

# Technology Integrated Health Management (TIHM)

Health economic evaluation

KSS Insights



June 2021

# Table of Contents

<b>Executive summary</b> .....	<b>3</b>
<i>Context</i> .....	3
<i>Key results</i> .....	3
<i>Recommendations</i> .....	4
<b>Purpose of the report</b> .....	<b>5</b>
<b>1. Introduction</b> .....	<b>6</b>
1.1. <i>Care of people with dementia</i> .....	6
People with dementia at home .....	6
People with dementia in residential care .....	7
Impact of dementia on healthcare services .....	7
1.2. <i>TIHM as a solution</i> .....	8
<b>2. Methodology</b> .....	<b>10</b>
2.1. <i>Data collection</i> .....	10
2.2. <i>Analysis</i> .....	10
2.3. <i>Perspective</i> .....	11
2.4. <i>General approach and sources</i> .....	12
2.5. <i>Choice of analysis and methodology</i> .....	13
Cost-benefit analysis .....	13
Approach and structuring of outcomes .....	14
Year weight percentage .....	15
NHS and gross benefit .....	15
Benefit cost ratio .....	15
Optimism bias .....	16
Sensitivity analysis .....	18
2.6. <i>Key Inputs and outcomes</i> .....	23
Scenario analysis .....	23
Benefit streams .....	24
Calculation of benefit streams .....	25
Calculation of costs .....	28
<b>3. Health Economic Results</b> .....	<b>35</b>
3.1. <i>Scenario 1: Surrey ICS</i> .....	35
5-Year NPV .....	35
Sensitivity analysis .....	36
3.2. <i>Scenario 2: over 75s with dementia in Surrey</i> .....	38

5-Year NPV .....	38
Sensitivity analysis .....	39
<b>3.3. Scenario 3: impact post-COVID .....</b>	<b>40</b>
5-Year NPV .....	42
Sensitivity analysis .....	43
<b>4. Discussion.....</b>	<b>45</b>
4.1. Health economic discussion .....	45
Headline findings.....	45
Uptake discussion .....	45
Benefit streams discussion .....	46
4.2. Other points of discussion .....	48
Alternative methodologies .....	48
HOWZ monitoring service .....	48
Potential additional benefits .....	49
Other system benefits .....	49
4.3. Limitations .....	50
<b>5. Key recommendations .....</b>	<b>52</b>
<b>6. Concluding remarks .....</b>	<b>53</b>
<b>7. References .....</b>	<b>54</b>



# Executive summary

## Context

---

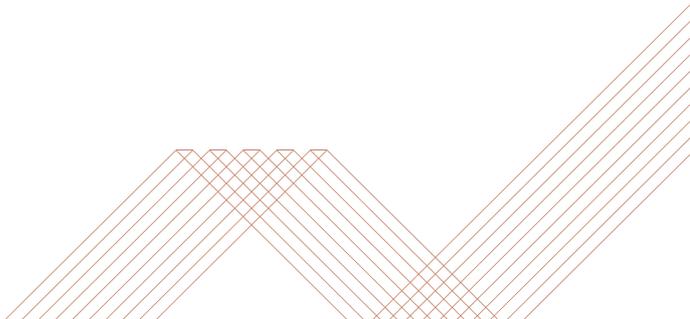
This report outlines the key findings, limitations, and recommendations from Kent Surrey Sussex Academic Health Science Network's (KSS AHSN) evaluation of the TIHM service across the Surrey Integrated Care System (ICS). This evaluation specifically considers the impacts of the TIHM remote monitoring service on people with dementia (PwDs) living in their own homes, either alone or with an informal caregiver. This caregiver is typically a family member or spouse.

The objectives of the report focus on addressing the following:

- Potential impact on patient outcomes including quality of life and physical and mental health benefits for dementia patients and informal caregivers, as well as considering risk of admission to a care home.
- Potential impact on clinical outcomes, including both elective and non-elective hospital admissions, accident and emergency (A&E) attendance, GP appointments, and ambulance callouts resulting in treatment, or conveyance to hospital.
- Cost-benefit analysis reflecting net present value outcomes of projected costs and benefits in various scenarios.

## Key results

---

- The overall return on investment (ROI) of the TIHM service from a health and social perspective across the Surrey ICS is 1:1.1, indicating that the service returns £1.10 for every £1 spent.
  - Nearly 90% of potential benefits realised were due to the savings to local authorities and private individuals by reducing the risk of being admitted into residential care.
  - Healthcare impacts were minimal, though there is the potential for further mental health benefits (relating to informal caregivers) that could be explored.
  - The overall ROI of the service based on external literature and data not collected during the COVID-19 pandemic was approximately 1:1.3 on the same scale.
- 

## Recommendations

---

The largest benefit realised in this evaluation was related to care home admissions, but the baseline was based on external literature. KSS AHSN recommends further data collection on care home admission, as well as severity of condition of those using TIHM regularly, to evaluate the risk of admission for people eligible for the service more accurately. This will yield a more precise estimates for benefit value.

In addition, KSS AHSN recommends that a further evaluation should take place on a larger population. This study should focus on the impact on a wider cohort of patients throughout the NHS. In addition, a detailed qualitative study should be undertaken to outline the main social benefits of TIHM in a clearer way, as well as understanding how the technology is perceived by clinical staff, caregivers, and patients. This should, ideally, be undertaken at a point where the COVID-19 pandemic has passed.

It is also noted that TIHM's criteria for patients has expanded to consider people with learning disabilities (PLDs) and there should be data collected so that an evaluation can be undertaken to consider benefits to this group, particularly those relating to social care.

There are some limitations to this study including the impact on the data due to the COVID-19 pandemic, as well as the reliance on literature for one of the scenarios. The data obtained spanned a four-month period, namely December 2020 – March 2021, during the second wave of the pandemic in the UK, and it is expected that the true value for money would be realised if data were collected over a longer period when the risks due to COVID are less severe. It is the recommendation of KSS AHSN that TIHM is evaluated on a larger scale and over a longer period of time.



## Purpose of the report

Kent Surrey Sussex Academic Health Science Network (KSS AHSN) was commissioned to conduct a health economic evaluation of the TIHM service, developed by the Surrey and Borders Partnership NHS Foundation Trust (SABP) in conjunction with the HOWZ remote monitoring service.

KSS AHSN is acting as an impartial and independent advisor to the intervention, assessing and reviewing the service's overall impact on patient and carer outcomes, as well as wider impacts on the NHS.

The primary focus of the report is to address the impact of TIHM on patient and carer outcomes within Surrey ICS, with the economic evaluation focusing mainly on this scenario both during and post the COVID-19 pandemic. The impact on a certain demographic of dementia patients – those aged 75 and over – has also been considered.



# 1. Introduction

The TIHM remote monitoring service has been set up so that vulnerable people, particularly those with dementia, are able to remain more independent in their own homes. There is hope that being able to monitor patients in this way will improve quality of life, as well as reduce contact with healthcare services such as hospitals and residential care.

The risk of developing dementia increases exponentially with age, with an estimated prevalence of 0.9% amongst 60 to 64-year-olds rising to 41.1% of people aged 95 or older (Prince, 2014). Between mid-2009 and mid-2019, the number of people aged 65 and over increased by 22.9% to 12.4 million (Office for National Statistics, 2019), and this number continues to grow at a faster rate than those under the age of 65. This results in an ageing population and, subsequently, a higher number of dementia patients. There were an estimated 883,100 dementia patients in 2019, and this is expected to increase to over 1.5 million people with dementia (PwDs) by 2040 in the UK (PSSRU, 2019).

Dementia is sub-classified into three stages: mild, moderate, and severe. This sub-classification is designated to each patient based on their mini-mental state examination (BGS) (MMSE) score, with a lower score representing a more severe stage of dementia. The maximum score is 30 points. A score of 20-24 suggests mild dementia, 13-20 shows signs of moderate dementia, and a score of 12 or less indicates severe dementia. As a person with dementia's health deteriorates, the demands of care increase as the individual is less able to remain independent. As the UK population continues to age, the number of individuals that require this high level of care will increase.

## 1.1. Care of people with dementia

---

### People with dementia at home

Sixty-one percent of PwDs live at home (Prince, 2014), either alone or with an informal caregiver who is typically a family member or spouse. In the UK, informal carers provide 1.34 billion hours of unpaid care to dementia patients each year, equating to £11.6 billion per year, or 44% of the total cost of dementia (Prince, 2014). These hours spent providing care often mean that carers have less time to commit to working; 15% of dementia carers say they are unable to work because of their care responsibilities (NHS, 2017).

The added responsibilities associated with being a carer can place a massive strain on the relationship between the PwD and caregiver. This in turn affects the mental health of the caregiver, with an estimated prevalence of depression of 31.24% and burden of 49.26% amongst this group of people (Collins, 2020).



## People with dementia in residential care

It is estimated that there is a prevalence of dementia in residential homes of 57.9%, and 70.3% in nursing homes (Prince, 2014). The overall prevalence has increased from 56% in 2002 to 70% in 2013 (CFAS, 2013). With the ageing population, and an estimated increase in the number of dementia patients, it seems likely that the demand for care home beds will surpass the current supply by 2022 (Grant Thornton, 2018).

The quality of care received by PwDs varies between care homes; 23% of dementia care services in England are said to be “failing”, compared to 19% of all services, and 1 in 3 homecare workers reportedly have had no dementia training (Alzheimer's Society, 2018).

Residential care is also very expensive for both local councils and families, with privately funded nursing homes costing the family of a PwD £1,060 per week on average (CMA, 2017). For some this cost can be subsidised by local authorities, but the criteria have remained unchanged for ten years, so fewer and fewer families are eligible for supportive funding (Alzheimer's Society, 2018).

## Impact of dementia on healthcare services

In addition to a poorer quality of life for patients, dementia has a profound impact on healthcare services, both in primary and secondary care. Approximately one in four people in acute hospital beds has some form of dementia (Lakey, 2009) and 42% of unplanned admissions to an acute hospital of people over 70 are for PwDs (Sampson, 2009).

As the UK population continues to age, these facilities will be more in demand, and exacerbate current problems in dementia care. Forecasts indicate that the number of dementia patients in need of palliative care will quadruple by 2040 (Etkind, 2017).



## 1.2. TIHM as a solution

---

The TIHM service was initially set up to install smart technologies in the homes of people with dementia (PwDs) living independently or with a family member who cares for them (an informal caregiver). From there the PwDs would be monitored by an external monitoring service (HOWZ) who referred the patient to the relevant service if it were deemed to be necessary.

TIHM 1.5 was a test bed for the technology by recruiting patients and aiming to show a positive Return on Investment by considering healthcare outcomes. TIHM 1.5 provided and installed a package of devices, including thermometers, blood pressure cuffs, and a sleep mat. TIHM 1.5 made use of the iView integrated user interface, developed in partnership with the University of Surrey, to extract insights and actionable information for healthcare staff and TIHM users (Rostill, 2018). TIHM 1.5 was particularly focussed on checking for possible symptoms of urinary tract infections (UTIs) or heightened aggression, irritability, and anxiety (AIA) amongst people with dementia.

Due to the COVID-19 pandemic, TIHM had to be adapted to reflect the needs of its users. The TIHM 2.0 service provides PwDs with various pieces of equipment, such as a hallway monitor, a smart plug, and a pulse oximeter, which is installed by the residents of a household with the assistance of the HOWZ monitoring service, whose existing software replaced the iView user interface. This was done to try and save on the cost of installation. The outputs are logged onto a tablet device, either manually or via Bluetooth connection, and submitted to a remote monitoring team.

Once the data has been collected, it is checked for any results beyond the patient's "normal level", which is established during the first seven days upon receipt of the equipment. If there are any outlying results present, a second reading is requested of the PwD. If the second reading is still an outlier, a decision is made on the level of concern, and the PwD is potentially transferred to the relevant care pathway.

