Kent Surrey Sussex Academic Health Science Network

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

SENIOR SMILES©

Cost benefit analysis of the Senior Smiles pilot

January 2019

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Executive Summary

Introduction

‘Senior Smiles’ is a preventive model of oral health care for people living in Residential Aged Care Facilities (RACFs). Developed by Associate Professor Janet Wallace and the oral health team at the University of Newcastle, the programme is currently funded by a $540,000 grant from the Elderslee Foundation.

Australia’s population is ageing, it is predicted that the over 65s will account for between 23% and 25% of the population by 2056 compared to 13% in 2007 (Australian Bureau of Statistics, 2013). Possession of natural teeth within this older population is likewise expected to escalate, as will the need to maintain the technically more complex, reconstructed and biologically older mouth.

Residents in Australian nursing homes (residential aged care facilities or RACFs) have been identified as a particularly vulnerable sub-population of elderly people with high oral health needs and limited access to dental care (Hopcraft, et al., 2012). Indeed, polypharmacy, impaired salivary function, poor oral hygiene related to cognitive and physical impairments and dependence on others for care are some of the factors responsible for the prevalence of tooth decay and periodontal diseases amongst RACFs residents. There is now a growing 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, infections and cardiovascular diseases (Benyamini, et al., 2004; Gil-Montoya, et al., 2015).

The preventive programme ‘Senior Smiles’ was trialled in 2014 in 5 RACFs in New South Wales (NSW) Central Coast. The model places a qualified oral health practitioner within the facility one to two days a week, depending on the number of residents, as a result the practitioners:

- provide the residents with oral health risk assessments and care plans;
- establish referral pathways with private and public dentists, prosthetists and specialists in geriatric dentistry to manage the more complex needs;
- collaborate with other staff members in the facilities to ensure oral health becomes part of daily care needs and that a holistic approach to residents’ care is established.

Following the success of the pilot, additional funding was secured, and the programme is currently in phase two of implementation on the NSW Central Coast, in the Hunter Valley and in Sydney, in five new facilities.

Purpose of report

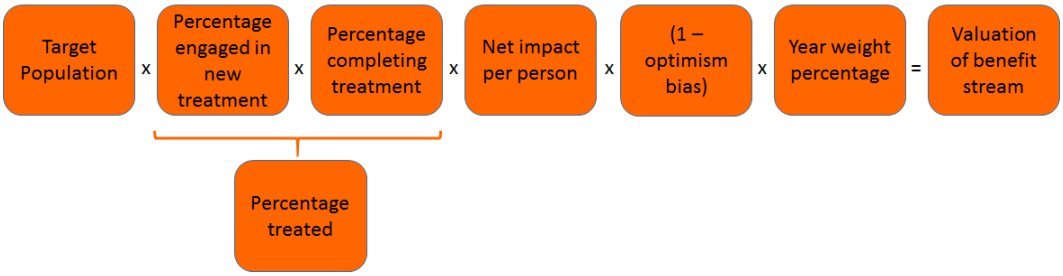
With the ever-increasing pressures placed upon health and social care systems, any interventions made ideally need to improve outcomes, increase safety and/or provide better value. This report has been conducted to understand the value impact achieved through the Senior Smiles programme to understand the return on investment and opportunity for wider rollout. It may also help focus decision-making on the scale and which elements of the programme are most suitable for replication.

Methodology

This study produces a current and an ex-post appraisal of the impact of the Senior Smiles programme. It estimates the impact of the value produced using the best available evidence from the pilot, the current implementation and other literature. This assessment is in line with the Department of Treasury and Finance 'Economic Evaluation for Business Cases Technical Guidelines' (Treasury and Finance, 2013).

The following core process is applied to the estimation of these benefits:

Figure 1 Calculation of net present benefits



This process takes a standard approach of working out the number receiving the treatment, multiplied by the net benefit or impact per person, multiplied by a factor to remove an optimism bias, and a second factor which accounts for phasing of delivery, with lower weights placed on roll-out years and a weight of 1 placed on full implementation years, to give a total net benefit of the benefit stream, over and above the counterfactual, for whom the percentage engaged in the new treatment, and the percentage completing treatment (the percentage treated) will be zero.

The counterfactual is the treatment that patients would have received in the absence of the Senior Smiles programme, which captures relative delivery compared to other RACFs attempting to deliver mouth care without the presence of the dental hygienist in their facility.

The report takes a three-year view of the programme for scenario 1 (pilot of the project). The facts that the oral health practitioners' wage was paid for a year and 2 of the 5 facilities carried on funding the oral health practitioners for an additional 2 years explained this decision. Indeed, while benefits are likely to have been observed in the 4th and 5th years after the pilot, the lack of data to quantify the degree to which these

benefits can be claimed to be the result of the pilot has motivated us to restrain the analysis to only the first three-year period.

Scenario 2 describes the current project implementation, whilst scenarios 3 and 4 model the outcomes should Senior Smiles be rolled out across New South Wales and Australia respectively. The report takes a three-year view of the programme for scenarios 2,3 and 4. It follows the funding plan of the current implementation (scenario 2) e.g. three-year funding and it assumes a fade out of the benefits once the funding will stop.

Results

Headline results

Table 1 lays out the headline findings for the three years to financial year 2016/17, modelled using a combination of actual results, recorded by the Senior Smiles team and academic studies conducted into relevant research areas. This table shows the costs and benefits at the 5 RACFs taking part in the pilot, whilst table 2 shows the results of modelling of the current implementation. Tables 3 and 4 show an indicative cost benefit analysis, were the programme to be rolled out across New South Wales (NSW) and across Australia in the same manner as previously.

Table 1 Base-case headline results by year – Senior Smiles pilot - scenario 1 ($,000, net present value – 2014 prices)

	2014/2015	2015/2016	2016/2017	Total
Healthcare system cash releasing savings	$ 29.9	$ 11.7	$ 11.3	$ 52.9
Healthcare system non-cash releasing savings	$ 689.4	$ 265.1	$255.6	$ 1,210.1
Societal benefits	$ 855.9	$ 324.3	$ 308.8	$ 1,489.1
Total Benefits	**$ 1,575.3**	**$ 601.2**	**$ 575.7**	**$ 2,752.1**
Total costs	**$ 223.5**	**$ 41.7**	**$ 40.6**	**$ 305.8**
Net present value (benefits – costs)	**$ 1,351.8**	**$ 559.4**	**$ 535.1**	**$2,446.3**
Benefit to cost ratio	**7.05**	**14.40**	**14.18**	**9.00**

Table 2 Base-case headline results by year – Senior Smiles current implementation - scenario 2 ($,000, net present value – 2014 prices)

	2017/2018	2018/2019	2019/2020	Total
Healthcare system cash releasing savings	$ 22.8	$ 21.9	$ 20.4	$ 65.0
Healthcare system non-cash releasing savings	$ 1,030.6	$ 971.0	$ 904.0	$ 2,905.6
Societal benefits	$ 1,225.4	$ 1,154.1	$ 1,087.9	$ 3,467.4
Total Benefits	**$ 2,278.9**	**$ 2,147.0**	**$ 2,012.2**	**$ 6,438.0**
Total costs	**$ 333.8**	**$ 315.4**	**$ 298.0**	**$ 947.2**
Net present value (benefits – costs)	**$ 1,945.1**	**$ 1,831.5**	**$ 1,714.2**	**$ 5,490.9**
Benefit to cost ratio	**6.83**	**6.81**	**6.75**	**6.80**

Table 3 Base-case headline results by year – Senior Smiles across New South Wales - scenario 3 ($,000, net present value – 2014 prices)

	Year 1	Year 2	Year 3	Total
Healthcare system cash releasing savings	$ 1,636.0	$ 1,540.7	$ 1,451.0	**$ 4,627.7**
Healthcare system non-cash releasing savings	$ 73,626.0	$ 69,334.6	$ 65,299.8	**$ 208,260.3**
Societal benefits	$ 99,685.2	$ 93,971.7	$ 88,585.7	**$ 282,242.7**
Total Benefits	**$ 174,947.2**	**$ 164,847.0**	**$ 155,336.5**	**$ 495,130.7**
Total costs	**$ 31,431.1**	**$ 29,488.2**	**$ 27,905.3**	**$ 88,824.6**
Net present value (benefits – costs)	**$ 143,516.1**	**$ 135,358.8**	**$ 127,431.2**	**$ 406,306.1**
Benefit to cost ratio	**5.57**	**5.59**	**5.57**	**5.57**

Table 4 Base-case headline results by year – Senior Smiles across Australia - scenario 4 ($,000, net present value – 2014 prices)

	Year 1	Year 2	Year 3	Total
Healthcare system cash releasing savings	$ 4,822.0	$ 4,541.0	$ 4,276.5	**$ 13,639.5**
Healthcare system non-cash releasing savings	$ 216,911.1	$ 204,268.1	$ 192,381.3	**$ 613,560.5**
Societal benefits	$ 293,535.2	$ 276,711.2	$ 260,851.4	**$ 831,097.7**
Total Benefits	**$ 515,268.3**	**$ 485,520.3**	**$ 457,509.1**	**$ 1,458,297.7**
Total costs	**$ 97,809.9**	**$ 91,787.8**	**$ 86,842.4**	**$ 276,440.2**
Net present value (benefits – costs)	**$ 417,458.3**	**$ 393,732.5**	**$ 370,666.7**	**$ 1,181,857.5**
Benefit to cost ratio	**5.27**	**5.29**	**5.27**	**5.28**

Sensitivity testing

Figure 2 presents the probability distribution for total net present benefits calculated using the Monte Carlo method to predict sensitivity of the outcome to variation in underlying assumptions as explained in section 1. This graph shows the costs and benefits for the pilot only, whilst figure 3 shows the probability distribution results of modelling of the current implementation and figures 4 and 5 do the same for the regional and national roll-outs.

Figure 2 Probability of total net present value (NPV) – Senior Smiles pilot (scenario 1)

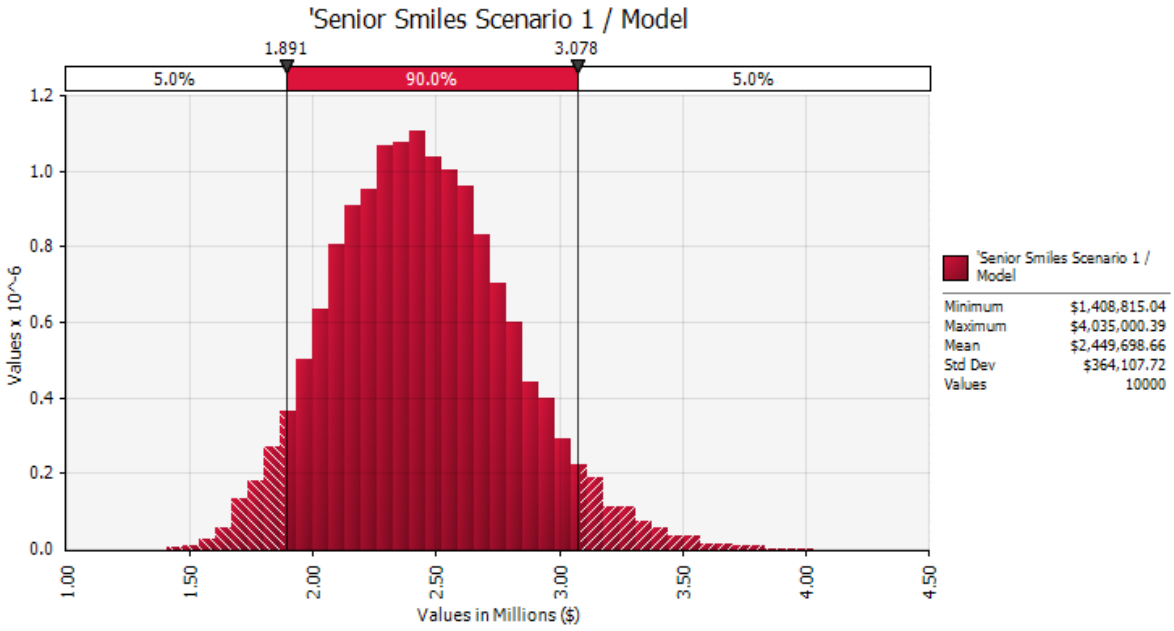


Figure 3 Probability of total net present value (NPV) – Senior Smiles current project (scenario 2)

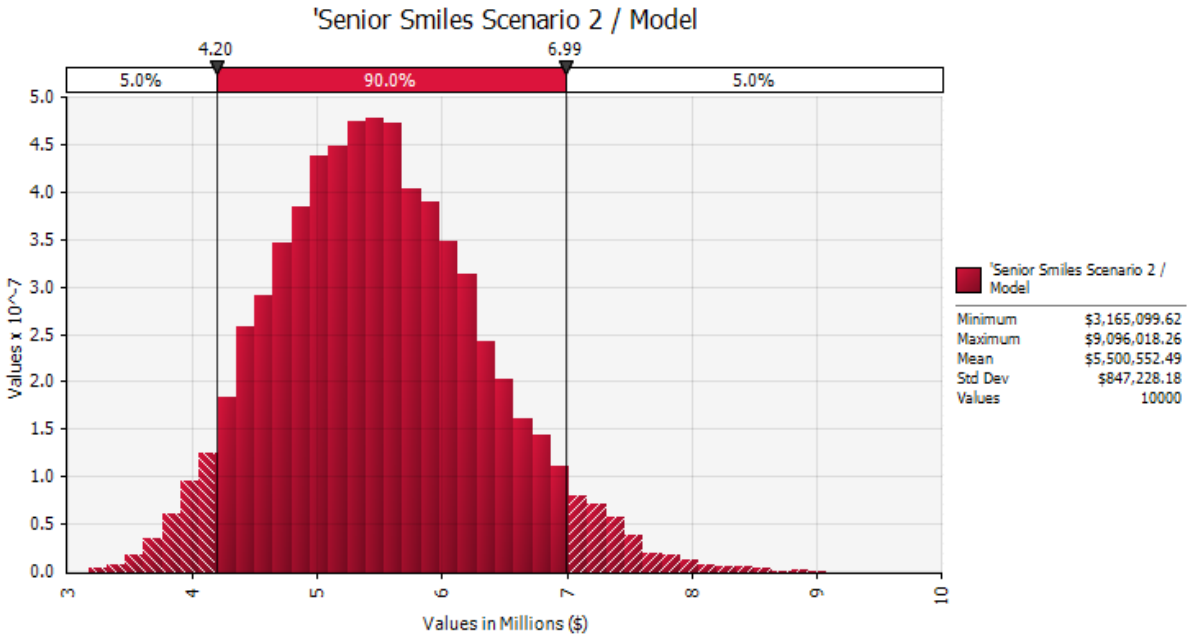


Figure 4 Probability of total net present value (NPV) – Senior Smiles across NSW (scenario 3)

