Unity Insights

Bleepa

Final evaluation report

September 2023

Contents

Executive summary

Context

Paper-based patient referrals can result in delays due to additional administrative burden and the time taken to communicate with other staff members to receive further information.

Bleepa is an application that allows clinical staff members to communicate, share, and review relevant patient information and complete inpatient referrals. A review of Bleepa was conducted in the Respiratory specialty at Royal Oldham Hospital (ROH), which identified that the clinical response time was 0.4 days when using Bleepa (based on referral to first response message) and 2.1 days without using Bleepa (Beattie, 2020).

Unity Insights was commissioned by Feedback Medical to conduct a real-world evaluation using quantitative data from ROH and Fairfield General Hospital (FGH). Here, the impact of Bleepa at a hospital, trust, and integrated care board (ICB) level was examined.

Key results

Overall, 3.8 staff members were involved on average per referral, who each are expected to save on 4.4 minutes on average per referral.

The median overall duration from submission of a referral to completion of a referral was 1.95 days.

Beattie (2020) identified previously; respiratory referrals took 2.1 days for a staff member to respond to. Since using Bleepa this has reduced to 0.28 days on average. The overall median response time for a referral at NCA across all specialties while using Bleepa was 0.55 days to complete.

This suggests that patients may receive treatment faster, which could yield a reduction in their length of stay.

Bleepa yielded a positive benefit-cost ratio (BCR), net benefit, and net present value (NPV). Three benefit streams were modelled:

- Time saved due to submitting a referral using Bleepa compared to previous referral methods.
- Time saved due to efficient messaging using Bleepa compared to previous referral methods.
- Reduced patient length of stay using Bleepa compared to previous referral methods.

This was apparent across retrospective analysis of Northern Care Alliance NHS Foundation Trust (NCA) when storing data on the premises (net benefit = £359k; BCR = 2.7), and across prospective analysis of NCA (NPV = £819k; BCR = 2.5) and NHS Greater Manchester ICB (NPV = £7.7m; BCR = 2.8).

Further, a positive BCR and NPV was identified when storing data on the Cloud in NCA (NPV = £135k; BCR = 1.1) and NHS Greater Manchester ICB (NPV = £5.7m; BCR = 1.9).

This suggested that **Bleepa could provide NHS non-cash releasing benefits to the system from a trust and ICB perspective**.

Surveys highlighted that **76% of staff identified time savings through using Bleepa**, which was consistent with the quantitative findings.

The "*accept"* and "*release"* features of Bleepa had **variations in use** across specialties and staff members. Some staff submitted referrals at the weekend to manage their caseload, whilst others waited until Monday when specialty staff were available to review the referral.

Staff members were satisfied with the use of Bleepa; **88% of staff noted Bleepa was easy to use** and **80% identified an improvement in staff communication** when using Bleepa compared to previous referral methods.

Approximately 32% of referrals could be handled without having to see the patient, suggesting that Bleepa could successfully handle at least 32% of patient referrals remotely.

Limitations

Baseline comparator data: Previous literature and survey responses was utilised as a baseline as the time taken to complete referrals was unable to be measured throughout the evaluation.

Specialty-specific feedback: Surveys could not gain insight into the specialties examined in the current evaluation due to a small sample size.

Unavailable metrics: Some metrics could not be collected from quantitative Bleepa referral data, such as staff job role or the destination specialty of the referral. A high optimism bias correction was applied within health economic modelling due to this uncertainty in data.

Recommendations

- Have a suitable baseline comparator to allow for more accurate comparison of data
- Calibrate staff use of Bleepa to ensure optimal usage
- Further develop the usability of Bleepa to enhance staff satisfaction
- Collect more metrics within Bleepa quantitative referral data, such as linking staff IDs to their hospital and specialty, and including the origin hospital and specialty of the patient referral to further the depth of analysis available

Conclusion

Overall, use of **Bleepa can lead to benefits for staff, patients, and the wider system**. Feedback Medical could work with hospitals to calibrate Bleepa usage within specialties to optimise how staff interact with the system between specialties and sites, which may lead to greater efficiencies. Once established, staff communication and satisfaction could improve. Inpatients may also have a shorter length of stay due to Bleepa. Further, NHS non-cash releasing savings for the trust or ICB could be identified through use of Bleepa.

1. Introduction

1.1. Context and background

There are significant pressures and demands on the health and social care workforce due to cumulative years of inadequate planning and under-resourcing (British Medical Association, 2022). This has been largely affected by the COVID-19 pandemic. The effects of the contributing factors severely impacted staff and patients, particularly within secondary care settings (Deakin, 2022).

Patients admitted to secondary care have a multifaceted experience, and an essential element of an inpatient stay is inter-specialty referrals (Shephard et al., 2018). Typically, referral teams in secondary care settings used multiple methods for inter-specialty referrals such as telephone calls, electronic forms, and paper forms. Telephone calls can be used to refer patients; however, the specific information the caller required was not always accessible from the recipient (Cathcart et al., 2016). This miscommunication surrounding patient referrals made up 34% of delays, which was identified to increase patient length of stay by 1.6 days (Ziff et al., 2019).

Telephone discussions between the referee and responder are often not documented within the patient notes (Bleepa, 2021a). This required additional administrative staff time to complete the paper trail by collecting further information and distributing referrals to clinicians in a hard-copy version (Bleepa, 2021a). This results in referrals taking a prolonged amount of time to complete and a risk of paper-based referrals being lost (Bleepa, 2021a).

Shephard et al. (2018) noted that paper-based referrals would often be left until staff members could leave the ward, which resulted in delays in obtaining advice from staff members surrounding patient referrals. The hospital examined the use of "*white card referrals*", consisting of staff members writing the referral on small pieces of white card. Most staff members noted they expected referrals to be reviewed the next day. Staff members were also asked how long it took to complete a "*white card*" referral, to which most replied "*10-20mins*".

Ryan et al. (2011) identified a time saving of 7.7 minutes when communicating with colleagues digitally compared to using paper-based methods. Further, Warren et al. (2011) suggested that digital eReferrals took one day less than paper-based referrals when sending them from primary care to secondary care. This implied that digital methods of communication may yield benefits for staff members and the system in terms of time savings, which could be spent completing other tasks, such as managing the patient backlog.

A reduction in time taken to complete referrals could allow patients to receive treatment faster as their referral is processed earlier. Consequences of delayed referrals can include increased levels of morbidity and mortality and decreased quality of life, thus lowering patient outcomes (Levin, 2000). Previous research identified that earlier treatment can result in better patient outcomes (Lard et al., 2001; Lees et al., 2010; Scholz et al., 2018). Ryan et al. (2011) identified that using electronic handovers, rather than paper-based handovers, could reduce length of stay by one day.

Reducing length of stay could yield benefits from a system perspective due to fewer bed day costs, as well as patient benefits due to receiving treatment faster and reducing patient deterioration. Extended length of stay has been identified to be detrimental for older adults as this can increase the risk of falls, sleep deprivation, and infections (NHS England, n.d.). Finding ways to reduce patient length of stay could allow for benefits to the system and patients.

The highlighted risks, and the disorganised nature of inter-specialty referrals within secondary care presents an opportunity for pathway redesign to target these issues and provide sustainable improvements across multiple disciplines (Shephard et al., 2018). This underpins priorities in the NHS Long Term Plan for digital transformation across the NHS to improve communication for healthcare professionals and accessibility for patients (NHS Long Term Plan, 2019).

Feedback Medical aims to offer safe, secure, and simple alternatives to improve traditional ways of working within healthcare through innovation (Feedback Medical, 2022). A new solution named Bleepa was created by Feedback Medical. Bleepa is a secure intra-hospital messaging system that allows communications across disciplines, links clinical systems, and gives access to medical grade images for patient referrals (Bleepa, 2022). Discussions based on images are recorded in Bleepa against the patient's records. Bleepa aims to yield efficiency savings across inter-speciality referrals within secondary care due to remote communication between clinicians, allowing patients to receive treatment quickly.

When a patient requires treatment from a secondary care specialty, a "*referral*" is submitted to the specialty using Bleepa. A staff member within the referral specialty destination can "*accept*" the patient referral within Bleepa. If the staff member requires more information from the referral origin, they can send multiple messages to communicate with other staff members. When the patient is ready to be discharged from the specialty, a staff member can "*release*" the patient referral on Bleepa.

Unity Insights was commissioned by Feedback Medical to evaluate the impact of Bleepa within Northern Care Alliance NHS Foundation Trust in Greater Manchester at two pilot sites: Royal Oldham Hospital (ROH) and Fairfield General Hospital (FGH). This evaluation aimed to understand the impact of technology on staff dynamics and workstreams within a secondary care setting.

Royal Oldham Hospital (ROH)

Prior to implementation of Bleepa at ROH, a paper-based approach was used. Due to this approach, additional administration tasks also had to be completed, such as printing out patient referrals to send to clinicians and filing paper referrals. This increased the time taken to complete a referral. Clinicians had to telephone other clinicians to provide advice or ask for further information regarding a referral. Clinical data and images were difficult to access, which resulted in more time taken to find such information.

In December 2019, Bleepa was introduced within the Respiratory specialty at ROH to process referrals from other departments. A review was completed by Beattie (2020) to examine the impact of Bleepa and decide whether to expand the implementation to other departments and sites. The

final report assessed the benefits identified using Bleepa and highlighted that, if Bleepa was implemented across all medical teams, up to 36.3 weeks of clinical time could be released. The following key benefits were recorded:

- Bleepa removed the need for administration tasks as referrals no longer needed to be processed and printed out to send to clinicians for review.
- Clinical response time was lowered through removing the need for administration tasks; the referral was immediately available for review.
    - Here, the previous referral system took 2.1 days to review a referral, whereas Bleepa took 0.4 days from referral to first review.
- Further time savings were identified as the receiving clinical team did not have to spend time identifying the location of the patient or referrer to feedback advice, or ask for more information, as this could be completed through the application. Despite this, there was no clear break down of time taken for each element of the response process.
- Bleepa led to increased workflow as staff had access to lists of referrals and those of which that were accepted and completed, which allows referrals to be monitored and actioned efficiently.

1.2. Evidence standards framework for digital health technologies (DHTs)

The National Institute for Clinical Excellence (NICE; 2022) published the *Evidence standards framework for digital health technologies (DHTs)*. The framework was developed in collaboration with NHS England, Public Health England, and MedCity to demonstrate the standards of evidence required for DHTs to present their value in accordance with the relevant principles of the Department of Health and Social Care code of conduct for data-driven health and care technologies (Department of Health and Social Care, 2021). *A guide to good practice for digital and data-driven health technologies* (Department of Health and Social Care, 2021) includes evidence relating to the technology's effectiveness in terms of its intended use, as well as its economic impact in terms of financial risk.

It is important to note that the standards within the *Evidence standards framework for digital health technologies (DHTs;* National Institute for Clinical Excellence, 2022) are not regulations; they are guidelines, and should be considered separately. Nonetheless, the guidelines provide a valuable benchmark to compare evidence and meeting these standards will, invariably, improve the business case for the digital solution in the NHS and beyond.

National Institute for Clinical Excellence (2022) classifies DHTs by function to enable them to be stratified into evidence tiers based on the potential risk to users. Here, higher risk tiers require stronger evidence to demonstrate value and cost-effectiveness. Functional classifications are intended to provide a pragmatic approach to differentiating the main functions of the types of DHTs

expected to be most widely developed and used in the UK health and care system. The evidence tiers, and their related functional classifications, are depicted in Figure 1.

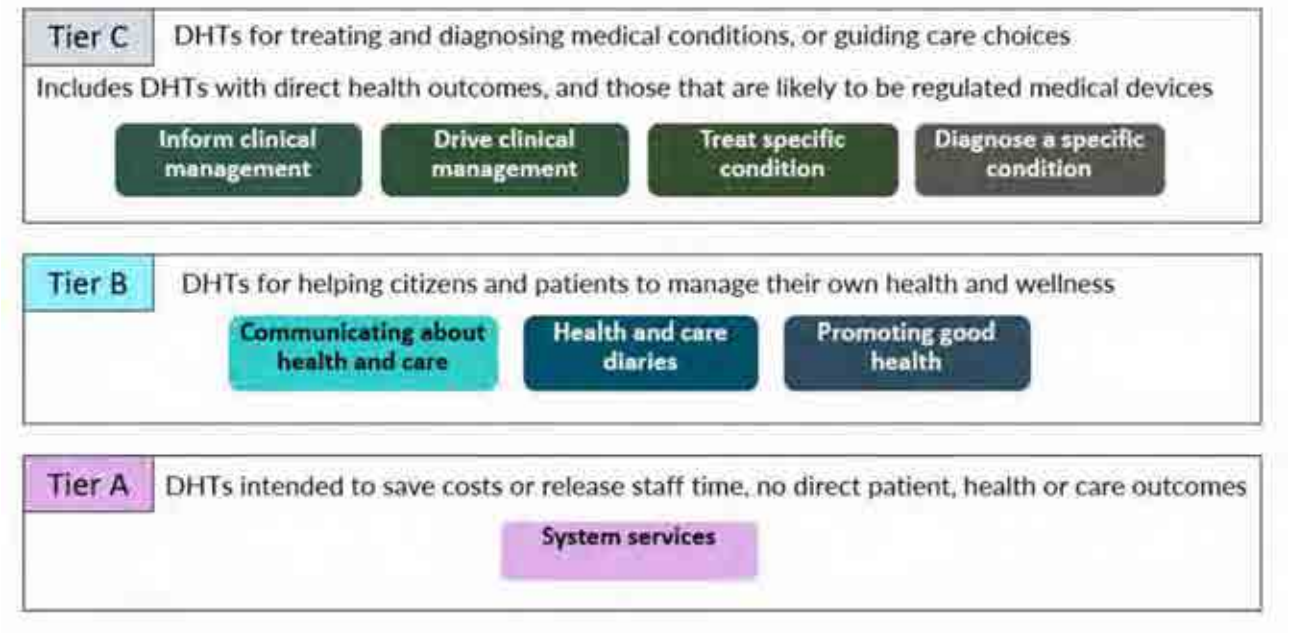


Figure 1: DHTs classified by intended purpose and stratified into risk tiers (National Institute for Clinical Excellence, 2022).

1.3. Bleepa and the *Evidence standards framework for digital health technologies*

To determine which NICE tier classification Bleepa is likely to fall under as part of the *Evidence standards framework for digital health technologies (DHTs;* National Institute for Clinical Excellence, 2022), a deduction exercise was conducted to determine where Bleepa would be best suited (Figure 1). This suggested that Bleepa was a Tier B solution; Bleepa is a system service that can release staff time due to its efficiencies (Tier A), however also allows two-way staff communication (Tier B). Bleepa does not inform or drive clinical management or diagnose or treat conditions (Tier C). This means that Bleepa is a Tier B solution.

To be classed in Tier A, Bleepa would need to be a DHT that provides system improvement for health and social care providers and have no direct user benefits. Bleepa has the potential to benefit users directly through the provision of their services, therefore it can be concluded that Bleepa does not fall under Tier A. For Bleepa to be considered a Tier C solution, it would need to be an intervention that monitors, diagnoses, or treats conditions in a patient. Bleepa is a platform that facilitates communication between clinical professionals. For this reason, Bleepa is unlikely to be categorised as a Tier C solution. Bleepa will mainly aim to improve communication through the

provision of a two-way platform and guidance information; therefore, it has been concluded that it is likely to fall under the Tier B category.

1.4. Compliance and regulations

For some health technologies in the UK, a UK Conformity Assessment (UKCA) mark may be relevant to demonstrate the technology is fit for purpose. Bleepa is a UKCA-accredited, general data protection regulations (GDPR)-compliant communications platform. Additionally, patient data is stored either on hospital servers or on the CareLocker Cloud network and not on local devices (Bleepa, 2021b). These factors minimise the security risk of using Bleepa in the transfer of sensitive patient information.

1.5. Purpose of the evaluation

The Feedback Medical team wanted to build on previous research through:

- Evidencing the impact of Bleepa in terms of time savings, cost savings, efficiency, and safety through quantitative data.
    - In the current evaluation, Beattie (2020) was used as a baseline to provide comparison alongside previous literature and qualitative insights. This allowed for the wider picture surrounding time savings and efficiency to be highlighted.
- Identify Bleepa user statistics, such as activity usage levels, and any additional measures that could be used to highlight the benefits of Bleepa.
- Obtaining qualitative insights to examine user feedback and satisfaction levels of using Bleepa.
- Aligning the above with reporting or key performance indicators (KPIs) that the trust is required to produce to strengthen the Bleepa value proposition.

The current evaluation aimed to build on the 2020 review (Beattie, 2020; Section 1.1) and strengthen the evidence base that supported the use case of Bleepa within ROH. The use of Bleepa within different specialties was examined to highlight specialty-specific benefits and barriers to implementation.

The initial purpose of the current evaluation was to undertake a real-world evaluation of the impact of Bleepa within multiple pathways (Cardiology, Gastroenterology, General Surgery, Palliative Care, and Respiratory) in ROH and within FGH Gastroenterology.

Evaluation themes

This section breaks down themes into specific elements that the evaluation aimed to explore. The evaluation themes were as follows (see 'Appendix A: Metrics' for a breakdown of metrics by evaluation theme):

- **Effectiveness:** This section sought to understand the staff time saving yielded when using Bleepa compared to the previous referral pathway.
- **Value:** The economic case of implementing Bleepa within ROH and FGH was identified. This helped obtain the economic value of Bleepa based on how it was used within each hospital and specialty to identify whether this differed for each scenario. Further, the cost of implementing Bleepa was identified to understand whether the benefits outweigh the costs, highlighted from the efficiency benefits.
- **Acceptability:** This theme sought to explore how staff members perceive Bleepa in terms of its ease of use. Further, staff satisfaction surrounding use of Bleepa was obtained and their confidence of using Bleepa assessed.
- **Implementation:** How Bleepa was integrated within the current speciality was explored in terms of the training and resources required to use Bleepa effectively within the hospital specialty.

1.6. Purpose of the current report

The final evaluation report depicts the overall evaluation findings which captures the learnings and findings from the current evaluation. Assumptions and limitations were discussed alongside key recommendations to provide further insight into Bleepa.

2. Methodology

This section describes the methods used to execute the different analytical components of the evaluation, including detail on the evaluation setting, cohorts, data collection, and analysis.

2.1. Evaluation setting

Both ROH and FGH from Northern Care Alliance (NCA) NHS Foundation Trust in NHS Greater Manchester Integrated Care Board (ICB) contributed towards components of the evaluation as both sites had already implemented Bleepa into specialties with high referral numbers. Here, staff

members from both hospitals completed the survey and interview components of the evaluation (Section 2.5). Further, Bleepa referral data was obtained from both hospitals (Section 2.4).

Beattie (2020) was intended to be used as a baseline throughout, however, there were limitations with using this as a comparison, which had been previously established in the interim report (Unity Insights, 2023a). This report only used data from Respiratory within ROH (Beattie, 2020), meaning that findings were only generalisable to Respiratory within ROH. Therefore, the findings from Beattie (2020) could not be directly compared against the findings within the previous interim report, which examined multiple specialties and hospitals. In the current report, findings will be compared against each other and previous literature, where applicable.

Royal Oldham Hospital (ROH)

ROH is part of Northern Care Alliance NHS Foundation Trust within NHS Greater Manchester ICB and cares for 230,000 people and had approximately 445 inpatient beds as of 2020 (Care Quality Commission, 2020a). ROH has been using Bleepa since December 2019 and has Bleepa referral data within the following specialties:

- Gastroenterology
- Cardiology
- Respiratory
- General Surgery
- Palliative Care
- Covid Ward

This hospital was used within the current evaluation as Bleepa had already been implemented in ROH since December 2019, suggesting that there was enough quantitative usage data to create insights.

On discussion with the project team, the Covid Ward was opened in ROH during the COVID-19 pandemic but closed briefly after opening. Therefore, Bleepa referral data surrounding the Covid Ward was not included within the final report. Additionally, referral data surrounding General Surgery and Palliative Care were also removed due to insufficient data (Section 2.4). Further insight surrounding referral data collection periods can be found in Section 2.4.

Fairfield General Hospital (FGH)

FGH is part of Northern Care Alliance NHS Foundation Trust within NHS Greater Manchester ICB and cares for 820,000 people and had approximately 235 inpatient beds as of 2020 (Care Quality Commission, 2020b). FGH has been using Bleepa since May 2021 and only has Bleepa referral data within the Gastroenterology specialty. This hospital was used within the current evaluation as Bleepa had already been implemented in FGH Gastroenterology since May 2021, suggesting that there was enough quantitative usage data to create insights.

2.2. Evaluation population

The Bleepa solution operates in secondary care settings for clinicians. Most staff who used Bleepa and completed survey responses were either trainee doctors (52%) or consultants/associate specialists (40%; Section 4.1). Only referrals completed using Bleepa were included within the current evaluation; referrals with a department that were not using Bleepa were not managed through Bleepa. This means that clinicians using Bleepa would also be likely to use other referral methods in addition to Bleepa.

Overall, there were a total of 6,867 unique patient IDs from 2021 to 2023 with 26.4% (*n* = 1,810) having multiple referrals. The quantitative impact of Bleepa was analysed by hospital, specialty, role, referral messages, and different time periods to identify any patterns or differences in trends (Section 2.4). Further, the qualitative impact of Bleepa for staff members was determined in terms of ease of use, satisfaction, efficiency savings, and the features of Bleepa (Section 2.5).

Forecast modelling also focused on the impact of Bleepa on patients in terms of their length of stay in inpatient care (Section 3). Further, such modelling also examined the wider system impact of time savings.

2.3. Logic model workshop

Unity Insights conducted a logic model workshop with the support of Feedback Medical to understand the overarching benefits associated with the Bleepa solution using an online digital whiteboard tool. Attendees included staff members working at Northern Care Alliance and the Feedback Medical team. Findings were collated and summarised by Unity Insights, and then sent to stakeholders for final comments and confirmation.

The following benefits were finalised after discussions with relevant clinicians (for more information, see ‘Appendix B: Logic model workshop’):

- Patients
    - Improved care experience
    - Increased time savings
- Clinicians
    - Increased ease of referrals
    - Increased time savings

Once agreed, the benefits identified through this exercise helped focus the key evaluation themes highlighted in Section 1.5.

2.4. Quantitative insights

Patient referral data from ROH and FGH was obtained from the Bleepa platform by Feedback Medical and analysed by Unity Insights. The study period was from July 2021 to April 2023. Overall, 9,907 referrals were made between July 2021 and April 2023, with 30,690 messages being sent in total to three specialties in ROH (Gastroenterology, Cardiology, and Respiratory) and one specialty in FGH (Gastroenterology).

Within the referral data, a "*referral"* was defined as a patient being referred from another department to a specialty within secondary care. The data was presented at referral-level. A staff member within the referral specialty destination could "*accept*" the patient referral using Bleepa. When the patient was ready to be discharged from the specialty referral pathway, a staff member could "*release*" the patient referral using Bleepa. Multiple messages could also be sent between clinicians in relation to a referral, and these were included in the referral-level dataset alongside relevant information such as the timestamp and a staff user ID number. Referrals with over 30 messages did not have the breakdown of specific messages, therefore were omitted from the analysis of the current evaluation. The patient journey is shown in 'Appendix C: Referral journey example'.

For patients with multiple referrals, the time stamps of messages did not always accurately relate to a single referral. This is because messages were duplicated between referrals in the dataset[1]. For subsequent referrals, "*Message 1*" corresponded with "*Message 1*" of the first message of the first referral for that patient. Due to this duplication of messages, data cleaning was required. The first and last message of each individual referral was found, removing messages that were duplicated from other referral records.

Total clinical response time was defined as the time difference between the first (referral) message and second message of any individual referral. It was concluded that the median figure would be the best representation of response time, instead of using the mean, as this would account for outliers that may skew the data. The median response time was calculated for NCA overall, ROH, FGH, and the specific departments. Please see 'Appendix I: Quantitative insights' for further clarification.

For the purposes of the analysis, the accepted time stamp was not used to analyse clinical response times as the "*accept*" referral functionality was not used consistently across departments and users. The accepted time stamp was only analysed to understand the behavioural patterns between departments and highlight areas for further exploration. ROH General Surgery and ROH Covid Ward data was omitted from the final analysis as Bleepa was not consistently or frequently used during the study period (Table 1). ROH Palliative Care was also omitted from the analysis

[1] This duplication could be a data quality issue on data extraction or may be a deliberate design decision so clinicians could review notes on a patient from prior referrals.

due to low volumes of patients and Bleepa platform usage. Metrics from the referral data can be identified within ‘Appendix A: Metrics’.

Table 1: The number of referrals between 2021 and 2023 across excluded specialties.

Excluded specialty	Number of referrals
ROH General Surgery	47
ROH Palliative Care	160
ROH Covid Ward	3

2.5. Qualitative insights

Survey

An online survey website was used to produce the survey and collected data was analysed through thematic analysis and frequency distributions. ‘Appendix D: Staff survey questions’ depicts the questions asked within the staff member survey.

The survey was sent to 250 staff members. In total, there were 51 respondents to the survey, 3 of which selected that they do not use Bleepa at any of their sites so were excluded from the survey questions that were relevant to Bleepa use. For the respondents that selected that they used Bleepa (*n* = 48), 20 questions were presented. The survey generated qualitative data from staff populations by using multiple choice questions and free-text boxes. The survey was distributed to staff in February 2023 and the cut-off date for inclusion in the final report was 12th July 2023. Metrics can be seen in ‘Appendix A: Metrics’. The staff survey corresponded to the following evaluation themes (Section 1.5):

- Demographics
    - Sites using Bleepa
    - Staff job role
    - Staff specialty
    - Staff use of Bleepa (submitting/receiving referrals using Bleepa)
- Acceptability
    - Ease of use
    - Staff satisfaction
    - Patient care and safety

- Effectiveness
    - Efficiency savings
- Implementation
    - Imaging features
    - Clinical data
    - Bleepa on your device
    - Suggestions to improve Bleepa

Interviews

Interviewees were selected through survey respondents who stated they were willing to be interviewed, identifying four interviewees who attended the interviews. Efforts were made to recruit a larger sample of staff members using Bleepa, but challenges with engagement and availability resulted in a smaller sample (Section 7.3). Semi-structured interviews (n = 4) were held on Microsoft Teams and were recorded and transcribed ('Appendix E: Staff interview questions'). The interview responses generated were analysed using thematic analysis.

