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Cost Benefit Analysis of Two Oral health Improvement Programmes

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Introduction: Oral health is frequently given a low priority when healthcare funds are allocated to new initiatives. One method to highlight the health and social benefits of new oral health initiatives is to use cost benefit analysis to show their value. ***Aim***: To demonstrate how Cost Benefit Analysis (CBA) has been applied to two recent oral health initiatives to evaluate their ability to reduce costs and improve the quality of life. ***Methods***: CBA was applied to the Mouth Care Matters project in Kent, Surrey and Sussex, and the Senior Smiles project - improving oral health in residential homes in Australia. ***Results***: Over a five-year period, the Mouth Care Matters project would generate £2.66 in cost savings, within the healthcare system, for every £1 spent. Over a three year period the Senior Smiles project would generate a cost saving for the healthcare system of $3.14 for every $1 spent. These evaluations were instrumental to enable a national rollout for Mouth Care Matters and a public endorsement of the programme for Senior Smiles. ***Conclusions***: Health economics can be a useful tool in aiding care organisations to assess the implications of decisions to spend limited resources in particular areas of healthcare over others.

Keywords*: Oral health, health expenditures, Economics, Health resources, Cost Benefits Analysis*

Introduction

Health economics is a developing field of science that takes the theory of economics - how a society allocates its resources - and bridges the gap to allocate these resources within healthcare (Kernick, 2003; Jakovljevic and Ogura, 2016). This involves the formal analysis of costs, benefits and consequences of health and social care. To simplify further, it is any investigation that aims to quantify, in financial/economic terms, the impact of a health intervention, care service or pathway (Mushkin, 1958). Funding for the Department of Health and Social Care continues to grow year-on-year to support the NHS (The King's Fund, 2019). It is concerning that experts report that this growth is insufficient to cope with increasing demands, particularly to support an ageing population and longer life expectancy (NHS Providers, 2018). All areas of care are affected, with acute hospitals, general practice, mental health and community services under increasing strain (Care Quality Commission, 2019). There is also growing evidence that quality of care in some services is being diluted and that access to some treatments within the NHS is being rationed (Care Quality Commission, 2019). Against this background of rising demands on limited resources, health economics is likely to become increasingly important at all levels of health care, to ensure spending decisions are equitable and maximise the benefits from the available resources (Cunningham, 2001; Kernick, 2003). Economic evaluation is an accepted method for the appraisal of health care programmes (Cunningham, 2001).

Faced with constraints such as those described in Figure 1, policy makers can obtain guidance from health economics to determine which interventions should be commissioned, how they should they be implemented and who should benefit from them.

There is ample evidence demonstrating a need to improve oral health for vulnerable adults in both hospital and community settings (Terezakis *et al*., 2011; Albrecht *et al*., 2016; Khokhar *et al*., 2016; Waldron *et al*., 2019). There are also many examples of quality improvement programmes focusing on improving patient experience and up-skilling staff through online training, small group teaching and ward-based training (Zenthofer *et al*., 2016; Binks *et al*., 2017; Patel *et al*., 2019). However, there is limited evidence of the cost-effectiveness of these programmes, which may impact on ongoing investment.

With the ever-increasing pressures placed upon health and social care systems, any interventions ideally need to improve outcomes, increase safety and/or provide better value. The ideal scenario is that all three are achieved by implementing the intervention. This paper will describe how health economics was used to measure the impact of two oral health improvement initiatives and to demonstrate the return on investment. It will also explore how health economics evaluation was instrumental in wider rollout of the programmes.

Two Oral Health Care Programmes

Both programmes share elements of a primary focus on the older population and a will to provide holistic care but were implemented in different settings (acute versus community care) and countries. Therefore, comparing their evaluation presents a more nuanced picture of their impact.

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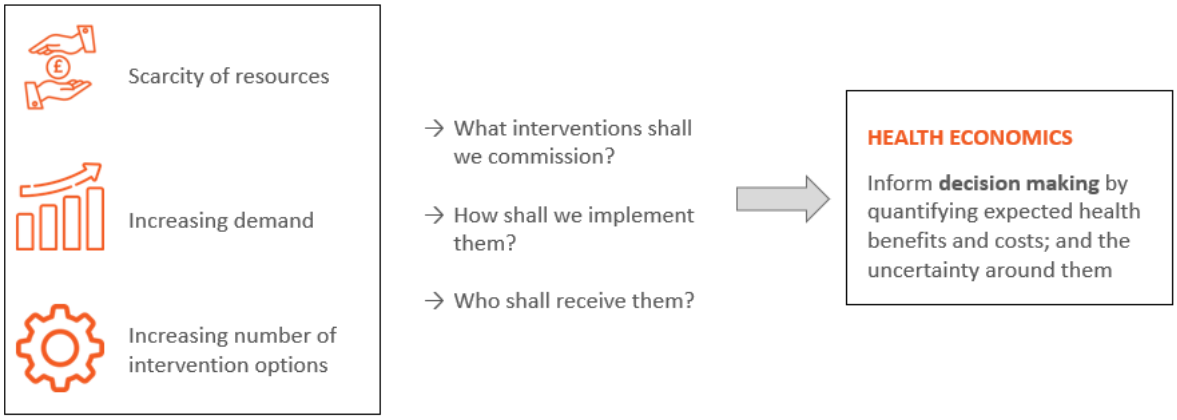