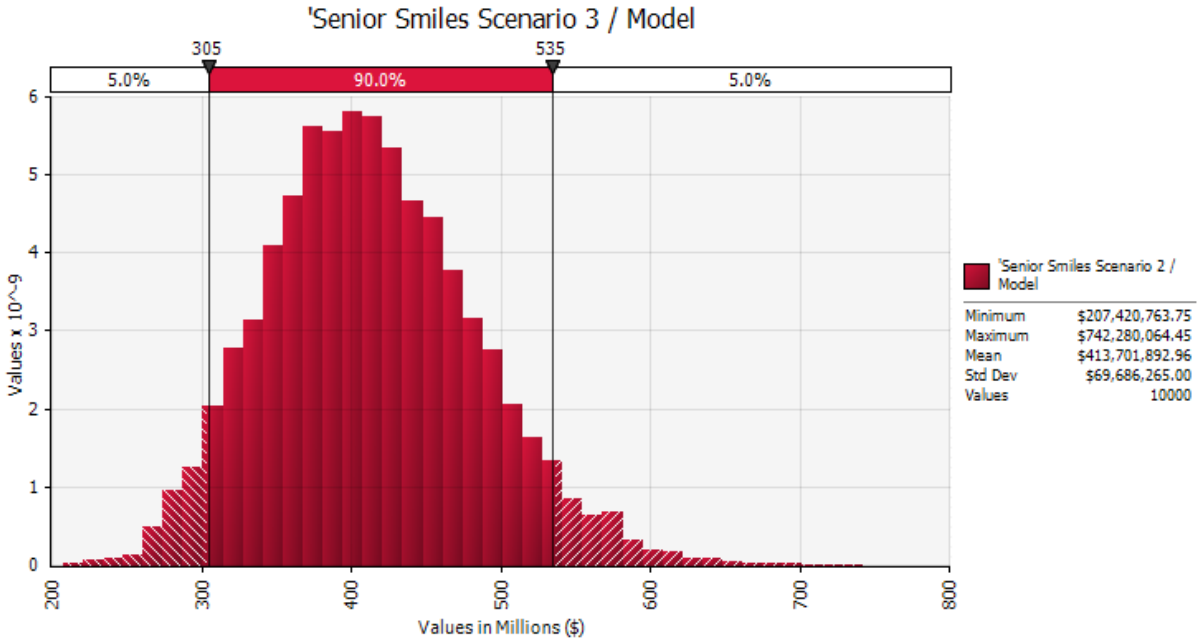
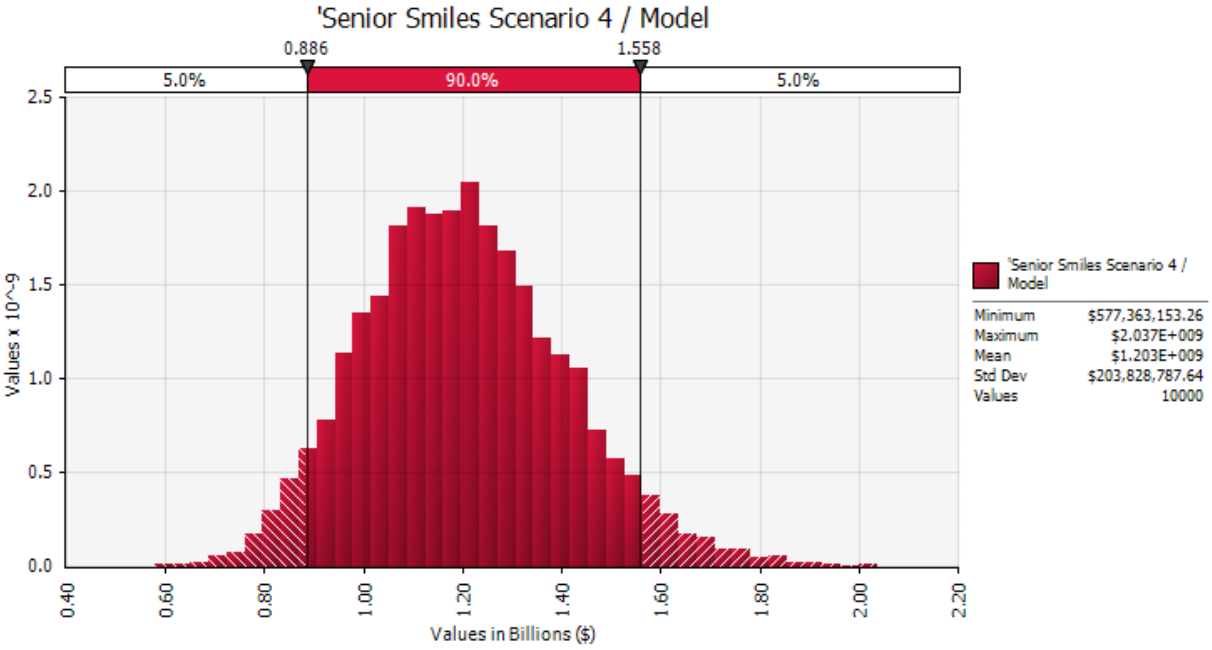


Figure 5 Probability of total net present value (NPV) – Senior Smiles across Australia (scenario 4)



Conclusions

This study's purpose is to understand the impact the Senior Smiles programme is having based on the investment it has been provided with. The economic analysis that has been conducted was designed to answer one primary question; could robust estimates of the total health and social economic benefits that Senior Smiles is contributing be generated via a desk-based study, augmented by standardised data and published sources.

Ability to deliver robust results

This study's primary findings are:

- It is possible for a desk-based study to generate estimates of the value produced that are sufficiently robust to be useful for policy-making, but there are areas where we have applied some caution in the application of the results in terms of estimating an overall net present value of the programme;
- Several of the benefit streams identified have information gathered from older research studies. As such there is little means to verify that benefits identified within these studies remain applicable to the present-day value attributed. To guard against over estimating on this basis, prudent application of a variable optimism bias attempts to control for this effect.
- The study has been compelled to use a number of assumptions in the absence of project data:
- As a result of the absence of some data, whilst it is possible to identify potential benefit streams, it is not necessarily the case that we can quantify these. Data

is not necessarily available, or there is insufficient evidence that in practical terms all the streams come to fruition. Where this is the case, the potential benefit has been explained, but has not been assigned an economic value.

Results of the study

The conclusions of this study, which has looked to identify the costs and benefits of the Senior Smiles programme:

- **The Senior Smiles programme is estimated to deliver tangible value in the order of $4.13 and $3.14 of benefit within the health care system for every $1 invested in the project for the pilot and the current implementation respectively.** This is based on cautious and prudent adjustments for optimism bias applied to both the benefits and the costs.
- **A further $4.87 and $3.66 are identified in social benefits for every $1 invested (respectively for the pilot and the current project).**
- Sensitivity testing around the base-case indicates that the overall **benefits generated per $1 invested range between $7.16 and $11.12 for the pilot and between $5.44 and $8.35 for the current project**. At the 90% confidence level, we do not observe a scenario where costs exceed benefits.
- **Should Senior Smiles be rolled out** it is estimated to deliver an overall gross benefit of $6.80 and $6.07 for every $1 invested respectively for a regional and a national spread.

External validation of model

The model and this report have been subject to external validation by Richard Heys, a professional economist. Richard has degrees in economics from the University of Oxford and UCL. He has worked as a professional economist, both for government and in the private sector for seventeen years. He has worked in partnership with the KSS AHSN for three years, validating economic analyses of health projects.

> "Although the final estimates present what appear to be relatively high benefit-cost ratios, I am content the approach taken within this model represents a robust estimation of the potential costs and benefits arising from the project based on the available evidence, and standard cost benefit techniques, and that prudent levels of optimism bias have been applied. The model applies the Australian discount rate, so will differ from UK models previously run by KSS AHSN."
>
> Richard Heys, January 2019

1 Introduction

Within the increasing older Australian population, there is a significant group at very high risk of developing complex oral diseases and dental problems – institutionalised older adults in Australian residential care facilities. The literature has consistently shown evidence of high levels of oral disease and conditions experienced by many of these residents, including coronal and root caries, gingivitis, plaque accumulation, oral mucosal lesions and denture problems (Locker 2003; Hopcraft, et al. 2012; Wright, et al. 2017).

Reasons for poor oral health can be attributed to the residents' high levels of functional dependence, medical comorbidity, polypharmacy and physical and cognitive impairment. Residents suffering from dementia are further compromise as they display challenging behaviours when given oral care and can be unable to ask for assistance when experiencing mouth pain. Institutionalised population also experiences difficulties accessing and paying for adequate dental services, as well as past negative experiences and anxiety (Lewis, et al., 2015). Studies conducted by Wallace et al. (2012-2013-2014) in 17 RACFs over a period of 4 years found limited or non-existent pathways to access dental treatment.

Dental research indicates many oral diseases associated with an ageing population can be easily prevented by good daily oral hygiene practices in conjunction with timely access to dental services. But with the scarcity of dental resources and the lack of a referral processes, much of the burden of oral care is placed upon the RACF care workers who represent more than two thirds of the workforce (according to Aged Care Workforce Survey 2012) yet hold minimal level health care qualifications and knowledge.

Besides mouthcare can remain in the background even when oral health training is available, as the staff capacity is already limited and stretched to perform urgent tasks such as toileting, bathing and feeding. Barriers that have been reported preventing the provision of oral care have been researched (Adams, 1996; Preston et al., 2006). These include:

- Lack of knowledge
- Lack of training
- Lack of time
- Lack of equipment
- Lack of oral assessment tools
- A disagreeable attitude towards the mouth
- Attitude towards own dental health

Historically, numerous programme such as SA Health & SADS (2009) were designed to enable nursing staff in RACFs to manage oral health. They provided training to the RACFs staff and relied on them to perform oral risk assessments and design care plans for residents. However, the staff turnover is high in RACFs and unless the training is provided very regularly, the barriers to mouth care mentioned previously soon re-appear and oral health drops off the agenda.

The Senior Smiles initiative originates from the realisation that these programmes are often not sustainable and do not translate into improved dental care for residents. Senior Smiles is based on a qualified oral health practitioner visiting the facility weekly to provide the residents with oral health risk assessments, oral health care plans and to establish referral pathways to manage more complex dental and oral health needs. The practitioner also collaborates with the facilities staff to ensure oral health becomes part of daily care.

The programme offers a preventive focus on oral care:

- It treats immediately simple oral health conditions such as xerostomia or ulcers.
- It initiates referral in a timely manner for more complex problems (periodontal disease, caries or oral cancers).

Senior Smiles has been supported by two substantial grants, one in 2013 from the then Medicare Local, and the current grant from the Elderslee Foundation Australia, who have pledged $540,000 over the next three-year period to support the spread of the model to more residential aged care facilities.

2 General Methodology

2.1 Standard Framework

This study produces an ex-post appraisal of the Senior Smiles pilot and an ex-ante appraisal of the prospective impact of the programme, estimated using the best available evidence from emerging project data and academic research. The project is assessed 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 in cost-benefit appraisals.

It is worth noting that the assessment is a socio-economic assessment of the costs and benefits of the Senior Smiles programme to Australian as a whole. It therefore captures costs and benefits that accrue outside the health and social care. The approach of the study is described below:

- **Costs:** The study captured costs which fall on the public health system i.e. the Australian government but also captures the private costs of social care and costs falling on volunteers.

- **Outcomes:** the study has not identified any non-health effects (taking the human costs of illness, including lost earnings as a 'health effect'), but it is not restricted from doing so.
- **Productivity:** In general, if the study identifies an impact on productivity, the analysis will attempt to capture it.

2.2 Standardised data sources

In addition to the framework described above, the Australian government has also looked to enable quicker and more efficient delivery of cost benefit appraisals, particularly by local government, through the funding and development of sets of standardised unit cost databases, from which we will look to draw data as standard. These are:

- **Australian Bureau of Statistics**' Key economic indicators 2018 – annual reports
- **Independent Hospital Pricing Authority**'s 'Australian Public Hospitals Cost Report 2015-2016 (Round 20)
- **Pharmaceutical Benefits Pricing Authority (PBPA)** annual report (2010)
- **General Practice Workforce Statistics** 'Service Volume and Benefit based on Non-referred Attendances (NRA)' (2016-17)
- **Ministry of Health, NSW** 'Oral Health Fee for Service Schedule of Fees for 2016'

These sources present an efficient and effective mechanism for identifying values for many costs and outcome benefits. They are broadly consistent with one another but where they are not, we will look to identify the original source data where possible to identify the most relevant source.

