Kent Surrey Sussex Academic Health Science Network

Unity Insights

Office for Life Sciences

NHS

Sleepio

Workforce high-level impact analysis

KSS Insights

March 2022

Contents

This report has been commissioned by KSS AHSN and completed in collaboration with Wessex and Oxford. Oxford has been the lead AHSN for the implementation of Sleepio.

WORKFORCE PROGRAMMES

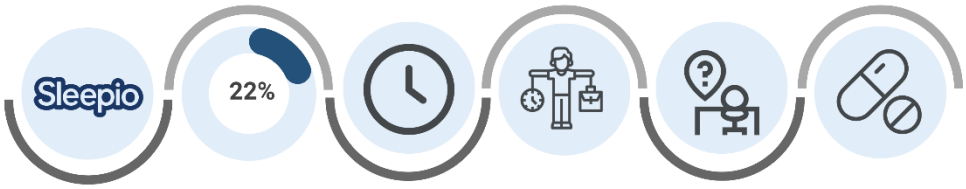
INDICATIVE FINDINGS

- Sleep is essential for several bodily functions.[1]
- Insomnia, disrupted sleep, affects about 10% - 48% of the UK population.[2]
- A UK study estimated that the insomnia prevalence among healthcare workers, during the COVID-19 pandemic, was approximately 38.5%.[3]

Sleepio

- Sleepio, developed by Big Health, "is a digital sleep improvement program that is scientifically proven to help overcome poor sleep and thereby improve mental health."
- In addition to workforce specific benefits such as a potential reduction in absenteeism and clinical time needed to perform CBT; Sleepio could result in increased Quality Adjusted Life Years (QALY) gains for patients using the platform and wider cash-releasing benefits such as a reduction in prescription costs.
- The aim of this analysis was to assess the potential workforce and wider system in-year impacts of the Sleepio solution across KSS, Oxford, and Wessex (April 2020 to April 2021).
- This high-level analysis contains several caveats and assumptions which have been further detailed in the report.

Indicative in-year impacts



Overall Sleepio impacts
Net benefit: £2.5m
Indicative BCR: 2.97

Percentage of impacts attributable to workforce benefits

Clinical time released
Approximately **719** hours released.

QALY Gains
Approximately **0.057** QALYS gained per active patient and staff member

Reduction in staff absenteeism
Approximately **1,619** hours no longer lost to absenteeism

Prescription savings
Approximately **3,196** fewer short-term insomnia medications prescribed

- Net benefits are shown in thousands of pounds for April 2020 to April 2021.
- The indicative benefit cost ratio across AHSNs illustrates that for every £1.00 invested, £2.97 is expected in return.

Overall, Sleepio may result in savings for the NHS, and could assist a strained workforce by addressing the insomnia treatment gap, enable patients to access treatment and assist the workforce in recovery following the effects of the pandemic.

1. Univeristy of Oxford (2021). https://www.ox.ac.uk/news/2020-06-12-oxford-researchers-lead-international-study-effects-covid-19-sleep
2. Sleep (2007). https://academic.oup.com/sleep/article/30/3/274/2708160?login=true
3. Brain, Behavior, and Immunity (2020). https://www.sciencedirect.com/science/article/abs/pii/S088915912030845X?via%3Dihub

1. Introduction

1.1. Context

Establishing workforce priorities

In September 2020, the NHS England and NHS Improvement South East (NHSEI SE) regional alignment group agreed several priorities for the South East region, across the following five themes:

1. Critical restoration at pace
2. A safe well managed winter
3. Workforce
4. Essential / statutory priorities
5. Enablers / prerequisites

Given the remit to spread innovation, the three Academic Health Science Networks (AHSNs) in the South East region (Kent Surrey Sussex, Wessex, and Oxford) were asked by the NHSEI SE to explore digital solutions currently deployed and ready for spread.

In response, each AHSN put forward three innovations. Wessex AHSN developed a template with a description of each innovation and its value proposition, using the following selection criteria:

- A robust evidence base
- Spread in at least one Sustainability and Transformation Partnerships (STP)
- Adoption at scale - demonstrating significant impact on a key challenge arising from COVID reset
- Addresses inequalities and aligns with phase 3 priorities
- Tested with a community of adopters as required across six STPs/ Integrated Care Systems (ICSs)

Establishing workforce programmes

A moderation meeting was subsequently held, attended by the three AHSN chief operating officers (COOs), as well as the KSS AHSN and Oxford Medical Directors. They prioritised nine proposals using “relevance to SE priorities” and “ease of implementation” as key criteria in selecting the top three with potential for rapid deployment, which were:

- S12 Solutions (Lead AHSN: Wessex)
- Sleepio (Lead AHSN: Oxford)
- Current Health or other remote monitoring solutions for care homes (Lead AHSN: KSS). This was subsequently superseded by the priority to deliver oximeters to patients and reporting acute Covid observations through digital solutions delivered in the Covid Oximetry @Home model
- Electronic repeat dispensing (eRD) was consequently agreed as the third regional project (Lead AHSN: Wessex)

These initiatives were agreed with the Regional Medical Director as priorities for spread due to their alignment with regional strategic priority areas, which includes workforce. KSS AHSN have sought to evidence the potential impacts of the identified workforce programmes through an exploratory high-level impact analysis.

Sleepio

Sleep is essential for several bodily functions such as immune system and memory function, tissue repair etc. Longer term consequences of disrupted sleep include an increased risk of hypertension, type 2 diabetes and developing anxiety or depression. Ultimately, sleep is key to mental and physical health (University of Oxford, 2020).

Insomnia, or disrupted sleep, affects between 10% - 48% of the UK population (approximately 6.7 - 32.2 million adults; Morphy, Dunn, Lewis, Boardman, & Croft, 2007), and can be categorised as either short-term (less than three months) or long-term (three months or longer; NICE, 2021). More than one in ten adults medicate the condition through sleeping tablets (13%) or alcohol consumption (13%; AVIVA, 2017). A study, conducted in the UK, found that the most common sources of treatment were from general practitioners (41.2%), and pharmacists (16.5%, Stinson, Tang, & Harvey, 2006). NICE recommend cognitive behavioural therapy (CBT) as the first-line treatment for insomnia (NICE, 2021); however, Stinson et al. (2006) found that only 7.1% of patients sought treatment from a psychologist. Currently, there is only one CBT therapist available for every 1,000 patients living with insomnia; creating an insomnia treatment gap, which may place strain on the workforce (Oxford AHSN, 2020)

The COVID-19 pandemic has impacted the NHS by placing unprecedented pressure on care services and staff (Giannis, Gerpoulos, Matenoglou, & Moris, 2020). As short-term insomnia is commonly associated with stressful events, which can change sleep patterns, COVID-19 has significantly impacted clinical rates of insomnia (20%) and other mental health conditions such as acute stress (16%), anxiety (19%), and depression (25%; Morin & Carrier, 2021). A UK study estimated that the insomnia prevalence among healthcare workers, during the COVID-19 pandemic, was approximately 38.5% (Pappa, et al., 2020). Additionally, an international study found that the sleep quality of front-line clinical staff was poor, with moderate and severe insomnia reaching approximately 62% and 27%, respectively (Wu & Wei, 2020). Furthermore, insomnia, coupled with work burnout, has been

shown to correlate with an increased risk of viral and bacterial infections. In healthcare workers, a study suggested that every additional hour of sleep is associated with 12% lower odds of becoming infected with COVID-19; highlighting the physiological importance of sleep (Kim, et al., 2021).

Developed by Big Health, Sleepio is an online, self-help, Cognitive Behavioural Therapy for Insomnia-based (CBT-I-based) platform. The six-week online programme delivers the components of CBT-I via an interactive, automated, web-based tool, which is personalised to meet the needs of the user. The solution has been available in the UK since 2012 (NICE, 2017).

Sleepio could potentially address the insomnia treatment gap, easing the strain on the workforce by reducing the clinical time needed by therapists to deliver in-person CBT-I. Sleepio may result in Quality Adjusted Life Years (QALY) gains for patients and NHS staff using the platform and wider cash-releasing benefits such as a reduction in prescription costs. Treating NHS staff insomnia could reduce the risk of staff being infected with COVID-19, and potentially reduce strain on the workforce due to a reduction in staff absenteeism and presenteeism (Kim, et al., 2021).