2.6. Health economic modelling

General approach

An ex-ante (forecasted) appraisal of the prospective impact of Bleepa, alongside an ex-post appraisal of the retrospective impact of Bleepa, was completed and estimated through best available evidence. The appraisal was in line with *The Green Book* (HM Treasury, 2022). The HM guidance is applied throughout the public sector to ensure consistent estimation of costs and benefits in cost-benefit appraisals. In recent years, the framework has been supplemented by several departmental or sectorial "*external supplementary guidance*" documents (HM Treasury, 2022). The methodology, including benefit and cost stream calculations, is expanded upon further in 'Appendix F: Health economic modelling methodology'.

Scenario analysis

Three distinct scenarios were modelled to comprehensively assess the effects, benefits, and costs of Bleepa across different cohorts. These scenarios aim to analyse the estimated monetisable outcomes and understand Bleepa's previous, current, and potential future impact. The three scenarios are summarised below:

- **Scenario 1:** Retrospective analysis (ex-post) of the impact of Bleepa in NCA using on prem (storing data on the premises) costing.
    - From July 2021 to March 2023 (financial year 2021/22 to 2022/23)

- **Scenario 2a:** Five-year net present value (NPV; ex-ante) impact of Bleepa in NCA when using on prem costing.
    - From April 2023 to March 2028 (financial year 2023/24 to 2027/28)
- **Scenario 2b:** Five-year NPV (ex-ante) impact of Bleepa in NCA when using Cloud-hosted (storing data online) costing.
    - From April 2023 to March 2028 (financial year 2023/24 to 2027/28)
- **Scenario 3a:** Five-year NPV of Bleepa across NHS Greater Manchester ICB when using on prem costing, in the following:
    - From April 2023 to March 2028 (financial year 2023/24 to 2027/28)
    - Manchester University NHS Foundation Trust
    - Northern Care Alliance NHS Foundation Trust (formerly Pennine Acute Hospitals NHS Trust)
    - Salford Royal NHS Foundation Trust
    - Tameside and Glossop Integrated Care NHS Foundation Trust
    - Wrightington, Wigan, and Leigh NHS Foundation Trust
- **Scenario 3b:** Five-year NPV of Bleepa across NHS Greater Manchester ICB when using Cloud-hosted costing, in the following:
    - From April 2023 to March 2028 (financial year 2023/24 to 2027/28)
    - Manchester University NHS Foundation Trust
    - Northern Care Alliance NHS Foundation Trust (formerly Pennine Acute Hospitals NHS Trust)
    - Salford Royal NHS Foundation Trust
    - Tameside and Glossop Integrated Care NHS Foundation Trust
    - Wrightington, Wigan, and Leigh NHS Foundation Trust

ROH Palliative Care and ROH General Surgery were intended to be included within the analysis, however there was insufficient data to provide a robust health economic analysis within these specialties (Section 2.4).

Optimism bias

Optimism bias (OB) is defined as "*the tendency for a project's costs and duration to be underestimated and / or benefits to be overestimated*" (MacDonald, 2002), as found by historical UK government reviews on public sector procurement. To account for such optimistic estimates, the health economic model applied OB correction factors (Figure 2) in response to the level of uncertainty in the data or assumptions used within the model.

			Data Source									
	Confidence grade		Formal service delivery contract costs Figures derived from local stats / RCT trials		Practitioner monitored costs Figures based on national analysis in		Costs developed from ready reckoners Figures based on generic national analysis		Costs from similar interventions elsewhere Figures based on international analysis		Cost from uncorroborated expert judgement	
			1		2		3		4		5	
Age of Data (publication)	< 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%

Figure 2: Optimism bias matrix.

The risk of an over-optimistic estimate is greatest when data is of low quality. This is due to the applicability of the estimate to the modelled pathway (HM Treasury, Public Service Transformation Network & New Economy, 2014). The quality of the data is defined by the relevance of the source data to the project data or age. Each data variable was graded according to its quality, and an assumption-specific OB factor was applied to the calculation at the benefit and cost stream level. This factor is decided by the lowest grade amongst the stream's data inputs.

The approach taken by Unity Insights was an adaptation of the model created by the Greater Manchester Combined Authority (GMCA) Research Team (HM Treasury, Public Service Transformation Network & New Economy, 2014). The GMCA model was featured in the supplementary guidance of *The Green Book* and offered a robust and prudent approach to economic analysis (HM Treasury, 2022).

Model-specific optimism bias correction

An additional, universal optimism bias correction of 15% was applied to all benefits and costs to ensure maximal prudence in the estimation of the impact of the intervention, as well as a GDP deflator to transform all inflation-adjusted figures in future years into current prices (present value) in line with *The Green Book* appraisals (HM Treasury, 2022).

Sensitivity analysis

A degree of uncertainty in the estimates of the model were accounted for by using sensitivity analysis. It is important to note that the sensitivity differed from optimism bias because sensitivity was applied on each individual assumption or input in the model, rather than by benefit or cost stream, in the case of optimism bias. Monte Carlo simulation was used to provide a range of estimates of the overall net benefit/NPV.

Monte Carlo analysis is a modelling technique that simulates the impact of the expected variance in key variables on the output of interest, in this case, the NPV. 'Appendix H: Sensitivity analysis methodology' contains a full description and example of the methodology used within the analysis.

Benefit streams

Benefit streams and their respective optimism biases are listed below. More information surrounding the equations and metrics used can be found in 'Appendix G: Health economic modelling scenarios and benefits and cost streams'.

Benefit stream 1: Staff time saved when submitting referrals using Bleepa

Table 2 depicts the optimism biases applied for each scenario within benefit stream 1. The optimism bias correction applied is based on the quality and relevance of assumption data used, using the matrix set out in Figure 2.

Table 2: The optimism biases applied for each scenario. Please note that scenario 2a and 2b both applied the same optimism bias and scenario 3a and 3b both applied the same optimism bias.

Scenario	Optimism bias applied
Scenario 1: Retrospective impact of Bleepa in NCA	40%
Scenario 2: Prospective impact of Bleepa in NCA	40%
Scenario 3: Prospective impact of Bleepa in NHS Greater Manchester ICB	40%

Benefit stream 2: Staff time saved due to efficient messaging using Bleepa

Table 3 depicts the optimism biases applied for each scenario within benefit stream 2.

Table 3: The optimism biases applied for each scenario. Please note that scenario 2a and 2b both applied the same optimism bias and scenario 3a and 3b both applied the same optimism bias.

Scenario	Optimism bias applied
Scenario 1: Retrospective impact of Bleepa in NCA	25%

Scenario	Optimism bias applied
Scenario 2: Prospective impact of Bleepa in NCA	25%
Scenario 3: Prospective impact of Bleepa in NHS Greater Manchester ICB	25%

Benefit stream 3: Reduced length of stay due to using Bleepa[2]

Table 4 depicts the optimism biases applied for each scenario within benefit stream 3.

Table 4: The optimism biases applied for each scenario. Please note that scenario 2a and 2b both applied the same optimism bias and scenario 3a and 3b both applied the same optimism bias.

Scenario	Optimism bias applied
Scenario 1: Retrospective impact of Bleepa in NCA	25%
Scenario 2: Prospective impact of Bleepa in NCA	25%
Scenario 3: Prospective impact of Bleepa in NHS Greater Manchester ICB	25%

Cost streams

Cost streams and their respective optimism biases are listed below. More information surrounding the equations and metrics used can be found in 'Appendix G: Health economic modelling scenarios and benefits and cost streams'.

Cost stream 1: Implementation cost of Bleepa

Table 5 depicts a breakdown of the metrics used within the cost streams.

[2] Here, it was assumed that Bleepa could lead to quicker responses to referrals, which could result in quicker treatment and shorter patient length of stay overall.

Table 5: The optimism biases applied for each scenario. Please note that scenario 2a and 2b both applied the same optimism bias and scenario 3a and 3b both applied the same optimism bias.

Scenario	Optimism bias applied
Scenario 1: Retrospective impact of Bleepa in NCA	0%
Scenario 2: Prospective impact of Bleepa in NCA	0%
Scenario 3: Prospective impact of Bleepa in NHS Greater Manchester ICB	0%

Cost stream 2: Yearly platform cost of Bleepa

Table 6 depicts a breakdown of the metrics used within the cost streams.

Table 6: The optimism biases applied for each scenario. Please note that scenario 2a and 2b both applied the same optimism bias and scenario 3a and 3b both applied the same optimism bias.

Scenario	Optimism bias applied
Scenario 1: Retrospective impact of Bleepa in NCA	0%
Scenario 2: Prospective impact of Bleepa in NCA	0%
Scenario 3: Prospective impact of Bleepa in NHS Greater Manchester ICB	0%

3. Quantitative insights

This section contains analysis of quantitative data, extracted from the Bleepa platform. The data contains pseudonymised patient and staff IDs; the referral, accepted, and released time stamps; and the time stamps of the messages that have occurred within each referral.

3.1. Frequency of referrals

Table 7 depicts the number of referrals in each financial year by specialty. Referral numbers were lower in 2021/22 compared to 2022/23 as historical data was only readily available from July 2021, thus data for the whole financial year was unable to be captured.

The number of referrals each month was calculated by dividing the total number in each financial year (April to March) by the number of months of data available. Here, 9 months of data was available for 2021/22 data and 12 months of data was available for 2022/23 data. The numbers suggest increased Bleepa usage from 2021/22 to 2022/23 by 45 referrals per month. This could be because staff became more familiar with using Bleepa so began to use this method to submit referrals more frequently, building it into the standard pathway.

Table 7: The number of referrals for each specialty in financial years ending in March.

Specialty	2021/22	2022/23
FGH Gastroenterology	980	1,377
ROH Cardiology	1,045	1,442
ROH Gastroenterology	1,087	1,770
ROH Respiratory	733	1,077
Average referrals per month	**427**	**472**

Figure 3 depicts the number of referrals counted by referrals with a "*referred*" time stamp, in FGH and ROH from July 2021 to April 2023. Overall, there were 9,908 referrals that occurred from July 2021 to April 2023. There were peaks of Bleepa usage within ROH and FGH in August 2021, March 2022, and June 2022. There was a usage peak in January 2023 in ROH.

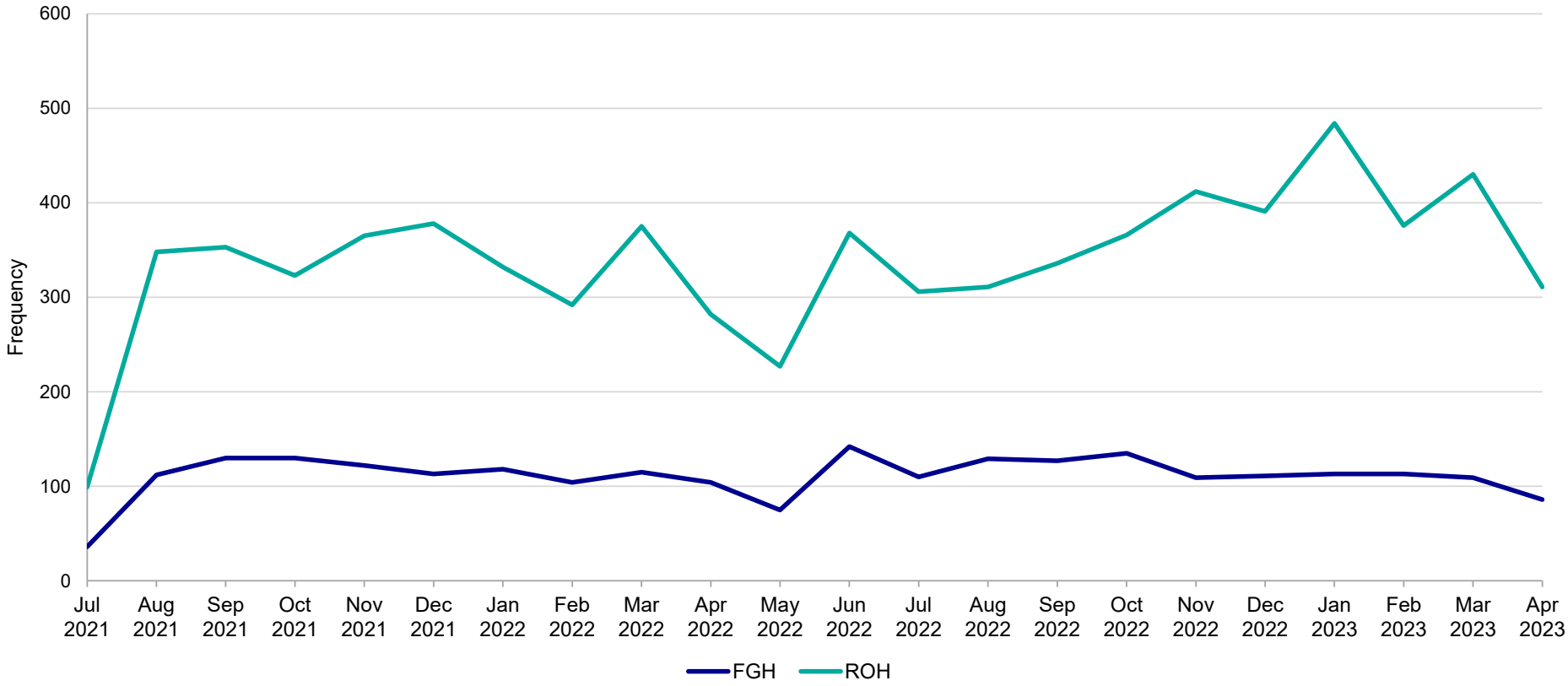


Figure 3: Number of referrals each month from 2021 to 2023 by hospital.

Between 2021 and 2023, there were 2,443 referrals in FGH Gastroenterology, 2,585 referrals in ROH Cardiology, 3,002 referrals in ROH Gastroenterology, and 1,878 referrals in ROH Respiratory.

Figure 4 highlights the number of accepted and released referrals for each specialty whilst using Bleepa. Lighter shades represent the percentage of released referrals, whilst darker shades represent the percentage of accepted referrals. The frequency of released referrals was much lower than the overall number of referrals within each specialty, suggesting that not all staff members may utilise this feature. It should be noted that, although Bleepa use is different in each specialty, neither usage method is necessarily incorrect.

There was a much higher rate of referrals released than accepted, suggesting large variances regarding how the accept function was used between specialties. The accepted feature was not used consistently within specialties in comparison to referred and released. Internal discussions with Feedback Medical noted that ROH Respiratory did not use the accept feature as intended, whereas ROH Gastroenterology did.

Figure 3 supported this; ROH Gastroenterology accepted 25% of referrals, whilst ROH Respiratory accepted 5% of referrals.

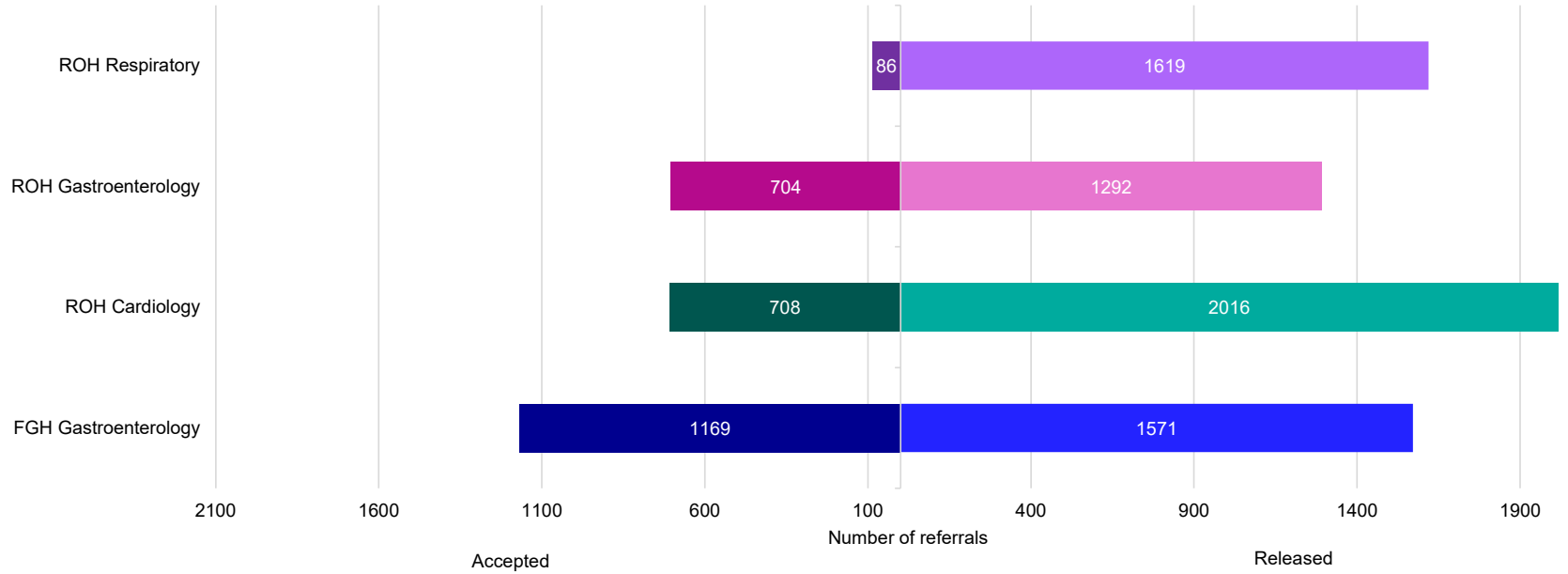


Figure 4: The number of accepted and released referrals for each specialty. Lighter shades represent the number of released referrals, whilst darker shades represent the number of accepted referrals.

Figure 5 depicts the overall average number of referrals by day of the week in ROH and FGH combined. Here, most activity was during weekdays, with little activity at the weekend. From Monday to Wednesday, there was a consistent referral rate, averaging between 460 and 469, most likely due to the low number of referrals that were submitted over the weekend. Clinicians who respond to referrals may not work on the weekends, hence the lower frequency of submitted referrals on Saturday and Sunday.

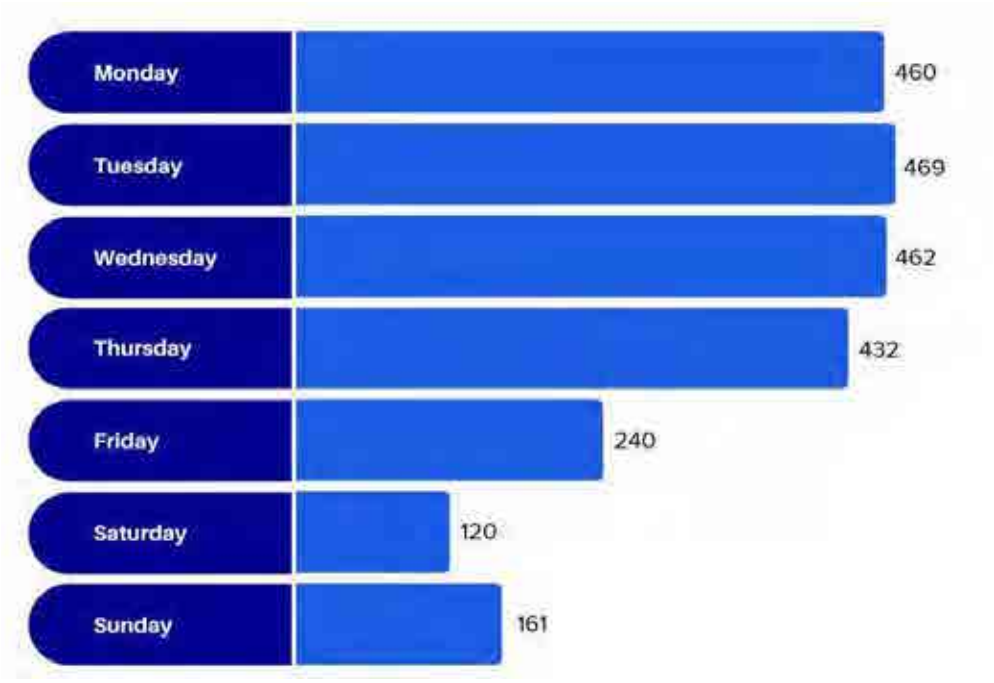


Figure 5: The average number of referrals each day from 2021 to 2023.

Figure 6 depicts the average frequency of Bleepa referrals by specialty and day of the week, including an overall average line. The frequency of referral activity for all specialties followed the overall trend of decreasing at the weekend, where Saturdays had the lowest number of data points across all specialties. ROH Gastroenterology had the highest number of referrals and ROH Respiratory had the lowest number of referrals.

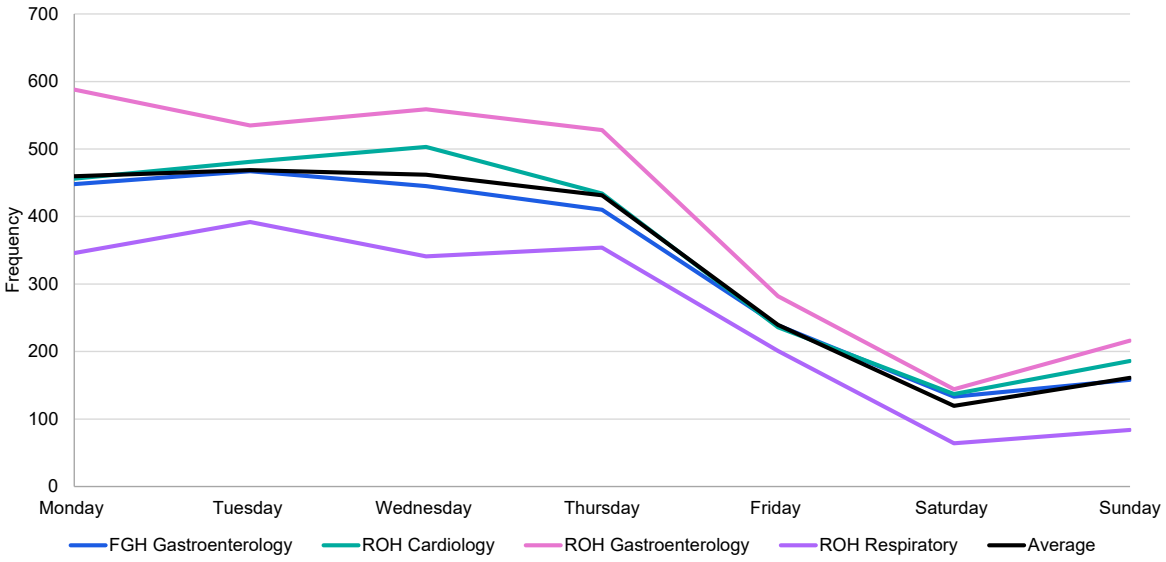


Figure 6: The average number of referrals each day by specialty from 2021 to 2023, counted by the number of first referral messages.

3.2. Messaging

Figure 7 highlights the average number of messages exchanged per referral in each specialty across the years, where the darkest shade represents 2021 figures, medium shades represent 2022 figures, and the lightest shades represent 2023 figures. This included all messages from the first message to the last message of a referral. Generally, the numbers remained consistent across the years for ROH Cardiology and ROH Respiratory. The number of messages per referral increased each year for FGH and ROH Gastroenterology departments. For FGH Gastroenterology and ROH Gastroenterology, there was a 30% and 18% increase respectively in the number of messages per referral from 2021 to 2023.

The increase in the number of messages exchanged per referral from 2021 to 2023 could suggest improvements in efficiencies of staff communication and ease of use over time. As staff become more familiar with Bleepa, staff interactions with the platform and overall efficiency could improve. With the system more established within clinical practice, it may be considered that it is now ‘business as usual’ (BAU) following these years of implementation.