Optimism bias

It has previously been reported that commissioners and practitioners are often overly optimistic about the outcomes that will be achieved by the project or programme and the amount of money that will be needed to deliver these outcomes (New Economy, 2015). It seems reasonable to assume that the degree of over optimism will be greater when the data and evidence upon which the cost effectiveness model is based are uneven, old or incomplete. Therefore, the model applies optimism bias correction factors in response to the level of uncertainty in the data or assumptions used. The optimism bias approach used is based on the confidence grade definitions shown in table 5.

Table 5 Optimism bias correction grading

Confidence grade	Colour coding in model	Data Source	Age of data	Known data error	Optimism bias correction
1		Formal service delivery contract costs Figures derived from local stats / RCT trials	1-2 years old	+/- 5%	5%
2		Practitioner monitored costs Figures based on national analysis in similar areas	2-3 years old	+/- 10%	10%
3		Costs developed from ready reckoners Figures based on generic national analysis	3-4 years old	+/- 15	15%
4		Costs from similar interventions elsewhere Figures based on international analysis	4-5 years old	+/-20%	25%
5		Cost from uncorroborated expert judgement Benefit from uncorroborated expert judgement	>5 years old	+-25%	40%

The confidence grade which the CBA model applies to the data is determined by the lowest assessment in any of the descriptive columns. The optimism bias correction factor for the data is then determined based on the lowest confidence grade found in relation to each individual outcome and costs are increased by the corresponding percentage factor (shown in the table above). Data in the spreadsheet are colour-coded to enable a quick visual assessment of the quality of the cost data inputs.

2.3 Methodological process

This study deploys a tried and tested approach to estimate the impact of the Senior Smiles programme. The approach has the following major stages:

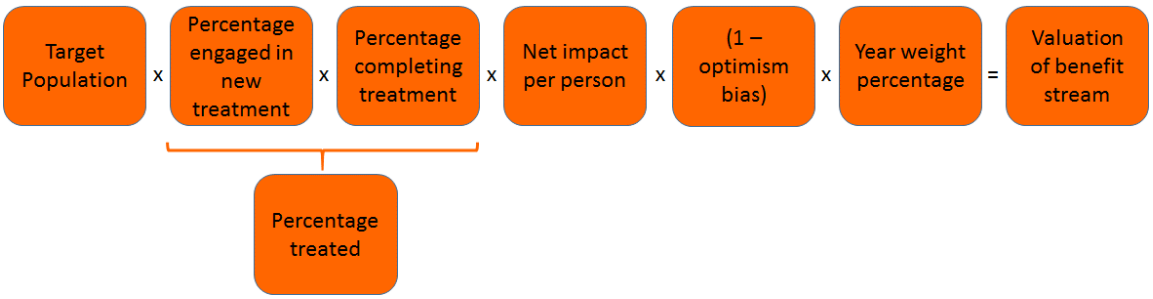
For each outcome, data are needed to determine inputs for the model. The input data required are the:

- total population in the project area e.g. the number of residents in a residential aged care facility (RACF);
- population at risk (e.g. number of residents with dentures);
- level of engagement with the target population (e.g. the percentage of oral health risk assessment completed);

- scale of impact in changing the outcome (percentage success at achieving the desired outcomes - e.g. avoiding a hospital admission).

This process takes a standard approach of working out the number receiving the treatment, multiplied by the net benefit or impact per person, multiplied by a factor to remove the optimism bias, to give a total net benefit of the benefit stream, over and above the counterfactual.

Figure 6 Calculation of total net present benefits



Gathering evidence from existing sources using a targeted literature review to populate the indicative formula outlined in Figure 6, sourcing materials through interviews with subject matter experts and more general literature review techniques to identify the best evidence and mechanism for estimating benefits. Key sources will be:

- **Evaluations of similar delivery models** to identify effectiveness rates and the best ways of measuring these.
- **Indirect benefit estimation methods** – using alternative methods to assess benefit streams if direct estimation methods are not applicable. Examples may be, 'willingness to pay' surveys of consumers of a service to identify what they would be willing to pay to receive this service.
- **Limited estimation methods** – in some cases there may not be sufficient data to capture the full range of benefits from an intervention. In these cases, we will look to identify all benefit streams and quantify those where we can. In particular we have discovered it is normally possible to identify avoided costs, which whilst they may fail to capture the wider social benefits provides a starting point for an assessment.

Applying a discount to future costs and benefits. To determine the present value of the costs and benefits for use in calculations of benefit cost ratios, the values of future costs and benefits are discounted to current prices. The discount rate is used to convert all costs and benefits to 'present values', so that they can be compared. The model uses a standard discount factor of 4%, following Department of Treasury and Finance (2013) guidance. The discount calculation can be expressed mathematically as:

$$D_n = \frac{1}{(1+r)^n}$$

For example, a payment of $150 at the middle of year 3 has a present value at the middle of year 0 of $133.35, with the following working:

$$\$\,150 * \frac{1}{1.04^n} = \$\,150 * 0.8889 = \$\,133.35$$

Applying the existing estimates of effectiveness to data on the size of the treatment groups in the area modelled, including any steps in roll-out.

The following chapters take each benefit stream in turn and describe the methodology used to estimate the value of the project for the scenario. Later chapters look at changes to the assumptions for other scenarios and the resultant benefits and costs.

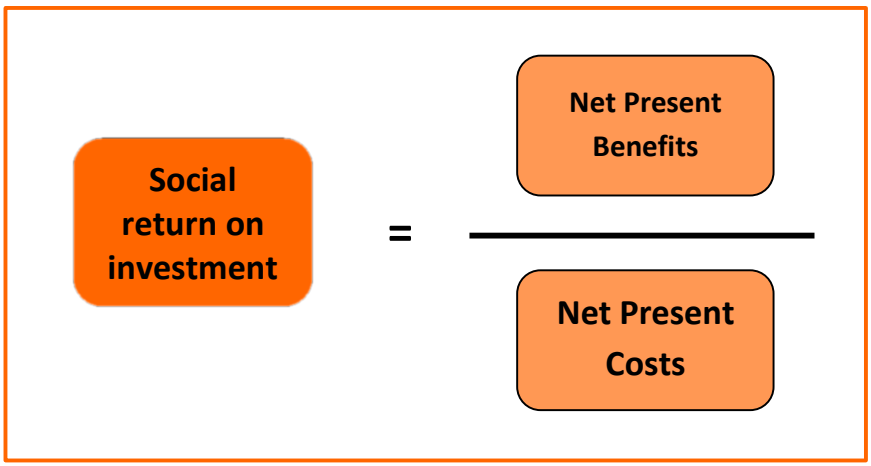
Net present value

The net present value (NPV) is a measure of the additional value created by implementing the project. To provide a consistent measure of costs and benefits now and into the future, future costs and benefits are discounted to produce present values. These present values are then used in the NPV calculation as follows: Net present value = Present value of the benefits – Present value of the costs

Cost benefit ratio

The financial return on investment. This is calculated by dividing the present value of the budgetary savings by the upfront budgetary cost of the intervention as shown in figure 4.

Figure 7 Cost benefit ratio calculation



Monetisation

To turn outcomes from the programme into a financial benefit, each outcome needs to be monetised. There are two overall benefit categories, one of which is further divided to allow a prudent understanding of how the benefit can be realised:

Efficiency Savings, either to the health care sector or others. How these benefits are realised depends of the "cashability" of the saving. "Cashability" refers to the extent to which a change in an outcome will result in a reduction in fiscal expenditure. The ability to cash depends on the type of benefit, scale, timing and the leadership in place to realise the savings. This report takes a prudent approach to identify benefits where the fiscal saving can be easily realised by dividing the fiscal savings into the following benefit streams:

- **Health-system related cash releasing benefits:** These benefits produce immediate cashable savings to the provider. An example of this benefit would be the de-prescribing of a drug, following intervention by the Senior Smiles team.
- **Health-system related non-cash releasing benefits:** These benefits are important to reducing demand and strain on services, but a fiscal value cannot be realised without decommissioning of services, which is often difficult due to factors of scale (e.g. shutting one bed on a ward has a small impact on spending, whereas shutting a whole ward allows for fixed costs to be saved). Benefits which can be described as non-cash releasing include reduced hospital length of stay and reduced re-admissions where the scale of the effect on any one institution is unlikely to release savings of a magnitude which can result in a change in behaviour by the institution.

Social value – The overall benefit to the public, including, but not limited to, employment related benefits, such as fewer sick days and improved health and wellbeing. A key element of understanding these benefits is the approach the model takes in calculating quality of life changes. Quality of life related benefits use a Quality Adjusted Life Year (QALY) calculation. The basic construction of a QALY valuation for a particular health state is the number of years of life spent in that state multiplied by a health state utility-based weighting (cf. Williams, 1985). So, for example, a health state which lasts 10 years and is valued at 0.9 in terms of health state utility would give 9 QALYs. The QALY provides a single index allowing a measurement of the effects of health interventions on mortality and morbidity.

This QALY is then given a financial value using the willingness to pay threshold value. Using a nationally-representative longitudinal survey including 28,347 individuals followed during 2002-2015 in Australia, Haung et al. (2018) refer to a threshold of A$42,000-A$67,000 per QALY. A sensitivity range is used to reflect the range within which this threshold is applied, with the lower value (A$42,000) taken as the prudent modal value.

Other benefits – Although this report is primarily concerned with the fiscal benefits associated with the Senior Smiles programme, it is important to acknowledge the other benefits for which there is evidence, for which an accurate value cannot be attributed. These benefits include reputational value and staff confidence and satisfaction levels.

2.4 Sensitivity analysis

Monte Carlo analysis is a modelling technique which simulates the impact of the expected variance in key variables on the output of interest, in this case the net present value. The approach is best described using an example.

Step One: Allocation of ranges:
Variables whose impact is of interest are given base-case values (or mean estimates), and an expected range. In the example below, we look at quality of life adjustment factor and expected life expectancy:

Step Two: example

Table 6 Presentation of the example used

Variable	Lower range estimate	Base-case / mean estimate	Upper range estimate
Quality of life adjustment factor	0.420	0.565	0.710
Life expectancy (years)	4.73	6.30	7.88

Step Three: Allocation of a distribution shape

All data has a shape to its distribution. If there is equal likelihood of any value within a range being drawn, then a rectangular distribution can be used (so called because a graph of the probability of any specific value being drawn would appear to be a rectangle). If there is a lower likelihood of a value at the extreme ends of the range being drawn, then a triangular distribution could be used.

If there is reason to believe the distribution meets the statistical qualities required to be defined as normal, Poisson, etc, then these can be applied. In this study, we have generally applied triangular distributions as this best reflects the ranges used and diminishing probabilities of more extreme ends. Where a different distribution has been used, it is expressly noted in the text.

Step Four: Random selection of values within the range

The model selects at random a value for each variable from within the range between the upper and lower estimate and calculates the outcome from each draw, considering the distribution shape selected and therefore the probability of any value being drawn.

Step Five: Repetition

Table 7 Five first draws of the repetition step

Variable	Draw 1	Draw 2	Draw 3	Draw 4	Draw 5
Quality of life adjustment factor	0.45	0.50	0.55	0.60	0.75
Life expectancy (years)	4.5	5.0	5.5	6.0	7.5
Quality of Life Year monetary value	$47.000	$47.000	$47.000	$47.000	$47.000
Benefit (lives saved x value of lives saved)	$95,175	$117,500	$142,150	$169,200	$264,375

Five draws are given above, using a rectangular distribution. These deliver estimates lying between $95,195 and $264,375. The draw is repeated thousands of times. In this study, we use 10,000 runs as standard.

Creating 10,000 estimates allows the creation of a distribution of possible outcomes from the draws made. From this distribution, we can then compute the range within which we expect 90% of the observations from the draws to fall. This is called the 90% confidence interval.

2.5 Modelled scenarios

The data available has been deployed to measure the impact of three scenarios; pilot of the project in 5 RACFs; rollout in 17 RACFs and rollout across all RACFs in New South Wales (NSW).

Scenario 1 covers the pilot of the programme implemented in 5 RACFs. This scenario has been included because it was the first enforcement of the programme and it provides a rich source of data from the project.

Scenario 2 covers the current implementation of Senior Smiles (which started in September 2017 and is bound to last for 3 years). Five facilities are taking part in this phase.

The scenario 3 simulates the roll out of Senior Smiles across all RACFs in New South Wales (NSW). Given the point at which this analysis is being conducted, roll out to NSW region has not been completed and data to allow the impact of the project to be evaluated is not currently available. To control for this uncertainty, where the data used for the assumptions comes from the results of the pilot or the current implementation, or is based on academic evidence, an additional optimism bias is applied to model the variability of implementation at scale.

Finally, scenario 4 is included to give an indication of the impact the project could have were the Senior Smiles programme to be rolled out across all residential aged care facilities in Australia.

Across all scenarios, the costs represented are the following:

- The dental hygienists' salaries.
- The cost of dental and GP referrals (when applicable).
- The healthcare costs generated by the decreased mortality, primarily additional length of stay resulting from patients who survive in hospital because mortality has fallen.
- The project management costs (salary of the project manager) when applicable.

3 Scenario 1 – Pilot of programme

3.1 Scenario description

This scenario aims to present the impact of the pilot carried out in 2014. To enable the pilot, an expression of interest was sent out to RACFs on the Central Coast, NSW, Australia. The 5 RACFs selected were within a 15-min radius of each other and the dental hygienist travelled to each RACF one day each week, for a period of 12 months. All residents across the selected 5 RACFs were invited to participate in the study. An information brochure and consent form with a reply-paid envelope enclosed was posted to each resident and/or their family/next of kin (NoK). A follow-up letter and phone call were also utilized where necessary. The consent permitted the dental hygienist to conduct oral health risk assessments for residents' on-site at the RACF. Consent for more complex dental treatment was obtained directly by the dental practitioner providing care either on-site or at the local public dental clinic or a local private dental practice.