Figure 1. *Health economics and the challenges of current health care system*

1. Mouth Care Matters (Improving oral health in hospitals in England)

Mouth Care Matters (MCM) is a Health Education England funded training initiative to improve the oral health of hospitalised patients in Kent, Surrey and Sussex (KSS) through up-skilling health care professionals to assess mouths and give supportive mouth care when needed. There is evidence to show that oral health deteriorates in individuals subject to hospitalisation (Terezakis *et al*., 2011). Hospitalisation changes an individual's routine, can cause stress and anxiety due to discomfort, with pathological changes making the body more susceptible to becoming frail (Sousa *et al*., 2014). Baseline data from 13 hospital trusts in KSS found standards of mouth care to be poor with an absence of mouth care policies or training for staff and inadequate availability of suitable mouth care products such as toothbrushes (Binks *et al*., 2017).

MCM is based on four core principles: Providing staff with the knowledge of the importance of mouth care; Ensuring staff are skilled to provide good mouth care; Ensuring patients have access to effective mouth care products and ensuring ward staff have support from staff with enhanced oral health skills

The programme involves delivering accessible training for all staff, introducing oral health assessments, having the correct tools on the ward and pathways for support. It has been the subject of a health economics evaluation (Kent Surrey Sussex Academic Health Science Network, 2017).

2. Senior Smiles (Improving oral health in residential homes in Australia)

Residents in Australian nursing homes are a particularly vulnerable sub-population of older people with high oral health needs and limited access to dental care (Hopcraft, *et al*., 2012). 'Senior Smiles' is a preventive model of oral health care delivery for people living in care homes. The programme is funded by a grant from the Eldersee Foundation.

'Senior Smiles' was evaluated in 2018. The model places a qualified oral health practitioner within the facility, one or two days a week, depending on the number of residents. The practitioners assess the residents' oral health risk, establish referral pathways with private and public dentists and collaborate with other facility staff to ensure oral health care becomes part of daily care needs.

Method

Cost benefit analysis (CBA) involves the economic and financial evaluation of all benefits and costs related to an intervention or programme in monetary terms; essentially the end output equals total benefits minus total costs (Listl *et al*., 2019). To turn positive outcomes from the intervention into a financial benefit, the impact of each outcome is monetised to bring a diverse set of outcomes into a common metric, which allows objective comparison. The key benefit categories are described in Table 1.

Through the CBA, a to-date and forecasted appraisal of the prospective impact of the two programmes was produced. The CBA of MCM was assessed in line with the standard HM Treasury guidance and assessed socio-economic inputs and outputs. This guidance, commonly referred to as 'The Green Book' (HM Treasury, 2018).

In addition to the framework guidance, the UK government has also supported the development and funding of three standardised unit cost databases. Throughout the CBA of MCM and Senior Smiles, cost estimates were first sought from these databases to minimise the burden on

Table 1. The categories of benefit

Type of benefits	*Principle*	*Example*
Cash-releasing	Produces immediate "cashable" savings to the health care system	Reduced medication use
Non cash-releasing	Reduce demand and strain on services	Reduced patients' length of stay, but without triggering a ward closure or other event that could release cash savings
Social	Assign a fiscal value to a social improvement that delivers no benefits within the health system	Improved quality of life

data providers and ensure comparability across different geographies. The relevant literature was also reviewed. The databases were:

- Department for Transport's TAG data book (Department of Transport, 2018)
- Personal Social Services Research Unit (PSSRU) 'Unit Costs of Health and Social Care 2016' (PSSRU, 2016)
- Greater Manchester Combined Authority, formerly New Economy, 'Unit Cost Database' (2019), which divides costs into financial costs and economic costs. These terms broadly equate to 'public sector delivery costs' and 'all other socio-economic costs' (GMCA, 2019)

The Senior Smiles CBA was conducted in line with Australian standards such as 'Economic Evaluation for Business Cases Technical Guidelines' (Department of Treasury and Finance, 2013) to ensure consistent estimation of costs and benefits. This operates in a broadly similar fashion, with the key differences being a different discount rate (4%) and an Australian value for the calculation of Quality Adjusted Life Years (QALYs) related benefits.