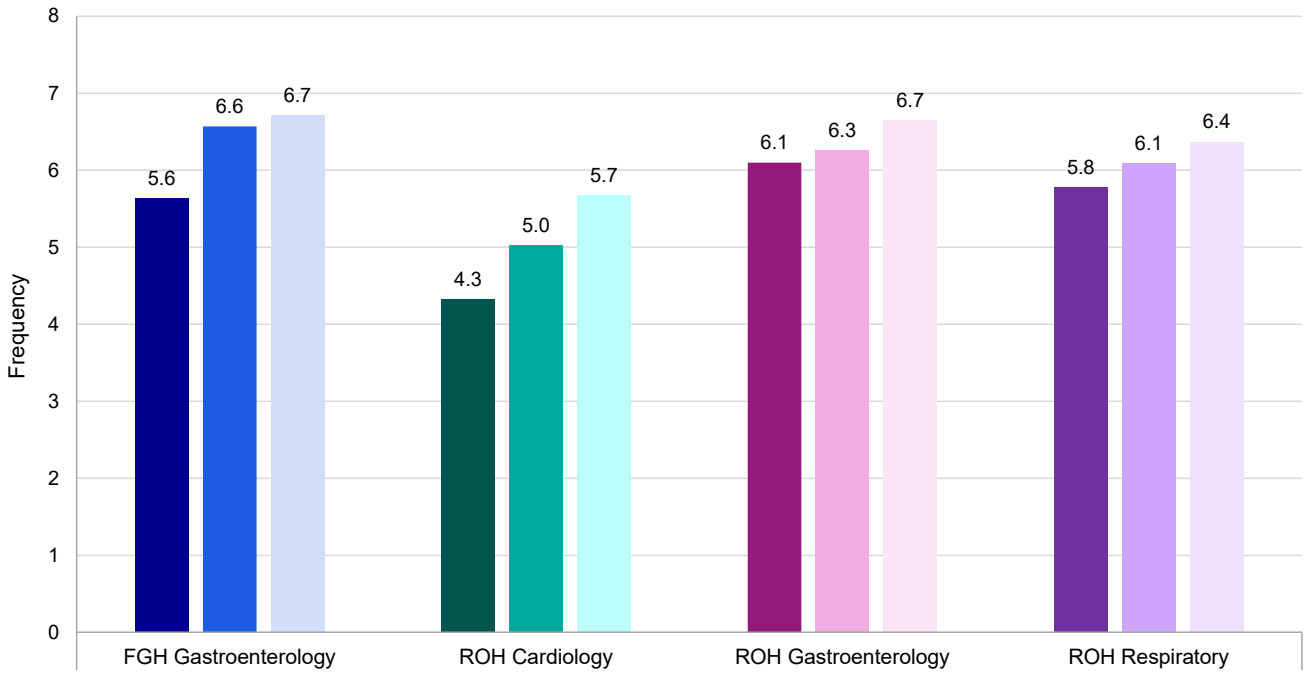


Figure 7: The average number of messages between the first and last message of each referral by specialty across 2021 to 2023. Here, the darker shades represent referrals in 2021, medium shades represent the number of referrals in 2022, and lighter shades represent the number of referrals in 2023.

Overall, there was an average of 4.79 messages exchanged per referral. Table 8 shows the average number of messages exchanged per referral for each specialty, where FGH Gastroenterology had the highest number of messages exchanged and ROH Cardiology had the lowest.

Table 8: The overall average number of messages exchanged per referral for each specialty between 2021 and 2023.

Workflow	Average number of messages
FGH Gastroenterology	6.07
ROH Gastroenterology	4.95
ROH Respiratory	4.56
ROH Cardiology	3.69

The average number of messages per referral each month gradually increased from 2021 to 2023 (Figure 8). There were peaks in the number of messages from FGH and ROH Gastroenterology

around February 2022 and a general increase from May 2022 to October 2022. For ROH Gastroenterology, there were also peaks in and April 2022, July 2022, September 2022, and November 2022. There was an increase in the number of messages per referral for ROH Respiratory in September 2022. ROH Cardiology remained generally consistent throughout the years.

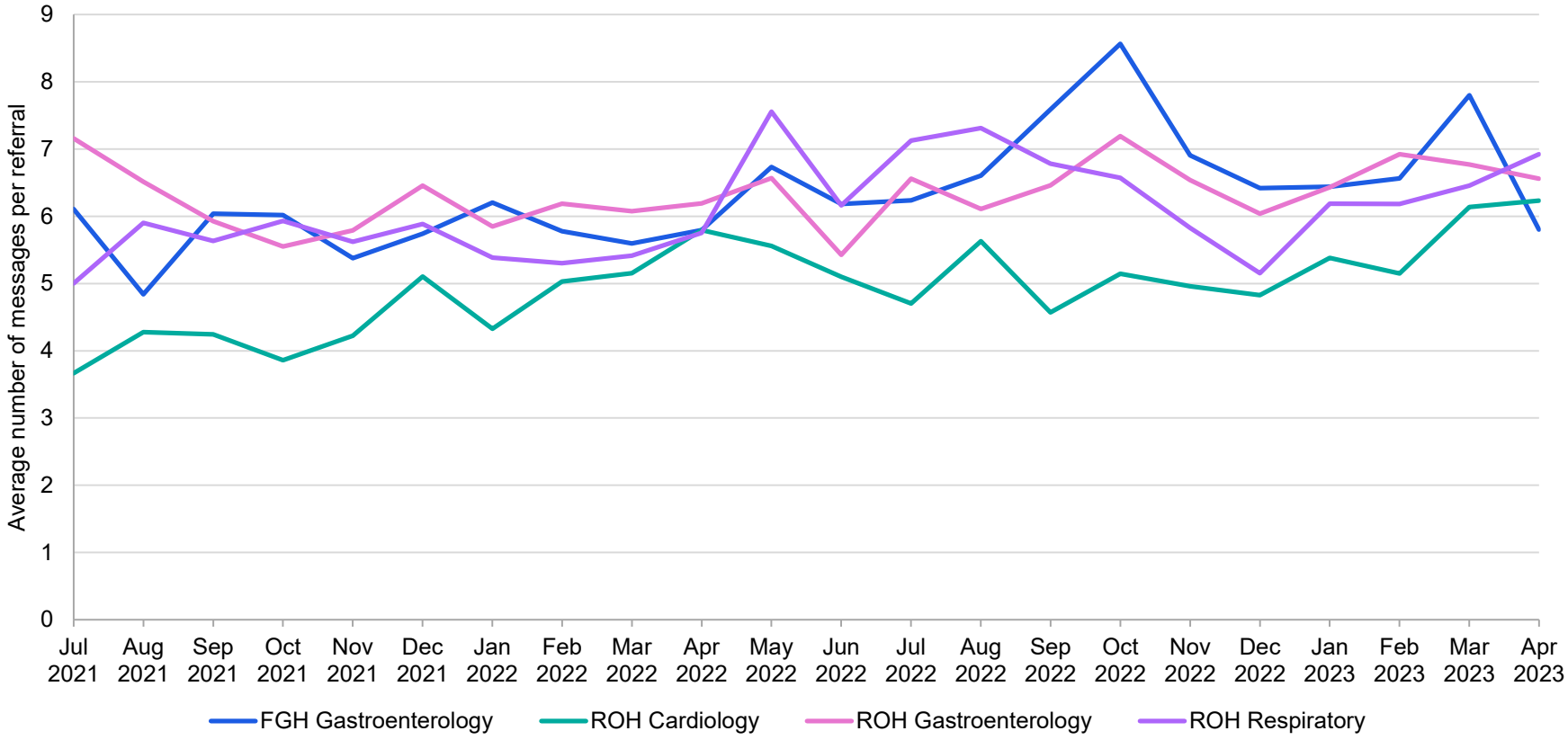


Figure 8: The average number of messages per referral in each specialty each month from 2021 to 2023.

3.3. Response times

The first median response time in days was calculated for the time between the first message of a referral and the next message from a different UserID from the first message (Figure 9). This shows the response time between departments submitting the referrals and those reviewing referrals. Overall, the median response time was 0.55 days, which was similar to the respective metric within Beattie (2020) of 0.4 days from referral to first clinical response when using Bleepa. ROH Respiratory had the fastest response time of 0.28 days and ROH Cardiology had the slowest response time of 0.63 days.

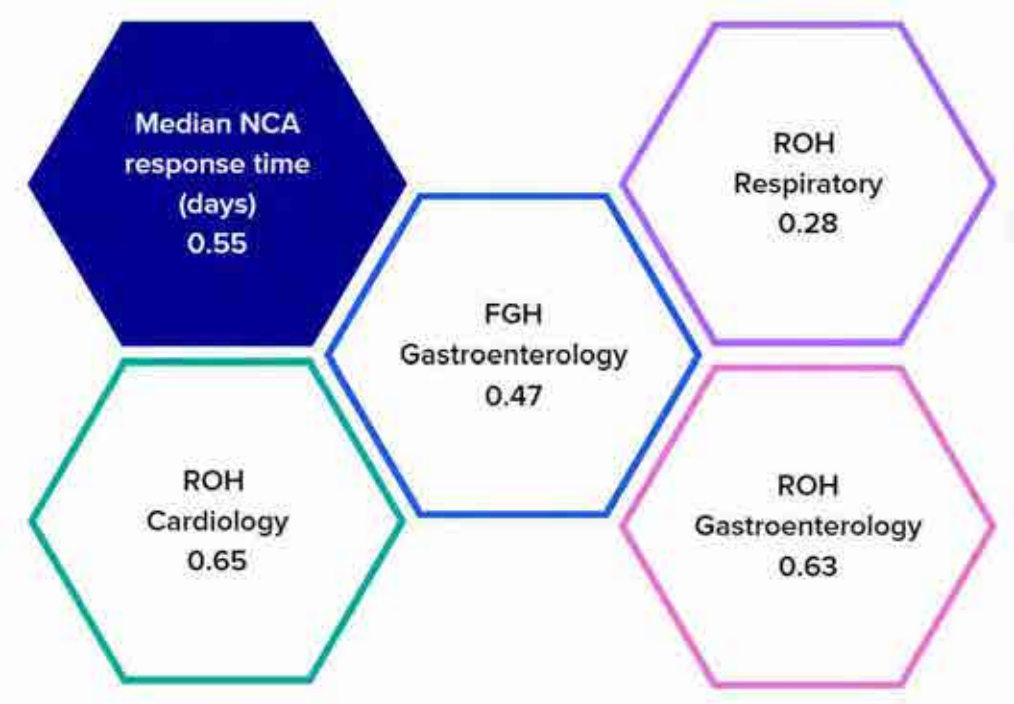


Figure 9: The first median response time in days from the first message of a referral to the next message with a unique userID by specialty for 2021 to 2023.

The median time taken for referrals to be completed across all specialities and hospitals was 1.95 days (Figure 10). The median response time from first message to last message in ROH was 1.80 days, and the median response time in FGH was 2.99 days. When analysing, results indicated that referrals to ROH Cardiology had the fastest completion time (0.92 days). ROH Gastroenterology took the longest time to complete (3.00 days).

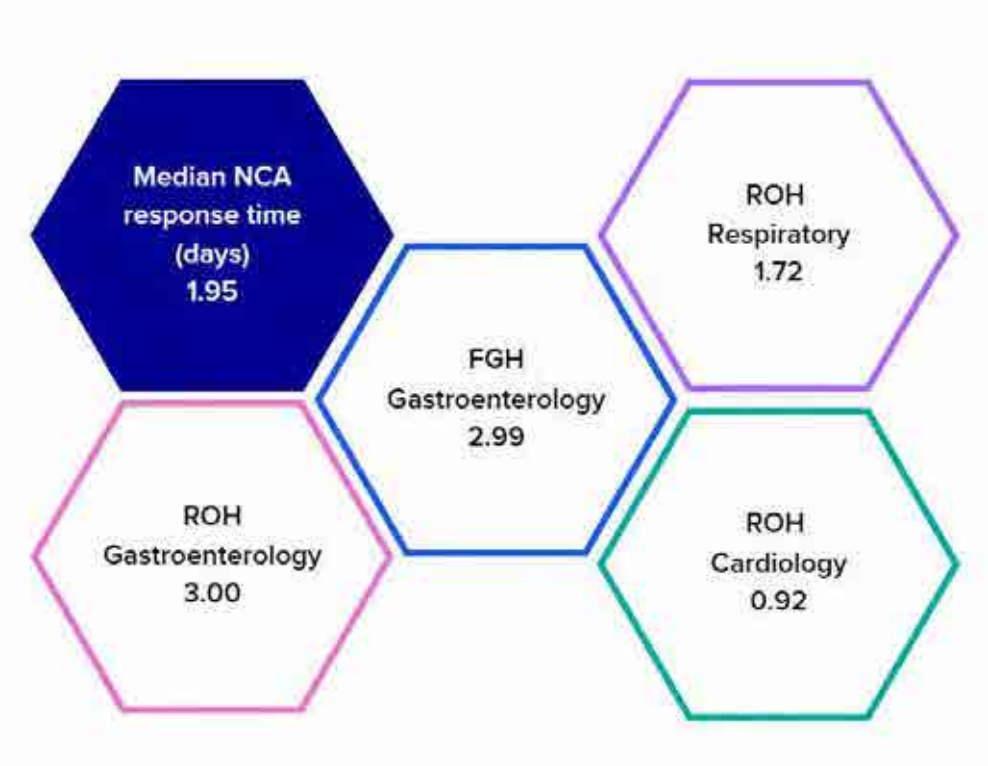


Figure 10: The median response time from the first message of a referral to the last message of a referral by specialty from 2021 to 2023.

Figure 11 shows the number of responses that occurred each day from 2021 to 2023. A response message was denoted by the first alternate "*UserID*" (staff ID) that appeared after the referral "*UserID*". For most referrals, the highest number of responses occurred on Monday to Wednesday and the lowest number of responses on Saturday, in line with the lower referral rate at the weekend. The low volume of responses over the weekend could have been due to the lack of specialty staff to review referrals.

Both Figure 9 and Figure 10 identified that ROH Cardiology had the fastest response time. This could be due to the specialty treating more urgent referrals, hence requiring a faster response time. Further, FGH Gastroenterology and ROH Gastroenterology had similar response times, indicating that this could be due to the nature of the specialty.

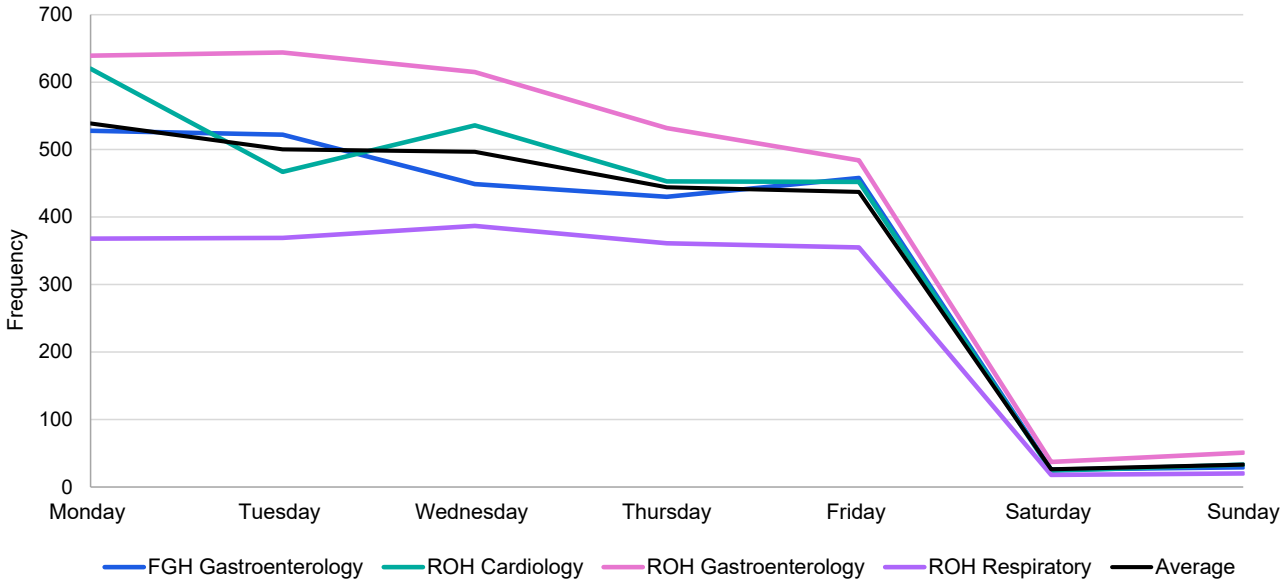


Figure 11: The number of response messages each day by specialty.

3.4. Unique staff users

The number of unique staff IDs per referral was similar across each specialty, with an overall weighted average of 3.80 staff contributing to one referral (Figure 12). Across ROH, the average number of staff was 3.77 per referral, and across FGH there were 3.91 staff per referral. ROH Gastroenterology had the highest number of staff per referral (3.96) and ROH Cardiology had the lowest number of staff per referral (3.52). Of the total number of unique staff IDs, 95% of staff submitted referrals and 63% of staff reviewed referrals.

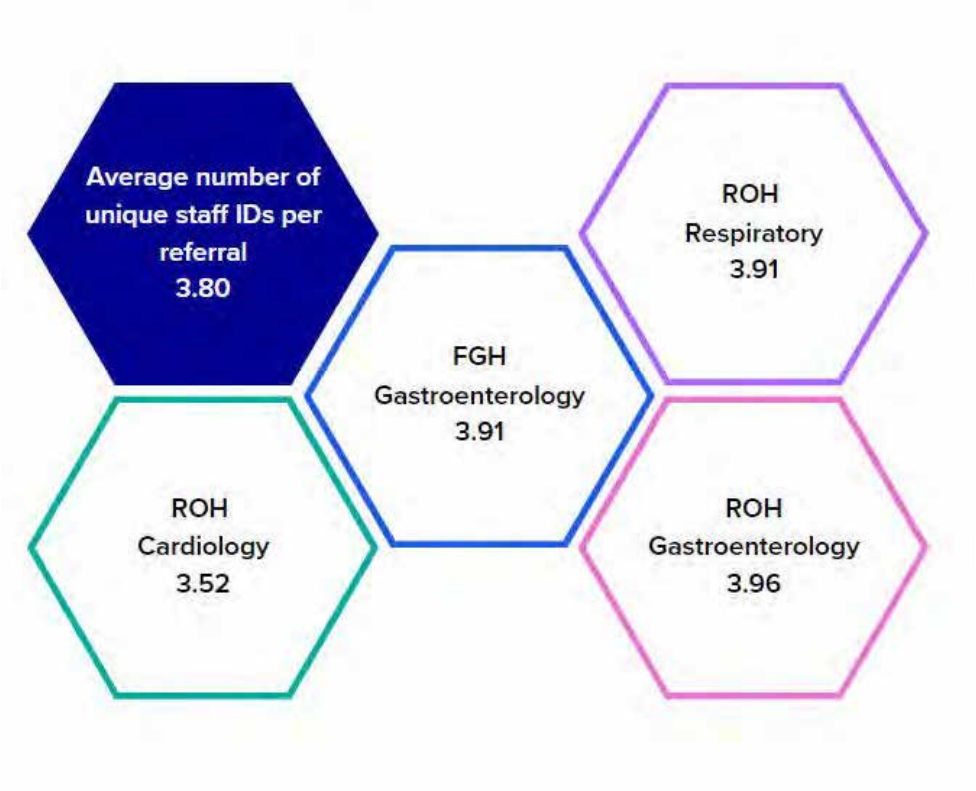


Figure 12: The average number of unique staff IDs in each referral 2021 to 2023.

Figure 13 depicts the number of unique staff IDs who submit referrals. There was a general increase in the number of users across the years for ROH Cardiology, ROH Gastroenterology, and ROH Respiratory. This could be because Bleepa was being embedded into the system and users became more familiar with the system and ways of working. From August 2022, there was a decline in the number of users for FGH Gastroenterology. Please note that the data received for April 2023 was not for the full month, hence the reduction observed in the chart. Overall, FGH Gastroenterology had an average of 111 users per month, ROH Cardiology had 119 users, ROH Gastroenterology had 136 users, and ROH Respiratory had 86 users.

Figure 13: The number of unique staff IDs who submit referrals from 2021 to 2023.

The number of unique staff users per referral is highlighted in Figure 14. Here, 60% of referrals had three or fewer unique staff IDs, with the median figure for the number of unique staff IDs per referral being three. Further, 5% of referrals had only one member of staff involved, which may suggest that these were referrals that did not have a response. This could be due to some patient referrals having a change of circumstances, such as a patient requiring urgent treatment.

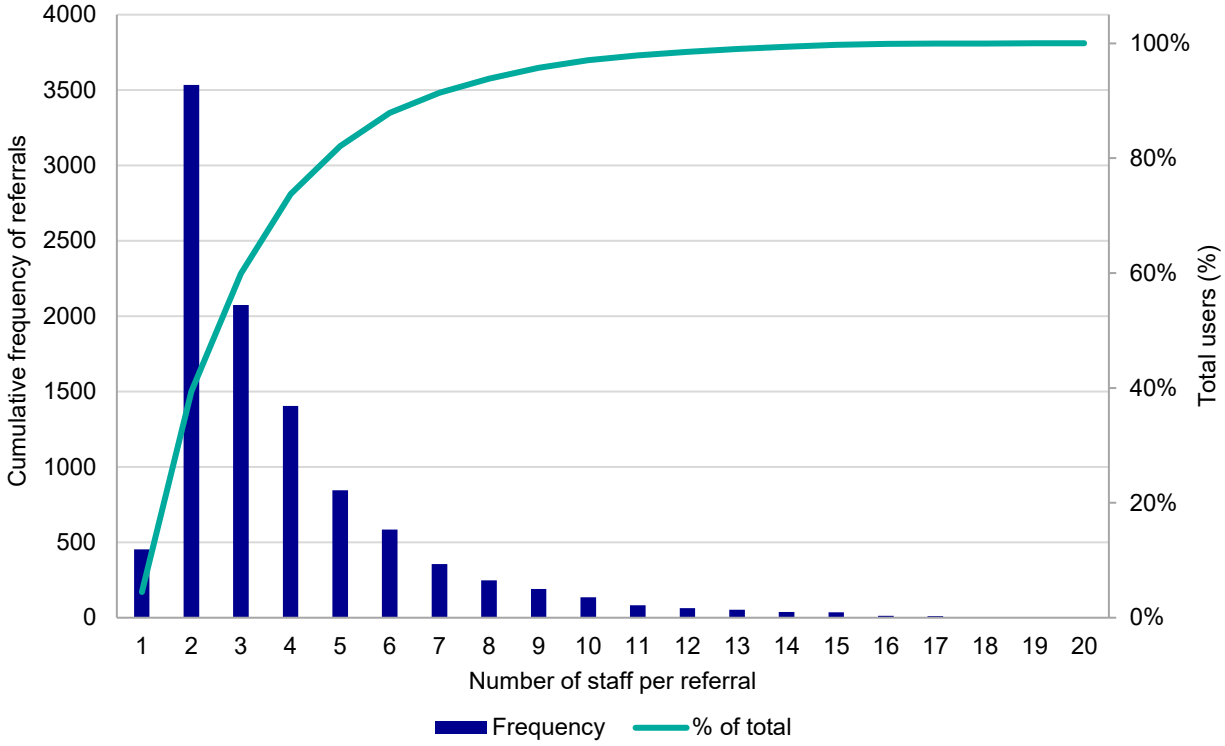


Figure 14: The number of unique staff IDs per referral between 2021 and 2023.

Approximately 25% of referrals had five or more unique staff IDs involved, suggesting that there was a notable number of patients who require large inputs from staff, which could be related to complexity of cases. This could suggest that Bleepa is being used for complex cases where multiple members of the clinical team require input on the referral.

4. Qualitative insights

This section depicts the qualitative insights generated through staff surveys and interviews to understand the impact of Bleepa in terms of effectiveness, acceptability, and the implementation process.

4.1. Demographics

Sites using Bleepa

Overall, 51 staff members completed the survey (Table 9). Over half of staff used Bleepa at ROH (62%), with the remaining either using Bleepa at FGH (32%) or not at all (6%). Respondents who did not provide a response or did not use Bleepa were omitted from subsequent analyses.

Table 9: The number of staff who completed the survey and used Bleepa at each site. Please note that some staff used Bleepa at multiple sites, hence values may not sum to 51.

Total number of staff who completed the survey	Number of staff who used Bleepa at ROH	Number of staff who used Bleepa at FGH	Number of staff who did not use Bleepa at all
51	33	17	3

Staff were asked in the survey whether they would consent to being interviewed. Here, six staff members consented, however only four completed interviews due to no responses from two staff members when contacted. Three interviewees worked in ROH, and one worked in FGH.

Staff hospital, specialty, and job role

Most staff worked at ROH (62%), with some staff using Bleepa at FGH (32%) or not at all (6%). Figure 15 highlights the breakdown in staff specialties within each hospital. Most staff surveyed were not within the main specialties examined in the current evaluation (Section 2.1; Figure 15). A large proportion of staff in ROH were in the Respiratory specialty, with much lower proportions of staff in other specialties, similar to the proportions within FGH.

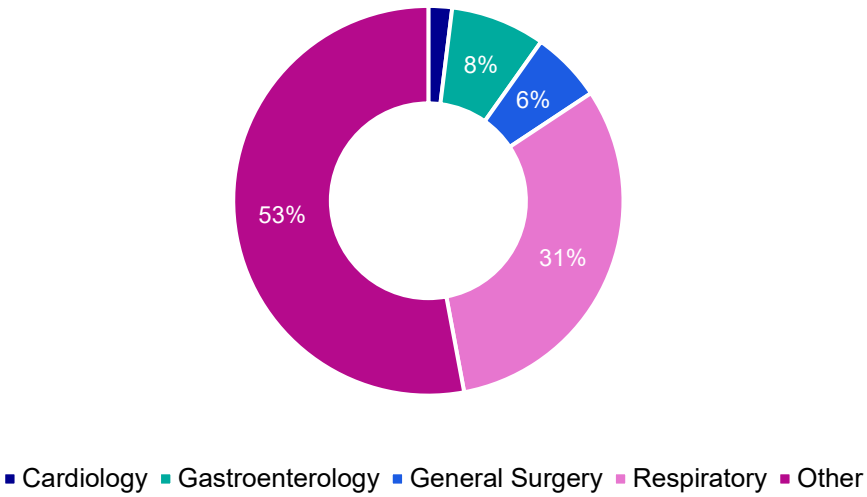


Figure 15: Breakdown of the specialties staff members worked within.

Most staff were consultants/associate specialists or trainee doctors (foundation, specialty trainee 1; ST1, junior fellow, or equivalent; Figure 16). Here, 67% of staff in ROH were trainee doctors and 59% of staff in FGH were consultants or associate specialists. Interviewees were either trainee doctors (in Endocrinology and Diabetes, Acute Internal Medicine, or Respiratory) or a consultant/associate specialist (in Neurology).