The core responsibility of the dental hygienist was to increase oral health awareness and practices in the RACFs. During the 12-month period that the Senior Smiles Model of care was operational in the 5 RACFS, 337 residents consented to participate. All residents received an oral health risk assessment and oral healthcare plan by the dental hygienist. Seventeen of the risk assessments had in-complete data and so only 320 records were analysed at baseline.

3.2 Key assumptions

The results of the individual benefit streams detail where the data regarding impact and cost information is sourced from. Where local data is not available, the following data, in order of preference, will be; regional or national specific data, with market forces factors applied; Australian focussed academic research; international academic research. Where academic research is used, preference is given to the most recent or relevant study evidence available. The base year in the model - e.g. the reference year for constructing an index (enabling to make comparison from this point) – is 2014 as it is the reference year for scenario 1. Any historical costing data used will be uplifted to current estimates using an inflation rate derived from the Consumer Price Index (CPI) published by the Australian Bureau of Statistics, the CPI is assumed to be an adequate proxy for the healthcare cost inflation in Australia.

3.3 Overall benefits

In total, 14 significant monetised benefits of the programme are identified, across the three benefit streams. Identified benefits are based on the programme being funded

for the period analysed by the model, with initial funding from Medicare Local, with the aged care facility assuming responsibility from 2015.

Table 8 Overall benefits expected ($,000, net present value, 2014 prices)

	2014/2015	2015/2016	2016/2017	Total
Healthcare system cash releasing savings	$ 29.9	$ 11.7	$ 11.3	$ 52.9
Healthcare system non-cash releasing savings	$ 689.4	$ 265.1	$255.6	$ 1,210.1
Societal benefits	$ 855.9	$ 324.3	$ 308.8	$ 1,489.1
Total	**$ 1,575.3**	**$ 601.2**	**$ 575.7**	**$ 2,752.1**

3.4 Overall costs

The costs included within the model are a combination of project costs and costs resulting from the implementation of project. Project costs, e.g. the salary of a full-time dental hygienist and the administrative costs, were supported by the Medicare Local funding. There is an additional cost included for the healthcare costs generated by the residents' decreased mortality. Finally, referrals to public dental practices were taken into account.

Table 9 Overall costs expected ($,000, net present value, 2014 prices)

	2014/2015	2015/2016	2016/2017	Total
Funding (Medicare Local)	$ 115.0	$ 0	$ 0	**$115.0**
Dental appointments (referral)	$ 9.4	$ 3.7	$ 3.5	**$16.6**
Healthcare costs (generated by decreased mortality)	$ 99.1	$ 38.1	$ 37.0	**$174.2**
Total	**$223.5**	**$ 41.7**	**$40.6**	**$305.8**

Referrals to public dental practices and the healthcare costs generated by the residents' decreased mortality are the costs resulting from the implementation of Senior Smiles.

Public dental appointment costs

In 2014, 40 residents received treatment from a public dental clinic and 36 were referred but didn't complete their treatment (10 on the waiting list, 16 resisted treatment, 6 experienced treatment issues and 4 were waiting for next of kin approval). In accordance with the methodology, the costs of received and awaiting treatments

were factored in 2014. After the pilot, 2 of the 5 aged care facilities carried on employing a dental hygienist in 2015 and 2016 and it is a reasonable assumption that the same proportion of the residents were referred to public dentists and received treatment. No data was collected after the pilot; therefore, we consider that assumptions for the costs generated in 2015 and 2016.

Table 10 Number of referrals to a dental clinic

	2014	2015	2016
Residents that received treatment	40	16	16
Residents waiting to receive treatment	36	14	14

3.5 Overall scenario results

Taking the costs and benefits specified above into account, the following return on overall investment can be seen:

Table 11 Overall return on investment ($,000, net present value, 2014 values)

	2014/2015	2015/2016	2016/2017	Total
Total Benefits	$ 1,575.3	$ 601.2	$ 575.7	$ 2,752.1
Total costs	$ 223.5	$ 41.7	$ 40.6	$ 305.8
Net present value (benefits – costs)	$ 1,351.8	$ 559.4	$ 535.1	$2,446.3
Benefit to cost ratio	7.05	14.40	14.18	9.00

We also provide a sensitivity analysis to investigate the net present value (NPV) which this analysis presents. This shows that overall NPV could vary between $1.91m and $3.30m at the 90% confidence level. At the lower end of this range, the benefit cost ratio (BCR) would reduce to 6.21:1, assuming costs remain constant. The benefits presented in the table above, however, are the most likely scenario.

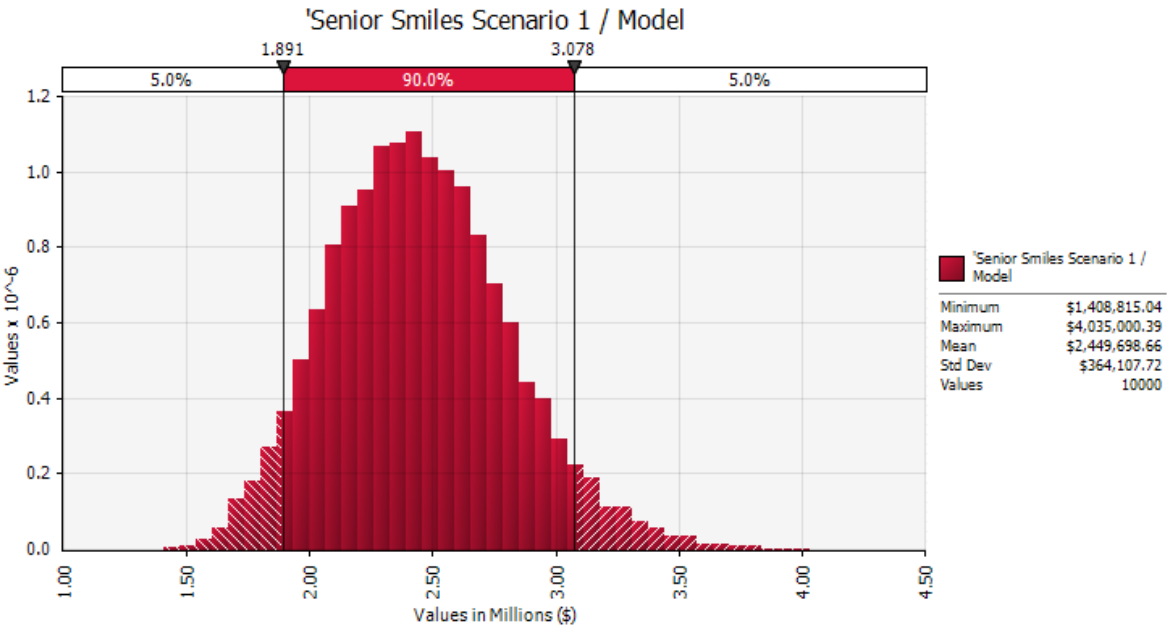


Figure 8 Probability of total net present value (NPV) – Senior Smiles pilot (scenario 1)

3.6 Nutrition

Introduction

Malnutrition is a common and significant clinical and public health problem, adversely affecting physical and psycho-social well-being, as well as reducing the likelihood of independence. Older people are known to be at disproportionate risk of malnutrition, with health conditions both contributing to having an inadequate food and nutrition intake and occurring as a consequence of an inadequate intake (Donini, et al., 2007). In Australia, reports of malnutrition risk on admission to rehabilitation wards are variable: 49% of inpatients in New South Wales (Beck, et al., 2001) against 33% of inpatients in Queensland (Banks, et al., 2007). The rates are higher for new admissions to residential care facilities; 50% or more reported for malnutrition risk in Queensland residents according to Banks et al.

The dental hygienist can assess the risk of oral health issues and identity potential patients where their oral health is affecting their diet. Evidence of completion of the oral risk assessment is therefore essential, as it confirms that the oral health assessment took place.

During the pilot, out of the 5 RACFs on the NSW Central Coast, 337 residents consented to participate in the study and all of them received an oral health risk assessment and oral healthcare plan by the dental hygienist. Seventeen of the risk assessments had incomplete data and so only 320 records were analysed at baseline. Of the 320 recorded oral health risk assessments, 210 (66%) residents were referred

to the hygienist for oral hygiene care. A 15% optimism bias factor was applied to this data, giving an impact by Senior Smiles of 53%.

The findings of the assessments provided by the dental hygienist were not accessible for this report, however Hugo et al (2016) conducted a prospective cross-sectional clinical investigation of 65 aged care residents from facilities in South-east Queensland and have found that 62% of the residents were malnourished. This research was used to assume the prevalence of malnutrition in our population, the optimism bias factor applied reducing the value to 53%.

These assumptions are applied to the resident population in our 5 RACFs, e.g. the 337 residents.

Results of benefit

Three benefit steams are seen from the research conducted. Guest et al, followed 1,000 randomly selected patients over a 6-month period. Those identified as malnourished experienced a greater consumption of health care resources. The main drivers of cost were the following health care interventions:

- More than twice as many GP visits (18.9 vs 9.12);
- 13% vs 5% hospitalisation;
- An increased length of stay of 2.98 days (6.24 vs 3.26 days)
- Drug prescriptions were increased with a 19% difference in expenditure between the two groups

In addition, a 13% mortality rate, compared to 2% in the control group was found over the study period. A reduction in this figure towards the mortality rate of non-malnourished patients results in significant social value.
Although a quality source, from a large randomised cohort, the age and UK-based origin of the data used as evidence means a 40% optimism bias correction is applied to the potential benefits arising from the benefits suggested by this source.

The cost of a GP visit for the provider was estimated using the General Practice Workforce Statistics (Department of Health, 2018) by dividing the total non-referred attendances (NRA) by the total NRA benefits for New South Wales for 2016-17.
The cost associated to a hospital stay was obtained with the National Hospital Cost Data Collection, Public Hospitals Cost Report, round 20, Financial year 2015-16 (Independent Hospital Pricing Authority, 2018) by using the average cost per day figures for NSW.

Finally, the prescription costs for our population is derived from the work of Reeve, et al., (2018). We used the mean cost of medicines per person in the comparison cohort for six months i.e. $1,234 in 2018 prices. The difference in median age (87 versus 80.2 in the cohort of the source used and our pilot population respectively) and the focus on End of Life care in the study explain why we applied a 40% optimism bias to this cost.

Applied to the population, the model suggests the following benefits from the programme.

Table 12 Benefits breakdown for improved nutrition ($,000, net present value, 2014 values)

	2014/2015	2015/2016	2016/2017	Total
Health care system cash releasing savings	$ 14.5	$ 5.7	$ 5.5	**$ 25.6**
Health care system non-cash releasing savings	$ 323.6	$ 123.9	$ 119.6	**$ 567.1**
Societal benefits	$ 362.4	$ 137.3	$ 130.8	**$ 630.5**

3.7 Lower incidence of Nursing Home Acquired Pneumonia (NHAP)

Pneumonia, an acute illness, is defined by the Centers for Disease Control and Prevention (2014) as ‘‘an infection of the lungs that can cause mild to severe illness in people of all ages’’. Compared with community dwelling older adults, RACF residents acquire pneumonia at a rate 10 times higher and are admitted to hospital 30 times more often. Pneumonia is the leading cause of death among aged care home residents, accounting for one-third to one-half of all deaths. Survivors have high rates of re-hospitalisation, long term morbidity and mortality (The Royal Australian College of General Practitioners, 2006).

Aspiration of colonised secretions from the oropharynx into the upper airway remains the primary mechanism by which microorganisms (such as Streptococcus pneumoniae, Haemophilus influenzae, Staphylococcus aureus and Enterobacter) enter the lungs (Amin et al., 2004; Marik, 2001). Poor oral hygiene and periodontal inflammation may foster oropharyngeal colonization with respiratory pathogens.

Following a mouth care intervention across eleven nursing homes in Japan where dental hygienists provided care once a week to the residents in addition to caregivers cleaning their teeth regularly, pneumonia and death from pneumonia decreased significantly (Yoneyama, et al., 2002): The relative risk for patients who did not receive oral care compared with those receiving oral care was 2.45. Similarly, Quagliarello, et al. (2005) showed that 21% of all cases of pneumonia in their 613-patient cohort could have been avoided if inadequate oral care and swallowing difficulty were not present.

Sjögren, et al. (2008), in conducting a systematic review of published RCT studies revealed positive preventive effects of oral hygiene on pneumonia and respiratory tract infection in hospitalised older people. He found mechanical oral hygiene has a preventive effect on mortality from pneumonia. Sjögren concluded that one in ten cases of death from pneumonia in the elderly may be prevented by improving oral hygiene.

The role of the Senior Smiles programme is to highlight the importance of the mouth and oral care for quality patient care. The presence of a dedicated dental hygienist providing weekly care to the residents, together with training of staff to identify and address oral health care issues in patients allows for the risk posed by oral health issues to be controlled.

Benefits calculation

Based on a 2016 study, presentations to the Emergency Department ranged between 16 to 211 visits per 100 beds per year across all RACFs. Hullick and colleagues (2016) included 12 RACFs in Newcastle (Australia) and data was collected between March and November 2011. Moreover, pneumonia is the primary diagnosis upon presentation in 14% of presentations for residents of RACFs (Lane, et al., 2012). Therefore, after applying the appropiate optimism bias to our two sources, the baseline risk of developing NHAP and being subsequently admitted to hospital is 6% for the RACF population. This prevalence rate doesn't include the residents being treated from pneumonia in the aged care facilities, further benefits could then be added to the current model.