An outline of the HOWZ pathway for TIHM 2.0 is shown in Figure 1:



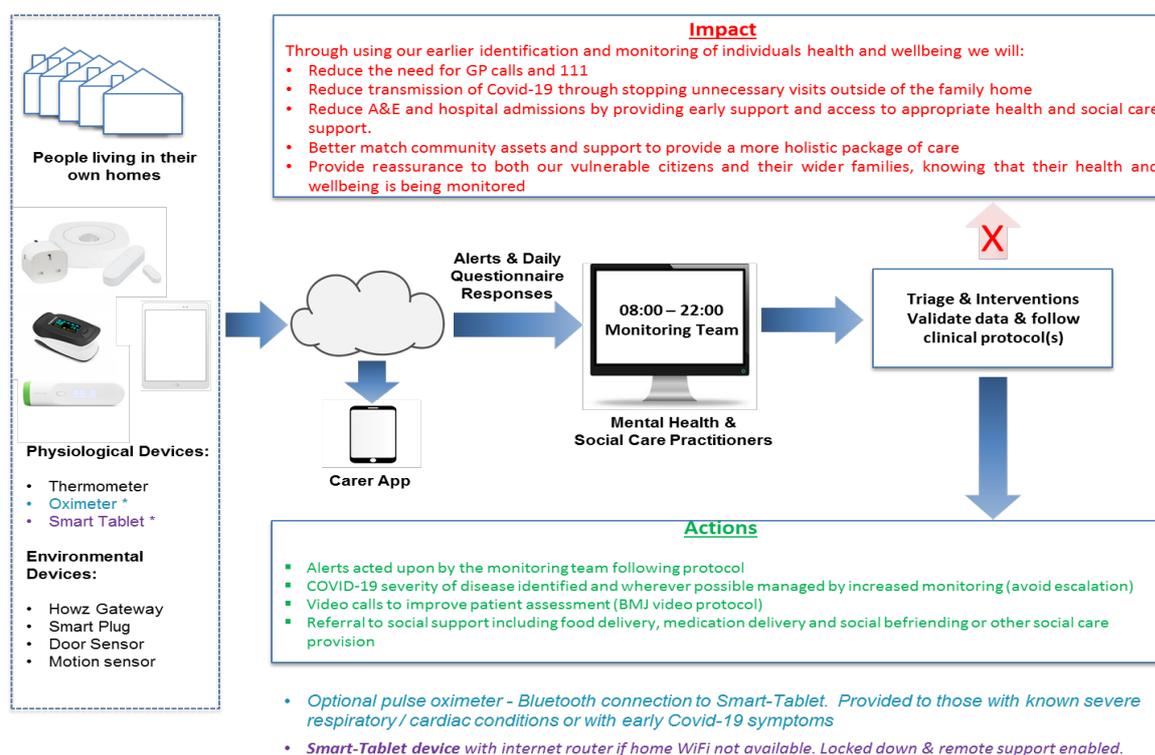


Figure 1: The HOWZ pathway for patient monitoring and potential benefits.

Early indications suggested that TIHM as a service may reduce PwD contact with both primary and acute care services, as well as offer social support to caregivers to help them cope. During the COVID-19 pandemic, keeping vulnerable people safe, such as PwDs, was a priority. It is believed that monitoring these people remotely would reduce their COVID risk without significantly impacting on meeting their care needs.

TIHM also claims to offer wider healthcare benefits. The business case indicated that the service could reduce calls to 999 and 111, reduce contacts with a GP, reduce inpatient stays and short stay admissions, and reduce the strain on social care.

TIHM 2.0 has also extended its criteria for eligibility to include people with learning difficulties (PLDs).

## 2. Methodology

### 2.1. Data collection

---

Quantitative data was collected on the TIHM cohort from SABP for the benefits outlined in the cost benefit methodology (Section 3.4.4), between December 2020 and March 2021. This data was pseudonymised and sent to the Surrey Heartlands CCG, where the pathways through secondary care were discovered.

There was also some qualitative data collected by HOWZ in the form of a questionnaire sent to both PwDs and their caregivers. Responses were collected and sent to KSS AHSN by HOWZ staff.

For any relevant data that was unable to be collected, existing literature from similar interventions elsewhere was used. This has been appropriately cited where it is used.

### 2.2. Analysis

---

The data was collected by using unique HOWZ patient identifiers to connect with Surrey Heartlands CCG NHS numbers and establish the PwD's care pathway once they were admitted to hospital, attended A&E, or called 999. This data was collected for all dementia patients within SABP's catchment area who were not in some form of residential care between December 2020 – March 2021. Once Surrey Heartlands CCG had collected information on secondary care pathways, patient identifiable data was either removed or encrypted and securely transferred to KSS AHSN. The data was then further analysed to uncover benefits.

Patients on the TIHM service were separated from those with a diagnosis of dementia not on the service, and inpatient attendances, 999 calls that resulted in an ambulance callout, the number of admissions to A&E, and those who incurred a charge due to excess bed days were counted. A population size was estimated based on audit data provided by Surrey and Borders Partnership NHS Foundation Trust (SABP) and (CPEC, 2019).

In addition, SABP collected a detailed audit on uptake and drop-off of those on the TIHM service, as well as reasons for withdrawal and demographic data for all TIHM patients up to the week of 29<sup>th</sup> April 2021. This audit data was used to estimate the care home admission rate for those on the TIHM service in 6 months. This number was compared to a weighted average calculated using risk to care home admission obtained from (Knapp, 2016) and population estimates from (CPEC, 2019).

For mental health benefits to carers, the percentage of carers who had some form of mental health improvement was estimated from research (Torkamani, 2014) and a quality adjusted life year (QALY, explained in Section 2.5) estimate was used from (Livingston, 2014).



Due to the low number of hospital admissions owing to COVID in both the baseline and TIHM groups, any COVID impacts were neglected from this analysis. A larger population, or data collected over a longer time period, may provide sufficient data for this particular benefit.

## **2.3.Perspective**

---

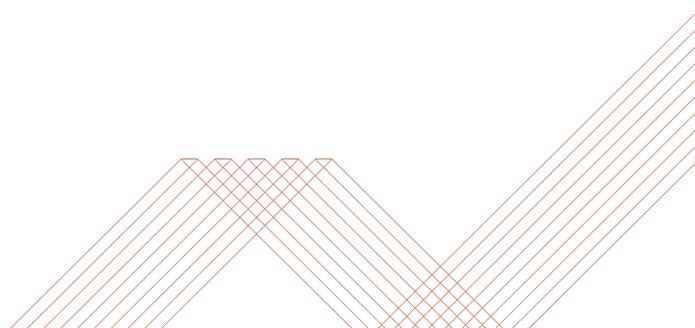
A health economic model can provide answers to multiple stakeholders as described in Table 1.



Table 1: Perspectives of key stakeholders towards a health economic and qualitative evaluation

Relevant stakeholder	Purpose of the health economic model
<b>TIHM</b>	<ul style="list-style-type: none"> <li>• Can assist in business decisions and modelling.</li> <li>• Gives a broader understanding to the size of the target resident population.</li> <li>• Helps provide a business case by quantifying economic and social outcomes.</li> </ul>
<b>Commissioners</b>	<ul style="list-style-type: none"> <li>• Shows wider social and economic benefit, rather than just cost savings.</li> <li>• Can be used to show current resources and costs required for the service.</li> <li>• Can provide some guidance for future commissioning and tariff structure.</li> </ul>
<b>Providers</b>	<ul style="list-style-type: none"> <li>• Provides an understanding of relevance and fit between the product and the sites of implementation.</li> <li>• Current costs and benefits of providing the service.</li> <li>• Helps predict future demand for services and the cost of such.</li> <li>• Can provide tangible evidence as to where the intervention could save costs and improve outcomes.</li> </ul>
<b>NHS Workforce</b>	<ul style="list-style-type: none"> <li>• Capacity of workforce, and the effectiveness of TIHM as a service.</li> <li>• Reduced strain on services may improve quality of life for NHS staff.</li> </ul>
<b>Patients</b>	<ul style="list-style-type: none"> <li>• Reduction in potential hospital admissions borne from improvements in monitoring a patient from their own home.</li> <li>• Qualitative analysis could highlight the extent to which quality of life of both patients and their loved ones are improved as a result of implementation of the TIHM service.</li> <li>• Potential financial savings due to delay in admission to residential care.</li> </ul>

## 2.4. General approach and sources



The following approach has been taken to assist in understanding the potential impact of the TIHM service on patients with dementia living in their homes:

- Building the health economic model using a tried and tested approach; for each outcome stream identified, data is needed to determine inputs for the model.
- Data collection from existing literature and live sites.
- Discussing findings and confirming preliminary assumptions around the impact across different scenarios and regional scales, based on the cost-benefit analysis.

This study produces a to-date current and an ex-ante appraisal of the prospective impact of TIHM estimated using:

- Data from patients using the TIHM service.
- Emerging academic research and industry reports.
- Statistics from relevant public-sector bodies.

In addition to the framework described above, HM Government has sought to enable quicker and more efficient delivery of cost-benefit appraisals, particularly by local government. This has been achieved through the funding and development of two sets of standardised unit cost databases, from which data will be sought as standard. These are:

- PSSRU's 'Unit Costs of Health and Social Care 2010 - 2018' (PSSRU, 2019)
- New Economy 'Unit Cost Database' (2015), which divides costs into financial costs and economic costs. These terms broadly equate to 'public sector delivery costs' and 'all other socio-economic costs' (GMCA Research Team, 2019)

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

## **2.5. Choice of analysis and methodology**

---

### **Cost-benefit analysis**

The aim of a cost-benefit analysis, which follows a similar approach to a cost-effectiveness analysis, lies in determining if the economic value of an intervention can justify its cost by comparing the cost of two or more alternatives and reviewing the return on investment. Savings are estimated from the healthcare system's perspective and the effects of an intervention on all costs should be considered (i.e., direct cost, effect on health expenditures, social and health outcomes to the patient). Costs and benefits ought to be discounted to



reflect the lower economic value of an expense, accounting for the time value of money, as well as the higher value of a benefit that is realised earlier (HERC, 2020).

The calculation in Figure 2 is applied to all benefit streams realised by the programme and summarised to show the full benefit potential from a financial and economic perspective.

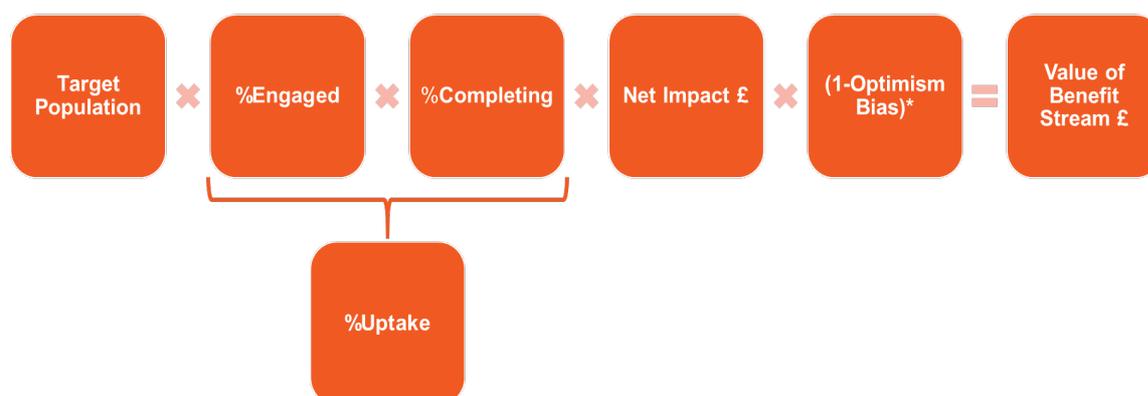


Figure 2: Valuation of benefit stream calculation.

## Approach and structuring of outcomes

To turn outcomes into a financial benefit, each stream had to be monetised. There are two broad benefit categories relevant to the cost-benefit analysis: NHS cash and non-cash releasing benefits.

How these benefits are realised depends on the *cash ability* of the saving. Cash ability refers to the way a change in an outcome will result in a reduction of 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 identifying benefits and separates the fiscal savings into the following benefit streams:

- **NHS related cash releasing benefits:** These benefits produce immediate cashable savings to the provider; an example of this benefit would be a direct reduction in procurement costs such as, in the case of a manufactured product, lower material costs.
- **NHS related non-cash releasing benefits:** These benefits are important in reducing demand and strain on services, but a fiscal value cannot be realised without decommissioning of services. Benefits which can be described as non-cash releasing include the generation of time savings for staff that allows staff to either improve the quality of their activity or carry out alternative activities.

- Social benefits:** 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 (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 used by NICE on behalf of the NHS. NICE methods refer to a threshold of £20,000 - £30,000 per QALY. A sensitivity range is used to reflect the range within which this threshold is applied, with the lower value (£20,000) taken as the modal value.

## Year weight percentage

Financial and economic weightings are applied to benefits to show how inflationary and economic pressures effect the value of benefit streams over time. For the in-year calculations, only inflationary pressures are applied to show effects in nominal terms, however for the net present value (NPV), a discount rate of 3.5% is applied to deflate the benefit to real terms to reflect the changing value of healthcare within GDP (HM Treasury, 2020). For social outcome streams linked to QALYs, the discount rate applied is 1.5%, as this excludes the change in value from an economic perspective and only considers social differences.

## NHS and gross benefit

The NHS monetary difference represents the difference between the monetary cash and non-cash benefits and the costs incurred from the intervention. Total gross benefit represents the full economic impact and therefore includes social benefits.

$$\text{NHS Benefit} = \text{Benefits incl. NHS cash and noncash savings}$$

$$\text{Total Gross Benefit} = \text{Benefits incl. NHS cash and noncash savings} + \text{social benefits}$$

## Benefit cost ratio

The benefit-cost ratio is a measure of benefits against costs and shows the return on investment. This can indicate the scale of investment and return based on the intervention's impact. This figure shows a measure of efficiency and good investment based on the overall

return; £X return for every £1 invested. The calculation can be applied for both NHS benefits and total gross benefits to show the wider economic impact the intervention may have.

$$\textit{Benefit Cost ratio} = \frac{\textit{Net Benefit Value}}{\textit{Costs}}$$

## Optimism bias

Optimism bias is defined as “the tendency for a project’s costs and duration to be underestimated and/or benefits to be overestimated” (Mott MacDonald, 2002), as found by historical UK government reviews on public sector procurement. To account for these ‘optimistic’ estimates, it is recommended that public sector economic analysis applies an optimism bias adjustment to reduce the benefits and increase the costs compared to the calculations using the raw data.