1.2. AHSN spread and demographics

AHSN spread

In 2018, Innovate UK funded a project which provided free direct online access to Sleepio to adults living, working, or studying in the Thames Valley (Berkshire, Buckinghamshire, Milton Keynes and Oxfordshire). This was the first large-scale NHS rollout of direct access to digital medicine (i.e., pateints could access the programme without needing a GP referral) whereby 15,000 people accessed the programme within 18 months (Oxford AHSN, 2021).

Sleepio became a regional workforce spread priority across KSS, Oxford, and Wessex in April 2020 to April 2021, and was made available to NHS staff, in England, for free during the height of the pandemic (between March 2020 – July 2021; Oxford AHSN, 2021). This free access was funded through the healthcare system. As the Sleepio initiative was led by the Oxford AHSN and was implemented as early as 2018; a longer exposure period to the solution could have resulted in a greater number of patients accessing the platform between April 2020 to April 2021.

Demographics

Patient surveys conducted in China and Italy showed that a significant proportion of respondents reported that the pandemic had affected their sleep quality (Steier, Durrant, & Hare, 2020). Both papers found that younger participants were more likely to report sleep

disturbance during the pandemic. The Italian study found that 57% of respondents reported poor sleep quality, high levels of anxiety and distress. Additionally, for the female sex, fear of contact with cases of COVID-19 and uncertainty around COVID-19 infection increased the likelihood of impaired sleep (Casagrande, Favieri, Tambelli, & Forte, 2020).

Some regions of the UK get better sleep than others (Figure 1). Notably, the majority of adults across the UK are unhappy with the amount of sleep they get (i.e., more than 50%). The highest proportion of unhappy sleepers, across the three AHSNs, seems to be within the KSS and Oxford AHSN regions (approximately 70% of adults are not satisfied with time spent sleeping; Zopiclone, 2021). A study has shown that insomnia sufferers tend to be female (63%) with a mean age of 45-years old (Luik, Farias Machado, & Espie, 2018).

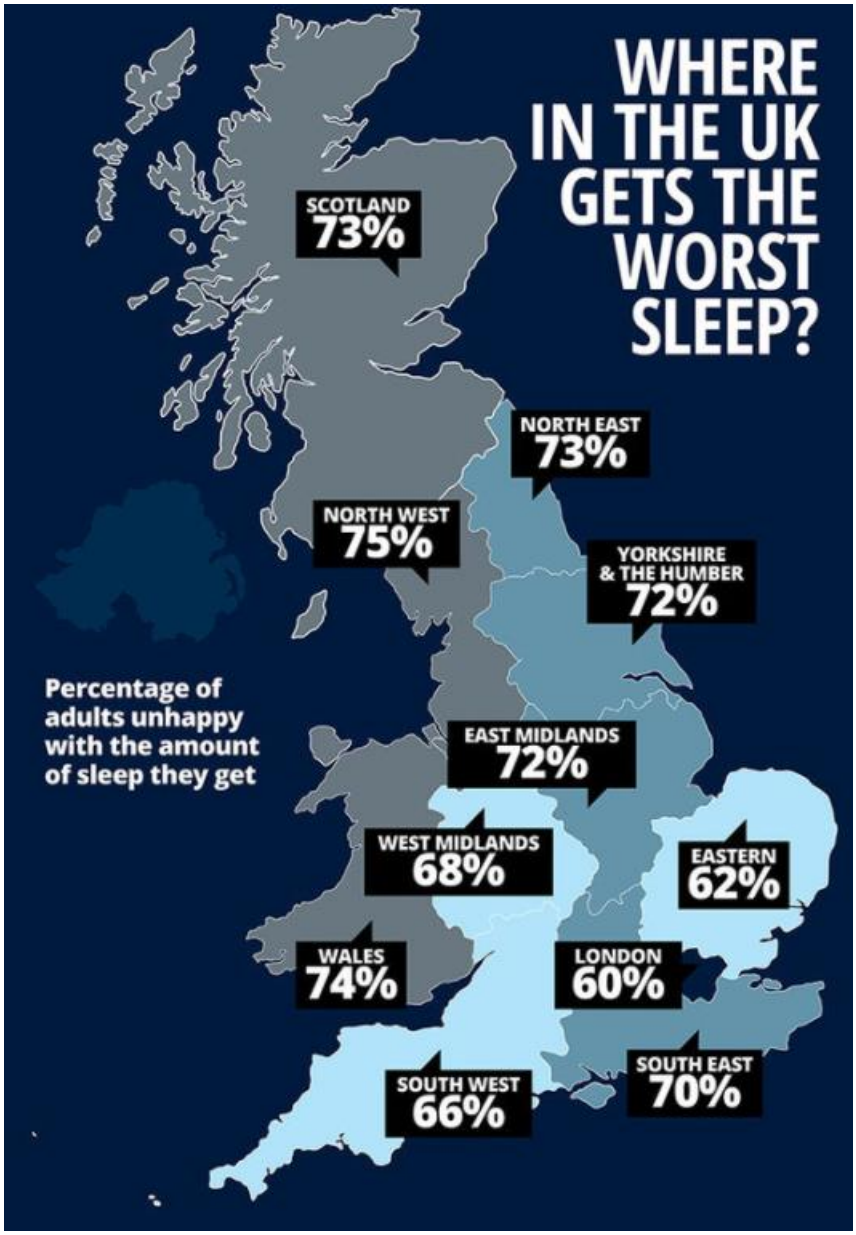


Figure 1: Heat map showing the percentage of people unhappy with the amount of sleep they get across the UK (Zopiclone, 2021).

1.3. Summary of evidence to date

There are approximately sixty-four published papers which include thirteen randomised controlled trials (RCTs) supporting the use of CBT-I to treat insomnia. A core finding can be summarised as 76% of Sleepio patients achieve clinical improvement in insomnia, after six weeks (Big Health, 2021). Evidence suggests that:

- Sleepio resulted in strong engagement, improved insomnia recovery rates, and better all-round mental health (Oxford AHSN, 2020).
- Sleepio patients living with insomnia had an average recovery rate of 56% (n=2,174; Oxford AHSN, 2020).
- Sleepio saves money through a reduction in GP appointments and prescription costs (Sampson, et al., 2021).

Feedback, collected by Oxford AHSN, demonstrated clinical and patient acceptability of the solution:

Patient feedback

"I do feel it is really helping with my sleep. I realise it's a long-term commitment and I'll continue to persevere and hopefully improve my sleep further." Female, 41 years old (Oxford AHSN, 2020, p. 30)

Clinical feedback

"The fact is many GPs are finding they have very few options other than to prescribe hypnotics for insomnia. Availability and access to CBT for insomnia is too often poor across the country and that's not going to change soon. I am delighted to be able to offer Sleepio for free to my patients - an effective digital tool with a robust clinical evidence base behind it. It's a simple digital prescription, and it means that patients can access CBT, the NICE gold-standard for insomnia treatment, in their own time and at their own pace." Dr. Ian Wood, GP based in Buckinghamshire (Oxford AHSN, 2020, p. 34)

The aim of this report is to assess the potential in-year net benefits of the Sleepio solution across Kent Surrey Sussex (KSS), Oxford, and Wessex (April 2020 to April 2021) through a high-level imapct analysis.

2. Methodology

This evaluation produced a high-level in-year analysis (April 2020 to April 2021) of the nominal Sleepio net benefits across KSS, Oxford, and Wessex. This analysis provides preliminary evidence on workforce and wider system benefits, and costs associated with Sleepio to articulate programme impacts. The predominant evidence source used to form

this high-level analysis was from ‘Sleepio in the Thames Valley’ (Oxford AHSN, 2020), academic research, data from relevant public-sector bodies, and AHSN collected metrics. Notably, this is a high-level impact analysis (i.e., the analysis detailed within this report should be view as exploratory).

Whilst assumptions, benefit and costs streams have been further detailed within this report (the Benefit calculations and Cost calculations sections); respective caveats should be reviewed in conjunction with the modelled impacts (Caveats).

Monetisation

To realise potential outcomes, benefit and cost streams must be monetised. Outcomes can be categorised as either direct (NHS related outcomes), indirect (to other public sector organisations), or social outcomes (wider UK society). Within this report, outcomes can be categorised as:

NHS related benefits

- NHS related cash releasing benefits: Benefits that provide immediate cashable savings to the NHS.
- NHS related non-cash releasing benefits: Benefits that help to reduce the demand and strain on NHS services, but for which a fiscal value cannot be realised without the decommissioning of services. For example, staff time savings could enable an improvement in the quality of staff activity or allow saved time to be utilised for other activities.