McLellan (2007) found that, once the model had applied an optimism bias, a daily oral regime results in a 34% reduction in the incidence of pneumonia amongst ventilated patients.

Researched savings resulting from reduced incidence of nosocomial pneumonia have only been conducted in the USA. In a NICE innovation briefing (NICE, 2015), the costs and resource consequences used research by Gopal, et al. put the cost of found estimates of between $10,019 and $40,000 per patient. Given the differences between the respective healthcare systems, together with the possible range of calculations for assessing purchasing power parity between currencies, direct comparisons of cost are problematic. Consequently, this study focuses on individual benefit streams, with, where possible, localised valuations to produce a more realistic picture of the potential costs and benefits associate with the project.

This study has identified the following benefit streams resulting from this reduced incidence of NHAP.

Reduced length of stay

Analysis of Healthcare Resource Groups codes for 2014/15 (NHS Digital, 2016) relating to pneumonia showed an increase of 5.96 days for these patients, compared to the mean trust length of stay, taken from HES (NHS Digital, 2017). This increased length of stay is consistent with academic research into the potential benefits (cf. Fields, 2008, Daubin, 2005).

This was applied to the mean cost per day for a patient admitted in acute services in NSW, of $1,791 (2016 values) according to the National Hospital Cost Data Collection - Australian Public Hospitals cost Report 2015-2016 – Round 20). Hospitals provide a calculated cost of care at the patient level for each episode of care. To ensure consistency in the approach to costing nationally, the Australian Hospital Patient Costing Standards (AHPCS) were delevoped through jurisdictional and Independent Hospital Pricing Authority (IHPA) input.

Reduced mortality

Research conducted by Fields (2008) shows that mortality amongst patients with VAP is 97% higher than the 10.3% baseline. By avoiding the development of pneumonia, this increased mortality is avoided.

To calculate the number of life years gained, the mean length of stay in a RACF of 145.7 weeks was used (Hopcraft, 2015), as 91% of discharges in 2015 were due to death according to the aged care industry. Once optimism bias is removed and a 25% adjustment applied to reflect the expected reduced quality of life, each life not lost is equivalent to 1.72 quality adjusted life years.

Other benefits

The model included the hypothesis that a reduced incidence of VAP would result in a reduced prescribing of antibiotics and other drugs associated with treating pneumonia. For most patients suffering from non-severe pneumonia, high dose of oral amoxicillin is recommended. The cost of amoxicillin is given by the Pharmaceutical Benefits Pricing Authority (PBPA) annual report (2010) at $10.73 (for capsule 500mg).

Results of benefit

Taken as a whole, these benefits contribute the following economic results to the programme. Note that the programme finished in December 2014, with subsequent benefits arising from a ‘fade out’ (see methodology for further details):

Table 13 Benefits breakdown for reduced pneumonia ($,000, net present value, 2014 values)

	2014/2015	2015/2016	2016/2017	Total
Health care system cash releasing savings	$ 0.1	< $ 0.1	< $ 0.1	**$ 0.2**
Health care system non-cash releasing savings	$ 133.1	$ 50.9	$ 49.1	**$ 233.0**
Societal benefits	$ 59.5	$ 22.5	$ 21.5	**$ 103.5**

Lost dentures

Often a consequence of dementia, lost or mislaid dentures are a common problem in care homes. Losing dentures can have serious consequences to the patient. Frail older people can find it distressing, even traumatic, to go through the process of having new dentures made and many are unable to adjust to new dentures, which impacts negatively on their nutritional status and sense of well-being.

In a study by the Australian Institute of Health and Welfare (Chalmers, et al., 2009) around "Caring for oral health in Australian residential care", the focus group comments highlighted how common dentures loss is and the struggle of the aged care facility staff to prevent it.

> *"People wander and take other residents' dentures"*
>
> *"We try to mark names on most dentures, but some aren't done"*
>
> *"Dentures are always going missing in the laundry"*
>
> *"Expectations of family about residents' dentures are far greater than the ability of the staff"*

In a study of denture loss within a community setting (Michaeli, et al., 2007), 24 of the 26 participants in the study wore their dentures either all day, or all the time. There is therefore the potential for a large impact on patient quality of life if one's dentures are lost.

As well as reduced quality of life for residents, losing dentures results in health care costs that are often supported by the State and Territory. Indeed, based on data collected across 10 RACFs, over 83% of the residents assessed were either full or part pension holder and therefore eligible for public dental care (Wright, et al., 2017).

Explanation of Senior Smiles work

As part of the risk assessment, the requirement of a denture pot to securely store dentures when not in use is made. By providing a pot to place the dentures, the risk of patients losing their dentures is diminished.
Besides, the education sessions provided by the oral health practitioner to the facility staff is a good opportunity to give them precious advice around denture care such as checking for dentures wrapped up in tissues on a meal tray or hidden in bed linen to reduce the risk of them being accidently disposed of.

Benefits calculation

Patients who lose their dentures suffer a reduced quality of life for the duration of the time taken to make new sets. Once made and fitted, patients continue to experience a diminished quality of life compared to patients who had old dentures before receiving the new ones (Hadzipasic-Nazdrajic, 2011), due to the practise of basing new dentures on old sets. Without an old set as reference, the likelihood of a good fit diminishes.

Because of the lack of figures around dentures loss in Australian care homes, data from the UK-based Mouth Care Matters programme was used. Twelve Trusts across Kent, Surrey and Sussex were audited using an incident recording system called Datix. The system was queried against incidences of the use of key words of “denture”, “lost” “plate” and “false teeth”. Between 2009 and 2016, 10.7 dentures were loss per Trust each year on average. The data originates from the UK and focuses on hospital denture loss which implies a different population size and turnover. To counter these limitations, a 40% optimism bias was applied, bringing the number of dentures loss per RACF to 5.5 per year.

Due to the number of variables influencing the number of dentures being reported as lost, it is difficult to infer the effect the Senior Smiles programme has had on the number of dentures lost. The percentage of residents who received an oral health risk assessment was used for the reduction of denture loss once the oral health practitioner is visiting the facility, the staff trained, and reminders posted. To control for optimism bias, a 40% correction has been included bringing the impact of the programme on the number of lost dentures to 48%. As with all benefits, the overall proportion of mouth risk assessment completed was also applied to the number, as without this, oral health practitioners would potentially be unaware of a resident’s dentures.

Reimbursement costs

Where a set of dentures are lost within the facility, the resident either supports the cost of replacing it or is eligible for public dental care. The provider cost for the replacement of dentures was calculating the simple average of the cost of a complete maxillary (or

mandibular) denture (category 771-712) and of a partial maxillary (or mandibular) denture (category 721-722) as the data provided doesn't specify the type of dentures replaced. Therefore, the figures used is A$619.85 per set of dentures according to the Oral Health Fee for Service Schedule of Fees 2016.

Quality of life

Significant study has been made of the effects of edentulism on quality of life. In researching the emotional effect of tooth loss, Fiske and colleagues (1998) found that themes identified in reaction to tooth loss included lowered self-confidence, dislike of appearance, altered behaviour in socialising and forming close relationships and premature ageing. It can be expected that if a patient's dentures are lost, then a significant amount of this disbenefit would return whilst the patient is without their dentures.

Similarly, Shah (2015) found that appearance, confidence and social life had improved by between 75% and 84.4% (mean 79.2%) amongst edentulous patients once fitted with dentures.

These differences to oral health related quality of life are translated to overall quality of life measures, necessary to calculate a QALY figure to which can be applied a value based on the NICE willingness to pay threshold. The model uses a methodology described in Brennan (2006) to achieve this, resulting in a 20% difference in the quality of a patient's life, once optimism bias is removed. This is multiplied by the fraction of a year that patients on average can expect to wait for dentures to be made, taken from expert opinion, with appropriate optimism bias applied. Multiplying this value by the willingness to pay threshold value used in the model (A$42,000) gives a logical estimation of the specific economic cost of reduced quality of life.

Other benefits

There is further quality of life benefits that relate to the reduced loss of dentures. The Alzheimer's Society (2015), in a fact sheet about dental care and oral health identified that dementia patients, if without their dentures for any length of time, can forget how to wear them, and may also be unable to co-operate with the dentist during the several visits required to make the new dentures. In this case, the disbenefits of being without dentures is prolonged, potentially for the rest of the person's life.

Unfortunately, the absence of quantitative analysis on the scale and impact of this issue means that this potential benefit was not able to be included within the model.

Table 14 Benefits breakdown for reduction in dentures loss ($,000, net present value, 2014 values)

	2014/2015	2015/2016	2016/2017	Total
Health care system cash releasing savings	$ 14.9	$ 5.8	$ 5.6	**$ 26.3**
Health care system non-cash releasing savings	$ 0.0	$ 0.0	$ 0.0	**$ 0.0**
Societal benefits	$ 8.2	$ 3.1	$ 3.0	**$ 14.3**

3.8 Xerostomia (Dry mouth)

Introduction

A dry mouth is caused by a lack of saliva in the mouth. Dry mouth or xerostomia is a common side effect of over 400 medications. Having a dry mouth can have a significant negative effect on oral health, causing pain, difficulty in eating, speaking and an increase in dental disease such as dental decay, gum disease and thrush. Steroids and antibiotics can also lead to changes in our immune system and make patients more susceptible to fungal infections (oral thrush).

A partnership model of oral health care, with dental services plus oral health education, was integrated into the community outreach services of a metropolitan hospital department of aged care was developed in 10 aged care facilities across NSW (Wright, et al., 2017). Aggregate data from 607 residents revealed that 49.5% of them had unhealthy or reduced salivary consistency and flow.

Quality of life

The calculation of quality of life follows the same methodology as with the lost denture quality of life benefit. The difference in oral health related quality of life is translated to overall quality of life following the methods described in Brennan (2006). Hahnel, et al (2014) have conducted the most in depth research into the effects of xerostomia on quality of life. Their research found the overall prevalence to range between 7% and 29% of patients over 60 years old. This is lower than the findings from Wright et al. (2017) but consistent with worse oral health outcomes observed in institutionalised elderly people. The research specific value has been used for the base case benefit calculation, with the range given by Hahnel et al used for the sensitivity calculation.

The successful treatment of xerostomia is difficult to achieve and often unsatisfactory (Chi, et al, 2008). In many cases, it is not possible to correct the xerostomia itself, and treatment is symptomatic. Where the symptom is caused by hyposalivation secondary

to underlying chronic disease, xerostomia can be considered permanent or even progressive (Furness, 2011). Given the difficulty in correcting xerostomia, the period used to calculate the quality of life gain is the average length of stay of the residents in the facility.

Reduced cost related to resulting periodontal disease and caries

Dry mouth patients may have decreased oral clearance, increased plaque accumulation and require dietary changes because of problems with swallowing. It impacts on oral health and has been linked to increased risk of caries, exacerbation of periodontal disease and oral discomfort (Brown, et al., 2017). Therefore, reducing the severity of dry mouth in the population can reduce the number of associated mouth conditions.

Although the link between dry mouth and periodontal diseases has been established by various studies over the years (Hopcraft & Tan, 2010; Han, et al., 2015; Mizutani, et al., 2015), these studies do not provide an estimate of the increased risk of periodontal disease of people having xerostomia. Therefore, to calculate the benefit, we assume that the proportion of patients suffering from dry mouth has at least the same risk of periodontal disease as our general population (elderly population).

According to Hopcraft (2015), the periodontal disease prevalence was of 26% for people aged 75+ years. Finally, the average provider cost for acute periodontal infection is $70.90 per visit (Oral Health Fee for Service Schedule of Fees 2016).

Similarly, Dreizen, et al., (1977) Petersen, et al. (2005) and Han, et al. (2015) all agree that xerostomia increases the risk of tooth decay but do not provide an estimate of the increased risk of caries of people having xerostomia. Therefore, to calculate the benefit, we assume that the proportion of patients suffering from dry mouth has at least the same risk of tooth decay as our population e.g. 66% of the 75+ years population (Hopcraft, 2015) after we applied the appropriate optimism bias.

The Oral Health Fee for Service Schedule of Fees (2016) for a tooth extraction from each quadrant (category 311), i.e. $133.55 per visit, was used to monetise the benefit.

Table 15 Benefits breakdown for reduction in dry mouth ($,000, net present value, 2014 values)

	2014/2015	2015/2016	2016/2017	Total
Health care system cash releasing savings	$ 0.0	$ 0.0	$ 0.0	**$ 0.0**
Health care system non-cash releasing savings	$ 15.7	$ 6.1	$ 5.9	**$ 27.7**
Societal benefits	$ 397.7	$ 150.7	$ 143.5	**$ 691.9**

3.9 Early identification of oral issues

Introduction

Oral cancer makes up 1%-2% of all cancers that may arise in the body. The majority of oral cancers consists of squamous cell carcinomas. Oral cancer carries a considerable mortality rate, being mainly dependent on the stage of the disease at admission (Van Der Waal, 2013).

The requirement to complete a risk assessment for all residents taking part in the Senior Smiles initiative ensures that the mouths of residents receive the same care and attention that other parts of the body do. With a dedicated oral health hygienist on site every week, referrals can be made to assist in the correct diagnosis of oral health conditions.

Benefits calculation

McGurk, et al (2005) found that 51% of patients with head and neck cancer experience a delay in diagnosis. Whilst in the majority of cases, this was due to patient delay in coming forward for diagnosis, it was found that in 20% of delayed cases, the patient was not responsible. Given the experiences found by the Senior Smiles team, this is felt to be a prudent representation of the scale of the issue that could be addressed by the project.