KSS AHSN’s approach is a development of the model created by the Greater Manchester Combined Authority (GMCA) Research Team (GMCA Research Team, 2019). The GMCA model is featured in the supplementary guidance of HM Treasury’s (2020) Green Book and offers a robust and prudent approach to economic analysis (HM Treasury, 2020).

It is reasonable to assume that the risk of over-optimistic estimates is greater where the data is of low quality (GMCA Research Team, 2019); such as due to the applicability of the estimate to the modelled pathway, the underlying methodology used for the estimate, or age. On optimism bias, each data input is graded according to its quality, and the calculation of a benefit (cost) stream is then decreased (increased) by a certain factor, decided by the ‘worst’ grade amongst the stream’s data inputs. The KSS AHSN optimism bias (OB) grades, and the relevant factor that the calculations will be increased or decreased by, are displayed in Table 2.

Table 2: Optimism bias by source quality

		Data Source										
		Formal service delivery contract costs		Practitioner monitored costs		Costs developed from ready reckoners		Costs from similar interventions elsewhere		Cost from uncorroborated expert judgement		
		Figures derived from local stats / RCT trials		Figures based on national analysis in similar areas		Figures based on generic national analysis		Figures based on international analysis				
		1		2		3		4		5		
Age of Data	< 2 Years	1	1.1	0%	2.1	10%	3.1	15%	4.1	25%	5.1	40%
	2 - 3 Years	2	1.2	5%	2.2	10%	3.2	15%	4.2	25%	5.2	45%
	3 - 5 Years	3	1.3	10%	2.3	15%	3.3	20%	4.3	30%	5.3	50%
	5 - 10 Years	4	1.4	15%	2.4	25%	3.4	30%	4.4	40%	5.4	55%
	> 10 Years	5	1.5	25%	2.5	30%	3.5	40%	4.5	50%	5.5	60%

In addition to the optimism bias factors applied at the benefit and cost stream level, a further factor of 15% is applied to reduce the benefits and increase the costs. This additional factor is included to protect against bias that may occur in the economic modelling approach and ensures KSS AHSN's role as an impartial, third-party assessor.

The KSS AHSN approach to optimism bias develops further from the GMCA model (GMCA Research Team, 2019). The GMCA model uses optimism bias to account for all types of uncertainty within the estimations due to sensitivity analysis not being used. The model used in this report, however, takes a more refined approach; accounting for certain types of uncertainty, namely those that are unlikely to be biased such as random errors, through sensitivity analysis. This reduces the necessity for optimism bias adjustments. In this way, KSS AHSN seek to provide more accurate estimates of the true costs and benefits while also providing information on the certainty and variability of the results.

## Sensitivity analysis

As discussed in the previous section on Optimism Bias, a degree of uncertainty in the estimates of the model are accounted for by using sensitivity analysis. It is important to note that the sensitivity differs from optimism bias in that it is applied on each individual assumption or input in the model, rather than by benefit or cost stream as in the case of optimism bias. The method used by KSS AHSN is Monte Carlo simulation to provide a range of estimates of the overall return on investment / net benefit.

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 of interest are given base-case values (or mean estimates), and an expected range. The range given to each assumption is dependent on the confidence grading applied seen in Table 3.

Table 3: Sensitivity ranges used by KSS AHSN.

		Data Source										
		Formal service delivery contract costs		Practitioner monitored costs		Costs developed from ready reckoners		Costs from similar interventions elsewhere		Cost from uncorroborated expert judgement		
		Figures derived from local stats / RCT trials		Figures based on national analysis in similar areas		Figures based on generic national analysis		Figures based on international analysis				
		1		2		3		4		5		
Age of Data	> 2 Years	1	1.1	+/- 10%	2.1	+/- 10%	3.1	+/- 15%	4.1	+/- 20%	5.1	+/- 25%
	2 - 3 Years	2	1.2	+/- 10%	2.2	+/- 15%	3.2	+/- 20%	4.2	+/- 25%	5.2	+/- 25%
	3 - 5 Years	3	1.3	+/- 15%	2.3	+/- 20%	3.3	+/- 25%	4.3	+/- 25%	5.3	+/- 30%
	5 - 10 Years	4	1.4	+/- 20%	2.4	+/- 25%	3.4	+/- 25%	4.4	+/- 30%	5.4	+/- 35%
	> 10 Years	5	1.5	+/- 25%	2.5	+/- 25%	3.5	+/- 30%	4.5	+/- 35%	5.5	+/- 40%

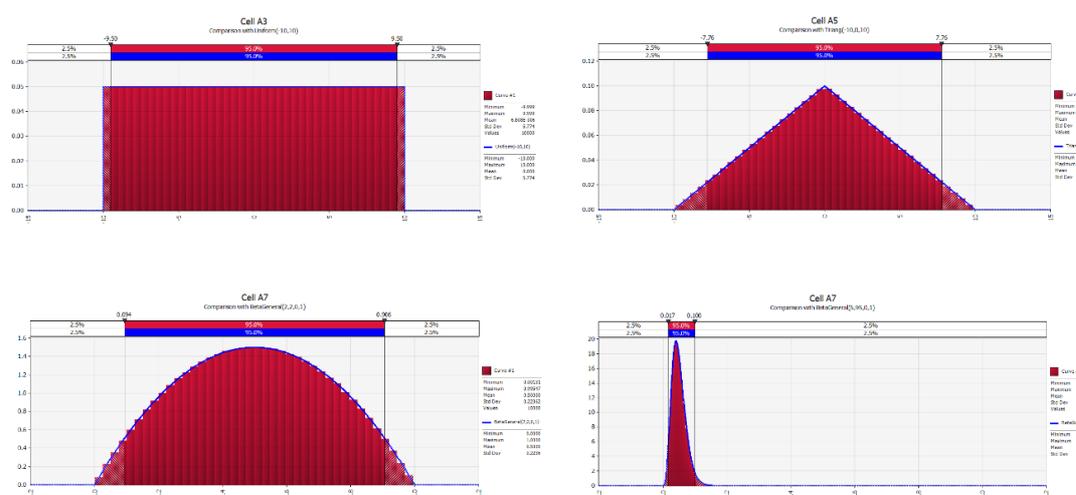
Table 4 shows the quality-of-life adjustment factor and life expectancy.

**Table 4: Example of sensitivity range allocation**

Variable	Sensitivity Grading	Range Applied	Lower range estimate	Base-case / mean estimate	Upper range estimate
Quality of life adjustment factor	2.4	+/- 25%	0.420	0.565	0.70
Life expectancy (years)	4.4	+/- 30%	4.41	6.30	8.19

## STEP TWO: 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 the data in question is a percentage of a population, then a Beta distribution has been used, as this distribution ensures that the analysis cannot include numbers less than 0% or greater than 100% of the population.



**Figure 3: Typical distribution shapes for Top-Left: Rectangular distribution, Top-Right: Triangular distribution, Bottom-Left: Beta distribution for percentages around 50% Bottom-Right: Beta distribution for percentages near 0% or 100%**

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, triangular distributions have generally been applied as this best reflects the ranges used and diminishing probabilities of more extreme ends, as well as Beta distributions in situations where percentages are used. Where a different distribution has been used, it is expressly noted in the text.

## STEP THREE: 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 FOUR: REPETITION

Five draws are seen in Table 5, using a rectangular distribution. These deliver estimates lying between £40,500 and £105,000. The draw is repeated thousands of times. In this evaluation 10,000 runs are used as standard.

Table 5: Example of random variation within Monte Carlo simulation

Variable	Draw 1	Draw 2	Draw 3	Draw 4	Draw 5
Quality of life adjustment factor	0.45	0.50	0.55	0.60	0.70
Life expectancy (years)	4.5	5.0	5.5	6.0	7.5
Quality of Life Year monetary value	£20,000	£20,000	£20,000	£20,000	£20,000
Benefit (lives saved x value of lives saved)	£40,500	£50,000	£60,500	£72,000	£105,000

Creating 10,000 estimates allows the creation of a distribution of possible outcomes from the draws made. From this distribution the range within which 90% of the observations from the draws are expected to fall is computed. This is called the 90% confidence interval, illustrated in Figure 4.

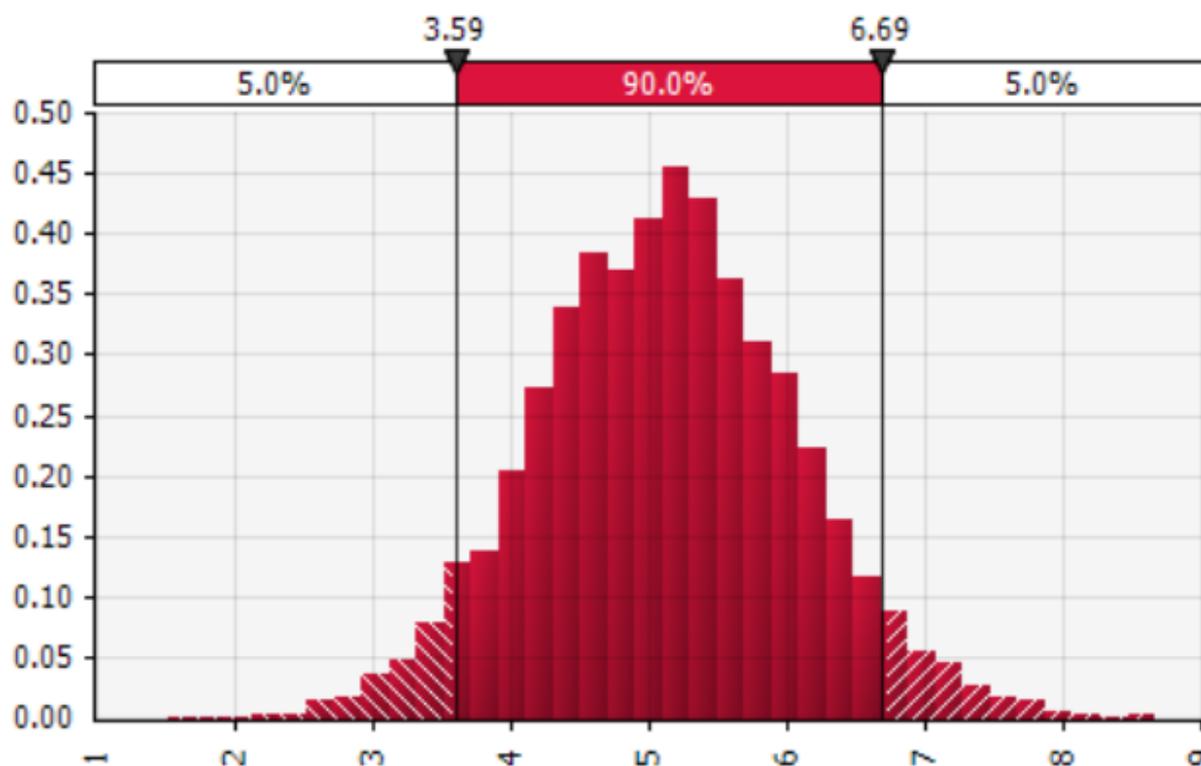
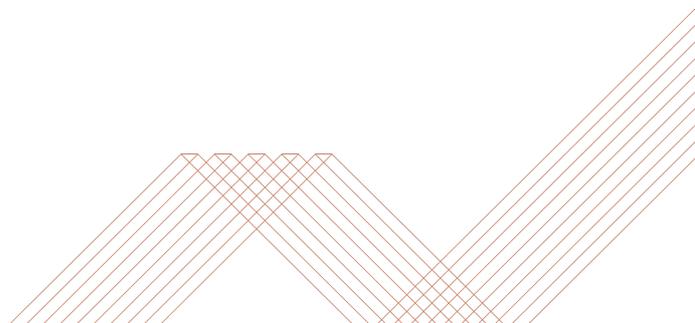


Figure 4: Illustration of sensitivity analysis

The source for many of the data inputs in the model may also include a confidence interval, such as if the source is an academic study. In these cases, the confidence interval from the data source is used to provide the maximum and minimum ranges for the data input in the sensitivity analysis. Where no confidence interval is provided, the quality of the data is graded in a similar way to optimism bias to express the degree of certainty that KSS AHSN has in the estimates. The grades, their criteria, and the relevant ranges that will be applied to the data inputs are displayed in Table 3.



## 2.6. Key Inputs and outcomes

To build an economic model such as a cost-benefit analysis, a certain number of inputs are required for calculation purposes and to compute the desired outputs. Various inputs are listed below in a structured approach, as used in the model.

