t+1} \times P_{t+1}$$

Where Q is the quantity of health care services to be delivered and H is the level of health in the population. Provider requirements are determined by four separate variables. *Demography* (P_{t+1}) remains a key determinant of requirements. However this is now translated into health needs through explicit consideration of *Epidemiology* (H/P), the average level and type of sickness in the population. No longer is the health profile of the population assumed fixed through time or across space. A third determinant, *Level of Service* (Q/H), represents the planned level and mix of services to respond to the health profile of the population while *Productivity*, the inverse of

(N/Q), translates the quantity of service requirements into requirements for each type of provider involved in the production of those services.

Each element of the model is variable across space and time. Hence planning must incorporate changes occurring in all four elements, e.g., the reduction in dental disease among children, the increased productivity in ophthalmology etc. Moreover each of these variables is potentially influenced by policies, although in the case of demography and epidemiology, potential policy levers are largely beyond the scope of health care planners. Levels of service and productivity, however, are influenced by planners through decisions about what health care to deliver and how it is to be delivered. Methods for the economic evaluation for sustainable service planning presented above provide an evidence base for these decisions. In practice, however, such policy levers have been largely left to professional interests, through adopting recommendations of professional groups for service expansions and controlling the deployment of alternative providers.

Summary:

In this paper we have explored the way economics contributes to understanding many of the problems encountered in promoting, protecting and restoring oral health in populations. If resources were not scarce economics would have no role to play in addressing these problems. However in many cases the problems faced arise directly from the limited resources while policy makers operate within resource constrained environments. Failing to consider economics as part of any investigation concerning oral health care fails to reflect the reality in which the problem occurs. There is a substantial and growing literature on economic aspects of oral health and health care that can be drawn upon (and added to) as we strive to ‘do better’ with whatever resources are made available to oral health.

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