Social benefits

Benefits that relate to the overall benefit to the wider public including, but not limited to, improved health and wellbeing. Quality of life related benefits use a Quality Adjusted Life Year (QALY) calculation. Since health is a function of length of life and quality of life, the QALY was developed to quantify these attributes into a single index number.

Other benefits

Although this report is primarily concerned with NHS non-cash releasing benefits, it is important to acknowledge other benefits, for which an accurate value cannot be attributed (unquantifiable and not monetisable benefits). These benefits include reputational value, staff confidence, and satisfaction levels.

Optimism Bias

Optimism bias ('OB') [1] has been applied to balance potential "optimistic" estimates within data as there is a propensity for a project's costs and duration to be undervalued, while benefits tend to be overestimated (HM Treasury, 2002). Applying optimism bias results in modelled assumptions falling along a grading scale. Overall, there is uncertainty in the model itself, as the data is a mix of collected metrics, literature, and AHSN specific studies; therefore, a 15% optimism bias has been applied unilaterally to modelled benefits and costs to account for potential "optimistic" estimates. For example, benefits x (1-0.15) and costs x (1+0.15).

Summary measures

Net benefits

The net benefits, a proxy measure for the net present value (NPV), can be defined as the value of 2020/21 impacts less the value of 2020/21 costs. A positive net benefit would indicate that 2020/21 savings could be expressed through the workforce programme.

$$Net\ benefits = Value\ of\ expected\ 2020/21\ impacts - Value\ of\ expected\ 2020/21\ costs$$

Indicative benefit cost ratio

The indicative benefit cost ratio, a proxy measure for the benefit cost ratio (BCR), can be defined as the value of the net 2020/21 impacts against the value of 2020/21 costs. The indicative BCR summarises the overall relationship between relative costs and impacts of the workforce programme (e.g., £X return for every £1 invested).

$$\boldsymbol{Indicative\ Benefit\ Cost\ Ratio} = \frac{\boldsymbol{Value\ of\ 2020/21\ impacts}}{\boldsymbol{Value\ of\ 2020/21\ costs}}$$

If the indicative BCR is greater than 1, the project could expect to deliver a positive net benefit (e.g., an indicative BCR of 2 indicates that for every £1 spent, there is an indicative

[1] Optimism bias (OB) 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, the model applies optimism bias correction factors in response to the level of uncertainty in the data or assumptions used within the model.

£2 return). If the indicative BCR is equal to 1, it could be expected that the benefits equal the costs. Where the indicative BCR is less than 1, the value of the costs will outweigh the benefits.

It is important to note that summary measures are not without limitations (i.e., measures may not fully capture all potential impacts of the intervention and counterfactual pathways).

Benefit calculations

Key benefit streams, both workforce related benefits and those addressing the wider healthcare system, were identified. Case studies and data reported from the implementation of Sleepio were investigated to determine possible benefits ascertained through this workforce programme between April 2020 to April 2021. As previously noted, a 15% optimism bias has been applied unilaterally to all modelled benefits. For example, benefit stream x (1-0.15). To avoid repetition, this element has not been added in the benefit descriptions below.

Benefits have been split across staff and patient cohorts to better articulate the workforce impacts of the solution (i.e., staff accessing treatment are still considered patients to the healthcare system).

Workforce benefits

Benefit stream 1 – reduction in clinical time to perform CBT-I

The implementation of Sleepio may have reduced the number of face-to-face CBT-I sessions. This could relieve pressure on the healthcare system as more time is released for care in other areas. This non cash-releasing benefit is calculated as follows:

- The number of patients registering for CBT-I (5,500 in KSS, 6,500 in Oxford, and 739 in Wessex) was multiplied by a CBT-I uptake rate (42.40%) to determine the number of patients actively using Sleepio.
    - The uptake rate was calculated using the number of patients who started Sleepio's digital CBT programme (7,078), divided by the number of registered patients who took Sleepio's 'Sleep Test' (16,695; Oxford AHSN, 2020).
- This was then multiplied by the percentage of patients who usually seek CBT-I as a treatment for insomnia (7.1%; Stinson, Tang, & Harvey, 2006). This figure was used as a proxy for access to CBT-I treatment within the NHS.
- The product was further multiplied by the Sleepio insomnia recovery rate (56%; Oxford AHSN, 2020).
- The calculation was then multiplied by the number of potential face-to-face CBT-I sessions avoided (4.3 sessions) through Sleepio use. This was calculated as follows:

- The average number of appointments accessed by patients using self-help interventions and computerised CBT (3.2[2]; Curtis & Burns, 2020, p. 111-112) was subtracted from the average number of appointments required to treat insomnia (7.5; NHS Digital, 2021).

- Finally, the products were multiplied by the cost of a CBT session to the healthcare system (£106; Curtis & Burns, 2020, p. 41). The first benefit stream has been illustrated in Figure 2.

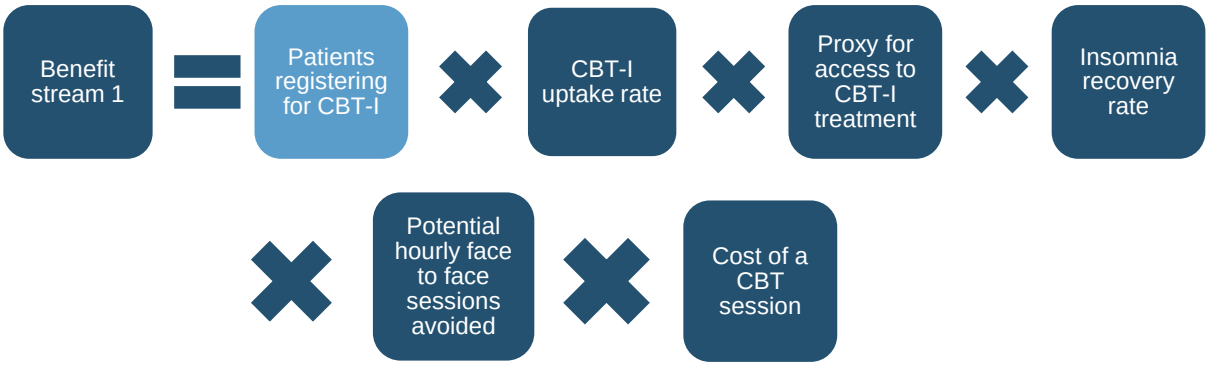


Figure 2: Benefit stream 1 – a reduction in clinical time to perform CBT-I. Figures in dark blue are kept consistent across AHSNs. Figures in light blue vary between AHSNs.

Benefit stream 1 assumptions

- Assumed that patients participated in one Sleepio course per year.
- Assumed that only patients suffering from insomnia access the platform.
- Assumed that 7.1% of patients have access to CBT-I treatment (Stinson, Tang, & Harvey, 2006).
- Assumed the calculated patient Sleepio uptake rate, and insomnia recovery rate of 42.4% and 56.0%, respectively, was the same across the KSS, Oxford, and Wessex cohorts (Oxford AHSN, 2020).
- Assumed that no further treatment is required once recovered from insomnia.

[2] Average number of supported computerised CBT (2.3; Curtis & Burns, 2020, p. 112) and guided self-help sessions attended (4.11; Curtis & Burns, 2020, p. 112).

- Assumed that on average 7.5 CBT-I sessions are required to treat insomnia (NHS Digital, 2021).
- Assumed that an average of computerised CBT and guided self-help sessions were reflective of expected face-to-face CBT-I sessions for patients utilising Sleepio.
- Assumed that CBT-I through Sleepio is not mutually exclusive from other insomnia treatments.

Benefit stream 2 – increased QALY gains for staff.

Sleepio was made available to clinical staff in addition to using it as a supplementary treatment for patients. QALY gains, associated with improved health and wellbeing from the treatment of insomnia, may be released as a benefit of Sleepio. To determine QALY gains for staff using the platform, the following calculation was used:

- The number of staff registering for CBT-I (430 in KSS, 2,340 in Oxford, and 330 in Wessex) was multiplied by a CBT-I uptake rate (42.40%) to determine the number of staff actively using Sleepio (calculated as in benefit stream 1).
- The calculation was further multiplied by an insomnia recovery rate (56%; Oxford AHSN, 2020).
- The number of recovered staff members was then multiplied by the average QALY gain per person using CBT-I (0.057; Hollinghurst, et al., 2014).
- Finally, this was multiplied by the value of a QALY (£20,000; NICE, 2013). The second benefit stream has been illustrated in Figure 3.