### Scenario analysis

Each of these scenarios has been run from financial year 2020/21 for 5 years to show the short term in-year financial impact and a medium 5-year NPV wider economic impact. As it is not possible to approach all patients within the first year modelled, several uptake assumptions have been applied. These include the proportion of patients approached out of the total within the ICS, and the subsequent proportion of these who may accept the offer of the service.

#### **SCENARIO 1: ROLLOUT TO SURREY ICS**

Scenario 1 concerns the spread of the TIHM service across the Surrey Integrated Care System (ICS). This area has been included within the modelling to provide an estimate as to the potential impact of the roll out across a larger area. The region of Surrey ICS is encompassed by KSS AHSN and extends upon the current geography of the project. Reviewing a larger geography allows the model to estimate the potential impact over a larger number of patients.

#### **SCENARIO 2: IMPACT AMONG DEMENTIA PATIENTS OVER 75**

To assess the potential impact of the TIHM service, the model will seek to forecast the impact on the service on a specific demographic of patients. In this case, PwDs over the age of 75, who may be more uncomfortable with technological interventions, are considered to investigate the differences in benefits. These PwDs may also be more likely to enter care homes due to the higher prevalence of more severe forms of dementia amongst this age group.

#### **SCENARIO 3: POST-COVID IMPACT**

As previously mentioned, the data collected for this analysis was done so during the second wave of the COVID pandemic, and as such, the real long term service benefits may not be realised. Thus a literature-based evaluation – which considers the impact of TIHM upon the resolution of the COVID pandemic – would be beneficial to understand the impacts on patient outcomes and healthcare services in the Surrey ICS in the longer term. This could also provide insights for TIHM's performance compared to other similar interventions elsewhere.



One of the limitations to looking at the model from a provider perspective, is that some of the benefits realised will not be seen at the same level as the costs, i.e., at the provider level. It is therefore important to assess the impact of TIHM from a wider system perspective.

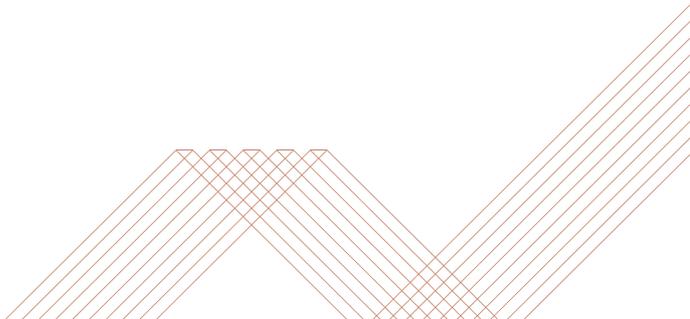
## Benefit streams

Included in the model are the following benefits, split into categories of NHS Benefits (those that directly benefit the NHS Service) and Social Benefits (those that benefit wider society):

### NHS & LOCAL AUTHORITY BENEFITS

- **Reduction in care home admissions, funded via local authorities:** It is believed that the implementation of TIHM will enable people with dementia to remain in their own homes for a longer period. This benefit considers those patients whose care home admission cost would be covered by a relevant local authority.
- **Reduction in ambulance callouts:** Having a support staff to provide reassurance for people with dementia and their carers may reduce calls to 999, and subsequent ambulance callouts.
- **Reduction in emergency admissions:** In a similar way to ambulance callouts, the reassurance provided by the TIHM service may avoid unnecessary emergency admissions.
- **Reduction in length of stay of dementia inpatients:** Patients on the TIHM service may be admitted to hospital with less severe conditions due to earlier detection, thus length of stay could be reduced. To establish a cost saving, this benefit will be divided into two sub-benefits: reduction of inpatient attendances and reduction of excess bed days.
- **Reduction in GP Appointments:** The TIHM service may help to reduce the pressure on GP services. This is only considered in Scenario 3, as primary care data was not collected by SABP for the purposes of this evaluation.

### SOCIAL BENEFITS

- **Reduction in care home admissions, funded privately:** As above, but this benefit stream considers those patients who fund their own care home residence.
  - **Improvement in the mental health of carers:** The reassurance of a remote monitoring team is thought to reduce the burden and stress on an informal carer, thus benefiting their mental health.
  - **Environmental benefits:** As TIHM aims to allow patients to remain in their own homes for more time, there will be a reduction of CO<sub>2</sub> emissions from a reduction in many of the aforementioned benefits.
- 

The impact of the TIHM service on COVID transmission could not be examined, due to the small number of COVID related admissions or cases in the questionnaire responses.

## Calculation of benefit streams

The benefit streams outlined below are those used within the model to assess the potential positive impact TIHM could have from a health economic perspective, run for each of the scenarios.

### *REDUCTION IN CARE HOME ADMISSIONS: PRIVATE FUNDING*

The calculation used within the model:

$$\begin{aligned} & \textit{Total Patient Population} \times \textit{\% of patients who would pay for private care} \\ & \qquad \qquad \qquad \times \textit{Uptake} \end{aligned}$$

$\times$  *average reduction in care home admission*  $\times$  *weekly average cost of privately funded care home patient (£)*

$$\times (1 - \textit{optimism bias})$$

The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1, 2, and 3 OB Grade: 20%

### *REDUCTION IN CARE HOME ADMISSIONS: LOCAL AUTHORITY FUNDING*

The calculation used within the model:

$$\begin{aligned} & \textit{Total Patient Population} \times \textit{\% of TIHM patients who have care paid for by Local Authorities} \\ & \qquad \qquad \qquad \times \textit{Uptake} \end{aligned}$$

$\times$  *average reduction in care home admission*  $\times$  *weekly average cost of local authority funded care home patient (£)*

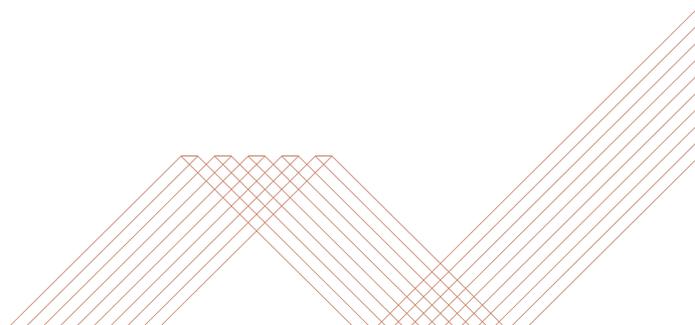
$$\times (1 - \textit{optimism bias}) .$$

The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1, 2, and 3 OB Grade: 20%

### *IMPROVEMENT OF CARER MENTAL HEALTH*

The calculation used within the model:



*Total Carer Population*

*× Uptake*

*× % of carers whose mental health has benefited due to TIHM × QALYS gained × Value of QALY (£)*

*× (1 – optimism bias)*

The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1, 2, and 3 OB Grade: 25%

*REDUCED AMBULANCE CALLOUTS*

The calculation used within the model:

*Total Patient Population*

*× Uptake*

*× Change in number of callouts per patient × Cost of ambulance callout (£)*

*× (1 – optimism bias)*

The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1,2, and 3 OB Grade: 30%

*REDUCED EMERGENCY ATTENDANCE*

The calculation used within the model:

*Total Patient Population*

*× Uptake*

*× Change in number of Emergency Attendances per patient × cost of emergency admission (£)*

*× (1 – optimism bias)*

The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1,2, and 3 OB Grade: 25%



**REDUCED INPATIENT ADMISSIONS**

The calculation used within the model:

$$\begin{aligned} & \textit{Total Patient Population} \\ & \times \textit{Uptake} \end{aligned}$$

$\times (\textit{regional inpatient admissions per population} \times \textit{regional median cost of inpatient stay (£)} - \textit{TIHM inpatient admissions per population} \times \textit{TIHM median cost of inpatient stay (£)})$

$$\times (1 - \textit{optimism bias})$$

The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1 and 2 OB Grade: 25%
- Scenario 3 OB Grade: 30%

**REDUCED EXCESS BED DAYS**

The calculation used within the model:

$$\begin{aligned} & \textit{Total Patient Population} \\ & \times \textit{Uptake} \end{aligned}$$

$\times \textit{change in number of excess bed days per patient} \times \textit{cost of excess bed day (£)}$

$$\times (1 - \textit{optimism bias})$$

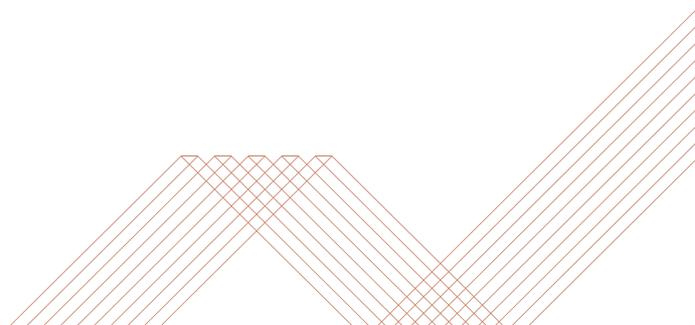
The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1 and 2 OB Grade: 25%
- Scenario 3 OB Grade: 30%

**REDUCED GP APPOINTMENTS**

The calculation used within the model:

$$\begin{aligned} & \textit{Total Patient Population} \\ & \times \textit{Uptake} \end{aligned}$$



$$\begin{aligned} & \times \text{change in number of GP Appointments per patient} \times \text{cost of GP Consultation (£)} \\ & \times (1 - \text{optimism bias}) \end{aligned}$$

This benefit stream in Scenario 3 showcases the potential saving of reduced GP contacts by use of the TIHM monitoring service. As the data for primary care was not of sufficient quality to be considered for analysis, this is a benefit stream based only on external literature. The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 3 OB Grade: 40%

### ENVIRONMENTAL IMPACT

The calculation used within the model:

$$\begin{aligned} & \text{Total Patient Population} \\ & \times \text{Uptake} \end{aligned}$$

$$\begin{aligned} & \times \text{net changes of previous benefit streams} \times \text{CO2 saving of each individual benefit stream} \times \text{Cost of CO2 emissions (£)} \\ & \times (1 - \text{optimism bias}) \end{aligned}$$

The optimism bias for this benefit stream applied has been based on the poorest quality source date for each scenario and the applicability on the assumption on the scenario population.

- Scenario 1,2, and 3 OB Grade: 20%

In the case of benefit streams resulting in a negative benefit (or dis-benefit), the optimism bias multiplier may change in the above calculations from (1-OB) to (1+OB), in order to make the calculations as prudent as possible.

## Calculation of costs

Costs of the service were sent to KSS AHSN by SABP and HOWZ, and were split into three streams:

- Costs of hardware procurement and maintenance
- Costs of HOWZ software and monitoring service
- Costs of SABP staff needed to support the TIHM service.

To consider the costs of TIHM at scale, SABP also provided hypothetical staff costs for up to 5,000 patients. This gives an indication of regional level costs, which will also be of use

when considering the performance of TIHM on a national scale. Table 6 shows these costs by valuation.

**Table 6: Costs of the TIHM service from SABP and HOWZ**

Cost	Value
HOWZ hardware	£300.00 per patient per year
HOWZ software – start-up (first 6 months)	£72.60 per patient per month
HOWZ software – running	£42.80 per patient per month
SABP staff – up to 2,500 households	£315,422.00 per year
SABP staff – up to 5,000 households	£491,917.00 per year

For the year 2020/21 SABP sent costs that TIHM has currently incurred over the year and these have been used in the analysis.

The calculation used in the health economic model is outlined in Figure 5. Note that, as all costs are obtained directly from the service providers and are recent, the optimism bias for all costs is 0%.



**Figure 5: Calculation of cost streams**

## MODEL ASSUMPTIONS

The assumptions of the model used to analyse TIHM are outlined below:

- It is assumed that the rate of deterioration is the same across all patients.
- Assumed that the TIHM patients analysed are representative of the population of the Surrey ICS.
- Assumed that the PwD population growth rate is constant between 2020 – 2025.
- Assumed that the entire population of Surrey ICS eligible for TIHM is approached in the year 2021/22.
- Assumed that the uptake figures collected by Stratcom are representative of the true uptake figure of the entire population, and that this stays constant throughout the process.

- Assumed that each user has an average car, producing 122 gCO<sub>2</sub>e per km.
- Assumed that the population within the Surrey ICS is consistent with the numbers quoted in (CPEC, 2019) and that dementia patients could be in the mild, moderate, or severe categories when considering the baseline.
- Assumed that severity of dementia is independent of age amongst TIHM patients, insofar as PwDs on TIHM are classified as “mild” or “moderate”, irrespective of their age.
- Assumed that dementia patients already admitted to residential care, and hence not eligible for TIHM, is constant across varying severities of dementia.
- Assumed that the percentage of those who are admitted into care homes that entirely self-fund is 41% (figure taken from (CMA, 2017)). The other 59% are assumed to have their placement paid for by the relevant local authority.
- Assumed that individuals who pay for their own residential care and those who are paid for by local authorities are mutually exclusive.
- Assumed that HOWZ service costs would reduce after 6 months of implementation.