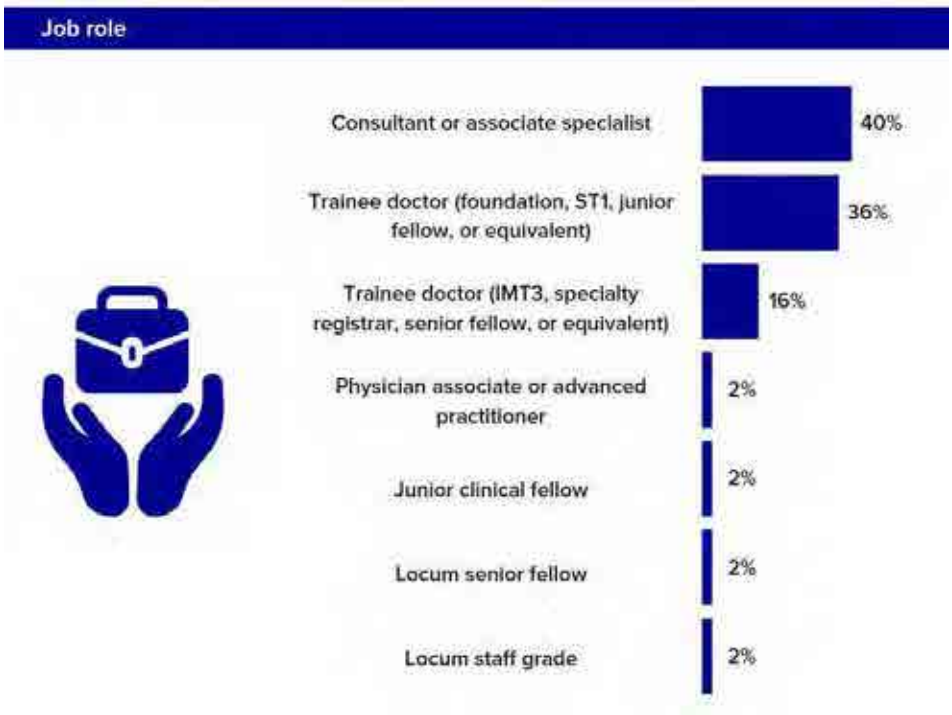


Figure 16: Breakdown of staff job roles of staff members who completed the survey.

Submitting and receiving referrals

Over three-quarters of staff completing the survey submitted referrals using Bleepa, with slightly less than a quarter receiving referrals using Bleepa (Figure 17). Further, all interviewees submitted referrals using Bleepa and only one reviewed patient referrals using Bleepa. One interviewee stated that they did not use Bleepa on a regular basis, only occasionally (Section 7.3).

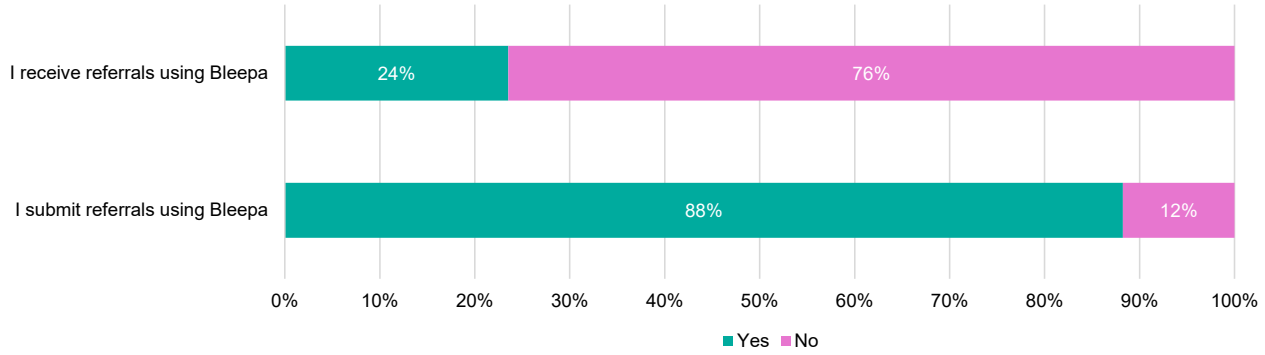


Figure 17: Breakdown of staff members who submitted and received referrals using Bleepa.

4.2. Acceptability

Ease of use

Most survey respondents suggested that Bleepa was easy to use overall and as part of their day-to-day work (Figure 18). One interviewee noted that Bleepa helped make the referral process "*better and streamlined*". Another interviewee said that Bleepa made it easier to know where to send referrals to. This may suggest that some staff considered that Bleepa was easier to use compared to previous referral methods, which the staff user referred to as "*more labour intensive*". A larger qualitative sample size would be required to corroborate and validate such early insights from a smaller sample size.

Figure 18: Staff perceptions surrounding Bleepa's ease of use.

Interviewees suggested Bleepa was easy to access; it was one of the clinical applications on their device. The Bleepa interface was also noted to be easy to navigate, with one staff member highlighting this was because they used the same log in information as their hospital log in. Once logged in to Bleepa, referrals were noted to be easily updated; other referral systems did not allow this feature.

Staff satisfaction

Most staff responded positively to each statement asked in Figure 19, suggesting that staff were satisfied with the use of Bleepa. Further, all four interviewees identified a positive impact due to Bleepa on their work and specialty. The final statement, "*sufficient training was provided to enable use of Bleepa*", had the most members of staff either "*disagree*" or "*strongly disagree*". Here, 31% of staff in FGH and 22% of staff in ROH disagreed with the statement. Speaking to Feedback Medical, training was offered, however was difficult to provide due to capacity of clinicians during working hours. Instead, a select few clinicians received training and often a *'train the trainer*' model used to cascade down to other users. Additionally crib sheets, and other training materials, were provided. It is therefore suggested that training was offered, however there was some inconsistency in the uptake from each working department.

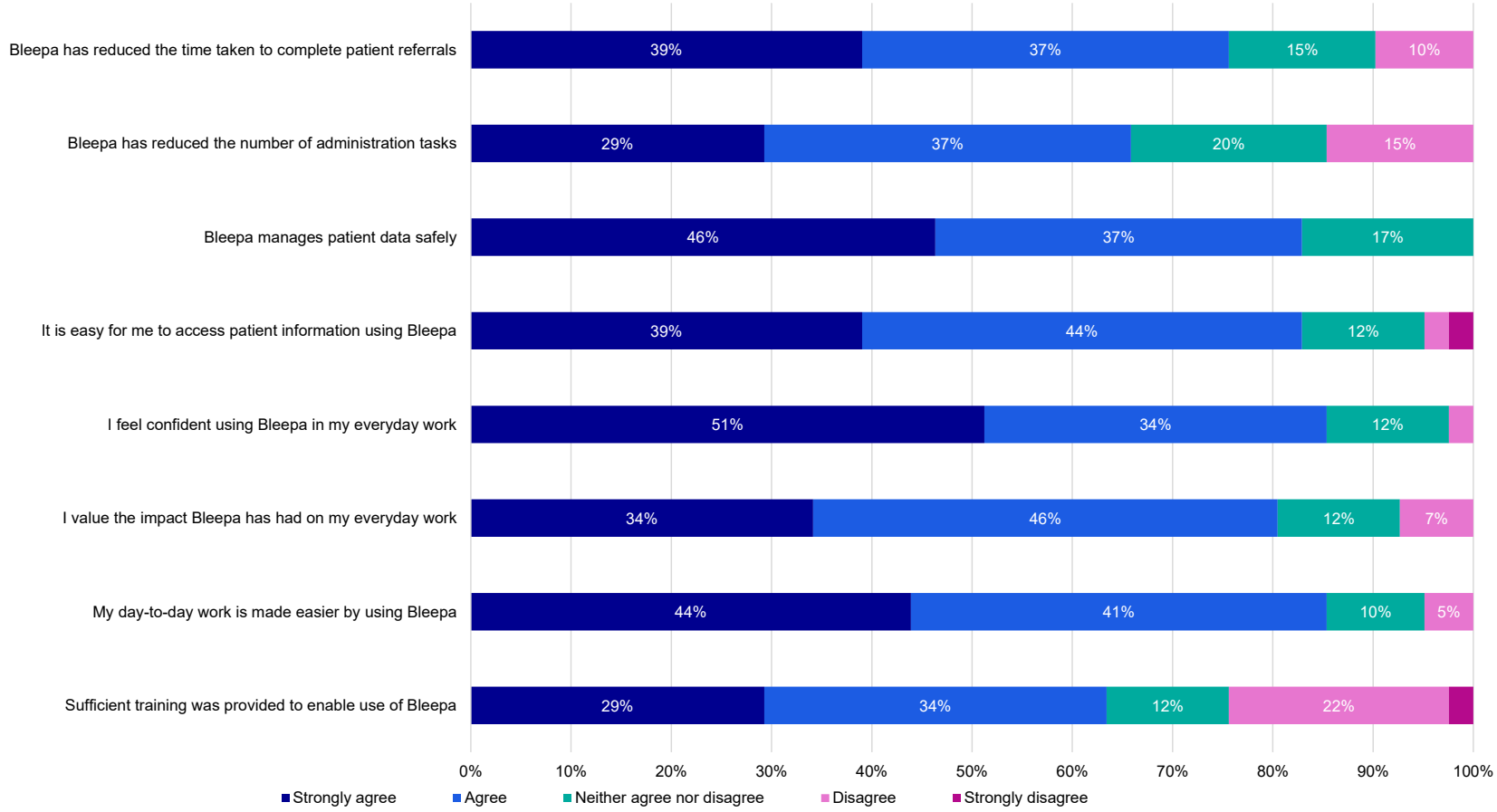


Figure 19: Staff member survey responses to statements surrounding staff satisfaction levels.

One interviewee raised that the training to use Bleepa consisted of providing the user with an A4 laminated sheet of paper containing guidance. From this, staff members would also learn as they used Bleepa, with IT staff visiting clinicians every August when there was a new influx of doctors. When asked whether the training process could be improved, one interviewee suggested that a step-by-step online guide or face-to-face training would be useful, particularly for users who are not as familiar with using technology.

Most staff surveyed identified an improvement in staff communication whilst using Bleepa (Figure 20). Interviewees noted that staff communication had improved since using Bleepa, with one interviewee noting that it was easier to reach their colleagues. Another interviewee highlighted that they no longer struggled to find staff members in person as they could contact staff through Bleepa. In some cases where urgent advice was required, the staff member was contacted in person.

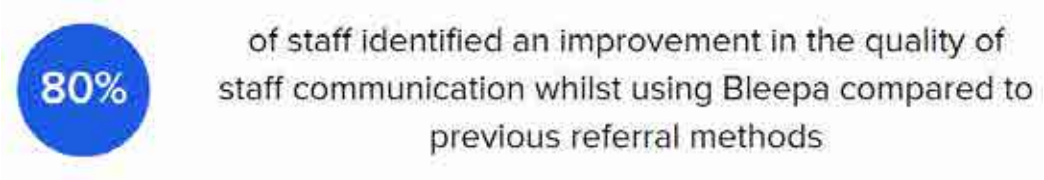


Figure 20: Staff perceptions of communication whilst using Bleepa compared to previous referral methods.

One staff member raised that Bleepa communication was only effective if the referral submission contained sufficient information to allow an appropriate response. Despite this, the same interviewee highlighted that the previous method was inefficient; doctors did not tend to provide clear referrals when at high capacity. Some staff could be more satisfied with Bleepa compared to previous referral methods as they may be able to communicate more effectively with their colleagues.

Bleepa was also noted to help with communication when reviewing referrals, with one interviewee stating: "*[Bleepa] facilitates the ability to give advice, which frees up time for review of the patients who need to be seen in person*". Here, the correspondence from previous referrals was noted to be "*useful for enhancing the quality of communications*" and "*ensures that colleagues within the same department can be confident which referrals have been actioned and those which are outstanding*". This could suggest that Bleepa may allow for effective staff communication during the referral review process.

Patient care and safety

Approximately 85% of staff identified an improvement in patient care and outcomes whilst using Bleepa (Figure 21), with all four interviewees also suggesting that patient care and outcomes had improved. One interviewee noted that this was because clinicians were made more accountable for referrals sent to them; referrals were less likely to get lost compared to previous referral methods. Another interviewee said it was easy to view the timestamps when advice was sought and followed

up. They suggested that patient care depended on the advice given and whether this was followed up. Some staff may have considered patient care and safety to have improved since using Bleepa due to the accountability of staff responding to referrals and the ability to view timestamps when advice was provided.

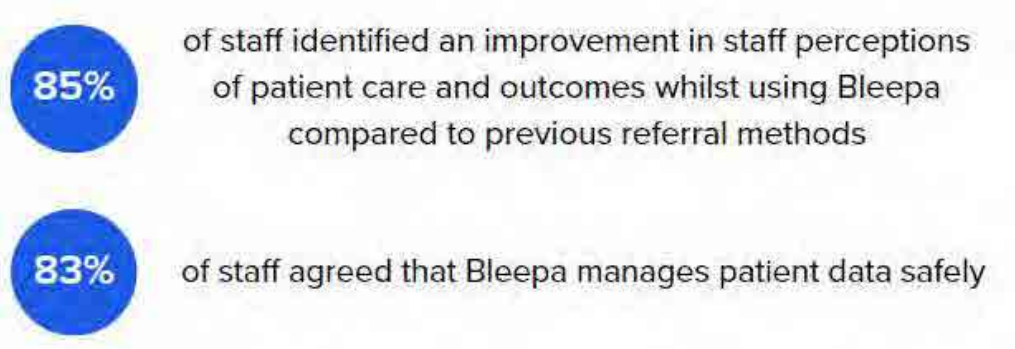


Figure 21: Staff perceptions surrounding patient care and safety due to Bleepa.

Most respondents agreed that Bleepa managed patient data safely (Figure 21). Further, the same proportion (83%) agreed it was easy to access patient information (Figure 19), suggesting a potential association between these survey statement responses, which yielded the fewest "*strongly agree*" and "*agree*" combined responses.

4.3. Effectiveness

Time taken to submit and review referrals

Using previous referral methods

Interviewees stated that previous referral methods they had used included bleeps, paper, and fax referrals. When asked how long referrals took to submit before Bleepa, one staff member responded that it was too difficult to estimate due to the level of variation in each referral and another did not use a previous referral system before Bleepa. Here, it was noted that different specialties used different referral systems, which could have led to staff taking more time to complete a referral as they had to identify the referral system used before starting to submit the referral. The other two staff members responded with either 10 minutes or 5 to 10 minutes to submit a referral before Bleepa.

One interviewee reviewed referrals using Bleepa. When asked how long it took them to review referrals using other referral methods, they could not provide an answer as they had not used a different referral system. When asked how long it took them to review referrals using Bleepa, they suggested "*on average it takes five minutes, longer, if I am responding remotely and will not go on to review the patient themselves*". They highlighted there were "*no system delays due to Bleepa*

(unless it is being glitchy and need to log out and log back in)". Despite this it was noted that there were some elements of patient information required that could not currently be viewed through Bleepa, such as "*bloods, previous letters, microbiology, radiology, [and] observations*". Although able to, Bleepa is not currently used to access additional patient data at NCA, rather just to complete the referral itself. Such qualitative findings suggest that some staff members at NCA may benefit from having access to further patient data.

Using Bleepa

Most survey respondents took less than 5 minutes to submit and review referrals (73% and 76% respectively; Figure 22). Interviewees suggested that Bleepa referrals took either between 5 and 10 minutes, 2 to 5 minutes, or 2 to 3 minutes to submit. The final interviewee was unable to suggest a time taken. Through calculating the weighted average of survey responses, the time taken to submit and review referrals using Bleepa was 4.14 and 4.45 minutes respectively.

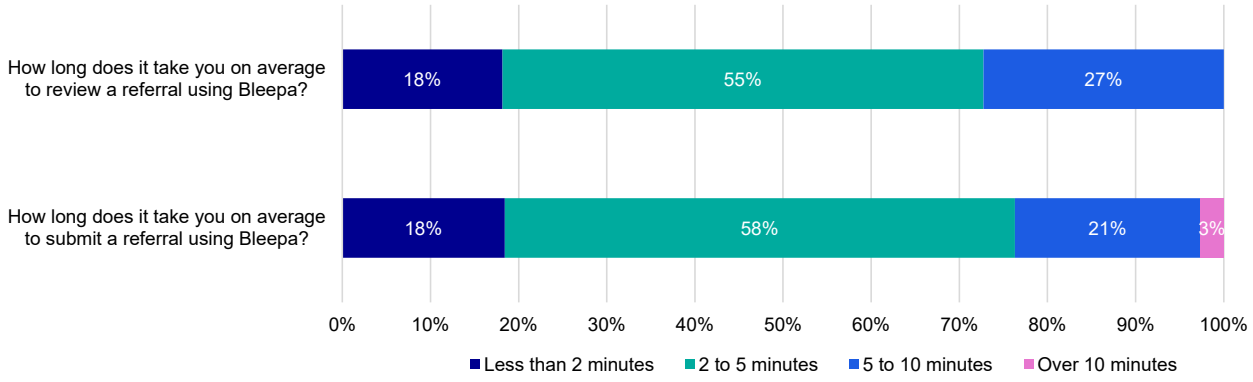


Figure 22: Survey responses to the time taken to submit and review Bleepa referrals.

When expanding on their answer, an interviewee suggested that this time saving was due to staff members being able to ask for more information and complete other tasks whilst waiting for a response. Another staff member noted that Bleepa did not take them away from their clinical work as they could allocate time in their day to respond to referrals. This suggests that staff members identified time savings due to using Bleepa, compared to previous referral systems, because they could complete tasks whilst waiting for a response from staff members.

"[Bleepa] is significantly more efficient than [the] previous system of emails and paper trails"

- *Interviewee who submitted and received referrals using Bleepa*

Referral length of time

Interviewees were asked why some referrals took longer than others to complete. Responses indicated that this could be due to some patient cases being more complex than others, or some staff members not being as familiar with Bleepa compared to others. Some patient cases may require more information or require answers to complex questions, which can increase the time taken to complete a referral. One interviewee suggested that some staff members, such as consultants or locum staff, may struggle to use Bleepa as junior doctors tend to use Bleepa more. This was noted to be especially apparent during junior doctor strikes.

Handling referral requests

Submitting referrals without seeing the patient

Most staff responded "*neutral*" to whether Bleepa allowed them to handle referrals without having to see the patient (Figure 23). Of the 23% who responded "*yes*", two respondents respectively suggested that either 20%, 30%, or 50% of referrals could be handled without having to see the patient. The remaining three respondents suggested either 15% or 40% of referrals could be handled without needing to see the patient or did not provide an answer. The weighted average of these responses was 32%, suggesting that approximately 32% of referrals could be handled without having to see the patient.

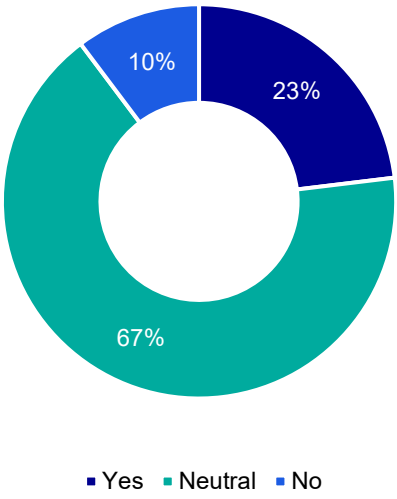


Figure 23: Survey responses surrounding whether Bleepa allowed staff to handle referrals without needing to see the patient.

Interviewees suggested that there was variation regarding whether they needed to see the patient when submitting referrals. This variation was dependent upon whether the staff member who submitted the referral provided enough information or whether the staff member who reviewed the

referral required more information. Variation was also suggested to be dependent upon the complexity of patient care, where more complex cases may be more likely to require patient interaction. One interviewee noted that this requirement was up to clinical judgement.

One interviewee working in Respiratory at ROH stated that they already used Bleepa remotely to provide advice on a patient they had not reviewed in person, though suggested that using Bleepa remotely should not be a priority as most referrals require an in-person review. This could suggest that remote use of Bleepa could be more suitable for submitting referrals, rather than reviewing referrals and its usage was dependent on clinical judgement. Despite this, a larger sample size would be required to substantiate this statement.

The responses generated by interviewees may identify the reason for the large proportion of staff members within survey responses who were "*neutral"* to this statement. This was further supported by most staff who responded "*yes*" stating percentages around 50%, suggesting that each referral is unique and may or may not require patient interaction.

Submitting referrals at the weekend

All interviewees worked at the weekend, with three out of the four also using Bleepa at the weekend to submit referrals. One interviewee tended to submit referrals at the weekend to keep on top of the referrals, instead of completing them all on Monday. When asked why there were fewer referrals completed at the weekend, responses suggested that this was not a priority as specialty staff were not available to review referrals at the weekend, therefore the patient would not be seen until Monday. This suggests that, although referrals were submitted at the weekend, staff in the referral destination were not present to review the referral.

Accepting referrals

When asked why some staff do not accept referrals using Bleepa, interviewees highlighted the requirement for this process to become streamlined. Currently, there is no standardised pathway for patient referrals. One interviewee also noted that some staff may not accept referrals using Bleepa as they may not be technologically literate. Here, a person-to-person approach of tailored training was suggested to improve how staff members use Bleepa. In contrast, one interviewee noted that they did not use the accept feature so referrals for the same patient could remain on the same list, allowing them to manage their caseload.

4.4. Implementation

Imaging feature

Approximately half of staff who receive and submit referrals using Bleepa noted that they did not use the imaging features (Figure 24). Despite this, 42% of staff who submit referrals did use the imaging features, and 29% of staff who received referrals also used the imaging features.

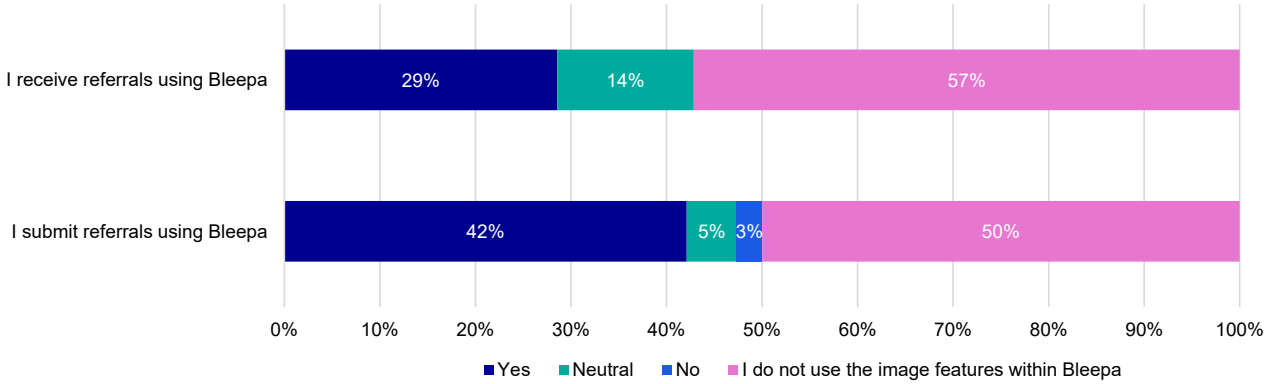


Figure 24: Staff responses surrounding whether they considered access to diagnostic quality imaging to be useful when reviewing patient information.

Only two staff members highlighted the need for complex image manipulation features to be integrated within Bleepa. These staff members were within the Respiratory specialty at Royal Oldham Hospital and noted the need to compare images and change the contrast of the images. The remaining staff either did not use the imaging features within Bleepa (71%), or responded with "*neutral*" (10%), or "*no*" (15%). Only one interviewee noted the need to view scans within Bleepa. During discussions with the Feedback Medical team, it was also highlighted that some staff members would appreciate the ability to compare images by viewing them side by side.

Clinical data

Overall, most respondents were either neutral (39%) or did not consider integration of other clinical data would be useful within Bleepa (24%). Of the 37% who did consider this useful, most (73%) mentioned blood results would be useful to include within Bleepa (Figure 25). Further, of the 37% who did consider integration of other clinical data to be useful, 27% (n = 4) noted that integrating imaging data would be useful. Two of these respondents were within Neurology and the other two were within either Gastroenterology or Acute Internal Medicine. This suggests that there was a need to view basic imaging data, however more complex imaging data may not be as beneficial to most staff.

Clinical data			
Blood results	73%	Imaging	27%
Lab results	20%	ECG	20%
Pathology	13%	Nursing observations	13%
ECHO	7%	Scan results	7%
Radiological findings	7%	Endoscopy results	7%

Figure 25: Breakdown of free-text responses to what clinical data staff members would find useful to be integrated within Bleepa (*n* = 15).

Mirroring the survey responses, all interviewees noted that integrating blood results into Bleepa would be beneficial. Further, integration of specific applications such as HealthView (patient records, such as discharges and GP records), Sectra (patient imaging results), PatientTrak (recording patient information on ward, such as NEWS scores and blood pressure), and Core Pathology (laboratory results) were suggested to be useful (Figure 26).

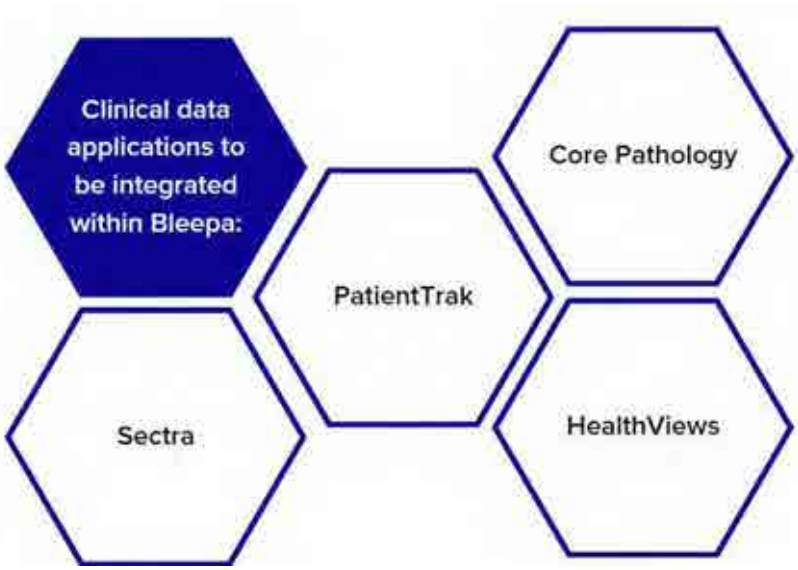


Figure 26: Suggestions of clinical data applications which could be useful to integrate within Bleepa.