In addition to this framework, the Australian government uses standardised unit cost databases, which provided data for the CBA. These were:

- Australian Bureau of Statistics' Key economic indicators 2018 – annual reports (Australian Bureau of Statistics, 2018)
- Independent Hospital Pricing Authority's 'Australian Public Hospitals Cost Report 2015-2016 (Round 20) (Independent Hospital Pricing Authority, 2018)
- Pharmaceutical Benefits Pricing Authority Annual Report (Australian Government – Department of Health, 2010)
- General Practice Workforce Statistics 'Service Volume and Benefit based on Non-referred Attendances (NRA)' (Australian Government – Department of Health, 2020)
- Ministry of Health, NSW 'Oral Health Fee for Service Schedule of Fees for 2016' (Ministry of Health, 2016)

These sources presented an efficient and effective mechanism for identifying values for many costs and outcome benefits. They were broadly consistent with one another.

Commissioners and practitioners are often overly optimistic about the outcomes that will be achieved by a project or programme and the amount of money that will be needed to deliver these outcomes (GMCA, 2019). This optimism bias will be greater when the data and evidence upon which the cost effectiveness model is based are uneven, old or incomplete. Within the CBA, optimism bias correction factors, dependent on the age and source, were applied to the data, to adjust for overly optimistic outcomes of the CBA.

The process within the CBA can be broken into four major steps for each outcome stream (Figure 2). A benefit stream common to the two models, such as the reduction of GP visits arising from the patients' improved nutrition, can be used as an example to explain this approach. It considered the following factors:

- total population in the project (e.g. the number of inpatients);
- population at risk (e.g. number of patients with self-reported or assessed nutrition problems);
- level of engagement with the target population (e.g. the proportion of patient notes where mouth care was recorded in the designated mouth care recording form);
- scale of impact in changing the outcome (percentage success at achieving the desired outcomes - e.g. reduction in the number of GP visits).

When forecasting for future years, the expected inflation rates were taken into account to inflate costs, before the GDP deflator was applied to reveal the real relative change in prices compared to the UK price. This converted all prices into 'real prices' equivalent to the base year.

In addition, the studies applied a discount rate to the future costs and benefits once they were converted into real prices.

The MCM model used a standard discount factor of 3.5% for all costs and benefits, thus differing from the HM Treasury (2014) guidance, which advised to discount QALY effects at the health rate of 1.5%. Hence, future health benefits were discounted at a higher rate which depressed the value of the benefits. This more conservative approach to benefits discounting was taken to evidence the positive impact of the intervention under "worst scenario" conditions.

The Senior Smiles model used a discount factor of 4% in accordance with the Australian Department of Treasury and Finance (2013) for all costs and benefits, as the Australian guidance places slightly different valuations on the above factors.

In addition to the initial analysis, sensitivity analysis was undertaken via Monte Carlo simulations on the CBA outcomes. This technique simulated the impact of

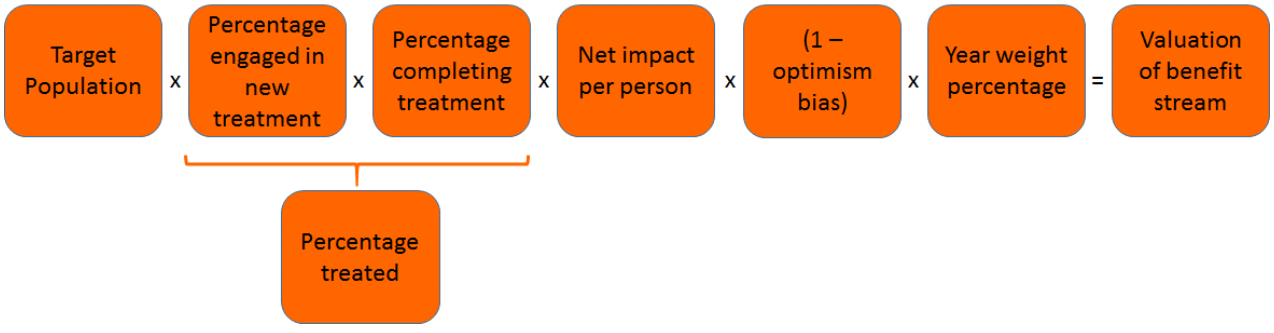

***Figure 2**. Calculation of total net present benefits*

the expected variance in key variables on the output of interest by running thousands of scenarios with randomly drawn values from within the declared confidence intervals to test their impact. This was undertaken to provide confidence and robustness to the CBA outcomes.