Mortality

The difference in 5-year survival rates between patients diagnosed when at stage I of the cancer, 80%, is compared with the survival rate for Stage III, 20% (van der Waal, 2013). This difference is taken to be the potential benefit for the patients experiencing a delay in diagnosis. The mean length of stay of 145.7 weeks (Hopcraft, 2015) in a RACF is used to model the remaining life expectancy of residents, as 91% of

discharges in 2015 were due to death according to the aged care industry. This study then multiplies the difference in survival by the 145.7 weeks period to produce a number of QALYs that can be combined with the willingness to pay threshold figure. One QALY is equal to 1 year of life in perfect health (on a 0 to 1 scale) therefore, a 20% reduction is applied to the number of QALYs calculated to account for the cognitive and physical impairments of the residents.

Health costs

To evaluate the difference in treatment costs, this study considers the average number of hospitalisation days for both a patient with stage I oral cancer (60 days) and a stage III patient (157.5 days) according to Zavras, et al (2002). Despite the age of the study making its use sub-optimal, as this report is only using the difference between the two figures to calculate the potential benefit of early diagnosis, we feel it is judicious to use it. The optimism bias factor used in the calculation also acts to offset the risks of using a study of this age. The cost of a head and neck procedure (major complexity – DRG code D02A) is of $28,084.83 with an average length of stay of 10.44 days according to the National Hospital Cost Data Collection (cost report round 20). In the benefit calculation, the average number of hospitalisation days is multiplied by the cost of a head and neck procedure and divided by the average length of stay for the same procedure to obtain a cost per day.

Table 16 Benefits breakdown for earlier detection of oral cancer ($,000, net present value, 2014 values)

	2014/2015	2015/2016	2016/2017	Total
Health care system cash releasing savings	$ 0.0	$ 0.0	$ 0.0	**$ 0.0**
Health care system non-cash releasing savings	$ 172.8	$ 67.4	$ 65.1	**$ 305.4**
Societal benefits	$ 28.1	$ 10.6	$ 10.1	**$ 48.8**

3.10 Improved oral health of staff

Introduction

It is not only patients who can benefit from additional training provided to the RACF staff and the advice and support of the dental hygienist. By expanding their understanding on oral health care, staff who receive training can apply the learning to themselves, resulting in fewer days lost to sickness.

Throughout the pilot, 239 members of staff participating in an oral health education session. However, there was no feedback questionnaires collected. Because of the similarities of the Senior Smiles project with the Mouth Care Matters programme – an UK- based project aiming at improving oral health in acute settings by training staff and strengthening recording processes – this study used the qualitative feedback collected during the implementation of Mouth Care Matters (MCM). The questionnaire was given to staff who had been trained, asking whether they had changed their oral health habits because of the training. A high optimism bias factor was used throughout the calculation to take into account the appropriateness of the data source.

Benefits calculation

In total, during the MCM programme, 179 staff who received training had responded, with 72% stating that they changed their oral health habits as result of training. This report has used the recommendation to not rinse after brushing teeth as a proxy for wider oral health changes. It is accepted that there will be various and potentially multiple changes made by staff but concentrating on one would provide a sensible estimation of the benefit produced. The proportion of staff making changes is also broadly in line with a national survey that found 62% of the population rinse their mouth after brushing.

To translate this to an effect that can be measured as a benefit, the results of a Scottish study (Chestnutt, et al., 1995) was used that found that rinsing after brushing proved to be associated with recurrent caries or tooth decay. With the oral health foundation (2017) finding that 5% of working time lost was due to oral health issues this can be translated to the cost of an average working day for an aged care employee level 1 (Australian Government, 2018), which is the group who have received the most instances of training.

There are further benefits resulting in fewer sick days lost beyond the direct cost to the RACF. Although the authors were not able to find specific evidence to apply an economic value on the other research, Clarke and Donaldson (2008) show the importance of an established nursing team on the quality of patient care.

Table 17 Benefits breakdown for oral health of staff ($,000, net present value, 2014 values)

	2014/2015	2015/2016	2016/2017	Total
Health care system cash releasing savings	$ 443.7	$ 173.2	$ 167.3	**$ 784.2**
Health care system non-cash releasing savings	$ 0.0	$ 0.0	$ 0.0	**$ 0.0**
Societal benefits	$ 0.0	$ 0.0	$ 0.0	**$ 0.0**

3.11 Avoided admissions: potentially preventable hospitalisations (PPH)

Potentially preventable hospitalisations (PPH) are those conditions where hospitalisation could have potentially been prevented through the provision of appropriate, preventive health interventions and early disease management, usually delivered in primary care and community-based care settings (inlcuding by general practitioners, medical specialists, dentists, nurses and allied health professionals). These are defined in accordance with the National Healthcare Agreement's definition of the PPH performance indicator. PPH rates are indicators of the effectiveness of non-hospital care. The rate of PPH in a local area may reflect the prevalence and severity of the conditions, or effectiveness and access to the non-hospital care system. There are three broad categories of PPH:

- **Vaccine-preventable:** diseases that can be prevented by vaccination such as pneumonia and influenza.
- **Acute:** diseases that theoretically not result in hospitalisation if adequate and timely care (usually non-hospital) was received, these include cellulitis, convultions and dental conditions for instance.
- **Chronic:** conditions that can be managed effectively through timely care to prevent deterioration and hospitalisation such as angina, asthma and chronic obstructive pulmonary disease (COPD).

In 2015-2016, the rate of PPH for dental conditions was 248 per 100,000 people and PPH for dental conditions represented 6% of all PPH (Australian Institute of Health and Welfare, 2015-16).

Benefits calculation

Using the data of all patients older than 65 years admitted to hospital for an oral-related condition in Western Australia over a ten-year period, Kruger & Tennant (2015) observed that dental caries accounted for 15.4% of admissions. During the pilot, 146 of the residents were referred to a dental clinic (out of the 320 participants). Had the programme not taken place, these residents would have been likely to be admitted to hospital. According to the National Hospital Cost Data Collection (cost weights for AR-DRG version 7.0) a hospital separation (or admission) for dental extractions and restorations (code D40Z) is costed at $3,041.

Table 18 Benefits breakdown for avoided hospital admission ($,000, net present value, 2014 values

	2014/2015	2015/2016	2016/2017	Total
Health care system cash releasing savings	$ 0.0	$ 0.0	$ 0.0	**$ 0.0**
Health care system non-cash releasing savings	$ 44.3	$ 16.8	$ 15.9	**$ 76.9**
Societal benefits	$ 0.0	$ 0.0	$ 0.0	**$ 0.0**

3.12 Reduced incidence of systemic disease

In recent years, there has been considerable interest in possible links between periodontal disease and systemic diseases.

Evidence has begun to emerge of linkages between chronic periodontal disease and other systemic disease, particularly atherosclerotic cardiovascular disease (CVD) (cf. Tonetti and Van Dyke, 2013) and diabetes (cf. Chapple and Genco, 2013). Winning and Linden (2015) describe two mechanisms with which to explain the link between the two issues. Firstly, a direct mechanism, where, as chronic periodontitis progresses, the ulcerated pockets provide a direct entry point for periodontal bacteria into the systemic circulation. Alternatively, the inflammatory response to periodontal bacteria or their by-products may have indirect systemic effects.

Despite this evidence as to the link between periodontal and systemic disease, the inclusion of benefits arising from the tackling of oral health care on long term conditions such as diabetes and CVD within the model is difficult for two reasons:

- Whilst there is clear evidence of a relationship between systemic disease and oral health, there has been no research into the effect of an aged care facility-based intervention in prevention or treatment of systemic disease that can take a significant time to develop.
- Such systemic conditions can take a very long time to develop or manifest. The requirement of the model 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 felt that to attempt to claim a significant benefit within this report is not currently possible. That is not to say that with good links between facility-based teams, Senior Smiles and local public dental practices, such benefits do not arise, or that research opportunities to clarify whether casual relationships exist could not occur.

While this study has been unable to include a reduction in long term conditions resulting from increased care during hospitalisation, the evidence suggests a strong link between oral hygiene and a positive effect on the development of diabetes and CVD. With greater research, such as longitudinal studies, into the direct association, the authors feel a benefit could, in future, be included, showing significant potential benefits.

3.12 Other benefits

In addition to the economic and patient quality of life benefits described above, other benefits relate to the Senior Smiles programme which can be seen to accrue over time. It is not prudent to attempt to attach an economic value to these benefits, due either to insufficient evidence, or no realistic way to monetise the benefit.

These benefits have been grouped under the type of benefit that they fall under.

Aged care facility reputation

Patient relatives in particular are often very conscious of the care received, with oral health being a particularly visible sign of care. Giving staff the tools and knowledge to address mouth care properly can lead to fewer complaints. At the extreme end, this may reduce the possibility of inquiry for serious concerns about the standards of aged care facility, as it was the case for the Opal Raymond Terrace Gardens nursing home after a resident found with maggots in her mouth died in October 2016.

Facilities implementing Senior Smiles can help to improve the knowledge of mouth care on a national level, adding to the body of research available and becoming a centre of excellence.

4 Scenario 2 – Current implementation of Senior Smiles

4.1 Scenario description

The scenario 2 assessed follows the roll out of the Senior Smiles initiative within 5 residential aged care facilities located in New South Wales (NSW), to cover a wider population than in Scenario 1. The project started in September 2017 and funding was obtained to run the project for 3 years. Modelling this provides evidence of the possible impact of the project as it is currently envisioned at an ambitious but realistic level.

The benefit streams identified remain the same as for scenario 1, although estimated values change in line with the changes to the treated population and the phasing of the roll-out.

4.2 Key assumptions

The rollout of the programme is underway, and some data is available to include in the model. Where data are available, and where it differs from the information collected within the pilot, the new data is used. Where new data is not available, the model uses the same assumptions as within scenario 1.

There are two key changes to the inputs to the model made within this scenario, compared to scenario 1; population and year weighting. The population reflects the larger cohort of residents involved in phase 2. Moreover, this implementation began in September 2017.The year weighting, control when costs and benefits are seen, reflects this.

Because both scenarios 1 and 2 take place in NSW, some costs obtained at a regional level are identical to the ones in scenario 1.

Finally, it should be noted that there is considerable uncertainty regarding how well implemented the roll out across NSW will be. To control for this uncertainly, and to ensure that the estimation of benefits and costs is a prudent one, an additional 15% optimism bias is applied to all assumptions used for this scenario where the source is either academic literature or based on results seen during the pilot.

4.3 Overall benefits

As with scenario 1, 14 significant monetised benefits of the programme are identified, across the three benefit streams of cash releasing and non-cash releasing healthcare system savings and societal benefits.

Table 19 Overall benefits for scenario 2 ($,000, net present value, 2014 values)

	2017/2018	2018/2019	2019/2020	Total
Healthcare system cash releasing savings	$ 22.8	$ 21.9	$ 20.4	**$ 65.0**
Healthcare system non-cash releasing savings	$ 1,030.6	$ 971.0	$ 904.0	**$ 2,905.6**
Societal benefits	$ 1,225.4	$ 1,154.1	$ 1,087.9	**$ 3,467.4**
Total benefits	$ 2,278.9	$ 2,147.0	$ 2,012.2	**$ 6,438.0**

4.4 Overall costs

The costs included within the model are a combination of:

- The dental hygienist salaries (covered by the Elderslee Foundation Australia funding)
- The cost of dental and GP referrals
- The healthcare costs generated by the decreased mortality, primarily additional length of stay resulting from patients who survive in hospital because mortality has fallen
- The project management costs (salary of the project manager)

Table 20 Overall costs for the scenario 2 ($,000, net present value, 2014 prices)

	2017/2018	2018/2019	2019/2020	Total
Funding (Elderslee Foundation Australia)	$176.2	$165.9	$156.4	**$498.5**
Dental appointments (referral)	$8.2	$7.7	$7.2	**$23.0**
GP appointments (referral)	$0.5	$0.5	$0.5	**$1.5**
Healthcare costs (generated by decreased mortality)	$148.9	$141.3	$133.9	**$424.2**
Total	$333.8	$315.4	$298.0	**$947.2**

4.5 Overall scenario results

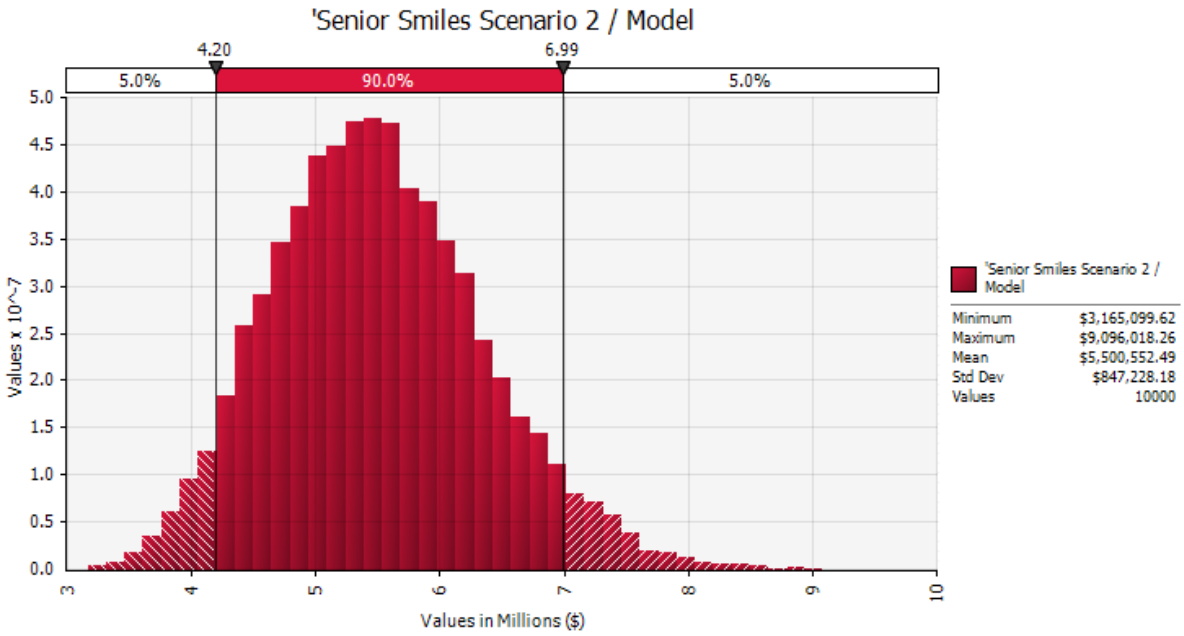
Taking the costs and benefits specified above into account, return on overall investment is as follows:

Table 21 Overall return on investment ($,000, net present vaue, 2014 prices.)