Bleepa on your device

Just under half of staff (49%) thought that having Bleepa on their mobile device would improve their experience of the platform (Figure 27). Interview responses highlighted that using Bleepa remotely would be a good addition, however staff members would not want to use Bleepa out of work hours as this could have a negative impact on their work life balance.

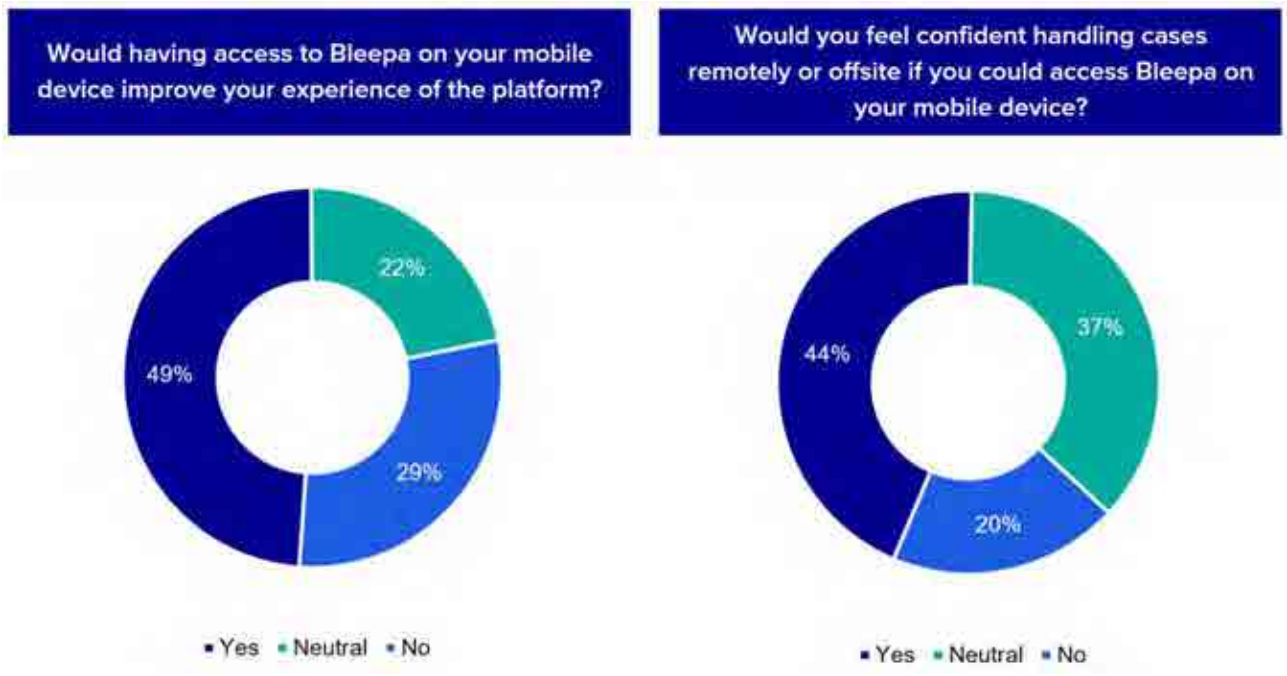


Figure 27: Staff perceptions surrounding accessing Bleepa remotely.

When asked surrounding their confidence of handling cases remotely on their mobile device compared to on a desktop within the hospital, similar proportions to that of the above were identified (Figure 27), with 44% of staff feeling confident handling cases remotely. Interview responses suggested that sometimes there was a need to speak to patients, however this varies and is down to clinical judgement.

Suggestions to improve Bleepa

Figure 28 depicts suggestions devised from survey responses surrounding improvements to Bleepa. Here, most staff members who provided a response noted improvements surrounding usability, with interviewees also raising improvements such as a single log-on feature and asking fewer questions.

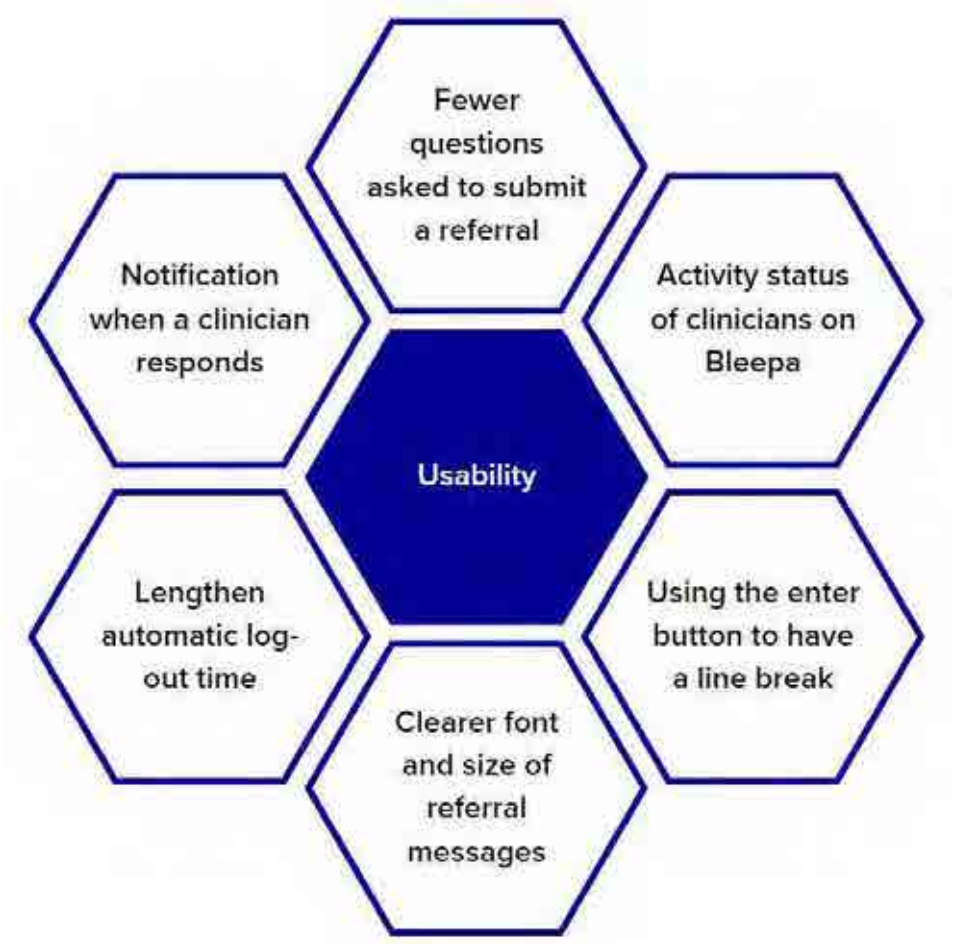


Figure 28: Staff member suggestions surrounding increasing usability to improve Bleepa.

Two survey respondents noted interoperability, supported by another interviewee who considered merging systems together would be an improvement to Bleepa. Some staff members in both survey (*n* = 6) and interviews (*n* = 1) also mentioned adding more specialties to Bleepa. The interviewee noted that Rheumatology was particularly keen to be added to Bleepa.

5. Forecast modelling insights

This section highlights the findings in terms of the forecast model analysis completed in the current evaluation to identify the potential monetary and economic value of Bleepa.

5.1. Scenario 1: NCA retrospective analysis

This section represents the results for scenario 1. The model provides estimates of the costs and benefits under each scenario over their respective periods. Table 10 depicts the results for scenario 1.

Table 10: Scenario 1 economic modelling results. Please note that the figures below have been rounded to the nearest GBP for presentation and as such, totals may not sum.

Scenario 1: NCA retrospective analysis	2021/22	2022/23	Total
Benefits			
1.1 benefit stream: time saving for submitted referrals in ROH	£14k	£20k	£34k
1.1 benefit stream: time saving for submitted referrals in FGH	£5k	£7k	£11k
1.2 benefit stream: time saved due to efficient messaging in ROH	£36k	£54k	£90k
1.2 benefit stream: time saved due to efficient messaging in FGH	£12k	£17k	£30k
1.3 benefit stream: reduced length of stay in ROH	£113k	£162k	£275k

Scenario 1: NCA retrospective analysis	2021/22	2022/23	Total
1.3 benefit stream: reduced length of stay in FGH	£57k	£76k	£133k
Total benefits	**£237k**	**£336k**	**£573k**
Costs			
Total costs	**£107k**	**£107k**	**£214k**
Net benefit (total benefit – total costs)			
Net benefit (90% confidence interval range)	**£130k** (£103k to £157k)	**£230k** (£191k to £269k)	**£359k** (£294k to £426k)
Total BCR	**2.2**	**3.1**	**2.7**

Sensitivity analysis

The sensitivity analysis assessed how various sources of uncertainty within the model contributed to the model's overall uncertainty. Figure 29 depicts the net benefit sensitivity analysis using @RISK software to represent the most likely outcomes as well as the potential range of results at a 90% confidence interval based on 10,000 simulations.

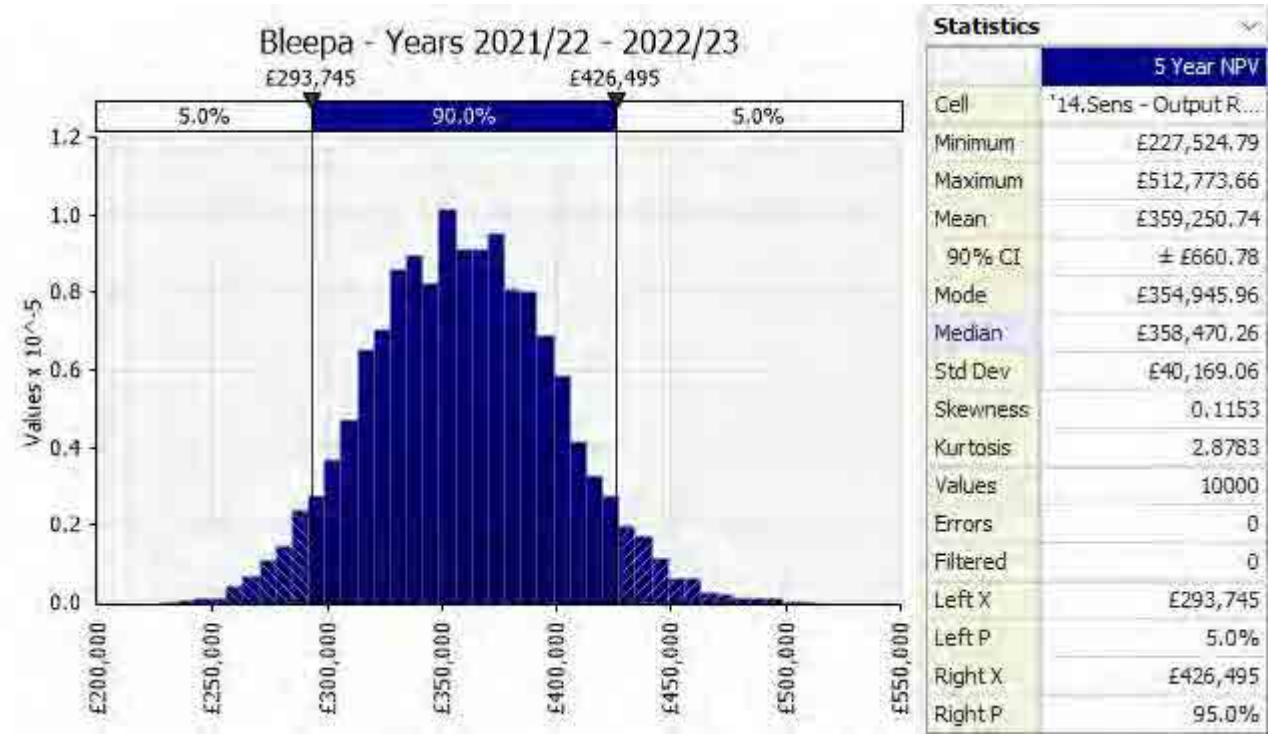


Figure 29: Net benefit sensitivity analysis for scenario 1.

The sensitivity analysis for scenario 1 indicated that, within a 90% confidence interval, the modelled net benefit falls between £294k and £426k, with an expected value (in other words, a mean) of £359k. The 90% confidence interval range of £133k is representative of the uncertainty in the assumptions used for the modelling.

The tornado chart in Figure 30 illustrates the individual impact of each variable input on the net benefit. Each comparison fixes all other assumptions to the expected value and uses the minimum/maximum values of the highlighted input to show the overall impact on the net benefit. This has been completed for the pilot analysis to identify which influencing factors affect the value of Bleepa the most. The results depicted that the length of stay (LoS) associated with clinical response time saving had the greatest effect on the evaluation. Uncertainty around the difference in time taken to respond to referrals using Bleepa at ROH also contributed to the minimum/maximum range of the results.

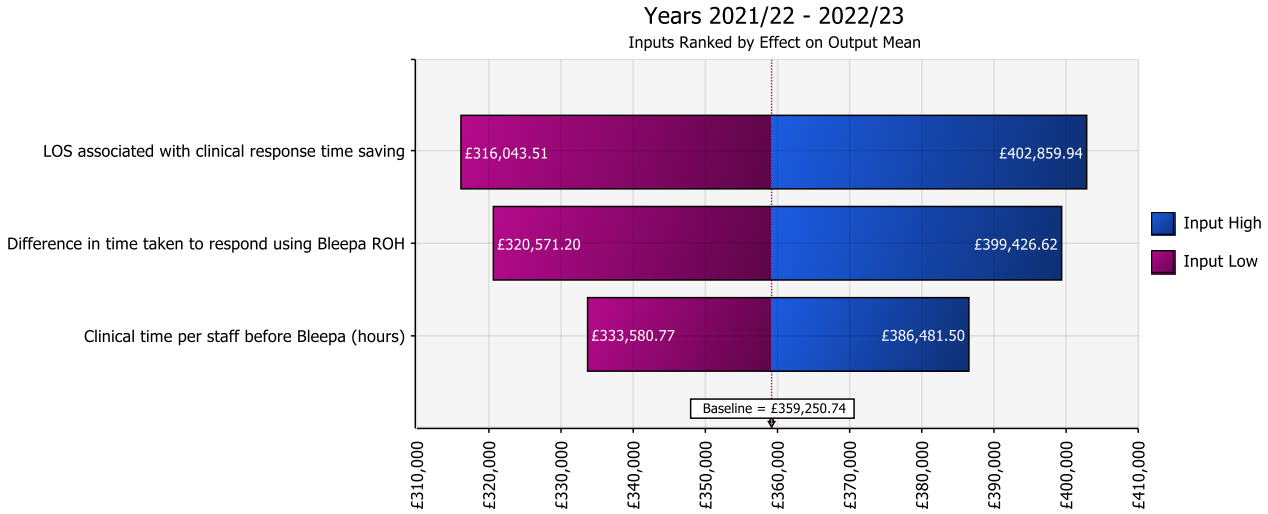


Figure 30: Tornado chart depicting key factors which influence the net benefit. The key indicates the expected change in outcomes when each factor is changed according to the minimum and maximum within the stipulated sensitivity range. The baseline figure is representative of the output mean (expected value).

5.2. Scenario 2: NCA five-year NPV

Scenario 2a: NCA five-year NPV using on prem costing

Table 11 depicts the results for scenario 2a. The model provides estimates of the costs and benefits under each scenario over their respective periods.

Table 11: Scenario 2a economic modelling results (£ represented as NPV in 2023 figures). Please note that the figures below have been rounded to the nearest GBP for presentation and as such, totals may not sum. These values have a GDP deflator and discounting applied.

Scenario 2a: NCA five-year NPV	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Benefits						
2.1a benefit stream: time saving for submitted referrals in ROH	£17k	£17k	£17k	£17k	£16k	£84k
2.1a benefit stream: time saving for submitted referrals in FGH	£6k	£5k	£5k	£5k	£5k	£27k
2.2a benefit stream: time saved due to	£45k	£45k	£45k	£44k	£43k	£223k

efficient messaging in ROH						
2.2a benefit stream: time saved due to efficient messaging in FGH	£15k	£14k	£14k	£14k	£14k	£72k
2.3a benefit stream: reduced length of stay in ROH	£136k	£133k	£130k	£127k	£123k	£648k
2.3a benefit stream: reduced length of stay in FGH	£64k	£62k	£61k	£59k	£57k	£304k
Total benefits	**£284k**	**£277k**	**£272k**	**£266k**	**£259k**	**£1,357k**
Costs						
Total costs	**£113k**	**£112k**	**£109k**	**£104k**	**£100k**	**£539k**
NPV						
Total NPV (90% confidence interval range)	**£107k** (£138k to £203k)	**£165k** (£133k to £198k)	**£164k** (£132k to £196k)	**£162k** (£131k to £193k)	**£158k** (£129k to £189k)	**£819k** (£664k to £979k)
Total BCR	**2.5**	**2.5**	**2.5**	**2.6**	**2.6**	**2.5**

Sensitivity analysis

The sensitivity analysis assessed how various sources of uncertainty within the model contributed to the model's overall uncertainty. Figure 31 depicts the NPV sensitivity analysis using @RISK software to represent the most likely outcomes as well as the potential range of results at a 90% confidence interval based on 10,000 simulations.

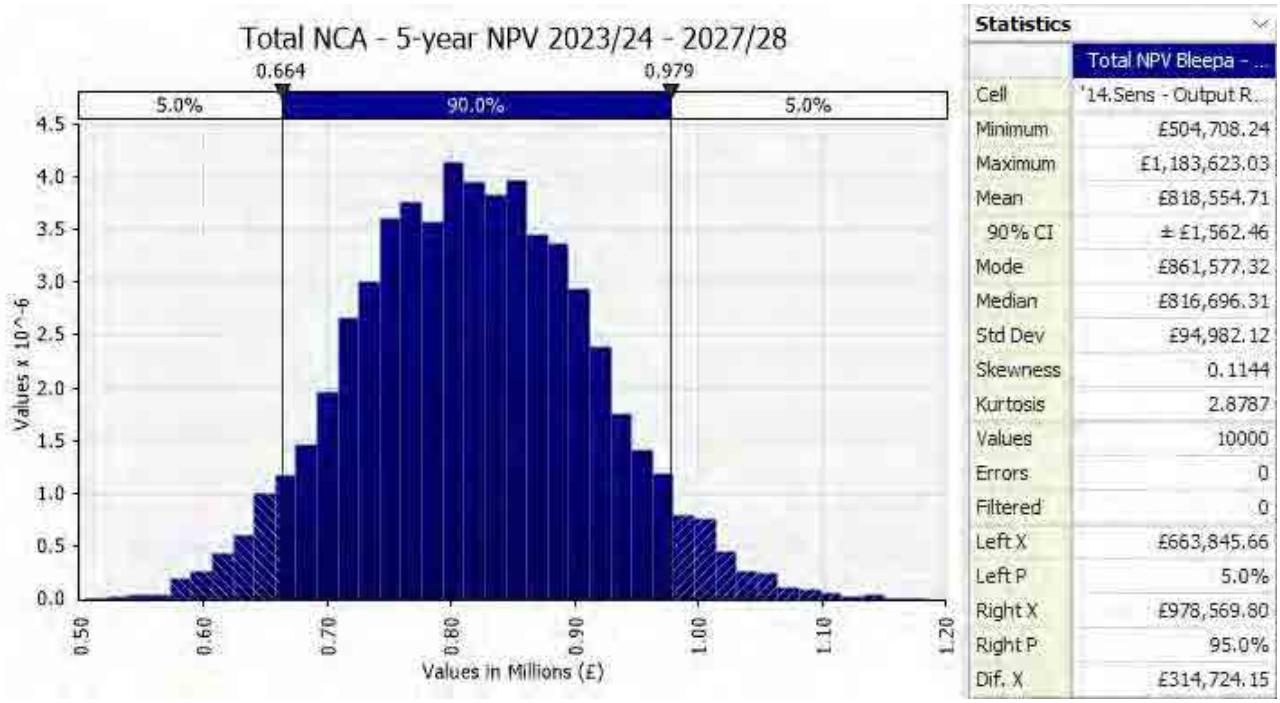


Figure 31: NPV sensitivity analysis for scenario 2a.

The sensitivity analysis for scenario 2a indicated that, within a 90% confidence interval, the modelled NPV falls between £664k and £979k, with an expected value (in other words, a mean) of £819k. The 90% confidence interval range of £315k was representative of the uncertainty in the assumptions used for the modelling.

The tornado chart in Figure 32 illustrates the individual impact of each variable input on the overall NPV. Each comparison fixes all other assumptions to the expected mean and uses the minimum/maximum values of the highlighted input to show the overall impact on the NPV. This has been completed for the pilot analysis to identify which influencing factors affect the value of the Bleepa the most. The results depicted that the length of stay (LoS) associated with clinical response time saving had the greatest effect on the evaluation. Uncertainty around the difference in time taken to respond to referrals using Bleepa at ROH also contributed to the minimum/maximum range of the results.

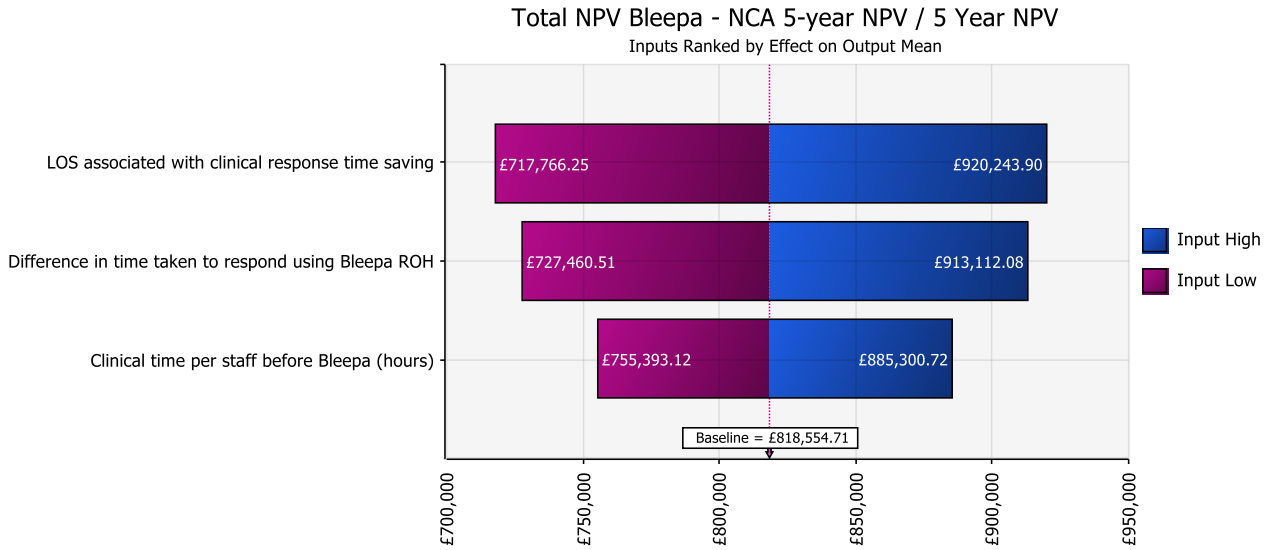


Figure 32: Tornado chart depicting key factors which influence the overall NPV value. The key indicates the expected change in outcomes when each factor is changed according to the minimum and maximum within the stipulated sensitivity range. The baseline figure is representative of the output mean.

Scenario 2b: NCA five-year NPV using Cloud-hosted costing

Table 12 depicts the results for scenario 2b. The model provides estimates of the costs and benefits under each scenario over their respective periods.

Table 12: Scenario 2b economic modelling results (£ represented as NPV in 2023 figures). Please note that the figures below have been rounded to the nearest GBP for presentation and as such, totals may not sum. These values have a GDP deflator and discounting applied.

Scenario 2b: NCA five-year NPV	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Benefits						
2.1b benefit stream: time saving for submitted referrals in ROH	£17k	£17k	£17k	£17k	£16k	£84k
2.1b benefit stream: time saving for submitted referrals in FGH	£6k	£5k	£5k	£5k	£5k	£27k

2.2b benefit stream: time saved due to efficient messaging in ROH	£46k	£45k	£45k	£44k	£43k	£223k
2.2b benefit stream: time saved due to efficient messaging in FGH	£15k	£14k	£14k	£14k	£14k	£72k
2.3b benefit stream: reduced length of stay in ROH	£136k	£133k	£130k	£127k	£123k	£648k
2.3b benefit stream: reduced length of stay in FGH	£64k	£62k	£61k	£59k	£57k	£304k
Total benefits	**£284k**	**£277k**	**£272k**	**£266k**	**£259k**	**£1.4m**
Costs						
Total costs	**£257k**	**£258k**	**£248k**	**£235k**	**£224k**	**£1.2m**
NPV						
Total NPV (90% confidence interval range)	**£27k** (-£10k to £64k)	**£19k** (-£17k to £55k)	**£24k** (-£11k to £60k)	**£32k** (-£3k to £66k)	**£34k** (£1k to £68k)	**£135k** (-£40k to £313k)
Total BCR	**1.1**	**1.1**	**1.1**	**1.1**	**1.2**	**1.1**

Sensitivity analysis for scenario 2b can be found in ‘Appendix K: Forecast modelling insights’.