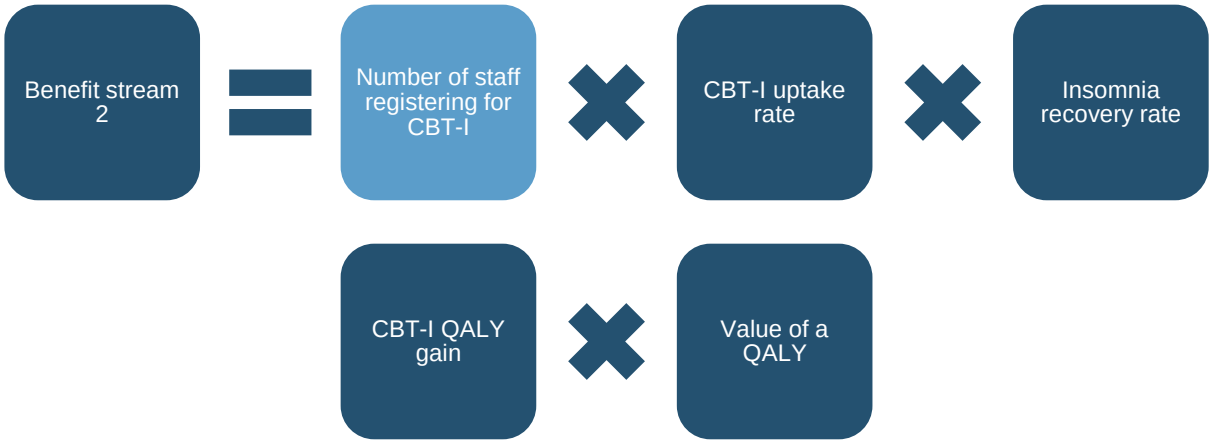


Figure 3: Benefit stream 2 – increased QALY gains for staff. Figures in dark blue are kept consistent across AHSNs. Figures in light blue vary between AHSNs.

Benefit stream 2 assumptions

- Assumed the calculated patient Sleepio uptake rate, and insomnia recovery rate of 42.4% and 56.0%, respectively, would be representative of a staff cohort (Oxford AHSN, 2020).
- Assumed the calculated staff Sleepio uptake rate, and insomnia recovery rate of 42.4% and 56.0%, respectively, was the same across KSS, Oxford, and Wessex cohorts (Oxford AHSN, 2020).
- Assumed that no further treatment is required once recovered from insomnia.
- Assumed that QALYs gained through therapy, within a cohort of patients with depression, would be equivalent to QALYs gained through CBT-I for staff cohorts with insomnia (Hollinghurst et al., 2018).
- Assumed 0.057 was the average QALY gain from staff accessing CBT-I, through Sleepio, across KSS, Oxford, and Wessex cohorts.
- Assumed that only recovered staff received QALY benefits.
- Assumed that the standard pathway included treatment from a GP and prescribed medication as advised by a GP (Hollinghurst, et al., 2014).
- Assumed that staff only suffering from insomnia access the platform.
- Assumed that staff participated in one Sleepio course per year.

Benefit stream 3 – reduction in staff absenteeism

The use of Sleepio by staff members could result in a reduction in staff absenteeism associated with mental health problems (Oxford AHSN, 2020). A reduction in hours lost to staff absenteeism was calculated through:

- The number of staff registered for CBT-I was multiplied by a CBT-I uptake rate (as in benefit stream 2).
- The full time equivalent (FTE) hours attributable to staff absenteeism due to mental health issues was calculated through several steps:

  Step one

  - The number of active staff users was multiplied by the FTE hours per staff member (1,950; NHS Digital, 2020), to determine the total FTE hours of the staff population using Sleepio.

  Step two

  - To determine the number of FTE hours attributed to absence due to sickness, the total FTE hours were multiplied by the sickness absence rate of 4% (NHS Digital, 2020). The sickness absence rate was calculated by dividing the number of FTE sick days (18,473,918; NHS Digital, 2021) by the total number of FTE days available (432,061,365; NHS Digital, 2021).

  Step three

  - The number of FTE hours dedicated to sickness was then multiplied by 27%, which is the percentage of FTE days allocated to mental health issues (NHS Digital, 2021).
  - The number of allocated mental health days was then multiplied by proportion of the population suffering from insomnia (31%; NICE, 2021).
- The calculation was then multiplied by the reduction in staff absenteeism (21%; Oxford AHSN, 2020).
- Finally, the products were multiplied by the hourly cost of a band 4 nurse to estimate the potential non-cash releasing benefits to the healthcare system (£33.00; Curtis & Burns, 2020, p. 108).
- The third benefit stream has been illustrated in Figure 4.

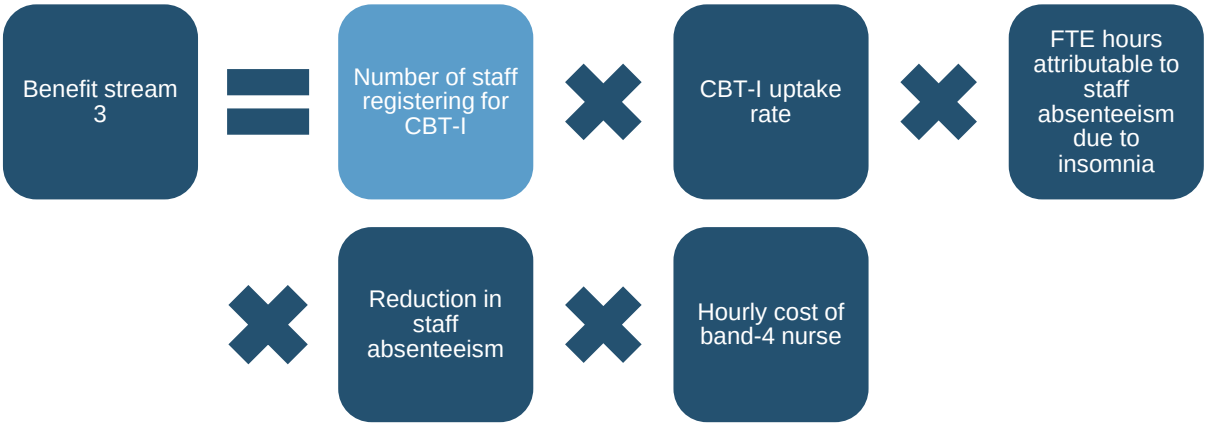


Figure 4: Benefit stream 3 – reduction in staff absenteeism. Figures in dark blue are kept consistent across AHSNs. Figures in light blue vary between AHSNs.

Benefit stream 3 assumptions

- Assumed the calculated patient Sleepio uptake rate, and insomnia recovery rate of 42.4% and 56.0%, respectively, would be representative of a staff cohort (Oxford AHSN, 2020).
- Assumed the calculated staff Sleepio uptake rate, and insomnia recovery rate of 42.4% and 56.0%, respectively, was the same across KSS, Oxford, and Wessex cohorts (Oxford AHSN, 2020).
- Assumed that FTE hours per staff member was 37.5 hours a week, equating to 1,950 hours per year on the assumption that staff members worked the full 52 weeks within a year (NHS Digital, 2020).
- Assumed an annual sick absence rate of 4% applied to all staff using the platform.
- Assumed that the reduction in absenteeism is representative of a staff cohort and was 21% across all AHSNs (Oxford AHSN, 2020).
- Assumed staff members benefitting from Sleepio were band 4 hospital-based nurses. The hourly cost of these nurses was assumed to be £33.00 (Curtis & Burns, 2020, p. 108).
- Assumed that staff only suffering from insomnia access the platform.
- Assumed that staff participated in one Sleepio course per year.