## POPULATION

For each scenario, the total population of mild and moderate dementia patients has been calculated based on estimates from the CPEC Report concerning dementia population (CPEC, 2019). From this, mild and moderate dementia patients already in care homes are removed due to them being ineligible for the TIHM service. This percentage has been calculated from figures in (Gungabissoon & al., 2020). For the carer population, the same source is used to calculate the proportion of these patients that receive some form of informal care. Costs of the programme such as staff training and programme operational costs will be incurred per patient, or per a certain number of patients.

The patient and carer population as of January 2020 has been used as a basis for projecting the population in each scenario from 2021/22 – 2024/25. There is an estimated increase of 7.5% over the period 2020 – 2025 (calculated from figures in (CPEC, 2019)).

- **Scenario 1 – Surrey ICS:** It has been estimated that the population for mild and moderate dementia patients is 2,522 and 4,464 respectively, with figures taken from (CPEC, 2019). Twenty-seven percent of these patients are estimated to already be in a care home (figure taken from (Wittenberg, 2019), and has been corroborated by SABP staff) leaving an estimated ICS population of 5,129 patients that are eligible for the TIHM service. An estimated 62% of these patients receive some form of informal care (Wittenberg, 2019, corroborated by SABP and HOWZ) giving 3,162 carers. This is summarised in Figure 6:

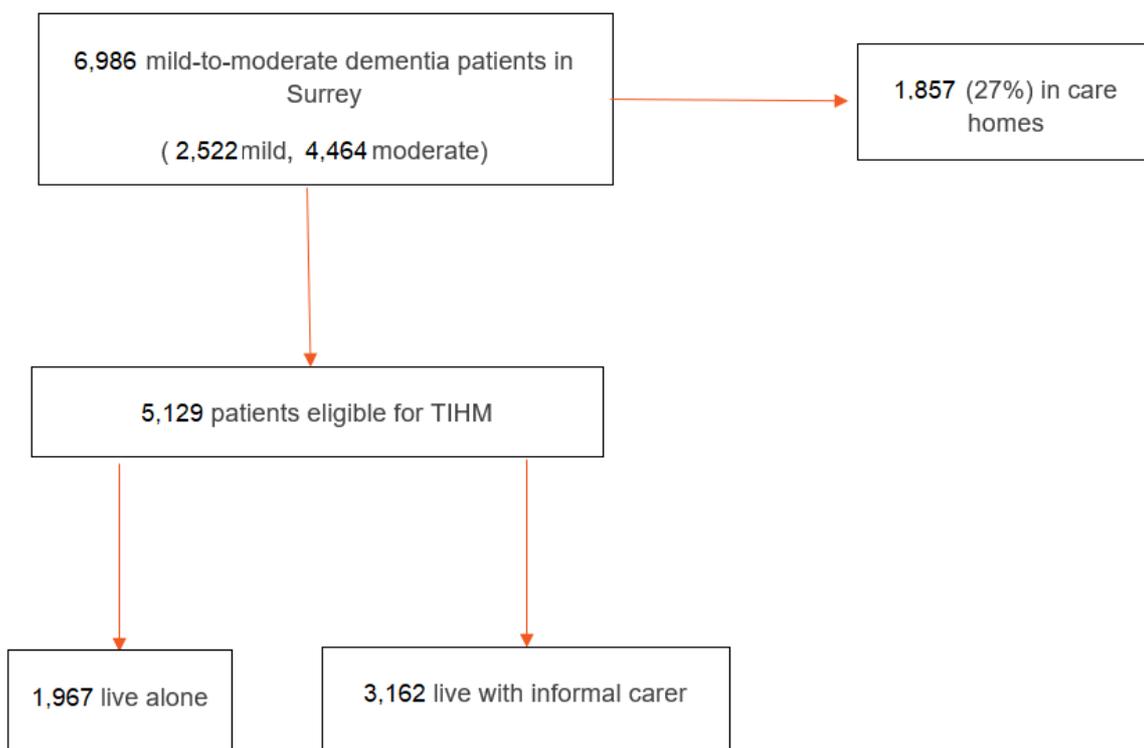


Figure 6: Surrey dementia patient breakdown

- Scenario 2 – Over 75s in Surrey:** Estimates from the TIHM cohort suggest that 81% of dementia patients are over the age of 75. Demographic data obtained from SABP confirms that this figure seems to be representative of the dementia population. This number has been multiplied by the population of Scenario 1 to give a patient population of 4,178 and a carer population of 2,576.
- Scenario 3 – Post-COVID:** Here the population has been calculated in the same way as Scenario 1, yielding a patient population of 5,129 and a carer population of 3,162.

## UPTAKE

The initial uptake figure of the TIHM service was estimated to be approximately 30%. Since employing the services of telemarketing company Stratcom, this figure has increased. Two samples of patients have been assessed at different times: one with an engagement rate of 55.7%, the second with a rate of 70%. For the purposes of this model, KSS AHSN has taken the average of these two figures; 62.85%.

The drop-off rate of the TIHM service is calculated by using the withdrawal numbers from the audit data and taking the maximum drop-off over one individual week. This figure yields an estimated drop-off rate of approximately 27%, giving a final uptake figure of  $62.85\% \times (1 - 27\%) = 45\%$ .

## VALUE OF BENEFIT STREAMS

The following values have been sourced for each of the benefit streams, with each cost adjusted to 2021 values:

### NHS & LOCAL AUTHORITY BENEFITS

Table 7: Monetary values of NHS and Local Authority benefits

Benefit Stream	Source	Original Value (As in source)	Updated Value (2020/21)
<b>Local authority care home admission</b>	(CMA, 2017)	£621 per patient per week	£700.34 per patient per week
<b>Ambulance callouts</b>	(New Economy, 2014)	£216 per callout	£236 per callout
<b>Emergency admissions</b>	(NHS Improvement, 2018)	£160 per admission	£169.34 per admission
<b>Reduction in dementia inpatients – Scenario 3</b>	(PSSRU, 2019)	£3,754 per inpatient	£3,866 per inpatient
<b>Excess Bed Days</b>	(NICE, 2015)	£222 per excess bed day	£239.19 per excess bed day
<b>GP Consultation</b>	(PSSRU, 2019)	£33 per consultation	£34 per consultation

### SOCIAL BENEFITS



Table 8: Financial values of social benefit streams by source value and 2021 values.

Benefit Stream	Source	Original Value (As in source)	Updated Value (2020/21)
Privately funded care home admission	(CMA, 2017)	£1,060 per patient per week	£1,142.09 per patient per week
Improvement in carer mental health	(HM Treasury, 2020)	£20,000 per QALY	£20,000 per QALY
Environmental Impact	(Treasury, 2018)	£67.25 per tonne of CO2e	£70.43 per tonne of CO2e

In addition to these values, the median inpatient costs for Scenarios 1 and 2 were calculated from available data in terms of tariffs incurred by patient admissions. These results are summarised in Table 9.

Table 9: Median inpatient admission tariffs for TIHM group and Surrey Heartlands CCG across Scenarios 1 and 2

	Baseline Value	TIHM Value
Inpatient Admissions – Scenario 1	£4,778	£4,183
Inpatient Admissions – Scenario 2	£4,778	£4,577

## EXAMPLE CALCULATION

To illustrate how the health economic evaluation calculates the financial benefits of the TIHM service, here is a calculation from the first benefit stream of Scenario 1:

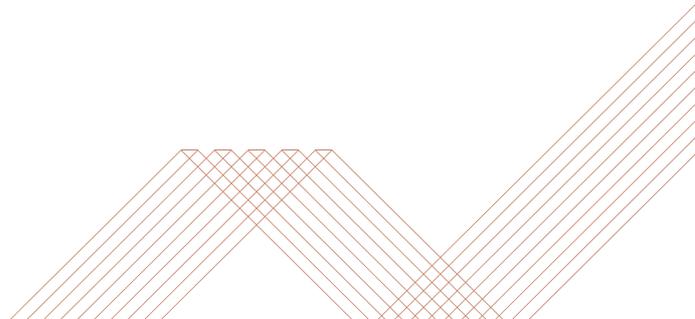
$$\begin{aligned} & \text{Total Patient Population [5,129]} \times \% \text{ of patients who would pay for private care [0.41]} \\ & \times \text{Uptake [0.45]} \end{aligned}$$

× average reduction in risk to care home admission per year [To be calculated in model] × annual average cost of privately funded care home patient (£) [1,060 × 52.18]

$$\times (1 - \text{optimism bias}) [1 - 0.2]$$



The intention of this calculation is merely illustrative to show how the figures sourced in this report are used in the health economic calculation. The final overall benefit value will be shown in Section 3.



## 3. Health Economic Results

### 3.1. Scenario 1: Surrey ICS

Table 10 indicates the non-financial benefits of TIHM according to the benefit streams highlighted in Section 2.6. Figures are rounded so calculations may not give exact answers, and all figures are an annual saving.

**Table 10: Non-financial values of benefits of TIHM service compared to the baseline of the Surrey ICS regional average for Scenario 1: Surrey ICS rollout.**

Benefit Stream	Value of Benefit Stream
<b>1.1 Longer time out of a care home (Privately funded)</b>	42% reduction of risk to care home admission (12.4% risk baseline vs 7.2% risk TIHM)
<b>1.2 Longer time out of a care home (Local authority funded)</b>	As above
<b>1.3 Improvement in Carer Mental Health</b>	0.009 QALYs gained
<b>1.4 Reduce Ambulance Callouts</b>	13% reduction in callouts per patient (0.69 baseline vs 0.6 TIHM)
<b>1.5 Reduce Emergency Admissions</b>	32% reduction in admissions per patient (0.66 baseline vs 0.45 TIHM)
<b>1.6 Reduce Inpatient Admissions</b>	23% reduction in admissions per patient (0.39 baseline vs 0.28 TIHM)
<b>1.7 Reduce Excess Bed Days</b>	Increase in excess bed days by 0.06 per patient (0.03 baseline vs 0.09 TIHM)
<b>1.8 Environmental Impact</b>	Saving of 0.07 tonnes CO <sub>2</sub> e per patient per year

### 5-Year NPV

Table 11 gives the output table for Scenario 1: Surrey ICS. Years indicate financial years, so 2020 references the period April 2020 – March 2021 for instance. Scenario 1 predicts a benefit-cost ratio of 1.0 in the first year after implementation (2021/22) increasing to 1.2 in the year 2024/25.

In the year 2020/21, it is estimated that the benefit-cost ratio is 1:0.5. This is possibly due to the smaller amount of people on the service compared to the running costs, as well as start-up costs that are initially generated for TIHM.

Table 11: Output table for Scenario 1 (in thousands).

TIHM For Dementia - Scenario 1 - ICS Rollout (£ net present value in 2020 prices)	2020	2021	2022	2023	2024	Total
<b>Benefits</b>						
1.1 - Longer Time out of a Care Home (Private funding)	£0.2m	£1.9m	£1.8m	£1.8m	£1.7m	£7.4m
1.2 - Longer Time out of a Care Home (Local Authority funding)	£0.2m	£1.7m	£1.6m	£1.6m	£1.6m	£6.7m
1.3 - Improved Carer Mental Health	<£0.1m	£0.2m	£0.2m	£0.2m	£0.2m	£0.6m
1.4 - Reduced ambulance callouts	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m	£0.1m
1.5 - Reduced Emergency Admissions	<£0.1m	£0.1m	<£0.1m	<£0.1m	<£0.1m	£0.2m
1.6 - Reduced Inpatient admissions	£0.1m	£0.3m	£0.3m	£0.3m	£0.3m	£1.2m
1.7 - Reduced Excess bed days	>-£0.1m	>-£0.1m	>-£0.1m	>-£0.1m	>-£0.1m	£-0.2m
1.8 - Environmental Impact	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m
<b>Total Benefits</b>	<b>£0.4m</b>	<b>£4.0m</b>	<b>£3.9m</b>	<b>£3.9m</b>	<b>£3.8m</b>	<b>£16.1m</b>
<b>Costs</b>						
<b>Total Costs</b>	<b>£0.9m</b>	<b>£4.0m</b>	<b>£3.3m</b>	<b>£3.2m</b>	<b>£3.1m</b>	<b>£14.5m</b>
<b>NPV</b>						
<b>Total NPV</b>	<b>£-0.4m</b>	<b>&lt;£0.1m</b>	<b>£0.7m</b>	<b>£0.6m</b>	<b>£0.6m</b>	<b>£1.5m</b>
<b>Total BCR</b>	<b>0.5</b>	<b>1.0</b>	<b>1.2</b>	<b>1.2</b>	<b>1.2</b>	<b>1.1</b>
*The figures above have been rounded to the nearest whole pound for presentation and as such totals may not sum						

## Sensitivity analysis

Figure 7 shows that the 5-year net present value (NPV) from 2020/21 – 2024/25 may vary from -£17.14 million to £20.02 million at the 90% confidence interval, with the expected value to be approximately £1.44 million. The mean value of the sensitivity analysis differs from that given in Table 11 due to some distributions not being symmetric, but the results presented in Table 11 reflect the most likely outcome for this scenario. It is worth noting that

there is no guarantee the NPV will fall within a 90% confidence interval and the potential value of the social benefits of TIHM could vary significantly from the modelled assumptions.