5.3. Scenario 3: ICB five-year NPV

Scenario 3a: ICB five-year NPV using on prem costing

This section represents the results for scenario 3a, which examines the four major trusts within NHS Greater Manchester ICB. The model provides estimates of the costs and benefits under each scenario over their respective periods. Table 13 depicts the results for scenario 3a.

Table 13: Scenario 3a economic modelling results (£ represented as NPV in 2023 figures). Please note that the figures below have been rounded to the nearest GBP for presentation and as such, totals may not sum. These values have a GDP deflator and discounting applied.

Scenario 3a: ICB five-year NPV	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Benefits						
3.1a benefit stream: time saving for submitted referrals in ICB	£0.2m	£0.2m	£0.2m	£0.2m	£0.2m	£1.0m
3.2a benefit stream: time saved due to efficient messaging in ICB	£0.4m	£0.5m	£0.5m	£0.6m	£0.6m	£2.6m
3.3a benefit stream: reduced length of stay in ICB	£1.4m	£1.6m	£1.7m	£1.8m	£1.9m	£8.4m
Total benefits	**£2.1m**	**£2.2m**	**£2.4m**	**£2.6m**	**£2.8m**	**£12.0m**
Costs						
Total costs	**£1.1m**	**£0.9m**	**£0.8m**	**£0.8m**	**£0.8m**	**£4.3m**
NPV						
Total NPV (90% confidence interval range)	**£1.0m** (£0.7m to £1.3m)	**£1.3m** (£1.0m to £1.7m)	**£1.6m** (£1.2m to £1.9m)	**£1.8m** (£1.4m to £2.2m)	**£2.0m** (£1.6m to £2.4m)	**£7.7m** (£5.9m to £9.6m)
Total BCR	**1.9**	**2.6**	**2.9**	**3.3**	**3.7**	**2.8**

Sensitivity analysis

The sensitivity analysis assessed how various sources of uncertainty within the model contributed to the model's overall uncertainty. Figure 33 depicts the NPV sensitivity analysis using @RISK software to represent the most likely outcomes as well as the potential range of results at a 90% confidence interval based on 10,000 simulations.

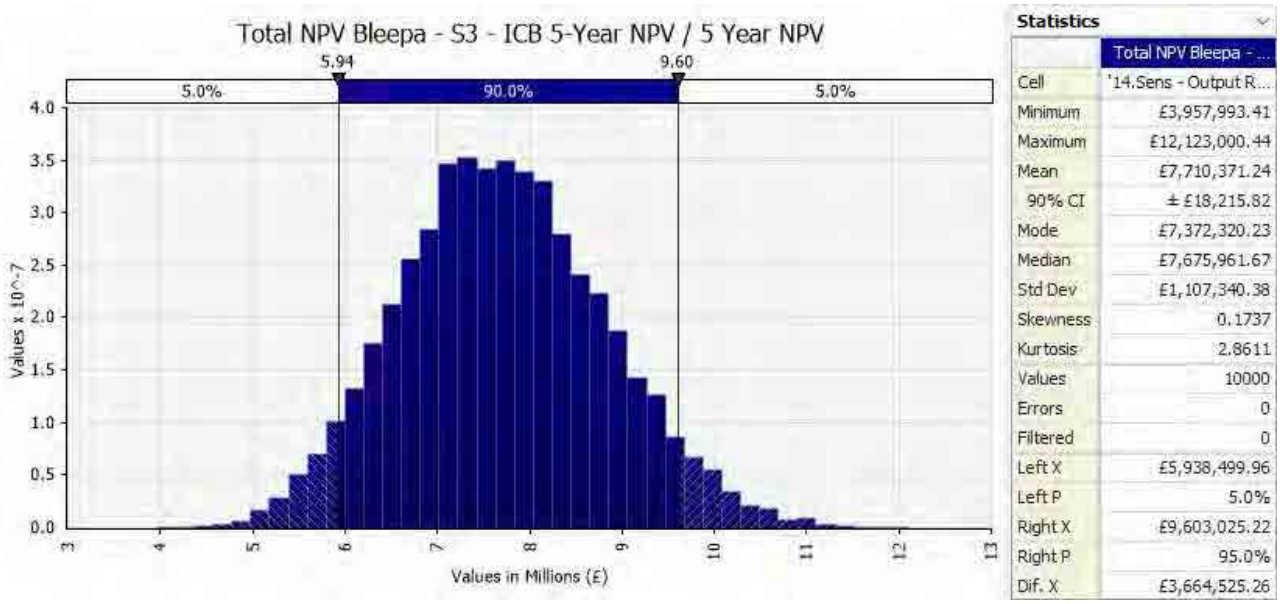


Figure 33: NPV sensitivity analysis for scenario 3a.

The sensitivity analysis for scenario 3a indicated that, within a 90% confidence interval, the modelled NPV falls between £5.9m and £9.6m, with an expected value (in other words, a mean) of £7.7m. The 90% confidence interval range of £3.7m was representative of the uncertainty in the assumptions used for the modelling.

The tornado chart in Figure 34 illustrates the individual impact of each variable input on the overall NPV. Each comparison fixes all other assumptions to the expected mean and uses the minimum/maximum values of the highlighted input to show the overall impact on the NPV. This has been completed for the pilot analysis to identify which influencing factors affect the value of the Bleepa the most. The results depicted that the difference in time taken to respond to a referral using Bleepa in NCA had the greatest effect on the evaluation. The reduction in LoS associated with clinical response time has the second highest influence on the NPV.

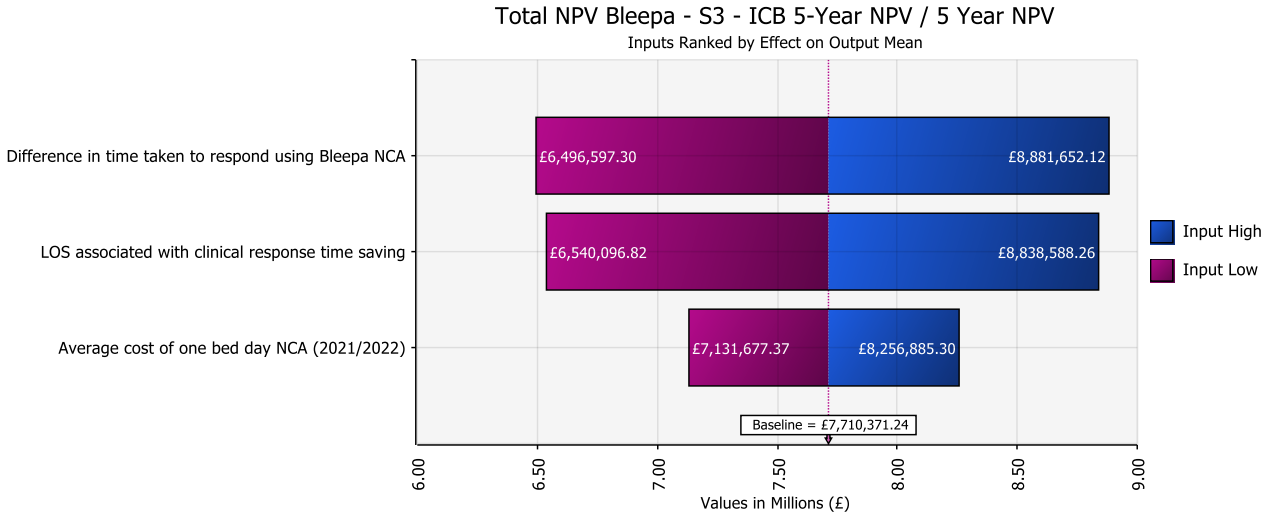


Figure 34: Tornado chart depicting key factors which influence the overall NPV value. The key indicates the expected change in outcomes when each factor is changed according to the minimum and maximum within the stipulated sensitivity range. The baseline figure is representative of the output mean.

Scenario 3b: ICB five-year NPV using Cloud-hosted costing

This section represents the results for scenario 3b, which examines the four major trusts within NHS Greater Manchester ICB. The model provides estimates of the costs and benefits under each scenario over their respective periods. Table 14 depicts the results for scenario 3b.

Table 14: Scenario 3b economic modelling results (£ represented as NPV in 2023 figures). Please note that the figures below have been rounded to the nearest GBP for presentation and as such, totals may not sum. These values have a GDP deflator and discounting applied.

Scenario 3a: ICB five-year NPV	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Benefits						
3.1a benefit stream: time saving for submitted referrals in ICB	£0.2m	£0.2m	£0.2m	£0.2m	£0.2m	£1.0m
3.2a benefit stream: time saved due to efficient messaging in ICB	£0.4m	£0.5m	£0.5m	£0.6m	£0.6m	£2.6m

3.3a benefit stream: reduced length of stay in ICB	£1.4m	£1.6m	£1.7m	£1.8m	£1.9m	£8.4m
Total benefits	**£2.1m**	**£2.2m**	**£2.4m**	**£2.6m**	**£2.8m**	**£12.0m**
Costs						
Total costs	**£1.4m**	**£1.3m**	**£1.2m**	**£1.2m**	**£1.1m**	**£6.2m**
NPV						
Total NPV (90% confidence interval range)	**£0.6m** (£0.4m to £1.0m)	**£0.9m** (£0.6m to £1.3m)	**£1.1m** (£0.8m to £1.5m)	**£1.4m** (£1.0m to £1.8m)	**£1.6m** (£1.2m to £2.1m)	**£5.7m** (£4.0m to £7.6m)
Total BCR	**1.5**	**1.7**	**1.9**	**2.2**	**2.5**	**1.9**

Sensitivity analysis for scenario 3b can be found in 'Appendix K: Forecast modelling insights'.

6. Discussion

6.1. Effectiveness

Time taken to complete referrals

Surveys combined with research identified an overall staff time saving of 5.86 minutes when submitting referrals using Bleepa, suggesting that Bleepa is effective in terms of saving time when submitting patient referrals (Section 4.3; Odisho et al., 2020; Shephard et al., 2018). The qualitative survey data is suggested to be a realistic representation of the time taken to complete referrals with and without Bleepa when cross referenced with similar figures were identified in Odisho et al. (2020) and Shephard et al. (2018), which also compared electronic and paper referrals.

Findings from the current evaluation suggest that Bleepa allows for faster response times compared to other referral methods. Beattie (2020) highlighted that the average duration from referral submission to reviewing a referral within ROH Respiratory was 2.1 days without using

Bleepa and 0.4 days using Bleepa. This figure was based on the first response message, rather than the full clinical referral review. The current evaluation suggested that the median average duration from referral submission (first message) to the next message was 0.55 days, with Respiratory being 0.28 days, and the median average duration from referral submission (first message) to the last referral message was 1.72 days within ROH Respiratory when using Bleepa (Figure 9; Figure 10). Both figures identified a time saving when using Bleepa compared to other referral methods, suggesting that Bleepa yields efficiency savings. Due to the larger sample size and data analyses across a longer period, there is greater confidence in the data obtained through the evaluation. This means that figures used in the current evaluation are considered more accurate compared to Beattie (2020).

Qualitative surveys highlighted that 66% of staff identified time savings when completing patient referrals through Bleepa (Figure 19). Staff suggested that Bleepa yielded time savings because staff could ask for more information and complete other tasks whilst waiting for a response, such as reviewing patients who needed to be seen in person.

Administration tasks

Around 66% of surveyed staff expressed their agreement that Bleepa had effectively reduced the number of administration tasks involved in completing referrals (Figure 18). This suggested that perceived time savings were identified for most Bleepa users. Despite this, the remaining staff, primarily from the Respiratory specialty, did not share the same sentiment; they did not perceive Bleepa to decrease the burden of administration tasks. This observation could suggest that certain staff members or specific specialties may still rely on traditional administration methods to complete some of their tasks, however a detailed analysis of the nature of these tasks completed by staff members were not examined within the current evaluation.

6.2. Value

Current evaluation findings and research by Beattie (2020) and Odisho et al. (2020) suggested that Bleepa can yield time savings when submitting, responding to, and reviewing referrals. Forecast modelling identified that such time savings led to cost-benefits within all three scenarios: retrospective analysis of NCA, prospective analysis of NCA, and prospective analysis of NHS Greater Manchester ICB. Throughout all scenarios, a positive BCR was identified, suggesting that Bleepa had (scenario 1), and can in the future (scenarios 2 and 3), deliver a positive net benefit/NPV to NCA and NHS Greater Manchester ICB. It can be suggested that Bleepa yields value to not only staff members (highlighted in Section 6.1, Section 6.3, and Section 6.4), but to the wider system (NHS non-cash releasing benefits) and patients (reduced length of stay).

In all scenarios, the BCR was the lowest in year one (Section 5). This was due to the initial implementation cost in the first year, less referral volumes, and the model analysis starting in July, thus not a full year was analysed. After year one, the BCR increased over time as only the annual platform license was costed. Cloud-hosted yielded a smaller NPV and BCR compared to on prem

costing in scenarios 2 (scenario 2a NPV = £819k, BCR = 2.5; scenario 2b NPV = £135k, BCR = 1.1) and 3 (scenario 3a NPV = £7.7m, BCR = 2.8; scenario 3b NPV = £5.7m, BCR = 1.9; Section 5). Although, forecast modelling was unable to account for the onsite running costs of Bleepa for on prem costing, such as server maintenance. This means that the actual impact of Bleepa may be different depending on the costs incurred from storing data on site. New sites implementing Bleepa may save more money in the long run by storing their data on the Cloud.

Sensitivity analysis indicated that, when all other assumptions were constant, the difference in the time taken to respond to a Bleepa referral in ROH had the greatest influence on the total NPV in each scenario (Section 5). The difference in time taken to respond to a Bleepa referral in FGH had the second greatest influence on the total NPV. Finding a more accurate baseline figure to measure the difference in the time taken to respond to a Bleepa referral in ROH and FGH would allow for increased confidence in the forecast modelling. This would allow for a more realistic minimum/maximum and a more appropriate distribution of datapoints for the simulation, generating a more robust model.

Time saving for submitted referrals

Scenario 1 (retrospective analysis of NCA 2021/22 to 2022/23) suggested that Bleepa yielded NHS non-cash releasing benefits due to the time saved when submitting referrals. As ROH had implemented Bleepa within a greater number of specialties, and therefore overall number of referrals, the total benefit identified for this benefit stream (£34k) was greater than that of FGH (£11k). This is mirrored within scenario 2 (five-year NPV prospective analysis of NCA 2023/24 to 2027/28), which showed a greater benefit for ROH (£84k) compared to FGH (£27k). At an ICB level, scenario 3 (five-year NPV prospective analysis 2023/24 to 2027/28) suggested that Bleepa could lead to benefits of £981k in NHS Greater Manchester ICB.

Time saving due to efficient messaging

Ryan et al. (2011) identified that staff saved up to 7.7 minutes when communicating with colleagues using digital methods compared to paper-based methods. Survey responses in the current evaluation identified a similar time saving of 5.86 minutes using Bleepa compared to paper-based methods. This supports the assumption that Bleepa yields time savings compared to other referral methods, suggesting that the figures used to quantify the time saving within benefit stream 2 could be considered appropriate.

Scenario 1 (retrospective analysis of NCA 2021/22 to 2022/23) suggested that Bleepa yielded NHS non-cash releasing benefits due to the time saved from efficient messaging. As ROH had implemented Bleepa within a greater number of specialties and had a greater number of Bleepa referrals, the total five-year benefit identified for this benefit stream (£90k) was greater than that of FGH (£30k). This is mirrored within scenario 2 (five-year NPV prospective analysis of NCA 2023/24 to 2027/28), which showed a greater five-year benefit for ROH (£223k) compared to FGH (£72k). At an ICB level, scenario 3 (five-year NPV prospective analysis 2023/24 to 2027/28) suggested that Bleepa could lead to five-year benefits of £2.6m in NHS Greater Manchester ICB.

Reduced length of stay

The current evaluation defined the response time used within benefit stream 3 as the time between the first and last message of the referral. This was the most prudent approach and identified a decrease in clinical response time of 0.15 days (2.1 days identified through Beattie, 2020, minus 1.95 days identified through quantitative analysis of Bleepa referral data; Figure 10).

Forecast modelling assumed that the reduction in patient length of stay was equal to the reduction in response time due to using Bleepa compared to other referral methods. Due to this assumption, an optimism bias correction was applied to benefit stream 3. Having access to a complete set of baseline figures to conduct more detailed statistical analysis and being able to measure actual patient length of stay with and without using Bleepa, would allow for a more robust model.

Scenario 1 (retrospective analysis of NCA 2021/22 to 2022/23) suggested that Bleepa yielded NHS non-cash releasing benefits due to a reduced length of stay. As ROH had implemented Bleepa within a greater number of specialties, the total benefit identified for this benefit stream (£275k) was greater than that of FGH (£133k). This is mirrored within scenario 2 (five-year NPV prospective analysis of NCA 2023/24 to 2027/28), which showed a greater benefit for ROH (£648k) compared to FGH (£304k). Further, the cost of a bed day at FGH was greater than that of ROH, hence these figures are not proportionally different in relation to referrals. At an ICB level, scenario 3 (five-year NPV prospective analysis 2023/24 to 2027/28) suggested that Bleepa could lead to benefits of £8.4m in NHS Greater Manchester ICB.

Reducing the delay in referral and treatment times could reduce patient deterioration and consequentially may reduce patient length of stay and improve patient outcomes (Lard et al., 2001; Lees et al., 2010; Levin, 2000; Scholz et al., 2018). Bleepa could reduce length of stay if treatment starts sooner due to the improved clinical response time.

6.3. Acceptability

Ease of use

Most staff members in both surveys and interviews suggested that Bleepa was easy to use in terms of accessibility and navigation (Section 4.2). The previous referral methods used were suggested to require more labour compared to Bleepa, which was noted to be more streamlined. This allowed staff to know where to send referrals to. Overall, this could suggest that Bleepa is easier to use than other referral methods, such as white paper or fax referrals.

Satisfaction

Most staff (80%) valued the impact Bleepa had on their everyday work and 85% felt confident using Bleepa in their everyday work (Figure 19). This suggests that most staff feel able to use Bleepa to complete referrals and may consider Bleepa to have a positive impact on their work. The remaining staff who appeared neutral or disagreed with the statements may not know how to use

Bleepa effectively due to having less experience using technology or due to minimal training, suggested through interview responses.

Patient care and outcomes

The majority of staff noted improvements in patient care and outcomes (85%) and thought Bleepa managed patient data safely (83%; Figure 21). One interviewee suggested that patient care and outcomes had improved because clinicians were more accountable for the referrals sent to them and were less likely to become lost compared to paper referrals. As stated in Section 6.2, previous literature identified that quicker referral and treatment times can lead to better patient outcomes (Lard et al., 2001; Lees et al., 2010; Levin, 2000; Scholz et al., 2018). It could be considered that Bleepa may reduce referral times and therefore time to treatment and patient length of stay. This could improve patient care, as patients receive treatment faster due to their referral being reviewed earlier when using Bleepa.

Communication

Overall, 80% of staff identified an improvement in staff communication when using Bleepa compared to other referral methods (Figure 20), suggesting that Bleepa allows for staff to communicate more effectively. Interview responses indicated this was because staff found it easier to contact their colleagues due to Bleepa's messaging capabilities. Previously, staff had to find their colleagues in person, which took time and could prove difficult in locating them.

Quantitative insights identified that referrals consisted of approximately 3.8 unique staff IDs on average (Figure 12). This suggests that multiple staff were communicating using Bleepa over sustained periods of time, implying that staff members may use Bleepa regularly. As Bleepa appeared to facilitate communication between multiple staff members, there may be a potential use case for Bleepa to help with the handover of information from a staff member from one shift to another. Integration with clinical data applications, such as PatientTrak and HealthView, could also facilitate effective handovers (Section 4.4).

Figure 7 highlights that staff in ROH Gastroenterology and FGH Gastroenterology appear to be sending slightly more messages on average over time. This suggests that staff may find it easier to communicate with their colleagues using Bleepa so tend to complete more of their communications through this method.

Quality of referral submissions

One staff member raised that Bleepa communication was only effective provided the referral message sent contained sufficient information to respond appropriately (Section 4.3). If the information in a submitted referral is insufficient, the reviewer may need to send a greater number of messages asking for more information. This could lead to referrals taking longer to complete.

Figure 8 identified an increase in average messages per referral in August 2022, when a new influx of junior doctors was noted to join each specialty. This may suggest that, because junior doctors may be unaware of the specialty-specific information required in referral submissions, quality of submitted referrals may be lower in August 2022 compared to other months. Further research

could determine whether this is the case by examining referral submission questions compared to the information provided and requested by Bleepa users. This could identify whether the questions asked in each specialty are suitable. This may lead to further cost savings related to efficient messaging, identified in benefit stream 2 (Section 5), if the average number of messages decreased.

6.4. Implementation

Accepting referrals

Overall, 27% of all referrals were accepted (73% were not accepted) and 66% of all referrals were released (34% were not released), suggesting that not all staff who used Bleepa were sharing the same usage behaviours. Interview responses implied that staff had differing perceptions regarding use of the "*accept*" feature. For example, one interviewee did not use the "*accept*" feature so they could manage their patients by keeping them on one list, whilst another suggested that those who do not use the "*accept*" feature may be technologically illiterate. This highlights the potential requirement for hospitals to work with Feedback Medical to adjust the process of using Bleepa to suit the needs of each specialty.

Figure 10 suggests that the response times between the first message of the referral and the last message by specialty shows variation, with average response times ranging from 0.92 days (ROH Cardiology) to 3.00 days (ROH Gastroenterology). Variations in response times could be due to availability of specialty staff or the nature of individual referrals, rather than due to Bleepa. Further insight surrounding whether this is the case should be explored to understand the true impact.

Training

No formal training is needed to use Bleepa due to its intuitive nature, however materials are available; this was highlighted through interviews and discussions with the Feedback Medical team. Survey responses indicated that 31% of staff in FGH and 22% of staff in ROH disagreed that "*sufficient training was provided to enable use of Bleepa*", suggesting improvements in the training process may be required. One interviewee suggested that a step-by-step online guide or face-to-face training would be useful. Figure 8 identified an increase in average messages per referral in August 2022 for ROH Gastroenterology and ROH Respiratory. New junior doctors typically start their role in early August (ID Medical, 2020), suggesting that the increase in messages per referral could be due to the new junior doctors as they may be unaware of the information that referral reviewers require. This could lead to an increase in messages flowing back and forth between staff. Standardised training, specific to each specialty, may lead to higher quality referral information.

Features of Bleepa

There was variation in the need for imaging features when using Bleepa. Figure 24 highlighted that 50% of staff who submitted referrals and 57% of staff who reviewed referrals did not use the

imaging features within Bleepa. Further, 42% of staff who submitted referrals and 29% of staff who reviewed referrals considered the imaging features to be useful when reviewing patient information. This suggests that some staff may use the imaging features of Bleepa more than others, which could be due to the nature of the referral or specialty. Breaking survey responses down by specialty was unable to be conducted in the current analysis due to the small sample size.

When asked whether integrating clinical data into Bleepa would be useful, 37% of surveyed staff considered this useful. It was expected that staff would prefer such integration within Bleepa as referrals take less time to complete. This suggests that staff may have misunderstood the question being asked. Interviews highlighted applications such as HealthView, Sectra, PatientTrak, and Core Pathology could be integrated into Bleepa. This would allow staff to access patient information faster, which could reduce the time taken to submit and review referrals and yield greater staff satisfaction.

Small interface changes to Bleepa were suggested (Figure 28). For example, staff members suggested lengthening the automatic log-out time, increasing the font size used, making staff activity status available, and notifying staff when a clinician responds to a referral on Bleepa. Improving the above could result in greater staff satisfaction levels and potentially yield efficiency savings, leading to benefits for patients and the wider system. At the time of the current report, the Bleepa team are currently working on and have completed some of the above recommendations.

7. Limitations

7.1. Baseline comparator

A time in motion study was intended to be completed to obtain baseline data surrounding the time taken to complete patient referrals, however this was unable to be conducted as it was difficult to find clinicians available to complete referrals and each specialty used the accept, submit, and release functions differently. Multiple approaches, such as through use of previous literature, were leveraged to compute an estimation of a comparator. Despite this, the baseline comparator may not be an accurate representation of actual baseline data that could have been collected through a time in motion study. Caution should be applied when creating inferences from the current evaluation due to this.

7.2. Quantitative insights

Time taken to complete referrals

The referral data depicts the time taken between submitting a referral and accepting a referral and between submitting a referral and releasing a referral using Bleepa. Although this provides the time taken between submitting and accepting or releasing a referral, this does not uncover the time staff members spend completing the referral process on Bleepa. The referral times defined by the parameters of the time between the first message and last message may not indicate an accurate representation of improved time efficiency of using Bleepa as some patients may take more time to be released from the specialty due to the treatment they require or their length of stay.

Available metrics and assumptions

The current evaluation has been conducted using the best available data at the current moment in time. Some data was excluded due to inconsistency of available information. The extraction of additional metrics could assist inferences of the data, leading to further insights and understanding. Some referrals had incomplete time stamps therefore the course of a referral could not be identified. Referrals with over 30 messages only displayed aggregated data and not a detailed breakdown of the date and time stamps of each message, therefore were omitted from the analysis. The data was only available from July 2021 to April 2023; therefore, an analysis of annual patterns was only available for 2022, or for the financial years of 2021/22 and 2022/23. These limitations of the dataset should be considered when reviewing the analysis.