Benefit stream 4 – staff prescription savings

Studies suggests that since the use of CBT-I, patients are less reliant on prescription medications and over the counter sleep aids (Oxford AHSN, 2021). Potential workforce prescription savings were calculated through:

- The number of staff registered for CBT-I was multiplied by a CBT-I uptake rate (as in benefit stream 2) to determine the number of staff actively using Sleepio for CBT-I.
- The number of staff actively using Sleepio for CBT-I was then multiplied by the reduction in prescription medication usage (56%; Oxford AHSN, 2020).
- Finally, the product was multiplied by the cost of prescription medication (£1.13) to estimate the potential cash-releasing benefits (NICE, 2021). The fourth benefit stream has been illustrated in Figure 5.

Figure 5: Benefit stream 4 – staff prescription savings. Figures in dark blue are kept consistent across AHSNs. Figures in light blue vary between AHSNs.

Benefit stream 4 assumptions

- Assumed the calculated patient Sleepio uptake rate, and insomnia recovery rate of 42.4% and 56.0%, respectively, would be representative of a staff cohort (Oxford AHSN, 2020).
- Assumed the calculated staff Sleepio uptake rate, and insomnia recovery rate of 42.4% and 56.0%, respectively, was the same across KSS, Oxford, and Wessex cohorts (Oxford AHSN, 2020).
- Assumed a 56% reduction in the usage of prescription medication and over the counter medication was the same across all AHSNs and that findings applied to staff cohorts (Oxford AHSN, 2020).
- Assumed 7.5mg Zopiclone is prescribed, in a 28-unit pack per patient per year, to treat insomnia (NICE, 2021).

Wider healthcare benefits

Benefit stream 5 – increased QALY gains for patients

Similarly, to the increased QALY gains for staff members, the increased QALY gains for patients can be calculated as follows:

- The number of patients registering for CBT-I (5,500 in KSS, 6,500 in Oxford, and 739 in Wessex) was multiplied by a CBT-I uptake rate (42.40%) to determine the number of patients actively using Sleepio (calculated as in benefit stream 1).
- The calculation was further multiplied by an insomnia recovery rate (56%; Oxford AHSN, 2020).
- The number of recovered patients was then multiplied by the average QALY gain per person using CBT-I (0.057; Hollinghurst, et al., 2014).
- Finally, this was then multiplied by the value of a QALY (£20,000; NICE, 2013).
- The fifth benefit stream has been illustrated in Figure 6.

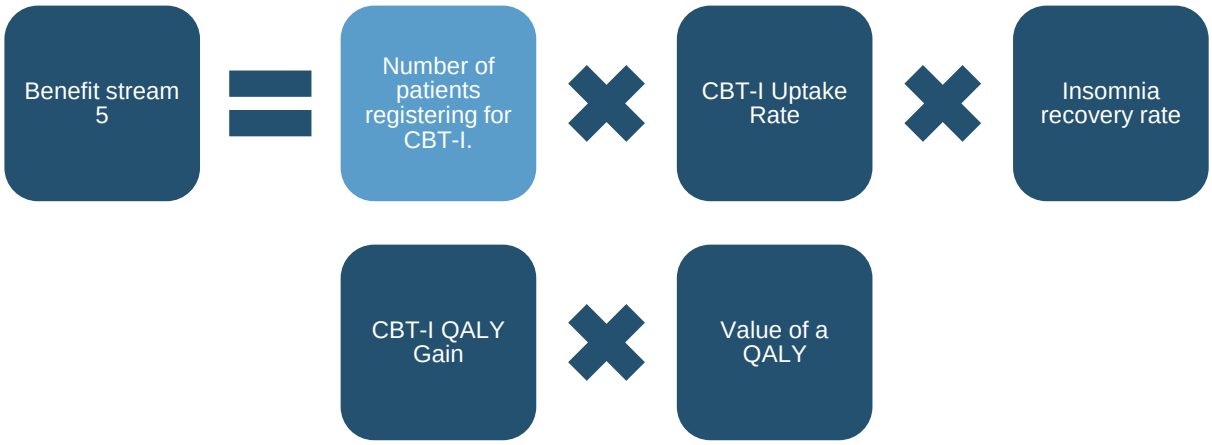


Figure 6: Benefit stream 5 – increased QALY gains for patients. Figures in dark blue are kept consistent across AHSNs. Figures in light blue vary between AHSNs.

Benefit stream 5 assumptions

- Assumed the calculated patient Sleepio uptake rate of 42.4% was the same across KSS, Oxford, and Wessex cohorts.

- Assumed that the insomnia recovery rate of 56%, recorded by Oxford, was equal across all three AHSNs (Oxford AHSN, 2020).
- Assumed that no further treatment is required once recovered from insomnia.
- Assumed that only patients recovering from insomnia received QALY benefits.
- Assumed that QALYs gained through therapy, within a cohort of patients with depression, would be equivalent to QALYs gained within insomnia patient cohorts (Hollinghurst et al., 2018).
- Assumed 0.057 was the average QALY gain from patients attending CBT-I, through Sleepio, across KSS, Oxford, and Wessex cohorts.
- Assumed that the standard pathway included treatment from a GP and prescribed medication as advised by a GP (Hollinghurst, et al., 2014).
- Assumed that patients participated in one Sleepio course per year.
- Assumed that patients only suffering from insomnia access the platform.

Benefit stream 6 – patient prescription savings

Similarly, to workforce prescription savings, patient prescription savings can be calculated as follows:

- The number of patients registering for CBT-I (5,500 in KSS, 6,500 in Oxford, and 739 in Wessex) was multiplied by a CBT-I uptake rate (42.40%) to determine the number of patients actively using Sleepio (calculated as in benefit stream 1).
- The product was then multiplied by the reduction in prescription medication usage to determine the number of patients no longer requiring prescription medication (56%; Oxford AHSN, 2020).
- Finally, the calculation was multiplied by the cost of prescription medication (£1.13; NICE, 2021).
- The sixth benefit stream has been illustrated in Figure 7.

Figure 7: Benefit stream 6 – patient prescription savings. Figures in dark blue are kept consistent across AHSNs. Figures in light blue vary between AHSNs.

Benefit stream 6 assumptions

- Assumed that the calculated patient Sleepio uptake rate of 42.4% was the same across KSS, Oxford, and Wessex cohorts.
- Assumed a 56% reduction in the usage of patient prescription medication and over the counter medication was the same across all AHSNs (Oxford AHSN, 2020).
- Assumed 7.5mg Zopiclone is prescribed, in a 28-unit pack per patient per year, to treat insomnia (NICE, 2021).

Cost calculations

As previously noted, a 15% optimism bias has been applied unilaterally to all modelled costs. For example, cost stream x (1+0.15). To avoid repetition, this element has not been added in the cost descriptions below.

Cost 1 – clinician solution costs

The total solution cost for staff is calculated as follows:

- The number of staff registering for CBT-I was multiplied by the annual licence fee (£70.00 per patient; as quoted by Big Health).

Cost stream 1 assumptions

- Assumed consistent platform charges of £70.00 per user for the period April 2020 to April 2021.
- Assumed the usage cost for NHS staff members using the platform for April 2020 to April 2021 was the same as the patient usage cost (£70.00 per patient; as quoted by Big Health).
- Assumed that the NHS staff usage cost was funded by the healthcare system.

Cost 2 – patient solution costs

The total solution cost for patients is calculated as follows:

- The number of patients was multiplied by the annual platform fee (£70.00 per patient; as quoted by Big Health).

Cost stream 2 assumptions

- Assumed consistent platform charges of £70.00 per user for the period April 2020 to April 2021.

3. Findings

This section of the report will detail the high-level analysis findings for Sleepio across the three AHSNs. Findings include:

- Net benefits
- Gross benefits
- Costs
- Respective units per benefit stream

After applying an OB, implementation of Sleepio across the AHSNs resulted in an approximate net benefit of £2.5m and an average indicative benefit cost ratio (indicative BCR) of 2.97. These findings suggest that for every £1 spent, there is an indicative return of £2.97 across the AHSNs. The outcomes of each AHSN implementing the Sleepio programme have been detailed in Figure 8 and Appendix A Table 2, Table 3 and Table 4.