Evidence was gathered from a multitude of sources in a targeted and in-depth literature review, involving subject matter experts where the academic literature had gaps. Data for the two projects were also collected as follows:

MCM

- Audits to assess the compliance with the Mouth Care Recording Packs, performed in December 2015 and in June 2016.
- Inpatient questionnaire using the 5 item Oral Health Impact Profile (OHIP-5) used in the pilot trust on 120 patients.
- Report run on Datix (incident reporting), with the legal team and lost property to track the number of lost dentures between 2009 and 2015 and in 2016.
- Audit of 50 patients using a dry mouth scale (Das and Challacombe 2016) at Surrey and Sussex Healthcare Trusts (SASH).
- Survey of junior doctors' previous oral health training and management of five scenarios.
- Staff questionnaires on current mouth care practice and barriers, completed by 179 members of staff.

Senior Smiles

- Oral health risk assessments for the pilot.
- Oral health risk assessments for the then ongoing project.

Results

The different models relied on the extensive body of evidence about the importance of good oral health in relation to general health and quality of life, linking poor oral health with malnutrition, respiratory, infections and cardiovascular diseases (Benyamini *et al*., 2004; Gil-Montoya *et al*., 2015).

This section summarises the results of the evaluations of the MCM programme in acute settings and the Australian project delivered in care homes. The model findings were displayed as benefit-cost ratios encompassing cash releasing, non-cash releasing and social savings together. Table 2, scenario 1 for years 1 to 5 shows a benefit of £26.70 for every £1 spent on MCM. The contribution to the savings varied by model and scenario but the benefit streams remained the same.

The model outputs found savings within all three benefit streams (cash releasing, non-cash releasing and social). The main areas where savings were modelled were improved nutrition, reduced hospital acquired pneumonia and the early identification of oral cancer. These areas consisted of multiple benefit streams.

Improved nutrition was found to result in fewer GP visits (non-cash releasing), shorter hospital stays, lower admission rates (non-cash releasing), lower prescribing rates (cash releasing) and improved quality of life (social). Due to improvements to mouthcare, a reduction in length of stay (non-cash releasing), prescribing (cash releasing) and mortality (social) rates resulted in fewer cases of ventilator associated pneumonia. While the mouthcare programs also helped to identify oral cancer at an earlier stage, which in turn led to a reduction in mortality (social), treatment (non-cash releasing) and inappropriate prescribing (cash releasing). The benefit streams identified stem from a greater oral hygiene focus with patients and the subsequent actions taken to address any oral issues identified.

Mouth Care Matters

The headline findings for the three scenarios of MCM are displayed in Table 2, which shows the Benefit - Cost Ratio (BCR) – that is the ratio of benefits to costs observed in the study in net present value terms - at the Surrey and Sussex Healthcare NHS Trust pilot site only (scenario 1), as well as the results of modelling of the rollout across KSS (scenario 2) and an indicative cost benefit analysis for a national rollout (scenario 3). For each year the value on the left includes all benefits, including social benefits in the BCR calculation, whilst the value on the right includes only cash releasing and non-cash releasing benefits (tangible benefits for the healthcare system).

Senior Smiles

Scenario 1 covers the pilot of the programme implemented in five care homes in 2014. Scenario 2 covers the current implementation of Senior Smiles (which started in September 2017 and is due to last for 3 years). Five facilities are taking part in this phase. Scenario 3 simulates the roll out of Senior Smiles across all care homes in New South Wales (e.g. 291 facilities in total).

The modelling for this project spans over three years instead of five, due to the model of care and funding structure, and is carried out subject to Australian CBA guidance, which applies a different discount rate and value of a QALY. Table 3 displays the CBR for years 1 to 3 rather than years 1, 3 and 5.

Table 2. Benefit to cost ratio (BCR) headline results by year for the MCM project (including social benefits on the left, excluding social benefits on the right)

	2015/16 Year 1		*2017/18 Year 3*		*2019/20 Year 5*		*From years 1 to 5*	
Scenario 1 – MCM at SASH	16.6	1.4	21.7	1.8	37.2	3.0	24.6	2.0
Scenario 2 – MCM across KSS	4.3	0.6	17.5	2.4	22.2	3.0	18.4	2.5
Scenario 3 – MCM across England	12.2	1.6	14.8	2.0	15.2	2.0	14.8	1.9

Table 3. Benefit to cost ratio (BCR) headline by year for the Senior Smiles project (including social benefits on the left, excluding social benefits on the right)

	Year 1		*Year 2*		*Year 3*		*From years 1 to 3*	
Scenario 1 – Senior Smiles pilot	7.1	3.2	14.4	6.6	14.2	6.6	9.0	4.1
Scenario 2 – current implementation	6.8	3.2	6.8	3.2	6.8	3.1	6.8	3.1
Scenario 3 – across New South Wales	5.6	2.4	5.6	2.4	5.6	2.4	5.6	2.4

Discussion

Through robust evaluation of their costs and benefits, the two projects demonstrated positive impacts on the health economy, on patient outcomes and on quality of life.