Due to incomplete time stamps within the data and a lack of link of staff IDs to their corresponding specialties the following assumptions were made in the analysis:

- The first message of any referral was the starting point of the referral and should correspond to the *"referred"* time stamp.
- The last message of any referral was the end point of the referral and should correspond to the "*released*" time stamp.
- For referrals that did not have a "*released*" time stamp, the last message was assumed to be the patient's release date.
- The measurement of response time was calculated by identifying the message time stamp of the first alternate user from the first "*UserID*".
- The first "*UserID*" of a referral was assumed to be the from the submission side and the second "*UserID*" was assumed to be from the reviewing specialty.
- The proportion of staff by job role was equal to that of the survey responses due to no data being collected to link "*UserID*" to job role.

7.3. Qualitative insights

Out of the 250 staff members who were sent the survey, 53 (21%) responded. The remaining 79% of staff members yet to complete the survey may have differing views compared to those who did respond to the survey. Further, only four interviews were conducted due to few staff members consenting to be interviewed and much lower proportions attending interviews. Further, one interviewee stated they did not use Bleepa regularly. Such findings would be more generalisable to the wider target population of staff members using Bleepa to complete patient referrals, if a greater proportion of staff members responded to the survey. This meant that analysis was unable to be discussed by job role or specialty due to insufficient numbers of staff present within each job role and specialty. The small sample size therefore makes the insights from the interviews limited and lack robustness.

Quantitative data identified that 95% (*n* = 721) of staff members submitted Bleepa referrals and 69% (*n* = 526) of staff members reviewed referrals (*N* = 762; Section 3.3). Out of the staff members surveyed who used Bleepa, 94% (*n* = 45) submitted and 25% (*n* = 12) reviewed referrals (Figure 17). As similar percentages of those who submit and review referrals were identified, this suggests that survey findings are somewhat generalisable to those who submit Bleepa referrals and less generalisable to those who review Bleepa referrals. This means that some caution should be applied when inferring conclusions surrounding qualitative insights.

Respondents within surveys and interviews did not reflect usage behaviours in quantitative analysis in terms of specialties. The referral data obtained identified a large proportion of Gastroenterology usage data for Bleepa. Despite this, survey data yielded responses from individuals who were not part of Gastroenterology. Therefore, further survey responses are required from the Gastroenterology specialty to understand their views on Bleepa to provide comparison against the referral data. This could provide further insight to understand usage behaviours and identify whether Bleepa yields efficiency savings within this specialty.

7.4. Forecast modelling insights

Real world data surrounding Bleepa was limited due to few metrics collected from quantitative Bleepa referral data. A high optimism bias correction was applied within health economic modelling due to this uncertainty in data. For example, the time taken to submit and review referrals using Bleepa was unable to be obtained as a time in motion study was unable to be conducted. This meant that such figures had to be sourced through surveys, interviews, and previous research. As more robust evidence becomes available, the accuracy and confidence in the modelling is expected to improve.

Benefit stream 3 assumed that the time saved due to completing referrals through Bleepa was equal to a reduction in patient length of stay. No real-world data was available to suggest this was the case, therefore a large optimism bias correction was applied to account for this assumption that was made.

Forecast modelling was unable to account for the onsite running costs when storing data on the premises, such as the cost to maintain servers. This means that the on prem cost of using Bleepa may not be accurate and could change as more information surrounding costing becomes available.

Other benefit streams could be explored to understand further potential benefits of Bleepa. For example, the environmental benefit of Bleepa due to reduced paper consumption could be examined. This would identify sustainability benefits, which commissioners may perceive as important when considering new referral systems to integrate. From this, the evidence base supporting the positive impact of Bleepa to staff, patients, and the wider system would be strengthened.

8. Recommendations

8.1. Bleepa functionality and usage

Optimise procedures

Feedback Medical should aim to work closely with hospitals to calibrate the procedures of accepting and releasing referrals to ensure effective use of Bleepa in each specialty and hospital. This could be done through formalised training. To save time, standardised training of champions could be completed, so they understand how to use Bleepa effectively and then share this knowledge with others internally. From this, it is hoped that further time savings could be identified between referral submission and release due to fewer messages being sent for each referral.

To determine whether formalised training has improved once implemented, the average number of messages per referral could be identified and compared to that of the current evaluation where it is expected that the average number of messages should decrease. Further, surveys could be conducted to ask staff members whether the training has helped them to understand how to use Bleepa effectively and whether any further improvements are required. Staff could also be asked questions surrounding the suitability of the questions asked within referrals; this could contribute to increased numbers of referral messages.

Enhanced usability

Staff surveys highlighted improving the usability of Bleepa, where the following improvements were suggested:

- Asking more succinct questions when submitting referrals
- Receiving a notification when a clinician responds to a referral
- Lengthening the automatic log-out time

- Having a clearer font and size of referral message text
- Using the enter button to have a line break instead of submitting the referral
- Including the activity status of clinicians on Bleepa

It is expected that through making the above improvements, staff may be further satisfied with using Bleepa in their day-to-day work and could make the referral process easier, thus yielding potential further time savings.

8.2. Ongoing monitoring of Bleepa value claims

Quantitative metrics

To explore further areas of understanding of the usage of Bleepa the following metrics have been outlined as potential metrics to generate for future insights:

- **Baseline comparator data:** Current research used literature and qualitative insights to identify the time taken to submit and review previous referral methods; a time in motion study was unable to be conducted. If possible, quantitatively measuring the real-world time taken to submit and review referrals without Bleepa in each specialty would be likely to identify more accurate figures and create more reliable insights into the effectiveness and value of Bleepa.
- **The hospital and specialty of the referral source:** Understanding the origin of the patient referrals could provide further insight into patient flow and common behaviours within certain specialties. Currently the data is viewed from the perspectives of the receiving specialty only and variances within referral data could be attributed to the origin specialties to identify patterns.
- **Staff IDs linked to the corresponding specialty and hospital:** Linking the staff IDs to their specialty and hospital can provide further insight into certain behaviours and patterns for certain users of Bleepa. For example, for referrals with multiple users present, it may be difficult to distinguish which user is from what specialty and from what side of the referral they are involved in. Understanding staff IDs alongside their specialty and hospital will show user involvement such as how many users tend to respond to referrals.
- **Patient metrics such as age, ethnicity, and ICD-10 codes:** Extracting patient information could inform the timings of each referral for example identifying more complex patients who may have increased risk factors could present an opportunity to understand if there is a relationship between patient complexity and the length of referrals. This could be used to compare against national statistics for patient demographics to show that Bleepa is in line with NHS standards of care.

When collecting data on the Bleepa system itself, ways to improve this process could be identified to reduce the amount of data manipulation required to create useful insights.

Qualitative metrics

Should a further evaluation into Bleepa be conducted, it is recommended that qualitative insights should be conducted with a specific focus on Bleepa usage in Gastroenterology, Respiratory, and Cardiology. This would allow for further comparison of quantitative and qualitative data to understand Bleepa usage behaviours with greater reliability.

An understanding surrounding staff availability and the nature of individual referrals could also be examined through qualitative insights. This would gain understanding surrounding why some referrals may require more staff members or messages. The impact of staff availability and the nature of referrals on perceived efficiency of Bleepa could be identified through this.

Expanding qualitative work into other specialties and trusts would allow an understanding of Bleepa's impact within newly integrated areas. Comparing these findings to that of the current evaluation would determine whether such efficiency outcomes are replicable. This could be used to formulate a blueprint for implementation to improve the embedding process of Bleepa into new sites or specialties.

8.3. Future implementation

Future implementation sites should consider integrating other clinical platforms, such as HealthView and PatientTrak, with Bleepa. This could yield further time savings as staff members would spend less time logging on to different platforms to access patient data; such data would be readily available on Bleepa.

9. Conclusion

Bleepa is an application which aims to improve patient referral processes and lower response times for inpatient referrals, as well as enable efficient and effective clinical communication. The current evaluation findings suggest that Bleepa was effective within specialties in ROH and FGH; Bleepa was suggested to lead to time savings compared to previous inpatient referral methods, such as paper-based fax referrals. Staff members suggested this was because Bleepa was easy to use and allowed staff to ask their colleagues for more information and complete other tasks whilst waiting for a response. This time saved was noted to be used to review patients who needed to be seen in person.

Although time savings were identified in the current evaluation, conclusions made using baseline comparator data consisting of previous literature should be applied with caution. The baseline comparator did not use real-world data; assumptions were applied. Should a real-world baseline

comparator be identified and used instead of that within the current evaluation, findings may change as the accuracy of data increases.

Staff members identified an improvement in staff communication since using Bleepa. This was indicated to be due to staff finding it easier to contact their colleagues through Bleepa's messaging capabilities. Further, 85% of surveyed staff felt confident using Bleepa in their everyday work, suggesting that staff accepted the use of Bleepa in their work.

Interviews and discussions with the Feedback Medical team highlighted that no formal training was in place to allow staff to use Bleepa. A quarter of surveyed staff selected that they disagreed with the statement "*sufficient training was provided to enable use of Bleepa*". This suggests that some staff may require more training than initially expected to allow appropriate use of Bleepa.

It is suggested that specialty-specific training should be standardised to allow for effective implementation within future sites. Quantitative and qualitative insights noted variability in use of the "*accept"* feature on Bleepa. It is suggested that this process should also be tailored to each specialty to allow for staff to use Bleepa efficiently in each specialty.

Feedback Medical should aim to enhance the usability of Bleepa; staff suggested changes such as including notifications and staff activity status, lengthening the log-out time, and having clearer font used within Bleepa. This could allow staff satisfaction to increase further.

The time savings yielded from Bleepa are assumed to lead to NHS non-cash releasing savings, identified through forecast modelling. Scenario 1 examined the retrospective impact of Bleepa between 2021 and 2023. Over the duration Bleepa was active using on prem costing, a net benefit of £359k was yielded. Modelled forward into scenario 2 to identify the prospective five-year impact of Bleepa, the NPV was £819k for on prem costing and £135k for Cloud-hosted costing respectively. Finally, when exploring the potential impact of Bleepa should the solution be integrated at an ICB-level, the five-year NPV was £7.7m for on prem costing and £5.7m for Cloud-hosted costing. This suggests that Bleepa can provide value to staff, patients, and the wider system.

Overall, use of Bleepa could lead to benefits for staff, patients, and the wider system. Should Bleepa be implemented in more specialties or sites, the Feedback Medical team should aim to standardise the training process and work with hospitals to tailor Bleepa usage to each specialty, ensuring effective use. Future evaluations should aim to identify a suitable baseline comparator to increase the accuracy of conclusions made. Once this has been established, it is likely that staff members in future sites are likely to experience improvements in staff communication and satisfaction levels, whilst inpatients could have a shorter length of stay and lead to NHS non-cash releasing savings for the trust or ICB.

10. References

Beattie, J. (2020). *Benefits Statement Bleepa*. [Unpublished].

Bleepa. (2021a). *Process Improvements & Time Savings*. https://bleepa.com//wp-content/uploads/2021/01/201117-Bleepa_Case-study-Process-Improvement_Final.pdf

Bleepa. (2023a). *CLOUD HOSTED Pricing proposal Bleepa NHS Trusts*. [Unpublished].

Bleepa. (2023b). *ON PREM Pricing proposal Bleepa NHS Trusts*. [Unpublished].

Bleepa. (2021b). *Introducing CareLocker*. Bleepa - Medical Imaging Communications. https://bleepa.com/carelocker

Bleepa. (2022). *Home*. https://bleepa.com/

British Medical Association. (2022). *An NHS under pressure*. The British Medical Association Is the Trade Union and Professional Body for Doctors in the UK. https://www.bma.org.uk/advice-and-support/nhs-delivery-and-workforce/pressures/an-nhs-under-pressure

Care Quality Commission. (2020a). *All inspections: The Royal Oldham Hospital*. https://www.cqc.org.uk/location/RW603/reports

Care Quality Commission. (2020b). *Fairfield General Hospital*. https://www.cqc.org.uk/location/RW601/inspection-summary

Cathcart, J., Cowan, N., & Tully, V. (2016). Referral Finder: Saving Time and Improving The Quality of In-hospital Referrals. *BMJ Open Quality*, *5*(1), u209356.w3951. https://doi.org/10.1136/bmjquality.u209356.w3951

Deakin, M. (2022). NHS workforce shortages and staff burnout are taking a toll. *BMJ*, *377*, o945. https://doi.org/10.1136/bmj.o945

Department of Health and Social Care. (2021). *A guide to good practice for digital and data-driven health technologies*. GOV.UK. https://www.gov.uk/government/publications/code-of-

conduct-for-data-driven-health-and-care-technology/initial-code-of-conduct-for-data-driven-health-and-care-technology

Feedback Medical. (2022). About Feedback Medical. *Feedback Medical*. https://fbkmed.com/about-us/

Harvey Walsh Ltd. (2023). *Hospital Episode Statistics*. https://www.axon360.co.uk/

HM Treasury. (2021). *GDP deflators at market prices, and money GDP*. https://www.gov.uk/government/collections/gdp-deflators-at-market-prices-and-money-gdp

HM Treasury. (2022). *The Green Book (2022)*. GOV.UK. https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent/the-green-book-2020

HM Treasury, Public Service Transformation Network & New Economy. (2014). *Supporting public service transformation: Cost benefit analysis guidance for local partnerships*. HM Government.

ID Medical. (2020, June 19). Everything You Need to Know About Junior Doctor Rotations. *ID Medical*. https://www.id-medical.com/junior-doctor-rotations/

Jones, K. C., & Burns, A. (2021). *Unit Costs of Health and Social Care*. Personal Social Services Research Unit. https://www.pssru.ac.uk/project-pages/unit-costs/unit-costs-of-health-and-social-care-2021/

Lard, L. R., Visser, H., Speyer, I., vander Horst-Bruinsma, I. E., Zwinderman, A. H., Breedveld, F. C., & Hazes, J. M. W. (2001). Early versus delayed treatment in patients with recent-onset rheumatoid arthritis: Comparison of two cohorts who received different treatment strategies. *The American Journal of Medicine*, *111*(6), 446–451. https://doi.org/10.1016/S0002-9343(01)00872-5

Lees, K. R., Bluhmki, E., Kummer, R. von, Brott, T. G., Toni, D., Grotta, J. C., Albers, G. W., Kaste, M., Marler, J. R., Hamilton, S. A., Tilley, B. C., Davis, S. M., Donnan, G. A., & Hacke, W. (2010). Time to treatment with intravenous alteplase and outcome in stroke: An updated pooled analysis of ECASS, ATLANTIS, NINDS, and EPITHET trials. *The Lancet*, *375*(9727), 1695–1703. https://doi.org/10.1016/S0140-6736(10)60491-6

Levin, A. (2000). Consequences of late referral on patient outcomes. *Nephrology Dialysis Transplantation*, *15*(suppl_3), 8–13. https://doi.org/10.1093/oxfordjournals.ndt.a027977

MacDonald, M. (2002). *Review of Large Public Procurement in the UK*. https://www.parliament.vic.gov.au/images/stories/committees/paec/2010-11_Budget_Estimates/Extra_bits/Mott_McDonald_Flyvberg_Blake_Dawson_Waldron_studies.pdf

National Institute for Clinical Excellence. (2022). *Evidence standards framework (ESF) for digital health technologies* [CorporatePage]. NICE; NICE. https://www.nice.org.uk/about/what-we-do/our-programmes/evidence-standards-framework-for-digital-health-technologies

NHS Digital. (2022). *NHS Workforce Statistics, October 2022 Doctors by Grade and Specialty*. https://view.officeapps.live.com/op/view.aspx?src=https://files.digital.nhs.uk/95/D6EB18/NHS%2520Workforce%2520Statistics%252C%2520October%25202022%2520Doctors%2520by%2520Grade%2520and%2520Specialty.xlsx&wdOrigin=BROWSELINK

NHS Digital. (2023). *COVID-19 Situation Reports*. NHS Digital. https://digital.nhs.uk/about-nhs-digital/corporate-information-and-documents/directions-and-data-provision-notices/data-provision-notices-dpns/covid-19-situation-reports

NHS England. (n.d.). *Reducing length of stay*. https://www.england.nhs.uk/urgent-emergency-care/reducing-length-of-stay/

NHS England & NHS Improvement. (2022). *A guide to the market forces factor*. https://www.england.nhs.uk/wp-content/uploads/2022/04/h-market-forces-factor-22-23.xlsx

NHS Long Term Plan. (2019). *Chapter 5: Digitally-enabled care will go mainstream across the NHS*. NHS Long Term Plan. https://www.longtermplan.nhs.uk/online-version/chapter-5-digitally-enabled-care-will-go-mainstream-across-the-nhs/

Odisho, A., Lui, H., Yerramsetty, R., Bautista, F., Gleason, N., Martin, E., Young, J., Blum, M., & Neinstein, A. (2020). *Design and development of Referrals Automation, a SMART on FHIR solution to improve patient access to specialty care*. https://academic.oup.com/jamiaopen/article/3/3/405/5941917

Personal Social Services Research Unit. (2021). *IV. Hospital-based health care staff*. https://www.pssru.ac.uk/pub/uc/uc2021/hospitalbased.pdf

Ryan, S., O'Riordan, J. M., Tierney, S., Conlon, K. C., & Ridgway, P. F. (2011). Impact of a new electronic handover system in surgery. *International Journal of Surgery*, *9*(3), 217–220. https://doi.org/10.1016/j.ijsu.2010.11.012

Scholz, K. H., Maier, S. K. G., Maier, L. S., Lengenfelder, B., Jacobshagen, C., Jung, J., Fleischmann, C., Werner, G. S., Olbrich, H. G., Ott, R., Mudra, H., Seidl, K., Schulze, P. C., Weiss, C., Haimerl, J., Friede, T., & Meyer, T. (2018). Impact of treatment delay on mortality in ST-segment elevation myocardial infarction (STEMI) patients presenting with and without haemodynamic instability: Results from the German prospective, multicentre FITT-STEMI trial. *European Heart Journal*, *39*(13), 1065–1074. https://doi.org/10.1093/eurheartj/ehy004

Shephard, E., Stockdale, C., May, F., Brown, A., Lewis, H., Jabri, S., Robertson, D., Moss, V., & Bethune, R. (2018). *E-referrals: Improving the routine interspecialty inpatient referral system | BMJ Open Quality*. https://bmjopenquality.bmj.com/content/7/3/e000249

Unity Insights. (2023a). *Bleepa: Interim report*. [Unpublished].

Unity Insights. (2023b). *Qualitative analysis*. [Unpublished].

Unity Insights. (2023c). *Quantitative analysis* [dataset].

Warren, J., White, S., Day, K. J., Gu, Y., & Pollock, M. (2011). *Introduction of Electronic Referral from Community Associated with More Timely Review by Secondary Services*. https://www.thieme-connect.com/products/ejournals/pdf/10.4338/ACI-2011-06-RA-0039.pdf

Ziff, O. J., Routledge, E., Turner, C., & Chandratheva, A. (2019). *Modernising inpatient referral systems: Switching from 'on call' to 'online'*. https://pmj.bmj.com/content/95/1123/292

11. Appendices

11.1. Appendix A: Metrics

Table 15 depicts the metrics used within the current evaluation for qualitative and quantitative analysis. Metrics used in health economic modelling can be identified within 'Appendix G: Health economic modelling scenarios and benefits and cost streams'.

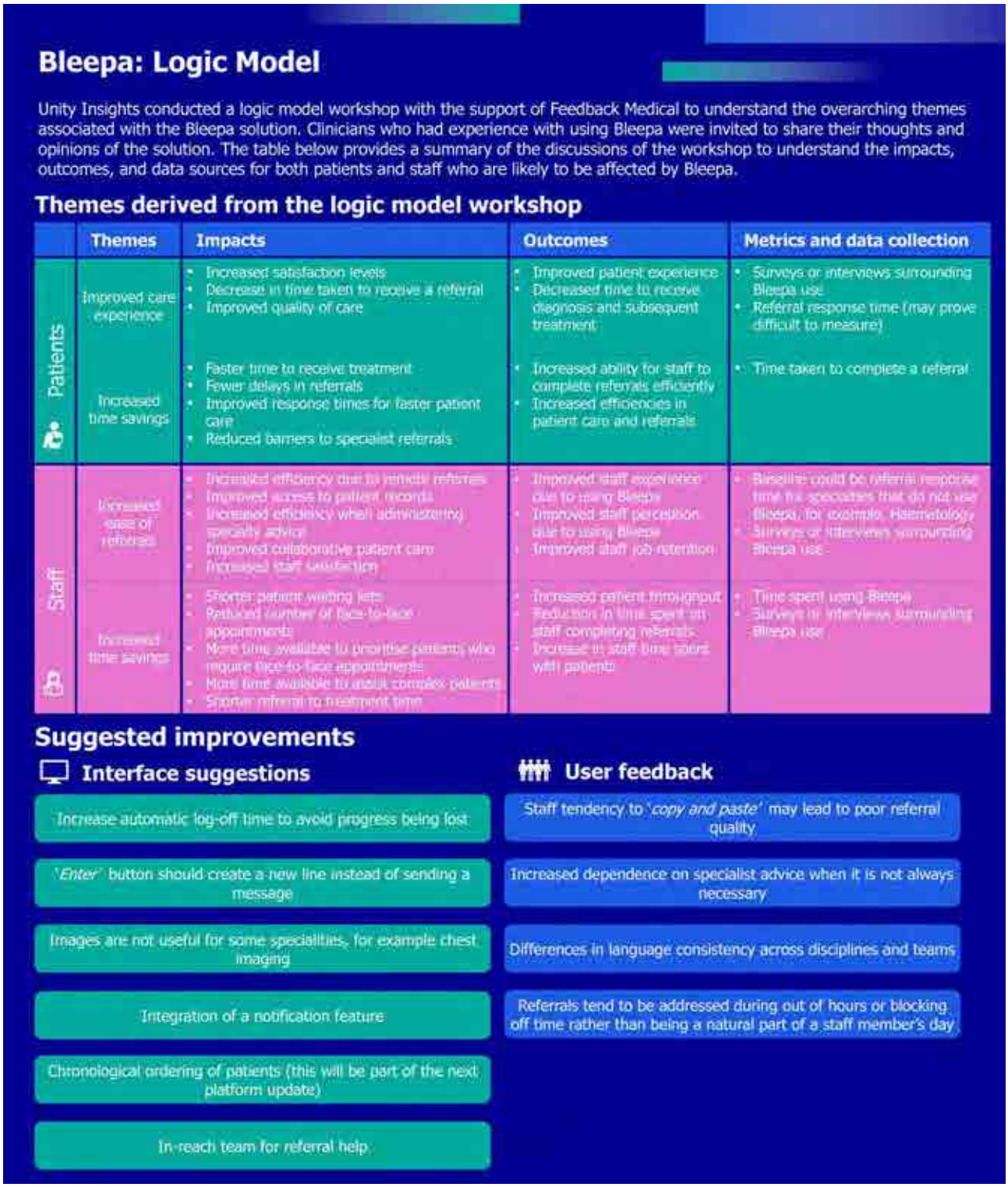
Table 15: Metrics used within the evaluation.

Evaluation theme	Outcome	Data source	Metric	Analysis
Effectiveness, value	Time savings	Bleepa application referral data	Frequency of referrals	Quantitative analysis to determine the frequency of referrals overall, by hospital, specialty, day of the week, month of the year
Effectiveness, value	Time savings	Bleepa application referral data	Referral response	Quantitative analysis to determine the average time taken to respond to a referral denoted by the first message after the referral message with an alternate "*UserID*"
Effectiveness, value	Time savings	Bleepa application referral data	Referral duration	Quantitative analysis of the number of messages exchanged per referral as an indication of the length of a referral by specialty
Effectiveness, value	Time savings	Survey data	Perceived duration of Bleepa use	Analysis of Likert scale questions "*Bleepa has reduced the number of administration tasks*" and "*Bleepa has reduced the time taken to complete patient referrals*", "*How long*

Evaluation theme	Outcome	Data source	Metric	Analysis
				does it take you on average to submit a referral using Bleepa?", and "*Whilst using the Bleepa platform, how long does it take you to review a referral?*"
Acceptability, implementation	Ease of use	Survey data	Ease of use when using Bleepa	Analysis of Likert scale questions "*How would you rate the Bleepa platform in terms of ease of use overall?*", "*How easy do you find using Bleepa in your day-to-day work?*", "*My day-to-day work is made easier using Bleepa*", and "*It is easy for me to access patient information using Bleepa*"
Acceptability	Staff satisfaction	Survey data	Satisfaction levels using Bleepa	Analysis of Likert scale questions "*By using Bleepa, quality of staff communication has:*" and "*Whilst using Bleepa, patient care and outcomes are:*"
Acceptability, implementation	Staff perceptions	Survey data	Perceived value of Bleepa	Analysis of Likert scale questions "*I value the impact Bleepa has had on my everyday work*" and "*Bleepa manages patient data safely*".
Acceptability	Confidence	Survey data	Confidence levels using Bleepa	Analysis of Likert scale question "*I feel confident using Bleepa in my everyday work*"

Evaluation theme	Outcome	Data source	Metric	Analysis
Acceptability, implementation	Staff satisfaction	Bleepa application referral data	Usage behaviours	Quantitative analysis of the number of unique "*userIDs*" (staff IDs) who submit and review referrals and the number of unique "*UserIDs*" (staff IDs) involved in one referral
Implementation	Integration	Bleepa application referral data	Bleepa usage behaviours	Quantitative analysis of the frequency of accepted and released time stamps in comparison to the number of referred time stamps for each specialty
Implementation	Resources required	Survey data	Features of Bleepa	Analysis of Likert scale and free-text questions "*Does having access to diagnostic quality imaging help you when reviewing a patient?*", "*Would having access to Bleepa on your mobile device improve your experience of the platform?*" and "*Would you feel confident handling cases remotely or offsite if you could access Bleepa on your mobile device?*"
Implementation	Improvements to Bleepa	Survey data	Suggested improvements to Bleepa	Analysis of free-text questions "*How could Bleepa be improved?*"

11.2. Appendix B: Logic model workshop



Bleepa: Logic Model

Unity Insights conducted a logic model workshop with the support of Feedback Medical to understand the overarching themes associated with the Bleepa solution. Clinicians who had experience with using Bleepa were invited to share their thoughts and opinions of the solution. The table below provides a summary of the discussions of the workshop to understand the impacts, outcomes, and data sources for both patients and staff who are likely to be affected by Bleepa.