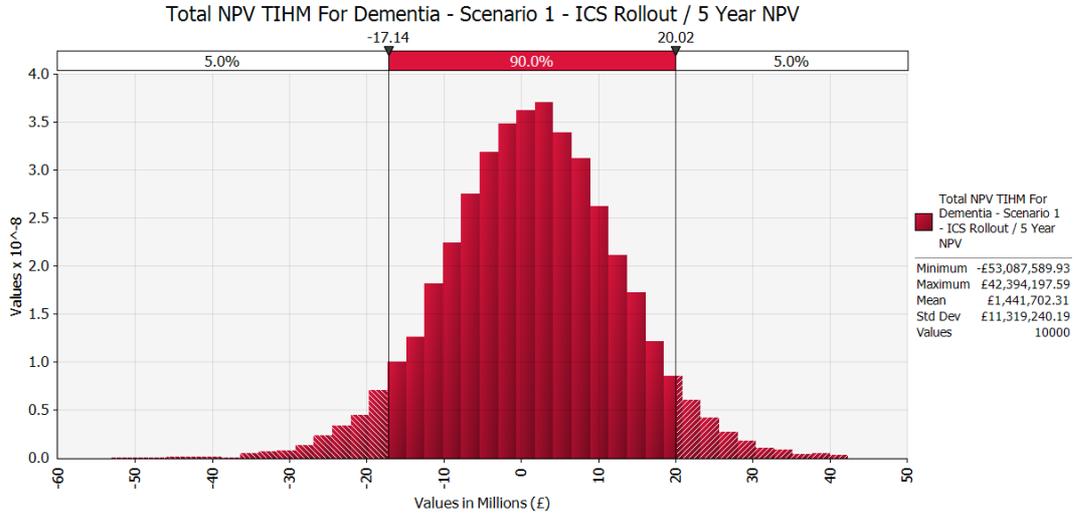


Figure 7: Sensitivity analysis of the 5-year net-present value (NPV) of TIHM in Scenario 1 Surrey ICS rollout

## 3.2. Scenario 2: over 75s with dementia in Surrey

Table 12 shows the non-financial value of each of the benefits in the Scenario 2 analysis considering PwDs aged 75 or over.

**Table 12: Non-financial values of benefits of TIHM service compared to the baseline of the Surrey ICS regional average for Scenario 2: patients over the age of 75.**

Benefit Stream	Value of Benefit Stream
<b>2.1 Longer time out of a care home (Privately funded)</b>	42% reduction of risk (12.4% risk baseline vs 7.2% risk TIHM)
<b>2.2 Longer time out of a care home (Local authority funded)</b>	As above
<b>2.3 Improvement in Carer Mental Health</b>	0.009 QALYs gained
<b>2.4 Reduce Ambulance Callouts</b>	13% reduction in callouts per patient (0.75 baseline vs 0.66 TIHM)
<b>2.5 Reduce Emergency Admissions</b>	35% reduction in admissions per patient (0.72 baseline vs 0.47 TIHM)
<b>2.6 Reduce Inpatient Admissions</b>	29% reduction in admissions per patient (0.42 baseline vs 0.3 TIHM)
<b>2.7 Reduce Excess Bed Days</b>	Increase in excess bed days by 0.08 per patient (0.05 baseline vs 0.13 TIHM)
<b>2.8 Environmental Impact</b>	Saving of 0.09 tonnes CO <sub>2</sub> e per patient per year

## 5-Year NPV

Table 13 gives the output table for Scenario 2: Surrey ICS patients aged 75 and over. Years indicate financial years, so 2020 references the period April 2020 – March 2021 for instance. Scenario 2 predicts a benefit-cost ratio of 1.0 in the first year (2021/22) increasing to 1.2 in the year 2024/25.

In the year 2020/21, it is estimated that the benefit-cost ratio is 1:0.5. This is possibly due to the smaller amount of people on the service compared to the running costs, as well as start-up costs that are initially generated for TIHM.

Table 13: Output tables for Scenario 2 (in thousands).

TIHM For Dementia - Scenario 2 - Patients over 75 (£ net present value in 2019 prices)	2020	2021	2022	2023	2024	Total
<b>Benefits</b>						
2.1 - Longer Time out of a Care Home (Private funding)	£0.2m	£1.5m	£1.5m	£1.5m	£1.4m	£6.1m
2.2 - Longer Time out of a Care Home (Local Authority funding)	£0.1m	£1.4m	£1.3m	£1.3m	£1.3m	£5.5m
2.3 - Improved Carer Mental Health	<£0.1m	£0.1m	£0.1m	£0.1m	£0.1m	£0.5m
2.4 - Reduced ambulance callouts	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m	£0.1m
2.5 - Reduced Emergency Admissions	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m	£0.2m
2.6 - Reduced Inpatient admissions	£0.1m	£0.2m	£0.2m	£0.2m	£0.2m	£1.0m
2.7 - Reduced Excess Bed Days	>-£0.1m	£-0.1m	>-£0.1m	>-£0.1m	>-£0.1m	£-0.2m
2.8 - Environmental Impact	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m
<b>Total Benefits</b>	<b>£0.4m</b>	<b>£3.3m</b>	<b>£3.2m</b>	<b>£3.2m</b>	<b>£3.1m</b>	<b>£13.2m</b>
<b>Costs</b>						
<b>Total Costs</b>	<b>£0.7m</b>	<b>£3.4m</b>	<b>£2.8m</b>	<b>£2.7m</b>	<b>£2.7m</b>	<b>£12.3m</b>
<b>NPV</b>						
<b>Total NPV</b>	<b>£-0.3m</b>	<b>£-0.1m</b>	<b>£0.4m</b>	<b>£0.4m</b>	<b>£0.4m</b>	<b>£0.9m</b>
<b>Total BCR</b>	<b>0.5</b>	<b>1.0</b>	<b>1.2</b>	<b>1.2</b>	<b>1.2</b>	<b>1.1</b>
*The figures above have been rounded to the nearest whole pound for presentation and as such totals may not sum						

## Sensitivity analysis

Figure 8 shows that the 5-year net present value (NPV) from 2020/21 – 2024/25 may vary from -£14.03 million to £16.00 million at the 90% confidence interval, with the expected value to be approximately £1.06 million. The mean value of the sensitivity analysis differs from that given in Table 13 due to some distributions not being symmetric, but the results presented in Table 13 reflect the most likely outcome for this scenario.

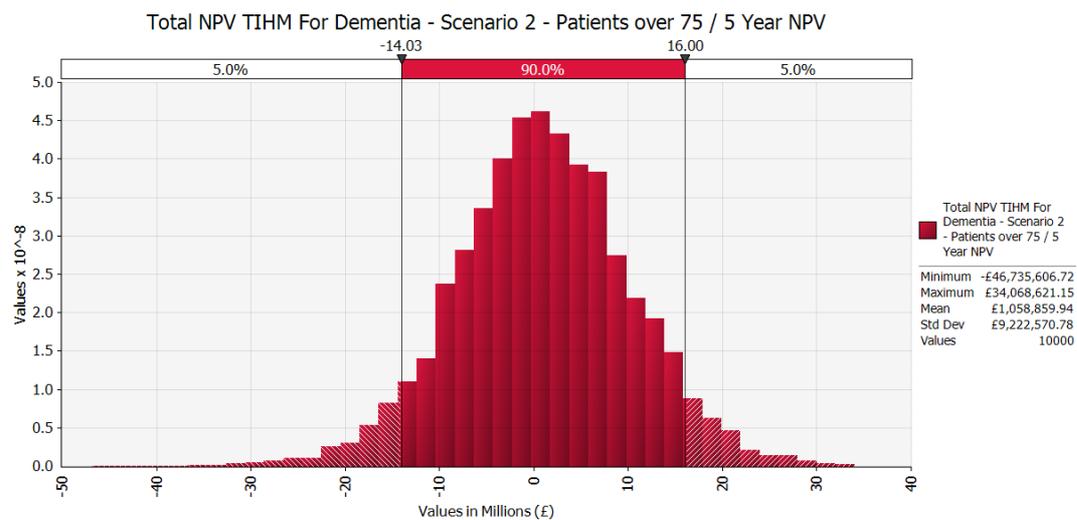


Figure 8: Sensitivity analysis of the 5-year net-present value (NPV) of TIHM in Scenario 2 Surrey ICS - 75 and over

### 3.3.Scenario 3: impact post-COVID

Table 14 highlights the potential healthcare savings to TIHM based on external literature studying remote monitoring services for PwDs implemented elsewhere. Benefit streams 3.1, 3.2, and 3.3 are calculated in the same way as they were in previous scenarios.

**Table 14: Non-financial values of benefits of TIHM service compared to the baseline of the Surrey ICS regional average for Scenario 3 Surrey ICS - Post COVID.**

<b>Benefit Stream</b>	<b>Value of Benefit Stream</b>
<b>3.1 Longer time out of a care home (Privately funded)</b>	42% reduction of risk (12.4% risk baseline vs 7.2% risk TIHM)
<b>3.2 Longer time out of a care home (Local authority funded)</b>	As above
<b>3.3 Improvement in Carer Mental Health</b>	0.009 QALYs gained
<b>3.4 Reduce Ambulance Callouts</b>	66% reduction in ambulance callouts (Watson, 2020) (0.69 baseline taken from data)
<b>3.5 Reduce Emergency Admissions</b>	38% reduction in emergency admissions (Deeny, 2018) (0.66 baseline taken from data)
<b>3.6 Reduce Inpatient Admissions</b>	0.1 admissions per patient saved (Piccini, 2016)
<b>3.7 Reduce Excess Bed Days</b>	Saving of 1.19 excess bed days per patient (Piccini, 2016)
<b>3.8 Reduce GP Appointments</b>	18% reduction in appointments (Cahill, 2012) (4.4 appointments baseline taken from (Deeny, 2018))
<b>3.8 Environmental Impact</b>	Saving of 0.1 tonnes CO2e per patient per year

## 5-Year NPV

Table 15 gives the output table for Scenario 2: Surrey ICS patients aged 75 and over. Years indicate financial years, so 2020 references the period April 2020 – March 2021 for instance. Scenario 2 predicts a benefit-cost ratio of 1.2 in the first year (2021/22) increasing to 1.4 in the year 2024/25.

In the year 2020/21, it is estimated that the benefit-cost ratio is 1:0.6. This is possibly due to the smaller amount of people on the service compared to the running costs, as well as start-up costs that are initially generated for TIHM.

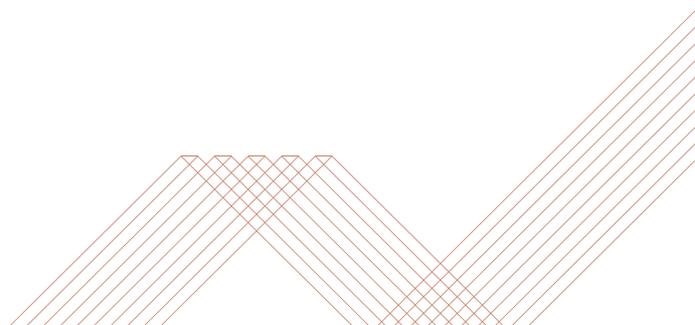


Table 15: Output table for Scenario 3 (in thousands).

TIHM For Dementia - Scenario 3 - Surrey ICS: Post COVID (£ net present value in 2019 prices)	2020	2021	2022	2023	2024	Total
<b>Benefits</b>						
<b>3.1 - Longer Time out of a Care Home (Private funding)</b>	£0.2m	£1.9m	£1.8m	£1.8m	£1.7m	£7.4m
<b>3.2 - Longer Time out of a Care Home (Local Authority funding)</b>	£0.2m	£1.7m	£1.6m	£1.6m	£1.6m	£6.7m
<b>3.3 - Improve Carer Mental Health</b>	<£0.1m	£0.2m	£0.2m	£0.2m	£0.2m	£0.6m
<b>3.4 - Reduced ambulance callouts</b>	<£0.1m	£0.1m	£0.1m	£0.1m	£0.1m	£0.6m
<b>3.5 - Reduce Emergency Admissions</b>	<£0.1m	£0.1m	£0.1m	£0.1m	£0.1m	£0.2m
<b>3.6 - Reduce Inpatient Attendances</b>	£0.1m	£0.5m	£0.5m	£0.5m	£0.5m	£2.0m
<b>3.7 - Reduce Excess Bed Days</b>	<£0.1m	£0.4m	£0.4m	£0.4m	£0.3m	£1.5m
<b>3.8 - Reduction in GP Appointments</b>	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m	£0.1m
<b>3.9 - Environmental Impact</b>	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m	<£0.1m
<b>Total Benefits</b>	£0.4m	£3.3m	£3.2m	£3.2m	£3.1m	£13.2m
<b>Costs</b>						
<b>Total Costs</b>	£0.9m	£4.0m	£3.3m	£3.2m	£3.1m	£14.5m
<b>NPV</b>						
<b>Total NPV</b>	£-0.4m	£0.8m	£1.4m	£1.4m	£1.4m	£4.6m
<b>Total BCR</b>	0.6	1.2	1.4	1.4	1.4	1.3
*The figures above have been rounded to the nearest whole pound for presentation and as such totals may not sum						

## Sensitivity analysis

Figure 9 shows that the 5-year net present value (NPV) from 2020/21 – 2024/25 may vary from -£13.40 million to £23.08 million at the 90% confidence interval, with the expected value to be approximately £4.77 million. The mean value of the sensitivity analysis differs from that given in Table 15 due to some distributions not being symmetric, but the results presented in Table 15 reflect the most likely outcome for this scenario.