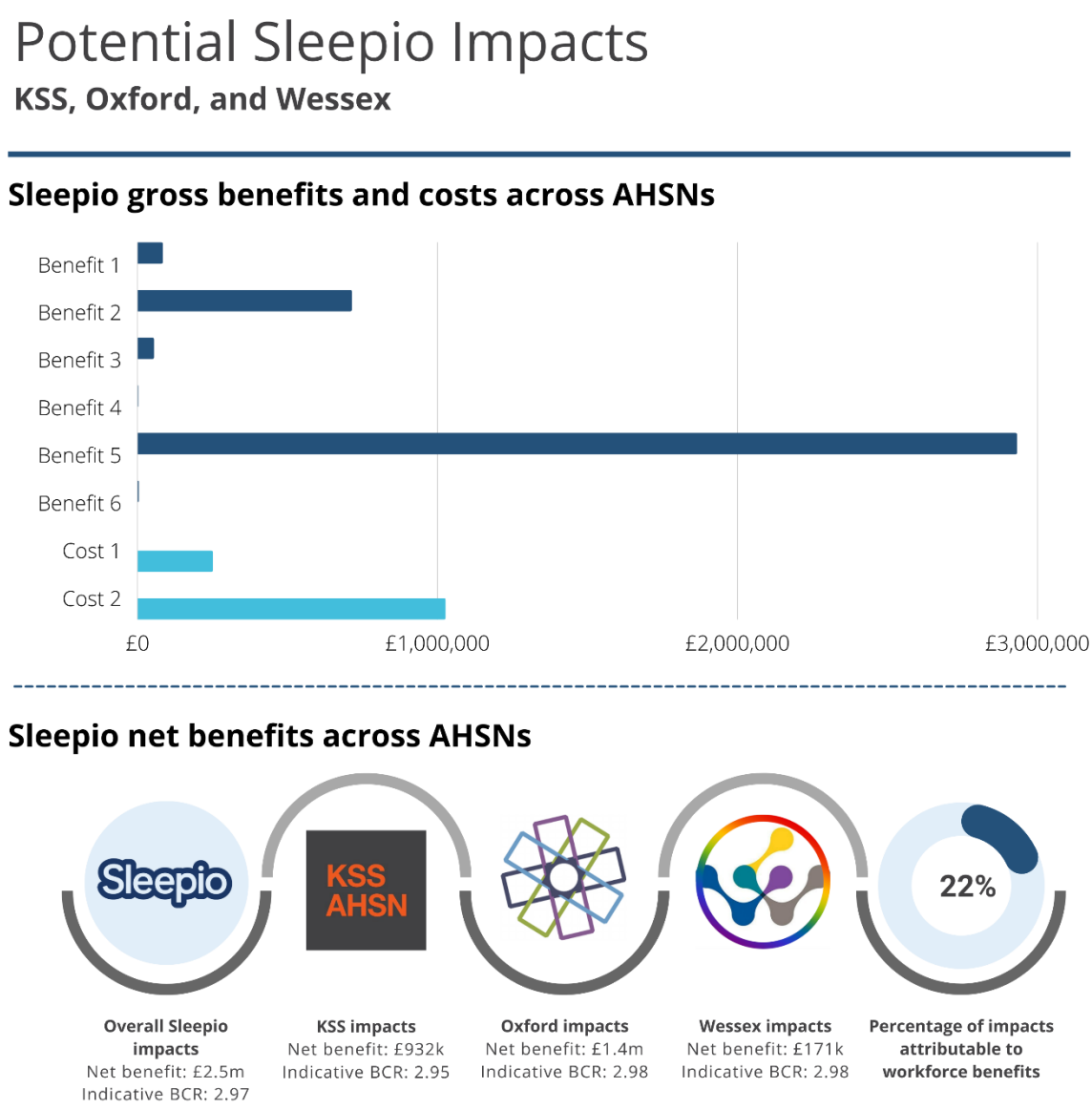


Figure 8: Sleepio outcomes for KSS, Oxford, and Wessex (April 2020 to April 2021). The figures are inclusive of the 15% OB.

Six benefit streams were considered across the Sleepio programme, of these, four were workforce related benefits

- Reduction in clinical time needed to perform CBT-I
- Increased QALY gains for staff
- Reduction in staff absenteeism
- Staff prescription savings.

Two benefit streams were considered wider system benefits for the purposes of model:

- Increased QALY gains for patients
- Patient prescription savings

Across the AHSNs, the gross benefits in descending order as a percentage of the total gross benefits are benefit 5 – increased QALY gains for patients (77%, potential gross benefits of £1.3m, £1.5m and £170k for KSS, Oxford and Wessex, respectively), benefit 2 – increased QALY gains for staff (19%, potential gross benefits of £99k, £538k and £76k for KSS, Oxford and Wessex, respectively), benefit 1 – reduction in clinical time needed to perform CBT-I (2%, potential gross benefits of £36k, £42k and £5k for KSS, Oxford and Wessex, respectively), benefit 3 – reduction in staff absenteeism (1%, potential gross benefits of £7k, £40k and £6k for KSS, Oxford and Wessex, respectively), benefit 6 – patient prescription savings (0.08%, potential gross benefits of £1k for both KSS and Oxford and £169 for Wessex) and benefit 4 – staff prescription savings (0.02%, potential gross benefits of £98, £534 and £75 for KSS, Oxford and Wessex, respectively). The unit savings per benefit stream have been detailed in Table 1.

Table 1: Gross benefits expressed in respective units per AHSN for the year April 2020 to April 2021

<table>
<tr><th>Benefit stream</th><th>Monetary value</th><th>Unit value</th></tr>
<tr><td rowspan="6">Benefit 1- reduction in clinical time needed to perform CBT-I</td><td colspan="2">KSS</td></tr>
<tr><td>£36k</td><td>Approximately 310 hours of clinical time released.</td></tr>
<tr><td colspan="2">Oxford</td></tr>
<tr><td>£42k</td><td>Approximately 367 hours of clinical time released.</td></tr>
<tr><td colspan="2">Wessex</td></tr>
<tr><td>£5k</td><td>Approximately 42 hours of clinical time released.</td></tr>
<tr><td rowspan="5">Benefit 2 - increased QALY gains for staff</td><td>KSS</td><td rowspan="5">Approximately 0.057 QALYs per NHS staff member recovering from insomnia between April 2020 to April 2021.</td></tr>
<tr><td>£99k</td></tr>
<tr><td>Oxford</td></tr>
<tr><td>£538k</td></tr>
<tr><td>Wessex</td></tr>
<tr><td rowspan="4">Benefit 3 - reduction in staff absenteeism</td><td>£76k</td></tr>
<tr><td colspan="2">KSS</td></tr>
<tr><td>£7k</td><td>Approximately 225 hours of reduced hours lost from absenteeism.</td></tr>
<tr><td colspan="2">Oxford</td></tr>
<tr><td>£40k</td><td>Approximately 1,222 hours of reduced hours lost from absenteeism.</td></tr>
</table>

Benefit stream	Monetary value	Unit value
	Wessex	
	£6k	Approximately **172** hours of reduced hours lost from absenteeism.
Benefit 4 - staff prescription savings	KSS	
	£98	Approximately **87** fewer short-term[3] insomnia medications prescribed.
	Oxford	
	£534	Approximately **473** fewer short-term insomnia medications prescribed.
	Wessex	
	£75	Approximately **66** fewer short-term insomnia medications prescribed.
Benefit 5 – increased QALY gains for patients	KSS	Approximately **0.057** QALYs per patient recovering from insomnia between April 2020 to April 2021.
	£1.3m	
	Oxford	
	£1.5m	
	Wessex	
	£170k	

[3] Short term insomnia refers to managing the condition through a short course of Z-drug prescriptions.

Benefit stream	Monetary value	Unit value
Benefit 6 - patient prescription savings	KSS	
	£1k	Approximately **1,110** fewer short-term insomnia medications prescribed.
	Oxford	
	£1k	Approximately **1,312** fewer short-term insomnia medications prescribed.
	Wessex	
	£169	Approximately **150** fewer short-term insomnia medications prescribed.

When monetising the possible net benefits of Sleepio, it is important to consider the costs of the programme to the healthcare system. Two cost streams were considered across the Sleepio programme:

- Solution usage costs per annum (staff)
- Solution usage costs per annum (patients)

Across the AHSNs, the costs in descending order, as a percentage of total costs are cost 2 – solution usage costs (patient) per annum (80%, potential costs of £443k, £523k and £59k for KSS, Oxford and Wessex, respectively) and cost 1 – solution usage costs (clinician) per annum (20%, potential costs of £35k, £188k and £27k for KSS, Oxford and Wessex, respectively).