	2017/2018	2018/2019	2019/2020	Total
Total Benefits	$ 2,278.9	$ 2,147.0	$ 2,012.2	$ 6,438.0
Total costs	$ 333.8	$ 315.4	$ 298.0	$ 947.2
Net present value (benefits – costs)	$ 1,945.1	$ 1,831.5	$ 1,714.2	$ 5,490.9
Benefit to cost ratio	6.83	6.81	6.75	6.80

The sensitivity analysis shows that the net present value could vary between $4.89m and $8.61m at the 90% confidence level. At the lower end of this range, the benefit cost ratio (BCR) would reduce to 4.85:1, assuming costs remain constant. The benefits presented in the table above, however, are the most likely scenario.

Figure 9 Probability of total net present value (NPV) – Senior Smiles current implementation (scenario 2)



5 Scenario 3 – Implementation of Senior Smiles across New South Wales (NSW)

5.1 Scenario description

The scenario 3 modelled is to assess the potential benefits that might accrue, together with costs, were the Senior Smiles programme to be extended across all RACFs in New South Wales (NSW) e.g. 291 facilities in total. Modelling this scenario provides evidence-based estimates of the possible impact of the project, were it to be adopted to a widest extent.

The benefit streams remain the same as for those identified within scenario 1.

5.2 Key assumptions

Given that this is an indicative scenario showing the potential benefits and costs were the programme to be rolled out further, rather than reflecting any actual programme results, this scenario builds on the assumptions made within scenario 2, adjusting the inputs where necessary to reflect the much larger populations and spread of the programme.

There are two key changes to the inputs to the model made within this scenario, compared to scenario 1 and 2; population and optimism bias control. With the involvement of all RACF across NSW, the population reflects the much larger cohort of potential patients.

Further to the controls discussed in the previous chapters regarding scenario 2, when considering a potential roll out across NSW an additional variability needs to be considered and mitigated. For scenarios 1 and 2 the current activities regarding mouth care were well known, and the counterfactual, the treatment that patients would have received in the absence of the Senior Smiles programme, is understood. This makes calculation of the marginal difference of the programme more straightforward.

When rolling out across NSW, the current level of oral health care at the various RACFs is a lesser known variable. To control for this difference of settings and ensure the estimation of benefits and costs is a prudent one, an additional 15% is applied to the benefit calculations, over and above the optimism bias correction used in scenario 2 to duplicate intervention bias correction. Intervention bias refers to how the researcher, or other factors, intervene with the test subjects.

Finally, given that there are no current plans for rollout across New South Wales, the year markers have been removed, replacing with Years 1 through 3 and with a staged

roll out included. Although this is almost certainly a much faster roll out than would be achieved in reality, it is felt that it is important to give an indication of costs and benefits that can be achieved at full implementation.

In the model, 2019 is chosen as the start year to respect the base year and discounting approach taking in the other scenarios.

When monetising the benefits, values are updated to reflect the different costings where applicable. This has been weighted to account for differing trust size.

5.3 Overall benefits

As with scenario 1, 14 significant monetised benefits of the programme are identified, across the three benefit streams of cash releasing and non-cash releasing healthcare system savings and societal benefits.

Table 22 Overall benefits ($,000, net present value, 2014 prices)

	Year 1	Year 2	Year 3	Total
Healthcare system cash releasing savings	$ 1,636.0	$ 1,540.7	$ 1,451.0	**$ 4,627.7**
Healthcare system non-cash releasing savings	$ 73,626.0	$ 69,334.6	$ 65,299.8	**$ 208,260.3**
Societal benefits	$ 99,685.2	$ 93,971.7	$ 88,585.7	**$ 282,242.7**
Total benefits	$ 174,947.2	$ 164,847.0	$ 155,336.5	**$ 495,130.7**

5.4 Overall costs

The costs included in this scenario are the same as those described in scenarios 1 and 2 with the exception that there is no private grant funding.

Table 23 Overall costs ($,000, net present value, 2014 prices)

	Year 1	Year 2	Year 3	Total
Dental hygienists' salary	$ 4,419.6	$ 4,166.2	$ 3,927.4	**$ 12,513.2**
Project management costs	$ 10,758.1	$ 10,141.5	$ 9,560.2	**$ 30,459.9**
Dental appointments (referral)	$ 1,413.5	$ 1,331.2	$ 1,253.7	**$ 3,998.3**
Healthcare costs (generated by decreased mortality)	$ 14,839.9	$ 13,849.3	$ 13,164.0	**$ 41,853.1**
Total	$ 31,431.1	$ 29,488.2	$ 27,905.3	**$ 88,824.6**

5.5 Overall scenario results

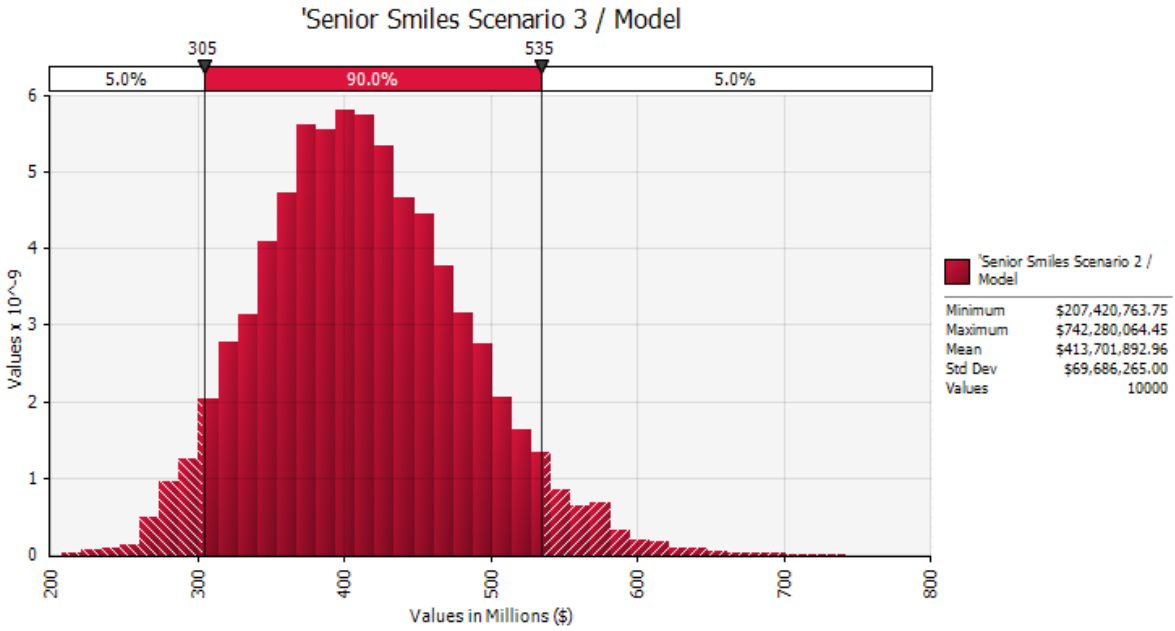
Taking the costs and benefits specified above into account, the following return on overall investment is as follows:

Table 24 Overall return on investment ($,000, net present value, 2014 prices)

	Year 1	Year 2	Year 3	Total
Total Benefits	$ 174,947.2	$ 164,847.0	$ 155,336.5	$ 495,130.7
Total costs	$ 31,431.1	$ 29,488.2	$ 27,905.3	$ 88,824.6
Net present value (benefits – costs)	$ 143,516.1	$ 135,358.8	$ 127,431.2	$ 406,306.1
Benefit to cost ratio	5.57	5.59	5.57	5.57

The sensitivity analysis shows that benefits could vary between $0.390bn and $0.706bn at the 90% confidence level. At the lower end of this range, the benefit cost ratio (BCR) would reduce to 4.55:1, assuming costs remain constant. Besides, the Monte Carlo simulation does not give negative NPV outcomes. The benefits presented in the table above, however, is the most likely scenario.

Figure 10 Probability of total net present value (NPV) – Senior Smiles (scenario 3)



6 Scenario 4 – Implementation of Senior Smiles across Australia

6.1 Scenario description

The scenario 4 modelled is to assess the potential benefits that might accrue, together with costs, were the Senior Smiles programme to be extended across all RACFs in New South Wales (NSW) e.g. 291 facilities in total. Modelling this scenario provides evidence of the possible impact of the project were it to be adopted to the widest extent.

The benefit streams remain the same as for those identified within scenario 1.

6.2 Key assumptions

Given that this is an indicative scenario showing the potential benefits and costs were the programme to be rolled out further, rather than reflecting any actual programme results, this scenario builds on the assumptions made within scenario 2, adjusting the inputs where necessary to reflect the much larger populations and spread of the programme.

There are two key changes to the inputs to the model made within this scenario, compared to scenario 1 and 2; population and optimism bias control. With the involvement of all RACF across Australia, the population reflects the much larger cohort of potential patients.

Further to the controls discussed in the previous chapters regarding scenario 2, when considering a potential roll out across Australia an additional variability needs to be considered and mitigated.
When rolling out across Australia, the current level of oral health care at the various facilities is a lesser known variable. To ensure the estimation of benefits and costs is a prudent one, an additional 15% duplicate intervention bias correction is applied to the benefit calculations, over and above the optimism bias correction used in scenario 2.

Finally, given that there are no current plans for rollout across Australia, the year markers have been removed, replacing with Years 1 through 3 and with a staged roll out included. Although this is almost certainly a much faster roll out than would be achieved in reality, it is felt that it is important to give an indication of costs and benefits that can be achieved at full implementation.
In the model, 2019 is chosen as the start year to respect the base year and discounting approach taking in the other scenarios.

6.3 Overall benefits

The figure 11 represents the estimation of the yearly Net Present Value (NPV) should the Senior Smiles programme be rolled out across Australia. The base-case NPV is positive for every state despite the optimism and weighting applied to scenario 4.

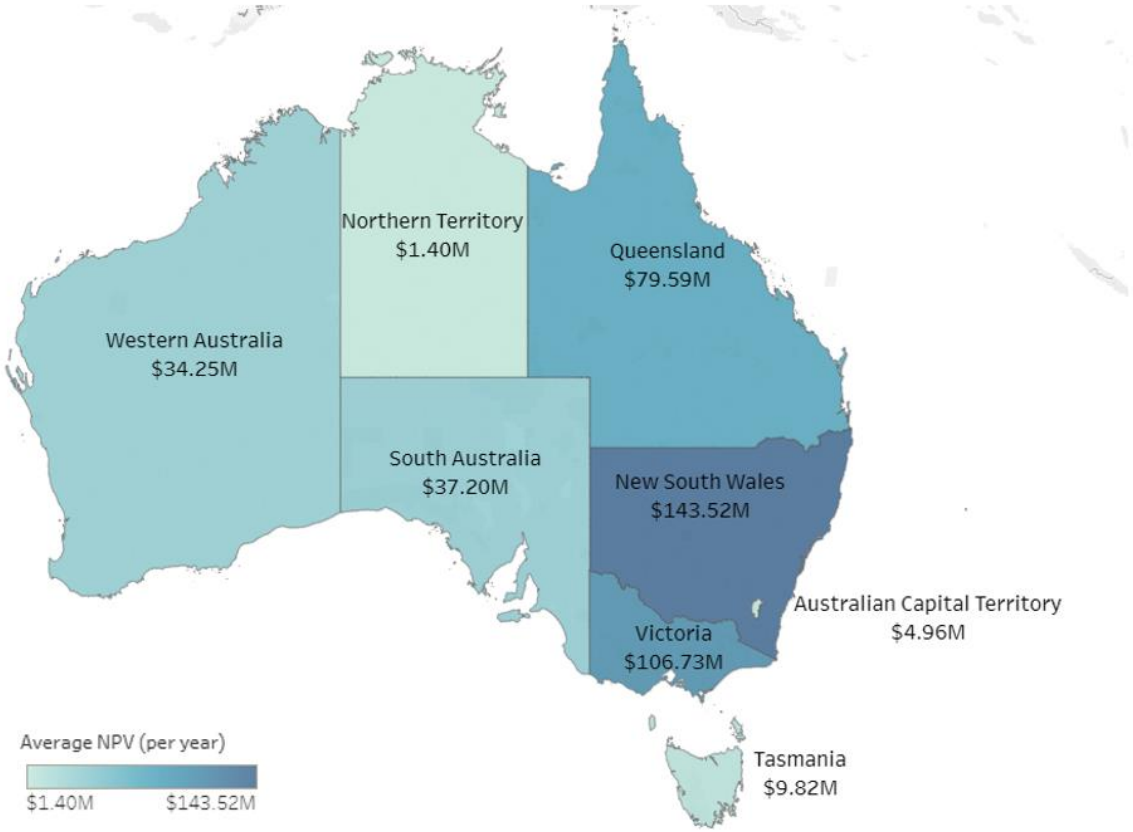


Figure 11 Net Present Value (NPV) distribution across the States and Territories (in $ million)

As with the previous scenarios, 14 significant monetised benefits of the programme are identified, across the three benefit streams of cash releasing and non-cash releasing healthcare system savings and societal benefits.