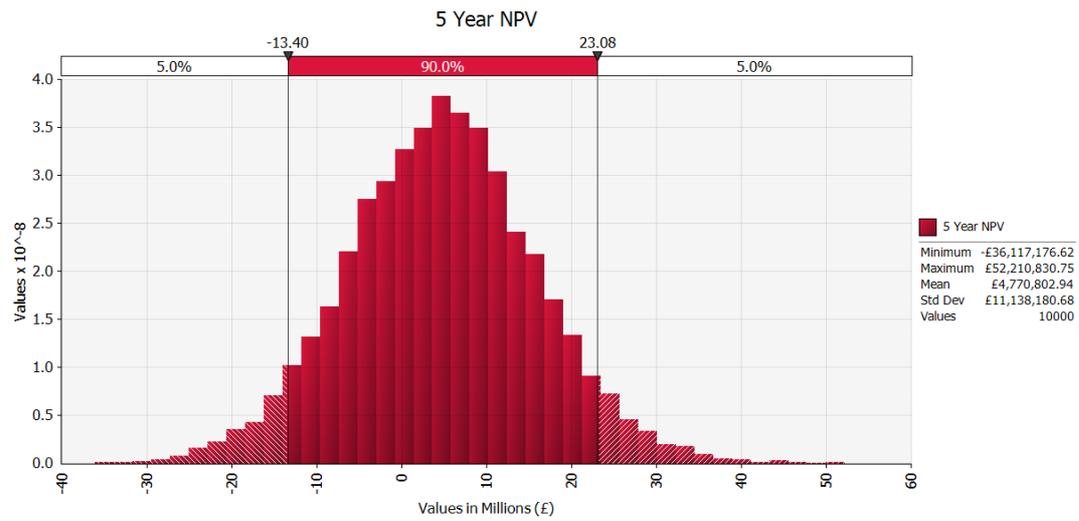


Figure 9: Sensitivity analysis of the 5-year net-present value (NPV) of TIHM in Scenario 3: Surrey ICS - Post COVID.

## 4. Discussion

### 4.1. Health economic discussion

---

This report was commissioned in-part to conduct analysis of the potential economic and financial impact of the TIHM service on patient quality of life, modelling three scenarios based on wider spread and implementation. Through robust investigation and analysis of the costs and benefits arising from the project, and appropriate application of these results within a model, KSS AHSN can suggest whether the TIHM service may have a positive/negative financial impact on the NHS and the healthcare system.

#### Headline findings

- The overall Return on Investment (ROI) for TIHM after 5 years is 1:1.1, with the net-present value suggesting that, at Surrey ICS level, the service recovers £1.10 in benefits for every £1 spent.
- ROI for healthcare benefits not related to social care or carer mental health is approximately 1:0.1.
- The main benefit stream influencing the financial value of TIHM is the reduction in risk of care-home admission, with nearly 90% of the financial benefits due to this potential saving.
- There are further savings related to carer's mental health that could be explored, as current results are based on external literature and thus may not represent TIHM's service offering.

#### Uptake discussion

To encourage uptake during the initial implementation of TIHM, SABP hired a telemarketing company, Stratcom, to assist with contacting eligible people. Initial uptake figures were assessed by Stratcom and was concluded to be approximately 55.7%. As the service began to improve its process, and more feedback was obtained by users of TIHM and HOWZ, the uptake figure was assessed again in December 2020. It was found to have increased to approximately 70% of people contacted were onboarded onto the service. A third round of assessment of uptake is currently underway, and there is potential for a further uptake increase to be found.

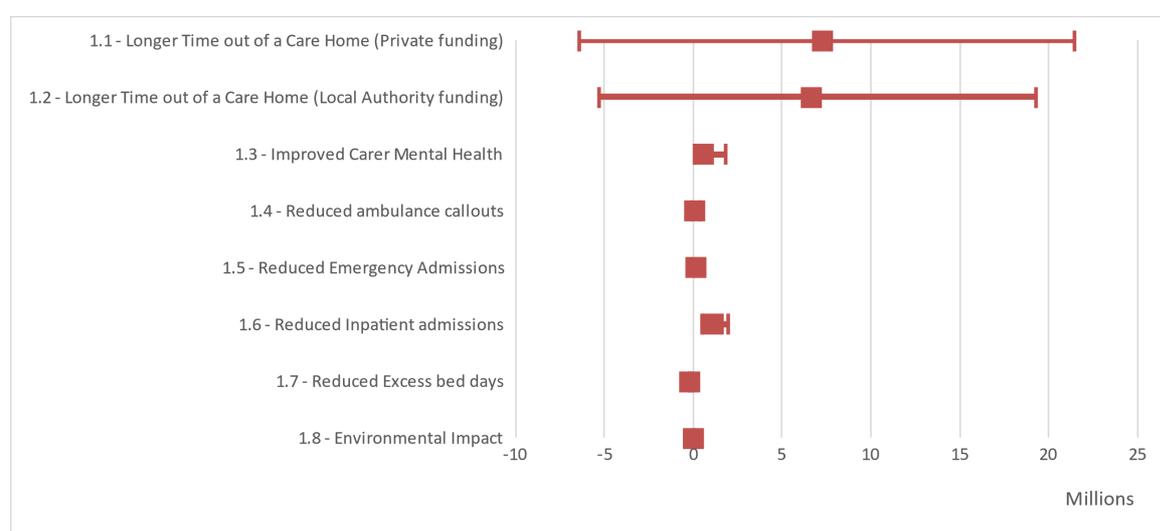
If TIHM can improve its uptake and usability figures as the service continues to be implemented, it could lead to larger savings, both to the NHS and to TIHM service users.



## Benefit streams discussion

### CARE HOME ADMISSIONS VS NHS BENEFITS

Undoubtedly, the main benefit stream in terms of valuation is the potential risk reduction of PwDs being admitted into residential care. Figure 10 illustrates the 90% confidence intervals for each benefit stream for Scenario 1, to highlight the potential benefits of the social care system. The most likely value, as shown by the red square at the centre of these intervals, far exceeds the tail of the largest benefit stream relating to healthcare benefits (inpatient admissions).



**Figure 10: Box and whisker plot of each of the benefit streams calculated in Scenario 1 with 90% confidence interval "whiskers".**

The overall ROI is broken down by NHS benefits vs benefits to the wider social care system. The main benefit streams impacting ROI is the potential reduction in risk to care home placement. This yields an ROI of 1:1.1. With the removal of the benefit stream related to private funded care homes, this ROI is reduced to 1:0.6. Once any benefits related to care homes are removed, the overall healthcare ROI is approximately 1:0.1. This is largely consistent with the various methodologies explored by KSS AHSN in the analysis.

The indication is that there are no large financial healthcare benefits provided by TIHM. By contrast, there may be a large social care benefits realised by wider employment of the TIHM service, namely reducing the risk of dementia patients being admitted to residential care, saving both local authorities and families of those affected by dementia. Further investigation and data collected over a longer period can be used to further reinforce this claim and help strengthen the business case for TIHM as a service.

## CAREGIVER SUPPORT

To highlight potential impacts of TIHM, as well as remote monitoring services in general, this analysis has showcased a potential saving in terms of quality-of-life improvements for informal caregivers. In this analysis, a literature-based benefit stream is shown to provide some form of benefit for informal caregivers.

This high-level result, however, may not give a complete picture of the entire benefit to caregivers that TIHM as a service can offer. Due to the complexity of dementia as a condition, there may be a variety of caregiver benefits at varying stages of the process. For example, a carer might be able to earn more money by being able to work for longer before they resort to caring for their loved one full-time, or there might be a reduction in burden on those already in full-time care due to the support that the monitoring service offers.

A more in-depth study, specific to TIHM, would provide more in-depth insights of the benefits to caregivers, and potentially uncover further specific benefits as well as QALY gains.

## HEALTHCARE BENEFITS OF TIHM

As mentioned previously in this report, the healthcare benefits of TIHM result in an ROI of approximately 1:0.1. Whilst there seems to be some benefit to the implementation of TIHM, it appears to be a costly intervention for the outcomes in a purely healthcare context.

On excess bed days, whilst there is an increase in excess bed days for TIHM users compared to the regional per patient numbers, it should be noted that only one patient incurred a charge due to excess bed days.

Moreover, by considering median tariff charges of those admitted to secondary care (outlined in Table 9), it seems that TIHM users are being admitted to secondary care with less severe issues, and thus are more likely to incur excess bed day charges. Further data collection, ideally post-COVID-19, would perhaps give greater insight into the effects of TIHM on excess bed days.



## 4.2. Other points of discussion

---

### Alternative methodologies

During the analysis of the TIHM service data, KSS AHSN explored a variety of possible baselines. The main challenge of the analysis was ensuring that the pathway against which TIHM would be compared was appropriate.

Initial data that was provided to KSS AHSN was such that the most appropriate way to analyse it was to compare the difference of outcomes for patients before and after joining TIHM. It was, however, determined that this approach would not deliver the most accurate outcomes due to the degenerative nature of dementia as a disease, and hence an alternative approach using TIHM data compared to the regional averages was agreed and further data collected. A matched cohort method would also have been suitable, but an appropriate comparable cohort was not able to be constructed given available data.

Another potential methodology that would be of interest, depending on software accessibility, is using risk stratification software to evaluate individual risk and compare that with observed outcomes. This methodology was not used as neither KSS AHSN nor SABP have access to such software.

### HOWZ monitoring service

This section notes the work of the HOWZ Monitoring Service in the context of TIHM and how it may be utilised moving forward. Median response times are less than two days for all metrics, as shown in Table 16.



Table 16: Key metrics inputted by the PwD for the HOWZ monitoring service and median time for responses.

Response	Median Carer Response Rate (Days)	Median Patient Response Rate (Days)
Body Temperature	1.39	1.44
COVID	1.34	1.34
Difficult	1.00	1.11
Feeling	1.32	1.35
Personal Care	1.32	1.40
Pulse Rate	1.29	1.34
SpO2	1.29	1.34
Symptoms	1.00	1.00

Further investigation into how the HOWZ monitoring service performs at scale would strengthen the business case for TIHM. HOWZ has already begun working to evaluate the hardware and software capabilities at larger scales, as well as the demands on the monitoring service.

## Potential additional benefits

There may be additional benefits of the TIHM service which at this time may have not been proven or lack the data to be monetised. Such benefits may include, but are not limited to:

- Carers reduce the number of hours per week providing care, decreasing their burden.
- Delay the time until informal caregivers must leave work to become a full-time carer.
- Reduce the impact of dementia patients who get lost because of purposeful walking.

## Other system benefits

Upon conducting the analysis of the data, other benefits of the TIHM service that would have been difficult to evaluate in a health economic analysis of this type were explored and are considered in this subsection.

One of the arguments in favour of TIHM is that it may improve the efficiency of the health service. An interesting outcome of the analysis relates to the use of walk-in centres, as well as patients recorded as attending a secondary care service who incur no significant cost and have no significant treatment (HRG code VB11Z). When compared to the baseline of the

regional average, it is noticed that TIHM's per patient VB11Z occurrences are roughly two-thirds the amount of the national baseline within the Surrey ICS (1.5% occurrence per patient baseline vs 1.1% per patient TIHM).

Another interesting metric to measure TIHM's impact on efficiency of the service is considering 999 calls that did not result in an ambulance callout. In total, the regional average saw 0.09 calls per patient that resulted in a "hear & treat" or "call only" outcome, compared to 0.06 calls per patient in the TIHM patients. There may be further savings of this type when considering carer distress, but that would need to be investigated further to truly understand the potential impact.

On more efficiencies to the ambulance service, Table 17 shows the percentage of ambulance callouts that were "See & Treat" vs "See & Convey" for both baseline and TIHM across the whole patient population:

**Table 17: Percentage of ambulance callouts that resulted in a patient being treated at the scene or conveyed to hospital, for both TIHM and non-TIHM service users.**

	See & Treat	See % Convey
<b>Baseline</b>	31.34%	68.66%
<b>TIHM</b>	34.33%	65.67%

Whilst the differences between the baseline and TIHM may not be significantly different, there is potentially a saving to the ambulance service in the following way; fewer PwD's that call 999 will result in an ambulance callout with no significant treatment, and hence there would be a decrease in see and treat callouts. By contrast, knowing that people calling 999 are on TIHM might allow ambulance crew to better prepare for treating patients without conveying them to hospital, hence increasing the amount of see and treat, and reducing the number of conveyances to A&E.