3.1. Difference in AHSN outcomes

The potential net benefits, after OB, for the solution could approximate £932k (indicative BCR=2.95), £1.4m (indicative BCR=2.98) and £171k (indicative BCR=2.98) for KSS, Oxford, and Wessex, respectively. The net benefit per Sleepio user to the healthcare system is £18 per staff member and £7 per patient across each of the AHSN's.

The per user benefits are consistent across AHSNs. Due to a lack of data, the same data source and assumptions were used across the regions. The difference in final impact is due

to the volume of patients (5,500 in KSS, 6,500 in Oxford and 739 in Wessex) and staff members (430 in KSS, 2,340 in Oxford and 330 in Wessex) accessing the platform. The reasons for the differences in user engagement and the user profile (staff: patient) across the AHSNs are unknown and could be due to local need for the service, demographic differences, clinical buy-in or a change in system pressures due to COVID-19 etc.

3.2. Unmodelled benefits

As the high-level impact analysis sought to identify the potential workforce benefits and costs that could be monetised, other benefits could not be accounted for within this analysis due to lack of data or the qualitative nature of these benefits. The potential unmodelled benefits Figure 9 are wide ranging and will be beneficial in different ways depending on the outcome (NHS cash releasing, NHS non-cash releasing, and social benefits).

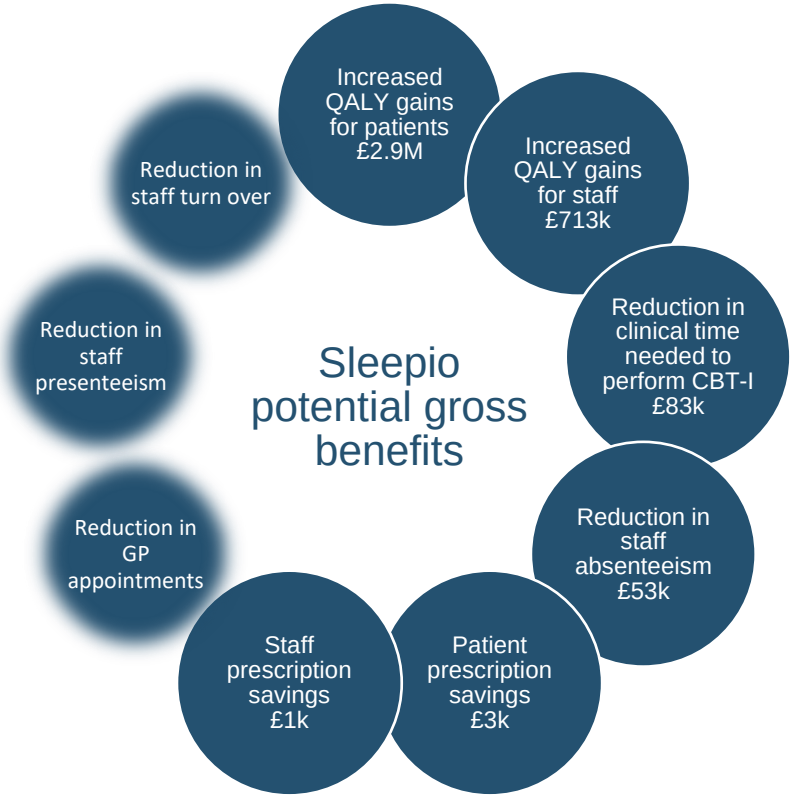


Figure 9. Potential gross modelled benefits vs. potential unmodelled benefits of Sleepio across KSS, Oxford, and Wessex (April 2020 to April 2021). The solid circles represent the analysed benefits (£ values given). Potential unmodelled benefits (circles with softer edges) have been indicated but no monetary value has been calculated.

4. Caveats

4.1. General model limitations

All figures produced are not based on real-world outcomes (i.e., they rely on literature and collected metrics). Without patient level data mapping their experience, the true effect of Sleepio cannot be known and represented appropriately. Additionally, the majority of model assumptions are drawn from Oxford sources (i.e., are based on a specific AHSN where reginal variability may occur for outcomes within other regions).

Economic analysis is not an exact science, and the outputs should be seen as a guide to decision-making, not as a substitute for experienced local knowledge. There will always be a need for assumptions or reliance on secondary data, which limits the ability to generalise and draw broad policy lessons from an individual project or programme review. As such, all outputs from the model are subjected to a range of risk and sensitivity tests, to understand more about the degree of confidence with which the outputs from the model should be treated.

4.2. Understanding the patient pathway

The inability to model outcomes according to individual patient co-morbidities, due to data depth and increased complexity, represented a limitation to this analysis. Co-morbidities will affect treatment costs, patient quality of life, insomnia recovery, and Sleepio uptake rate. For example, studies have shown that the use of prescription sleeping aids is likely to be reduced after CBT-I; however, a patient's reliance on sleeping tablets varies from person to person, making it difficult to accurately represent the cost reduction (Drake, et al., 2019). Additionally, depression and anxiety are co-morbidities of insomnia and can exacerbate clinical trajectories and outcomes, making causal claims impossible (Guest, 2020).

Due to the range of the possible patient pathways post-therapy, it was assumed that once a patient has received Sleepio therapy, no additional therapy or treatment costs are required. Whilst high-intensity therapies, such as high-intensity CBT, consist of therapy sessions over a set amount of time, mental health problems may reoccur or worsen if a patient is not given proper support.

4.3. Access to CBT-I treatment

Access to in-person CBT-I can be limited depending on various circumstances such as geographical orientation, therapist availability and the cost of treatment. A study has shown that there is only one CBT trained psychologist for every 1,000 patients living with insomnia in the UK (Oxford AHSN, 2020). However, it is difficult to understand what proportion of CBT-I need is achieved through this ratio. Within the analysis, to determine the time released to further care since the use of Sleepio, a treatment pathway rate of patients in the UK receiving CBT-I as a first line of treatment for insomnia was required. Since this remains unknown, the above percentage (7.1%) of patients seeking treatment from a psychologist, was used as a proxy (Stinson, Tang, & Harvey, 2006).

4.4. Prescription and treatment costs

Where specific data on the impact of CBT-I was not available, data on the impact of CBT for cohorts with depression, anxiety, and obsessive-compulsive disorder, was assumed to be representative of a patient cohort with insomnia (NHS Digital, 2021; Curtis & Burns, 2020; Cheng, et al., 2018). For example, QALY gains through therapy treatment, average prescription costs, the number of and cost of therapy sessions required to treat the mental health condition (NHS Digital, 2021; Curtis & Burns, 2020). As insomnia is a different patient cohort, these figures may not be representative of the real-world costs incurred in treating this patient cohort.

Patients may be accessing a combination of treatments for insomnia. For example, patients accessing Sleepio may still be using prescriptions, or patients may be accessing Sleepio in addition to attending face-to-face therapy sessions. In some cases, patients may even be referred to a sleep clinic or neurology if further sleep disorders are suspected (NICE, 2021). The evaluators tried to account for possible pathway variation by attempting to understand the possible reduced need for in-person CBT-I session when similar interventions are taken up by a patient cohort with obsessive-compulsive disorder (Curtis & Burns, 2020, p. 112).

4.5. Staff absenteeism

The reduction in absenteeism quoted in the Oxford study refers to a patient cohort. Within the analysis, it was assumed that this too applies to staff members. Furthermore, the reduction in staff absenteeism was calculated on the assumption that the staff benefitting from using Sleepio were band 4 hospital-based nurses. A lower banding was assumed in order to remain prudent (i.e., staff absenteeism benefits may be understated within this model).

4.6. Sleepio solution costs

According to the UK governments Digital Marketplace a Sleepio license costs £70 per year (GOV.UK Digital Market Place, 2020). NICE reports that the solution cost is £200 per user per year; however, pricing models for the NHS may include discounts and may vary depending on the number of users (NICE, 2017). For the purposes of this analysis, it was assumed that the solution cost per user for both NHS staff and patients was £70 per year as quoted by Big Health. This licence cost included any relevant implementation fees.

4.7. In-year analysis

Within this analysis, the base year and first year are the same, therefore, certain economic factors could not be included within the analysis. For example, no discounting was applied. As this evaluation entailed an in-year analysis, benefits have been explored retrospectively and typical economic measures could not be obtained. Instead, the net benefit and the indicative BCR were used as a proxy for a Net Present Value (NPV) and Benefit Cost Ratio (BCR).