As a result of the evaluation, HEE funded a national implementation of MCM. The nationwide spread led to staff in over 30 Trusts receiving two-day training and over 100 Trusts utilising the MCM resources developed to support oral health initiatives. During the training, 276 MCM champions were trained across the country. They went on to train over 1,485 staff in their Trusts to date. The national roll-out also enabled the collection of a large dataset on oral health care (1,679 patient questionnaires), as well as oral health practices and policies (1,830 staff member questionnaires) to contribute to the existing body of evidence. Similarly, the Senior Smiles programme was able to leverage these findings to obtain the endorsement of the Australian Dental Association (ADA, 2018) as well as being awarded the second prize at the Australian Society of Special Care In Dentistry (ASSCID) conference (Senior Smiles, 2017). Hence, health economics modelling impacted both the MCM and Senior Smiles programmes. It enabled their roll out and contributed in raising their profile.

Oral health is an influencing factor in many multifactorial conditions. When well-managed it can reduce the incidence of illnesses, such as pneumonia and malnutrition (Sjögren *et al*., 2008; Moynihan *et al*., 2009). Poor oral health can cause embarrassment, resulting in social isolation, depression and low self-esteem (Masood *et al*., 2017). However, mouth care improvement programmes often struggle to be recognised as a priority in acute and community settings (Murphy *et al*., 2018). Monetising oral health programmes brings to light the real cost of poor oral health management for the system and for the patient. It presents compelling evidence on the unmet needs and their consequences to commissioning services.

Tables 2 and 3 show positive BCRs for the two programmes. It should be noted that social benefits are included in these calculations. Whilst monetising social benefits is a way to capture the impact of quality of life improvement, the assignation of a financial value is an abstract construct and does not necessarily translate into financial savings.

There are intrinsic limitations to economic modelling. It is not an exact science and its outputs should *guide* decision-making rather than replace experienced local knowledge. The context, the drivers of the programme, as well as what needs to be addressed are key when interpreting the financial picture produced by the economic modelling. In many ways this analysis provides a more informed set of questions rather than definitive answers.

Both evaluations relied on academic sources for some of the estimates of value and magnitude of benefits, which resulted in the need to apply higher optimism bias correction, thus reducing the benefits within the models. Therefore, designing the data collection system early in a project and allocating sufficient resources to sustain it are crucial to ensuring the modelling produces as a prudent, robust, yet realistic, estimate.

The evidence for some health benefits cannot always be claimed as significant. In recent years, there has been considerable interest in possible links between periodontitis and systemic diseases.

Despite this association between periodontal and systemic diseases, the inclusion of benefits arising from improving oral health care on long term conditions such as diabetes and CVD, within the different models, can be questioned for two reasons:

- There has been no research into the effect of a hospital-based intervention in prevention or treatment of systemic disease which can take a significant time to develop.
- Such systemic conditions can take a very long time to develop or manifest. The requirement of the models, to discount future benefits to reflect commissioning preference for benefits realised sooner, would greatly erode the potential benefit gain.

Taking these two issues together, it is not possible to claim a measurable benefit. That is not to say that with good implementation of MCM and Senior Smiles such benefits do not arise. This example highlights that not all potential benefits are actual or can be quantified and monetised, especially when associations may not be causal or when interventions are innovative and explore new models of care. Should extensive and thorough data and metrics be collected, modelling the incidence of long-term conditions would still remain a challenge, as the benefits are likely only to be realised beyond commissioners' timeframes.

Conclusions

Health economics can be a useful tool in aiding care organisations to assess the implications of decisions to spend limited resources in particular areas of healthcare over others. Clinicians should have a basic understanding of how health economics impacts clinical decisions, but there should also be an understanding of its limitations. Investing in oral health improvement programmes has economic benefits in addition to patient benefits. Economic evaluations can support applications for funding similar programmes in the future.

In this case health economics modelling benefitted both the MCM and Senior Smiles programmes, enabling them to spread further and contributed in raising their profile.

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Conflicts of interest

None to declare.

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