As this is currently speculative, further data would need to be collected to validate these hypotheses. A qualitative survey or some case studies may be of use in determining if this is worth investigating further.

### 4.3. Limitations

- The data for this analysis was collected over the period of December 2020 – March 2021, when the effects of the "second wave" of the COVID-19 pandemic in the UK were still being felt across the entire health service. This may have had an impact on the findings, especially for qualitative benefits with counterfactuals based on external literature.
- In terms of the time scales on which the data was collected, a more accurate measure of TIHM's value as a service could be realised if data is collected over a

longer period. Due to dementia being a degenerative condition over a period of many years, it would be beneficial to SABP and HOWZ to collect information of this type to more accurately capture the true benefits of the service compared to alternative pathways.

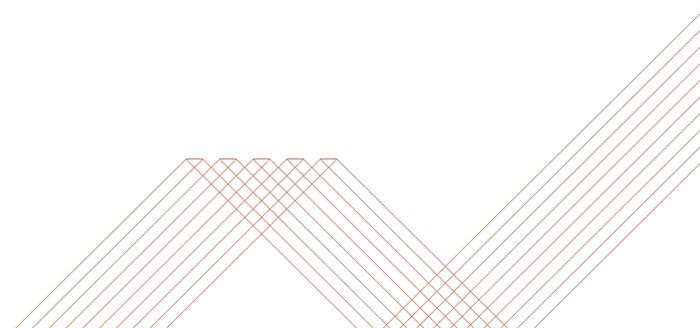
- In the collection of data for people with dementia using the TIHM service, information on patients' severity of dementia did not exist. Subsequently, populations have had to be assumed based on external literature (CPEC, 2019) for the baseline. It is thought that the benefits of TIHM would vary among different severities of dementia. For a patient with a milder form of dementia, TIHM may offer more benefits related to caregivers. For more severe dementia patients, the savings preventing care home admissions may be more relevant, but this will only be known if such data becomes available.
- Many of the qualitative benefits of the TIHM service, such as those relating to the mental health of informal caregiver, have not been sufficiently analysed in this work. It is the recommendation of KSS AHSN that a detailed qualitative evaluation of the TIHM service for both patients and carers is undertaken. It is hoped that such a study may allow for more benefits to be modelled, including some of those outlined.
- It is noted that this analysis lacks a large-scale scenario analysis, such as the impact of TIHM on the wider NHS. It is recommended that a new commission is established to consider such a scenario.
- It should be noted that the way a residential care placement is funded is not as simple as has been presented in this report. Frequently, private individuals will supplement local authority payments for care home placements, in a practice known as cross-subsidy.
- Due to the COVID-19 pandemic, some benefits may not have been fully realised or may not be representative of the TIHM service in the longer term. This has been somewhat mitigated by the inclusion of a literature-based review in this evaluation for comparative purposes, but the true impact will be difficult to evaluate whilst the pandemic is still ongoing.



## 5. Key recommendations

To summarise the findings of this report, KSS AHSN recommends the following improvements to TIHM's service to maximise return on investment:

- A study should be undertaken to evaluate the performance of TIHM as a service at scale. This type of evaluation should consider how TIHM performs in terms of reducing its costs as well as maximising benefits.
- The value of TIHM seems to largely be related to social care, namely the reduction of care home admissions and the subsequent financial savings to both private individuals and local authorities. Whilst TIHM does deliver positive health benefits from an ROI perspective, these are at additional cost to the health service. KSS AHSN recommends that a detailed study should be undertaken to support the hypothesis in this report that TIHM's savings to local authorities and private individuals exceed those benefits related to healthcare.
- An in-depth qualitative study related to mental health benefits, particularly for informal caregivers, could further strengthen the business case for TIHM as a service for families of people with dementia, as well as building the case for future demographics of patients considered by TIHM, such as people with learning difficulties (PLDs).



## 6. Concluding remarks

With an ageing population and an expected increase in the prevalence of dementia amongst the UK population (CFAS, 2013), it is expected that the demands placed on health and social care will increase unsustainably in the next few years (Grant Thornton, 2018). TIHM is an example of a remote monitoring service that may support the health service as it enables individuals to remain independent in their own homes for longer, as well as offering support for informal caregivers and their families, thus reducing stress in those groups.

Whilst this report does seem to indicate that TIHM offers a positive ROI overall, most of that return is due to the potential risk reduction to care home admissions for mild and moderate persons with dementia. There are further social benefits to be explored in terms of mental health of caregivers and other benefits to social care, as it seems that the healthcare impact of TIHM is not sufficient to result in a positive ROI at current cost.

This health economic analysis has primarily focussed on the financial impact of TIHM as a service for people with dementia, but it should also be noted that TIHM has recently begun to expand its offering to people with learning difficulties (PLDs) and their carers. Further benefits, especially those related to promoting independence and impact on social care, could yet be realised as this group of users is expanded.



## 7. References

- Alzheimer's Association. (2020). *2020 Alzheimer's Disease, Facts & Figures*.
- Alzheimer's Society. (2018). *Dementia - the true cost: Fixing the care crisis*. Retrieved from <https://www.alzheimers.org.uk/sites/default/files/2018-05/Dementia%20the%20true%20cost%20-%20Alzheimers%20Society%20report.pdf>
- BGS. (n.d.). *bgs.org.uk*. Retrieved from [https://www.bgs.org.uk/sites/default/files/content/attachment/2018-07-05/mini-mental\\_state\\_exam.pdf](https://www.bgs.org.uk/sites/default/files/content/attachment/2018-07-05/mini-mental_state_exam.pdf)
- Cahill, S. a. (2012). *Creating Excellence in Dementia Care - A Research Review for Ireland's National Dementia Strategy*.
- CFAS. (2013). A two-decade comparison of prevalence of dementia in individuals aged 65 years and older from three geographical areas of England. Retrieved from <http://www.cfes.ac.uk/cfas-ii/cfasii-key-findings/#PrevDem>
- CMA. (2017). *Care Homes Market Study: Final Report*. Retrieved from <https://assets.publishing.service.gov.uk/media/5a1fdf30e5274a750b82533a/care-homes-market-study-final-report.pdf>
- Collins, R. a. (2020). *Prevalence of depression and burden among informal caregivers of people with dementia: a meta-analysis*.
- CPEC. (2019). *Projections of older people with dementia and costs of dementia care in the United Kingdom, 2019 - 2040*.
- Deeny, S. T. (2018). *Reducing emergency admissions: unlocking the potential of people to better manage their long-term conditions*. Retrieved from <https://www.health.org.uk/sites/default/files/Reducing-Emergency-Admissions-long-term-conditions-briefing.pdf>
- Etkind, S. e. (2017). How many people will need palliative care in 2040? Past trends, future projections and implications for services. *BMC Medicine*, 15. Retrieved from <https://bmcmmedicine.biomedcentral.com/articles/10.1186/s12916-017-0860-2>
- GMCA Research Team. (2019). *Cost Benefit Analysis*. Retrieved from <https://www.greatermanchester-ca.gov.uk/what-we-do/research/research-cost-benefit-analysis/>
- Grant Thornton. (2018). *Care homes for the elderly: where are we now?* Retrieved from <https://www.grantthornton.co.uk/globalassets/1.-member-firms/united-kingdom/pdf/documents/care-homes-for-the-elderly-where-are-we-now.pdf>
- Gungabissoon, U., & al., e. (2020). The association between dementia severity and hospitalisation profile in a newly assessed clinical cohort: the South London and Maudsley case register. *BMJ Open*.

- HERC. (2020). *Cost-Effectiveness Analysis*. Retrieved Jan 21, 2020, from <https://www.herc.research.va.gov/include/page.asp?id=cost-effectiveness-analysis>
- HM Treasury. (2018). *The Green Book: Central Government Guidance on Appraisal and Evaluation*. London: HM Treasury.
- Knapp, M. e. (2016). Predictors of care home and hospital admissions and their costs for older people with Alzheimer's Disease: findings from a large London case register. *BMJ Open*. doi:<http://dx.doi.org/10.1136/bmjopen-2016-013591>
- Lakey, L. (2009). *Counting the Cost: Caring for people with dementia on hospital wards*. Alzheimer's Society.
- Livingston, G. e. (2014). Long-term clinical and cost-effectiveness of psychological intervention for family carers of people with dementia: a single-blind, randomised, controlled trial. Retrieved from <https://www.thelancet.com/action/showPdf?pii=S2215-0366%2814%2900073-X>
- Mott MacDonald. (2002). *Review of Large Public Procurement in the UK*. London: HM Treasury.
- New Economy. (2014). *New Economy databook (Unit Cost Database (v.1.4))*. Retrieved from <http://www.neweconomymanchester.com/our-work/research-evaluation-cost-benefit-analysis/cost-benefit-analysis/unit-cost-database>
- NHS. (2017). *Personal Social Services Survey of Adult Carers in England (SACE)*.
- NHS England and NHS Improvement. (2019, March). *A guide to the market forces factor*. Retrieved from NHS England and NHS Improvement: [https://improvement.nhs.uk/documents/4995/1920\\_Guide\\_\\_to\\_MFF.pdf](https://improvement.nhs.uk/documents/4995/1920_Guide__to_MFF.pdf)
- NHS Improvement. (2018). *Reference costs 2017/18: highlights, analysis and introduction to the data*. Retrieved from [https://improvement.nhs.uk/documents/1972/1\\_-\\_Reference\\_costs\\_201718.pdf](https://improvement.nhs.uk/documents/1972/1_-_Reference_costs_201718.pdf)
- NICE. (2015). *Costing statement: Implementing the NICE guideline on Transition between inpatient hospital settings and community or care home settings for adults with social care needs (NG27)*. Retrieved from <https://www.nice.org.uk/guidance/ng27/resources/costing-statement-pdf-2187244909>
- Office for National Statistics. (2019). *Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2019*. Retrieved from [ons.gov.uk: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2019estimates](https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2019estimates)
- ONS. (2020). *Dataset: Estimates of the population for the UK, England and Wales, Scotland and Northern Ireland*. London: ONS.

- Piccini, J. e. (2016). Impact of remote monitoring on clinical events and associated health care utilization: A nationwide assessment. *Heart Rhythm*, 13(12), 2279 - 2286. doi:<https://doi.org/10.1016/j.hrthm.2016.08.024>
- Prince, M. e. (2014). *Dementia UK: Second Edition - Overview*. Alzheimer's Society.
- PSSRU. (2010). *Unit Costs of Health and Social Care*.
- PSSRU. (2019). *Unit Costs of Health and Social Care*. Canterbury: Personal Social Services Research Unit, University of Kent. Retrieved from <https://www.pssru.ac.uk/project-pages/unit-costs/unit-costs-2019/>
- Rostill, H. N. (2018). Technology integrated health management for dementia. *British Journal of Community Nursing*, 23(10).
- Sampson, E. (2009). Dementia in the Acute Hospital: Prospective cohort study of prevalence and mortality. *195*(1), 61--66. doi:10.1192/bjp/bp.108.055335
- Torkamani, M. e. (2014). A Randomized Controlled Pilot Study to Evaluate a Technology Platform for the Assisted Living of People with Dementia and their Carers. *Journal of Alzheimer's Disease*. Retrieved from <https://content.iospress.com/download/journal-of-alzheimers-disease/jad132156?id=journal-of-alzheimers-disease%2Fjad132156>
- Treasury. (2018). *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal*.
- Vandepitte, S. e. (2020). Cost Effectiveness of an in-home respite care program to support informal caregivers of persons with dementia: A model-based analysis. *Journal of Geriatric Psychiatry*. doi:<https://doi.org/10.1002/gps.5276>
- Voss, S. e. (2018). How do people with dementia use the ambulance service? A retrospective study in England: the HOMEWARD project. *BMJ Open*. Retrieved from <https://bmjopen.bmj.com/content/bmjopen/8/7/e022549.full.pdf>
- Watson, P. B. (2020). The Impact of Rapid Response and telecare services on elderly and vulnerable residents. *Health and Social Care in the Community*. Retrieved from [https://onlinelibrary.wiley.com/doi/full/10.1111/hsc.13123?casa\\_token=vDTP2Of4IfsAAAAA%3A\\_p-BLVdArEH1I-3WtqZGd7FqxqZCu1DnEQGfGf6y3h0jrzy5U\\_OUbzlbzZ7jP0OcV3Hem\\_w\\_Hlf54apl](https://onlinelibrary.wiley.com/doi/full/10.1111/hsc.13123?casa_token=vDTP2Of4IfsAAAAA%3A_p-BLVdArEH1I-3WtqZGd7FqxqZCu1DnEQGfGf6y3h0jrzy5U_OUbzlbzZ7jP0OcV3Hem_w_Hlf54apl)
- Williams, A. (1985). The value of QALYs. *Health and social service journal*, 36.
- Wittenberg, R. e. (2019). The Costs of Dementia in England. *Journal of Geriatric Psychiatry*.