Table 25 Overall benefits ($,000, net present value, 2014 prices)

	Year 1	Year 2	Year 3	Total

Healthcare system cash releasing savings	$ 4,822.0	$ 4,541.0	$ 4,276.5	**$ 13,639.5**
Healthcare system non-cash releasing savings	$ 216,911.1	$ 204,268.1	$ 192,381.3	**$ 613,560.5**
Societal benefits	$ 293,535.2	$ 276,711.2	$ 260,851.4	**$ 831,097.7**
Total	$ 515,268.3	$ 485,520.3	$ 457,509.1	**$ 1,458,297.7**

6.4 Overall costs

The costs included within the model are a combination of project costs and costs resulting from the implementation of project. Project costs include the dental hygienists' and the project manager's salary. Costs resulting from implementation of the project include items such as GP and dentist appointments that will take place after a referral. Finally, there is a cost included for additional healthcare cost generated by a decrease of mortality.

Table 26 Overall costs (,000)

	Year 1	Year 2	Year 3	Total
Dental hygienists' salary	$14.5	$13.7	$12.9	**$41,194.8**
Project management costs	$35,416.7	$33,386.8	$31,473.3	**$100,276.8**
Dental appointments (referral)	$4,160.9	$3,918.5	$3,690.2	**$11,769.5**
Healthcare costs (generated by decreased mortality)	$43,682.7	$40,766.9	$38,749,.5	**$123,199.0**
Total	$97,809.9	$91,787.8	$86,842.5	**$276,440.2**

6.5 Overall scenario results

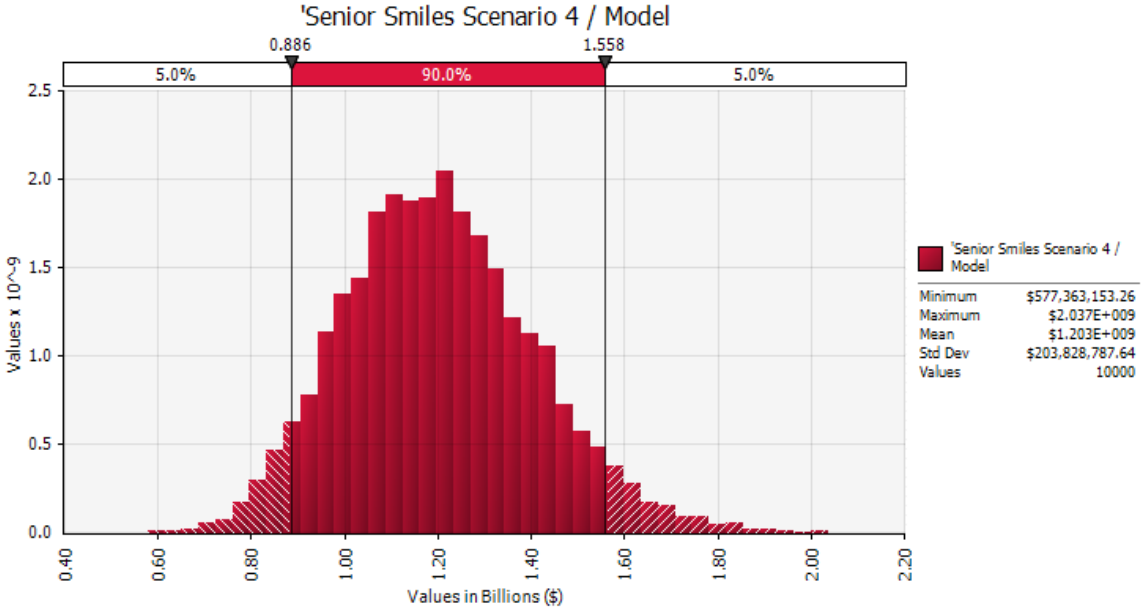
Taking the costs and benefits specified above into account, the following return on overall investment is as follows:

Table 27 Overall return on investment (,000)

	Year 1	Year 2	Year 3	Total
Total Benefits	**$ 515,268.3**	**$ 485,520.3**	**$ 457,509.1**	**$ 1,458,297.7**
Total costs	**$ 97,809.9**	**$ 91,787.8**	**$ 86,842.4**	**$ 276,440.2**
Net present value (benefits – costs)	**$ 417,458.3**	**$ 393,732.5**	**$ 370,666.7**	**$ 1,181,857.5**
Benefit to cost ratio	**5.27**	**5.29**	**5.27**	**5.28**

The sensitivity analysis shows that the NPV could vary between $1.125bn and $2.069bn at the 90% confidence level. At the lower end of this range, the benefit cost ratio (BCR) would reduce to 4.22:1, assuming costs remain constant. Again, the minimum value estimated was positive, suggesting no combination of assumptions across 10,000 random draws resulted in a negative Net Present Value, suggesting the risk of a negative outcome is less than 10,001:1. The benefits presented in the table above, however, remain the single most likely scenario.

Figure 12 Probability of total net present value (NPV) – Senior Smiles (scenario 4)



7 Discussion

This report was commissioned to analyse the impact of the Senior Smiles programme as implemented during the 2014 pilot, and as the programme is currently carried out in 5 RACFs in New South Wales (NSW).

Through robust research of the costs and benefits arising from the project and appropriate application of these results within a model, we can show that the programme makes a significant positive impact on the health economy and patient quality of life.

The conclusions of this study, which has looked to identify the costs and benefits of the Senior Smiles programme show that:

- **The Senior Smiles programme is estimated to deliver tangible value in the order of $4.13 and $3.14 of benefit within the health care system for every $1 invested in the project for the pilot and the current implementation respectively.** This is based on cautious and prudent adjustments for optimism bias applied to both the benefits and the costs.
- **A further $4.87 and $3.66 are identified in social benefits for every $1 invested (respectively for the pilot and the current project).**
- Sensitivity testing around the base-case indicates that the overall **benefits generated per $1 invested range between $7.16 and $11.12 for the pilot and between $5.44 and $8.35 for the current project**. At the 90% confidence level, we do not observe a scenario where costs exceed benefits.
- **Should Senior Smiles be rolled out** it is estimated to deliver an overall gross benefit of $6.80 and $6.07 for every $1 invested respectively for a regional and a national spread.

The future benefits rely on Senior Smiles programme being implemented, in scope, scale and speed, in line with current plans, including both frontline staff training and a dental hygienist for referral support and to keep the momentum going in each facility. Without continued focus, the benefits gained in future years can be expected to ‘fade out’ as training is forgotten, and workforce changes occur.

The authors encountered several limitations. The need to rely on academic sources for some of the benefits often resulted in the need to apply higher optimism bias correction, reducing the benefit within the model. With consistently collected, baselined evidence from the RACFs implementing Senior Smiles, localised data could be used in future roll-out. As well as reflecting better the implementation of this intervention, with reduced need for higher optimism bias correction, the benefits may well be higher. Utilising an informatics partner (such as the KSS AHSN) to assist in the definition, collection and analysis of data to monitor and evaluate the project as it

is rolled out further would significantly improve uncertainty associated with less evidence-based assumptions.

Even where potential benefits were able to be estimated, these would be improved by rigorous recording of data, including linking of oral care processes with outcomes, such as length of stay, development of complications, and in-hospital mortality.

Economic modelling is not an exact science and its outputs should be seen as a guide to decision-making and not a substitute for experienced local knowledge. There will always be some need for assumptions or reliance on secondary data, which limits the ability to generalise and draw broad policy lessons from an individual project or programme review. All outputs from the model are subjected to a range of risk and sensitivity tests to understand more about the degree of confidence with which the outputs from our model should be treated. As further evidence is made available, particularly from the current implementation or a regional roll-out, the model should be reviewed and amended accordingly. This will act to further enhance the accuracy of the model and the ability to draw wider conclusions.

Second, when partners commission and evaluate interventions they should be advised to consider more than just the benefit-cost ratio of the project. They should consider interventions from a range of perspectives, including qualitative feedback, strategic contribution and capacity to deliver, alongside the Net Present Value or Benefit Cost Ratio.

Despite these limitations, this report has demonstrated a significant return on investment, in addition to the clear patient care benefits provided by the Senior Smiles programme. With improved data collection as the programme rolls out across New South Wales or Australia, the demonstrable benefits of the project can be expected to increase.

The study highlights the critical oral health needs of the residents living in aged care facilities and the burden these needs represents on the Australian health care system if unaddressed. An intervention such as Senior Smiles appears financially viable, profitable and effective in real-life settings. Collaboration between States and Territories governments and the RACFs to make this initiative sustainable would fulfil the double aim to improve the care and the well-being of the institutionalised population while providing good value for money for all parties involved.

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Appendix A - Benefits breakdown by stream

The following tables provide nominal benefits identified for the programme detailed in the report by scenario. Benefits listed in these tables are 3-year sum totals, following the year weighting and roll out profile as detailed in the relevant scenario section.

Scenario 1 – Senior Smiles pilot (after optimism bias, $ nominal)

Benefit stream	Benefit value
Nutrition - Decreased GP visits	$48,271.3
Nutrition - LoS & Avoided admissions	$538,689.8
Improved nutrition - Lower prescribing rates	$26,556.3
Improved nutrition - Quality of life benefits	$652,391.9
Ventilator Associated Pneumonia (VAP) - LoS	$241,216.0
Ventilator Associated Pneumonia (VAP) - Prescribing	$172.1
Ventilator Associated Pneumonia (VAP) - Mortality	$107,113.4
Losing dentures - denture replacement costs	$27,261.9
Losing dentures - Patient QoL	$14,799.0
Dry mouth - Quality of life	$715,869.8
Dry mouth – Periodontitis management	$4,170.1
Dry mouth – Caries treatment	$24,481.9
Early ID of oral cancer - reduced mortality	$50,520.5
Early ID of oral cancer - reduced treatment costs	$316,253.2
Oral health of staff - Fewer sick days	$812.0

Avoided admissions - PPH	$79,575.75

Scenario 2 – Current implementation of Senior Smiles (after optimism bias, $ nominal)

Benefit stream	Benefit value
Nutrition - Decreased GP visits	$139,120.5
Nutrition - LoS & Avoided admissions	$1,483,495.5
Improved nutrition - Lower prescribing rates	$77,480.6
Improved nutrition - Quality of life benefits	$1,817,862.9
Ventilator Associated Pneumonia (VAP) - LoS	$664,283.6
Ventilator Associated Pneumonia (VAP) - Prescribing	$464.7
Ventilator Associated Pneumonia (VAP) - Mortality	$329,498.1
Losing dentures - denture replacement costs	$41,193.4
Losing dentures - Patient QoL	$22,342.2
Dry mouth - Quality of life	$1,994,741.3
Dry mouth – Periodontitis management	$11,630.0
Dry mouth – Caries treatment	$75,376.1
Early ID of oral cancer - reduced mortality	$155,409.3
Early ID of oral cancer - reduced treatment costs	$973,696.0
Oral health of staff - Fewer sick days	$3,065.2
Avoided admissions - PPH	$230,313.6

Scenario 3 – Implementation of Senior Smiles across New South Wales (after optimism bias, $ nominal)

Benefit stream	Benefit value
Nutrition - Decreased GP visits	$11,441,092.0
Nutrition - LoS & Avoided admissions	$121,470,035.0
Improved nutrition - Lower prescribing rates	$6,381,898.1
Improved nutrition - Quality of life benefits	$150,255,361.9
Ventilator Associated Pneumonia (VAP) - LoS	$54,392,180.4
Ventilator Associated Pneumonia (VAP) - Prescribing	$38,048.5
Ventilator Associated Pneumonia (VAP) - Mortality	$26,040,312.9
Losing dentures - denture replacement costs	$2,111,346.6
Losing dentures - Patient QoL	$1,155,960.9
Dry mouth - Quality of life	$206,094,047.1
Dry mouth – Periodontitis management	$952,274.6
Dry mouth – Caries treatment	$5,901,213.0
Early ID of oral cancer - reduced mortality	$12,282,029.3
Early ID of oral cancer - reduced treatment costs	$76,230,849.3
Oral health of staff - Fewer sick days	$69,855.8
Avoided admissions - PPH	$19,561,859.1

Scenario 4 – Implementation of Senior Smiles across Australia (after optimism bias, $ nominal)

Benefit stream	Benefit value
Nutrition - Decreased GP visits	$33,678,039.3
Nutrition - LoS & Avoided admissions	$357,559,627.9
Improved nutrition - Lower prescribing rates	$18,785,777.9
Improved nutrition - Quality of life benefits	$442,292,218.7
Ventilator Associated Pneumonia (VAP) - LoS	$160,109,016.2
Ventilator Associated Pneumonia (VAP) - Prescribing	$111,999.8
Ventilator Associated Pneumonia (VAP) - Mortality	$76,652,357.7
Losing dentures - denture replacement costs	$6,950,756.1
Losing dentures - Patient QoL	$3,805,534.4
Dry mouth - Quality of life	$606,659,171.6
Dry mouth – Periodontitis management	$2,803,118.8
Dry mouth – Caries treatment	$17,370,831.5
Early ID of oral cancer - reduced mortality	$36,153,425.2
Early ID of oral cancer - reduced treatment costs	$224,393,399.6
Oral health of staff - Fewer sick days	$229,972.0
Avoided admissions - PPH	$57,582,358.3