Although the in-year analysis assesses population and uptake figures within the year the data were collected; a definitive impact cannot be calculated as patient outcomes and pathways were not recorded. While these elements also apply to a cost-benefit analysis (CBA, which estimates future economic impacts), a CBA is considered more economically robust than the in-year analysis as the CBA assesses forecasted economic outcomes over a more prudent five-year period rather than the one-year period.

As this is an April 2020 to April 2021 in-year analysis, the health economic findings cannot be compared against other sites in future years. To compare NPVs and BCRs for different sites in future years a CBA would be the more robust and prudent analysis to utilise. The in-year analysis should only be used as an internal illustrative point of estimated past Sleepio impacts.

External quality assurance of the high-level impact analysis has been carried out by Richard Heys, an experienced economist who is content that the modelling undertaken is accurate and that optimism bias has been appropriately applied. An internal quality assurance process verified modelling assumptions in terms of reviewing model sources.

5. Recommendations

If future evaluations on Sleepio are to be undertaken, consensus should be reached on how metrics are recorded across the AHSNs (e.g., insomnia recovery rate). By considering the key information and metrics needed to quantify potential workforce benefits, data collection frameworks could be created and implemented, enabling appropriate comparative data sources, rather than the use of anecdotal evidence. Additionally, data collected consistently, across comparator sites (AHSNs where Sleepio has not been implemented), over a longer period could provide insight into potential seasonal variation and imbedding periods. Recording metrics associated with benefits within the Local Impact Tool could aid in further evidencing Sleepio's impact on the workforce as well as the wider healthcare system (Appendix B). Utilising a health economic model such as a CBA, which assesses economic outcomes over a forecasted period of five years, utilises economic metrics such as an NPV and a BCR to inform solution performance and health economic factors (such as inflation[4], deflation, discounting etc.) and could provide further robust findings on the Sleepio programme. Further pragmatism could be added by including benefit and cost specific OB, sensitivity[5] and scenario analysis[6]. Additionally, a sensitivity analysis could infer which factors are most influencing modelled outcomes and could provide further insights on the difference in outcomes across AHSNs. For example, further understanding how assessments submitted and training of different professional groups affect outcomes.

Although focus has been placed on metrics and data that can be converted into a monetary benefit, the collection of qualitative data is important in reporting the potential benefits of Sleepio to the workforce and patients. Surveys and feedback providing insight on the impacts felt by the staff using the solution may allow for further metrics to be uncovered. Unmodelled benefits, such as the impact of improved sleep on patients suffering with anxiety and depression, the possible reduction in GP appointments, and the possible reduction in staff presenteeism, turnover etc. have not been included within this analysis. Insomnia is often a comorbidity of anxiety and depression; therefore, improved sleep may positively impact patients suffering with these mental health issues (Mason & Harvey, 2014). Surveys on the impacts of Sleepio for patients with anxiety or depression may provide further insights on the benefits of Sleepio. Limitations to surveys should be considered, such as the sample size and geographic orientation of the population.

[4] Adjusting for inflation removes the general effects of inflation, and presents costs and benefits included within the appraisal in 'real' base year prices rather than in nominal prices. Nominal prices reflect current monetary value (i.e., do not account for inflation).

[5] A modelling technique that assesses the extent to which each input is contributing to output uncertainty.

[6] Scenario analysis is a form of 'what if' analysis and is considered useful where there are future uncertainties within the implementation of solutions or programmes.

6. Conclusion

Within this evaluation paradigm, key monetisable benefit streams of Sleepio can be divided into those impacting the workforce and those impacting the wider healthcare system. Workforce benefits associated with staff utilising Sleepio could include a reduction in clinical time needed to perform CBT-I, increased QALY gains for staff, a reduction in staff absenteeism and prescription savings. Wider healthcare system benefits include patient QALY gains and the reduction in prescription sleeping aid medication for patients.

Considering the limitations to the collected metrics and analyses, this report and methodology provide an initial approach in estimating monetary outcomes. Key recommendations included agreement between AHSNs on metrics needed to monetise and further evidence key benefits of the Sleepio platform and the inclusion of qualitative reporting to document the impacts felt by the workforce. Further analysis would be required to understand the variability of savings across different geographic regions of the UK.

Overall, Sleepio may result in a benefit for the NHS and could assist a strained workforce by addressing the insomnia treatment gap, enable patients to access treatment and assist in the workforce recovering following the effects of the pandemic.

Appendices

Appendix A - Results

KSS

Table 2: Potential outcomes within the current Sleepio population within KSS for April 2020 to April 2021. Indicative BCR= Indicative benefit cost ratio.

Benefits	Total
Workforce benefits	
Reduction in clinical time needed to perform CBT	£35,877
Increased QALY gains for staff	£98,925
Reduction in staff absenteeism	£7,411
Staff prescription savings	£98
Other benefits	
Increased QALY gains for patients	£1,265,315
Patient prescription savings	£1,254
Total benefits	**£1,408,880**
Costs	
Solution usage costs (clinician) per annum	£34,615
Solution usage costs (patients) per annum	£442,750
Total costs	**£477,365**
Net benefit	**£931,515**
Net benefit to the healthcare system per staff member	**£167**
Net benefit to the healthcare system per patient	**£156**
Indicative BCR	**2.95**

Oxford

Table 3: Potential outcomes within the current Sleepio population within Oxford for April 2020 to April 2021. Indicative BCR= Indicative benefit cost ratio.

Benefits	Total
Workforce benefits	
Reduction in clinical time needed to perform CBT	£42,401
Increased QALY gains for staff	£538,334
Reduction in staff absenteeism	£40,329
Staff prescription savings	£534
Other benefits	
Increased QALY gains for patients	£1,495,372
Patient prescription savings	£1,482
Total Benefits	**£2,118,452**
Costs	
Solution usage costs (clinician) per annum	£188,370
Solution usage costs (patients) per annum	£523,250
Total Costs	**£711,620**
Net benefit	**£1,406,832**
Net benefit to the healthcare system per staff member	**£167**
Net benefit to the healthcare system per patient	**£156**
Indicative BCR	**2.98**

Wessex

Table 4: Potential outcomes within the current Sleepio population within Wessex for April 2020 to April 2021. Indicative BCR= Indicative benefit cost ratio.

Benefits	Total
Workforce benefits	
Reduction in clinical time needed to perform CBT	£4,821
Increased QALY gains for staff	£75,919
Reduction in staff absenteeism	£5,687
Staff prescription savings	£75
Other benefits	
Increased QALY gains for patients	£170,012
Patient prescription savings	£169
Total Benefits	**£256,683**
Costs	
Solution usage costs (clinician) per annum	£26,565
Solution usage costs (patients) per annum	£59,490
Total Costs	**£86,055**
Net benefit	**£170,628**
Net benefit to the healthcare system per staff member	**£167**
Net benefit to the healthcare system per patient	**£156**
Indicative BCR	**2.98**

KSS, Oxford, and Wessex

Table 5: Potential outcomes within the current Sleepio population across KSS, Oxford and Wessex for April 2020 to April 2021. Indicative BCR= Indicative benefit cost ratio.

Benefits	Total
Workforce benefits	
Reduction in clinical time needed to perform CBT	£83,099
Increased QALY gains for staff	£713,178
Reduction in staff absenteeism	£53,427
Staff prescription savings	£707
Other benefits	
Increased QALY gains for patients	£2,930,699
Patient prescription savings	£2,905
Total Benefits	**£3,784,015**
Costs	
Solution usage costs (clinician) per annum	£249,550
Solution usage costs (patients) per annum	£1,025,490
Total Costs	**£1,275,040**
Net benefit	**£2,508,975**
Net benefit to the healthcare system per staff member	**£167**
Net benefit to the healthcare system per patient	**£156**
Indicative BCR	**2.97**

Appendix B – Local Impact Tool

The Local Impact Tool summarises the potential impacts of various initiatives on the wider healthcare system. These initiatives have been implemented across AHSNs.

To fully understand the spread and impact of these local initiatives, the benefit streams associated with each initiative and the cumulative change in the metric measured since April 2020 is reported. To document their impact on the healthcare system, it would be beneficial to monetise these benefits. This paper serves as a good example of how benefits for an initiative can be monetised using high-level estimation to further evidence initiative impacts.

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