Themes derived from the logic model workshop

	Themes	Impacts	Outcomes	Metrics and data collection
Patients	Improved care experience	• Increased satisfaction levels • Decrease in time taken to receive a referral • Improved quality of care	• Improved patient experience • Decreased time to receive diagnosis and subsequent treatment	• Surveys or interviews surrounding Bleepa use • Referral response time (may prove difficult to measure)
	Increased time savings	• Faster time to receive treatment • Fewer delays in referrals • Improved response times for faster patient care • Reduced barriers to specialist referrals	• Increased ability for staff to complete referrals efficiently • Increased efficiencies in patient care and referrals	• Time taken to complete a referral
Staff	Increased ease of referrals	• Increased efficiency due to refresh/ refreshes • Improved access to patient records • Increased efficiency when administering specialty advice • Improved collaborative patient care • Increased staff satisfaction	• Improved staff experience due to using Bleepa • Improved staff perception due to using Bleepa • Improved staff job retention	• Baseline could be referral response time for specialties that do not use Bleepa, for example, Haematology • Surveys or interviews surrounding Bleepa use
	Increased time savings	• Shorter patient waiting lists • Reduced number of face-to-face appointments • More time available to prioritise patients who require face-to-face appointments • More time available to assist complex patients • Shorter referral to treatment time	• Increased patient throughput • Reduction in time spent on staff completing referrals • Increase in staff time spent with patients	• Time spent using Bleepa • Surveys or interviews surrounding Bleepa use

Suggested improvements

Interface suggestions

- Increase automatic log-off time to avoid progress being lost
- '*Enter*' button should create a new line instead of sending a message
- Images are not useful for some specialities, for example chest imaging
- Integration of a notification feature
- Chronological ordering of patients (this will be part of the next platform update)
- In-reach team for referral help

User feedback

- Staff tendency to '*copy and paste*' may lead to poor referral quality
- Increased dependence on specialist advice when it is not always necessary
- Differences in language consistency across disciplines and teams
- Referrals tend to be addressed during out of hours or blocking off time rather than being a natural part of a staff member's day

11.3. Appendix C: Referral journey example

Figure 35 and Figure 36 depict the patient journey through the Bleepa platform. Each row corresponds to an individual referral from start to finish. The journey starts in Figure 35 with column A identifying the referral destination, split out by hospital (column B) and specialty (column C). The pseudonymised patient ID (column D) and the number of patient ID referral (column E) indicates the referral number the row relates to for the relevant patient.

Workflow	Referral Destination Hospital	Referral Destination Specialty	PatientId	Number of patient ID referral	Referred_TimeStamp	Referred_UserId	Accepted_TimeStamp	Accepted_UserId	Releasedd_TimeStamp	Releasedd_UserId	Message1
ROH Cardiology	ROH	Cardiology	[redacted]	1	06/09/2021 11:39	[redacted]		[redacted]	06/09/2021 14:47	[redacted]	06/09/2021 11:39
ROH Gastroenterology	ROH	Gastroenterology	[redacted]	1	19/04/2023 14:47	[redacted]		[redacted]	21/04/2023 03:52	[redacted]	19/04/2023 14:47
ROH Gastroenterology	ROH	Gastroenterology	[redacted]	1	06/12/2022 03:53	[redacted]	06/12/2022 15:40	[redacted]		[redacted]	06/12/2022 03:53
ROH Gastroenterology	ROH	Gastroenterology	[redacted]	1	13/09/2022 12:32	[redacted]		[redacted]	14/09/2022 08:27	[redacted]	13/09/2022 12:32
FGH Gastroenterology	FGH	Gastroenterology	[redacted]	2	14/09/2022 17:09	[redacted]	15/09/2022 11:24	[redacted]		[redacted]	14/09/2022 17:09
ROH Gastroenterology	ROH	Gastroenterology	[redacted]	1	30/09/2022 12:52	[redacted]		[redacted]		[redacted]	30/09/2022 12:52
ROH Cardiology	ROH	Cardiology	[redacted]	1	11/10/2021 09:02	[redacted]		[redacted]	11/10/2021 10:37	[redacted]	11/10/2021 09:02
ROH Cardiology	ROH	Cardiology	[redacted]	1	12/01/2023 14:55	[redacted]		[redacted]	13/01/2023 10:07	[redacted]	12/01/2023 14:55
ROH Respiratory	ROH	Respiratory	[redacted]	2	13/01/2023 10:29	[redacted]		[redacted]	13/01/2023 13:31	[redacted]	13/01/2023 10:29
ROH Cardiology	ROH	Cardiology	[redacted]	3	05/04/2023 10:06	[redacted]		[redacted]		[redacted]	05/04/2023 10:06

Figure 35: Part one of the referral journey example.

UserId1	Message2	UserId2	Message3	UserId3	Message4	UserId4	Message5	UserId5	Message6	UserId6	Message7
[redacted]	06/09/2021 14:47	[redacted]		[redacted]		[redacted]		[redacted]		[redacted]	
	20/04/2023 07:32		21/04/2023 03:52								
	06/12/2022 11:54		06/12/2022 11:56		06/12/2022 15:40						
	13/09/2022 13:51		13/09/2022 14:25		13/09/2022 15:03		14/09/2022 08:05		14/09/2022 08:27		14/09/2022 09:37
	15/09/2022 09:06		15/09/2022 11:24		15/09/2022 12:09		16/09/2022 09:07		16/09/2022 09:26		16/09/2022 09:27
	03/10/2022 15:39										
	11/10/2021 10:36		11/10/2021 10:37								
	13/01/2023 10:06		13/01/2023 10:07								
	13/01/2023 11:35		13/01/2023 13:28		13/01/2023 13:31		03/04/2023 09:50		03/04/2023 09:52		
	05/04/2023 10:38										

Figure 36: Part two of the referral journey example.

Column F includes the referred time stamp, which should always match *"Message1"* in the sequence. Column G shows the pseudonymised "*UserID*" of the staff member who submitted the referral. This is the same for column H and I and column J and K, which

shows the time stamp and corresponding user ID. Each row shows the number of messages exchanged on the Bleepa platform, named in chronological order of occurrence. The released time stamp in column J should always match the last message in the referral row. For patients with multiple referrals, some message time stamps were carried over, resulting in all the time stamp messages in the patient's history appearing in each referral row (Figure 36; column T to column X).

11.4. Appendix D: Staff survey questions

Table 16 depicts the survey questions administered to staff members and their respective response options.

Table 16: Staff survey questions and response options.

Question number	Question	Response
Demographic data		
1	Which sites do you currently work at? (Please select all that apply)	**Multiple choice tick box:** Fairfield General Hospital Royal Oldham Hospital Other (please specify comment box)
2	Which sites do you currently use Bleepa at? (Please select all that apply)	**Multiple choice tick box:** Fairfield General Hospital Royal Oldham Hospital Other (please specify comment box) I do not use Bleepa at any sites **– logic to ask no further questions after Q4**
3	What is your job role?	**Single choice tick box:** Trainee doctor (Foundation, ST1, junior fellow, or equivalent) Trainee doctor (IMT3, specialty registrar, senior fellow, or equivalent) Physician associate or advanced practitioner Consultant or Associate Specialist

Question number	Question	Response
		Nurse (Bands 5 to 7) Other (please specify comment box)
4	What specialty do you work within?	**Single choice tick box:** Cardiology Gastroenterology General surgery Palliative care Respiratory Other (please specify comment box)
	Bleepa-related questions	
5	Do you submit or receive referrals through Bleepa? (Please select all that apply)	**Multiple choice tick box:** I submit referrals using Bleepa **– logic to include Q14** I receive referrals using Bleepa **– logic to include Q15** I submit and receive referrals through Bleepa **– logic to include Q14 and Q15** Neither
6	How easy do you find using Bleepa into your day-to-day work?	**Single choice tick box:** Very easy Easy Neither easy nor difficult Difficult Very difficult

Question number	Question	Response
7	How would you rate the Bleepa platform in terms of ease of use overall?	**Single choice tick box:** Very easy Easy Neither easy nor difficult Difficult Very difficult
8	Whilst using Bleepa, patient care and outcomes are:	**Single choice tick box:** Much improved Somewhat improved About the same Somewhat worse Much worse
9	By using Bleepa, quality of staff communication has:	**Single choice tick box:** Much improved Somewhat improved About the same Somewhat worse Much worse
10	Please rate your level of agreement with the following statements: Sufficient training was provided to enable use of Bleepa. My day-to-day work is made easier by using Bleepa. I value the impact Bleepa has had on my everyday work. I feel confident using Bleepa in my everyday work.	**Single choice tick box:** Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree

Question number	Question	Response
	It is easy for me to access patient information using Bleepa. Bleepa manages patient data safely. Bleepa has reduced the number of administration tasks. Bleepa has reduced the time taken to complete patient referrals.	
11	Does having access to diagnostic quality imaging help you when reviewing patient information?	**Single choice tick box:** Yes No I do not use the image features within Bleepa
12	There is a need for more complex image manipulation features to be integrated within Bleepa (e.g., 3D reconstructions or multiple plane reconstruction images)	**Single choice tick box:** Neutral No I do not use the image features within Bleepa Yes **– comment box to suggest image features**
13	Integration of other clinical data within Bleepa would be useful (e.g., blood test results, electrocardiograms, pathology data)	**Single choice tick box:** Neutral No Yes **– comment box to suggest which clinical data**
14	How long does it take you on average to submit a referral using Bleepa?	**Single choice tick box:** Less than 2 minutes 2 to 5 minutes 5 to 10 minutes

Question number	Question	Response
		Over 10 minutes
15	Whilst using the Bleepa platform, how long does it take you to review a referral?	**Single choice tick box:** Less than 2 minutes 2 to 5 minutes 5 to 10 minutes Over 10 minutes
16	Does Bleepa allow you to handle some referral requests without having to see the patient? If yes, roughly what proportion would you say?	**Single choice tick box:** Yes, please tell us the proportion **– comment box to suggest proportions** No
17	Would having access to Bleepa on your mobile device improve your experience of the platform?	**Single choice tick box:** Yes No Neutral
18	Would you feel confident handling cases remotely or offsite if you could access Bleepa on your mobile device?	**Single choice tick box:** Yes No Neutral **Comment box to explain answer regardless of which option selected:** Please explain your answer
19	How could Bleepa be improved?	**Free-text**
Interview consent question		
20	Would you be interested in being contacted for an interview to discuss Bleepa further? If yes, please state your email address.	**Single choice tick box:**

Question number	Question	Response
		Yes (Please state your email below) **– comment box for email** No

11.5. Appendix E: Staff interview questions

Table 17 depicts the interview questions as part of the staff member interview process.

Table 17: Interview questions asked to staff members who used Bleepa.

Question number	Question	Theme
1	How does Bleepa impact your work and overall specialty? • How does Bleepa impact your work compared to previous referral methods you have used in the past? • How has Bleepa impacted patient care and safety? • How has Bleepa impacted staff communication?	Staff satisfaction / ease of use
2	How long did it used to take to respond to a patient referral without Bleepa and how long does it take with Bleepa? • What method did you use to respond to a patient referral previously? • Do you believe Bleepa is quicker than before? If so, how much by?	Efficiency savings
3	Do you work at the weekend? If so, do you use Bleepa at the weekend? • Referral data suggests that Bleepa is used more on Mondays, why do you think this is the case?	Referral behaviours
4	Is there a need for the ability to use Bleepa remotely? Why / why not? • How would this impact your work life balance?	Features of Bleepa

Question number	Question	Theme
	• Does completing Bleepa referrals require interaction with a patient?	
5	Some clinical specialities "*accept*" referrals on Bleepa, however some do not. Do you use this feature of Bleepa? Why / why not?	Referral behaviours
6	Some referrals take longer than others to complete. Why do you think it may take some staff longer than others to complete referrals? • Level of usage? • Patient-related?	Referral behaviours
7	Is there a need for more features to be added to Bleepa? Why? • Complex image manipulation features • Clinical data, such as blood tests	Features of Bleepa
8	How can Bleepa be improved / made easier? • Improvements to staff training • Have there been any challenges in completing referrals through Bleepa and what is the impact of this? • Improvements to the user interface	Features of Bleepa / ease of use

11.6. Appendix F: Health economic modelling methodology

Sources

Evidence used to form the current evaluation was sourced from academic research and statistics from relevant public-sector bodies. The main unit cost databases that were used to source data include:

- PSSRU's *Unit Costs of Health and Social Care 2021* (Jones & Burns, 2021)
- Market force factors, National Cost Collection: *National Schedule of NHS costs - Year 2020-21 - NHS trust and NHS foundation trusts* (NHS England & NHS Improvement, 2022)

Choice of analysis and methodology

Forecast model analysis

A forecast model analysis aims to determine whether the economic value of an intervention can justify the service's costs by comparing the cost of two or more alternatives and reviewing the return on investment (ROI) based on a static model of the world. Savings are estimated from the perspective of the UK's society. It is not possible to include all costs and benefits within the appraisal, however, the service's effects should be considered and outcomes that are most likely to determine the difference between alternative options should be included within the appraisal. The NPV and benefit cost ratios (BCRs) are important economic and summary measures that can be derived from such an appraisal and consist of the following formulae:

$$Net\ present\ value = \frac{Net\ cash\ flow}{(1 + Discount\ rate)^{Time\ of\ the\ cash\ flow}}$$

$$Benefit\ cost\ ratio = \frac{Present\ value\ benefits}{Present\ value\ costs}$$

The BCR measures the present value of benefits against the present value of costs. This ratio summarises the overall relationship between relative benefits and costs of Bleepa (for example, £X return for every £1 invested). A BCR greater than one indicates that Bleepa may deliver a positive NPV (for example, a BCR of two indicates that for every £1 spent, there is an expected £2 return). If the BCR is equal to one, then the present value of the benefits equals that of the costs. Where the BCR is less than one, the value of the costs will outweigh the benefits.

Monetisation

To realise economic outcomes, benefit and cost stream 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, non-cash releasing benefits are expected to be identified. These help to reduce the demand and strain on NHS services, but a financial 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.

Costs

Costs are monetised within the appraisal but are not categorised in the same way as benefits.

Adjustments for inflation

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[3] (in other words, the first year of the intervention). Within this appraisal a Gross Domestic Product (GDP) deflator (using March 2022 Office for Budget Responsibility forecast; HM Treasury, 2022b) has been used to convert nominal to real values. Various rates were applied depending on data type, namely:

- Inflation rate (using March 2022 Office for Budget Responsibility forecast; HM Treasury, 2022b)
- Healthcare inflation defined as The NHS cost inflation index (NHSCII) PSSRU's *Unit Costs of Health and Social Care 2021* (Jones & Burns, 2021)

Discounting

Discounting is a technique that enables the comparison of costs and benefits on a consistent basis and accounts for the concept of "*social time preference*"[4] (in other words, it allows costs and benefits that occur at different time periods to be compared on a "*present value*" basis). Discounting is applied to all future costs and benefits and is not applied retrospectively.

A discount rate of 3.5% is applied to benefits to deflate outcomes to real terms and reflect the changing value of healthcare within GDP (HM Treasury, 2021). For social outcome streams linked to welfare or utility values (for example, QALYs), a discount rate of 1.5% is applied as this excludes the change in expected growth per capita over time and only considers health and life effects.

[3] Nominal prices reflect current monetary value (in other words, do not account for inflation).

[4] Society prefers to receive goods and services sooner rather than later.

For the purposes of NPV, prices were discounted to 2022/23 prices. For scenario 1, the retrospective analysis, price was held constant in 2021/22 and 2022/23 prices to show historic nominal impact.

Potential risks

In terms of the forecast model analysis component, some potential risks may arise. For example, data collection regarding the time taken to complete a Bleepa patient referral may be limited. This may arise if a time-in-motion study cannot be completed or there are not enough data points. If this is the case, data obtained through a literature review may be used. Using old sources or the quality of the source may lower the accuracy of the forecast model.

11.7. Appendix G: Health economic modelling scenarios and benefits and cost streams

Table 18 depicts a breakdown of the metrics used within the benefit streams.

Table 18: The metrics used in the forecast analysis with their corresponding figure, source, optimism bias, and sensitivity ranges used in the Monte Carlo simulation.

Metric	Figures	Source	Optimism bias	Sensitivity minimum/ maximum range
Total number of referrals (2021/22)	NHS Greater Manchester ICB Gastroenterology: 69,475 NHS Greater Manchester ICB Respiratory: 30,710 NHS Greater Manchester ICB Cardiology: 30,915 NCA Gastroenterology: 5,950 NCA Respiratory: 3,895	Harvey Walsh Ltd (2023)	0%	+/- 0%

Metric	Figures	Source	Optimism bias	Sensitivity minimum/ maximum range
	NCA Cardiology: 3,020			
Number of submitted Bleepa referrals (2021/22; 2022/23)	ROH (2021/22; 2022/23): 2,865; 4,289 FGH (2021/22; 2022/23): 980; 1,377 ROH Gastroenterology (2022/23): 1,770 ROH Cardiology (2022/23): 1,442 ROH Respiratory (2022/23): 1,077 FGH Gastroenterology (2022/23): 1,377	Unity Insights (2023b)	0%	+/- 10%
Average number of different staff members per referral (2022/23)	ROH Gastroenterology: 4.0 ROH Cardiology: 3.5 ROH Respiratory: 3.9 FGH Gastroenterology: 3.9	Unity Insights (2023b)	0%	+/- 10%

Metric	Figures	Source	Optimism bias	Sensitivity minimum/ maximum range
Time taken to submit a referral before Bleepa	10 minutes	Unity Insights (2023a)	40%	+/- 25%
Time taken to submit a referral using Bleepa	4.14 minutes	Unity Insights (2023a)	0%	+/- 35%
Clinical time used per user per referral sent before Bleepa	5.4 minutes	Beattie (2020)	20%	+/- 25%
Clinical time used per user per referral sent using Bleepa	1.0 minute	Beattie (2020)	20%	+/- 25%
Time taken to respond to a referral without using Bleepa	2.10 days	Beattie (2020)	40%[5]	+/- 25%
Time taken to respond to a referral using Bleepa	NCA Respiratory: 0.28 days	Unity Insights (2023b)	0%	+/- 10%

[5] Due to the additional assumption that starting treatment earlier due to faster response times resulted in the proportionate earlier discharge time and therefore a shorter length of stay.

Metric	Figures	Source	Optimism bias	Sensitivity minimum/ maximum range
	NCA weighted average: 0.55 days			
LoS associated with clinical response time saving	Awaiting a medical decision/intervention including writing the discharge summary: 5.2%	NHS Digital (2023)	20%	+/- 15%
Staff cost per hour	Foundation doctor (FY1; 2021/22): £44 Foundation doctor (FY2; 2021/22): £50 Associate Specialist (2021/22): £137 Consultant Medical (2021/22): £143 Weighted average cost of all staff members (2021/22): £81	Personal Social Services Research Unit (2021)	15%	+/- 15%
Cost of one bed day (2021/22)	ROH Gastroenterology: £576	Harvey Walsh Ltd (2023)	10%	+/- 5%

Metric	Figures	Source	Optimism bias	Sensitivity minimum/ maximum range
	ROH Cardiology: £584 ROH Respiratory: £501 FGH Gastroenterology: £817			

Benefit stream calculations

The calculations for each benefit stream are listed below.

Benefit stream 1

$$Benefit\ stream\ 1: Time\ saving\ for\ submitted\ referrals\ due\ to\ using\ Bleepa\ = Number\ of\ submitted\ Bleepa\ referrals\ \times\ (Time\ taken\ to\ submit\ a\ referral\ without\ Bleepa - Time\ taken\ to\ submit\ a\ referral\ using\ Bleepa) \times (Weighted\ average\ cost\ of\ staff\ (2021/22) \times (1 - Optimism\ bias)$$

Benefit stream 2

$$Benefit\ stream\ 2: Time\ saved\ due\ to\ efficient\ messaging\ = (Average\ number\ of\ users\ per\ Bleepa\ referral - 1\ (initial\ referrer\ user)\ \times \text{(Clinical time used per user per referral without } using\ Bleepa - \text{Clinical time used per user per referral } using\ Bleepa) \times (Weighted\ average\ cost\ of\ staff\ (2021/22) \times (1 - Optimism\ bias)$$

Benefit stream 3

Benefit stream 3 is broken down by the weighted average of referrals and bed day costs and bed day savings of ROH and FGH. The time taken to respond to a referral using Bleepa for the respiratory specialty (0.28 days) was defined as the time between submitting a referral and the first response message. Using the median time taken to respond accounted for potential outliers in the data skewing the average. This resulted in the metric being a fair comparison to that of the clinical response time without using Bleepa in the Respiratory specialty within Beattie (2020; 2.1 days). A factor was then applied using NHS Digital's *Situation Reports* (2023). This was determined by the proportion of late discharged patients, whose primary reason was "*awaiting a medical decision/intervention including writing the discharge summary*". Data was used from July 2021 to March 2023 to best represent the time period of when Bleepa was used.

- Late discharge cases (7+, 14+, 21+): 2,258,033
- Awaiting a medical decision/intervention including writing the discharge summary: 107,932
- Delayed discharge (or LoS) associated with clinical response time saving: 5.2%

$$Benefit\ stream\ 3: Reduced\ Length\ of\ Stay\ (LoS)\ due\ to\ Bleepa = Number\ of\ submitted\ Bleepa\ referrals\ in\ 2022\ \times$$

$$(Time\ taken\ to\ respond\ to\ a\ referral\ without\ using\ Bleepa - Time\ taken\ to\ respond\ to\ a\ referral\ whilst\ using\ Bleepa) \times LoS\ associated\ with\ clinical\ response\ time\ saving \times Average\ cost\ of\ one\ bed\ day\ (2021/22) \times (1 - Optimism\ bias)$$

Cost stream calculations

Table 19 depicts a breakdown of the metrics used within the benefit streams. It was noted that there were no implementation costs applied to NCA for the pilot, and the platform cost was provided at a discounted rate shown below.

Table 19: The metrics used in the forecast analysis with their corresponding figure, source, and optimism bias. Please note that scenario 1, scenario 2a, and scenario 3a use on prem costing, whilst scenarios 2b and 3b use Cloud-hosted costing.

Metric	Figures	Source	Optimism bias
Platform cost (NCA specific)	£106,822	(Bleepa, 2023b, 2023a)	0%
Implementation cost	On prem: £45,819 Cloud-hosted: £21,900	(Bleepa, 2023b, 2023a)	0%
Platform cost (Enterprise solution)	On prem: £175,082 Cloud-hosted: £241,624	(Bleepa, 2023b, 2023a)	0%
Number of additional trusts adopting Bleepa (applicable to scenario 3)	4	Modelling assumption	0%

The calculations for each cost stream are listed below.

Cost stream 1

$$Cost\ stream\ 1: Implementation\ cost\ of\ Bleepa = Implementation\ cost\ of\ Bleepa \times Number\ of\ trusts\ adopting \times (1 - Optimism\ bias)$$

Cost stream 2

$$Cost\ stream\ 2: Platform\ cost\ of\ Bleepa = Platform\ cost\ of\ Bleepa\ \times\ (1 - Optimism\ bias)$$

Assumptions

- The total number of referrals in 2021/22 was as follows (Harvey Walsh Ltd, 2023):
    - NHS Greater Manchester ICB
        - Gastroenterology = 69,475 referrals
        - Cardiology = 30,915 referrals
        - Respiratory = 30,710 referrals
    - NCA NHS Foundation Trust
        - Gastroenterology = 5,950 referrals
        - Cardiology = 3,020 referrals
        - Respiratory = 3,895 referrals
- The number of submitted Bleepa referrals in 2021/22 was as follows (Unity Insights, 2023c):
    - ROH = 2,865 referrals
    - FGH = 980 referrals
- The number of submitted Bleepa referrals in 2022/23 was as follows (Unity Insights, 2023c):
    - ROH Gastroenterology = 1,770 referrals
    - ROH Cardiology = 1,442 referrals
    - ROH Respiratory = 1,077 referrals
    - FGH Gastroenterology = 1,377 referrals

- The number of reviewed Bleepa referrals in 2022/23 was as follows (Unity Insights, 2023c):
    - ROH Gastroenterology = 1,770 referrals
    - ROH Cardiology = 1,442 referrals
    - ROH Respiratory = 1,077 referrals
    - FGH Gastroenterology = 1,377 referrals
- The total uptake of referrals was as follows (Unity Insights, 2023c):
    - Year 1 (2023/24) = 68%
        - This was based on the ratio of pilot volumes for years 2021/22 and 2022/23 within Bleepa quantitative referral data through the following equation:

$$Number\ of\ submitted\ Bleepa\ referrals\ in\ ROH\ and\ FGH\ in\ FY\ 2021/22 / Number\ of\ submitted\ Bleepa\ referrals\ in\ ROH\ and\ FGH\ in\ FY\ 2022/23 =$$

$$\frac{2865 + 980}{4289 + 1377} = 68\%$$

    - Year 2 (2024/25) = 75%
    - Year 3 (2025/26) = 82%
    - Year 4 (2026/27) = 91%
    - Year 5 (2027/28) = 100%
    - The factor per year was identified through the following equation:

$$\left(\left(\frac{Year\ 5\ uptake}{Year\ 1\ uptake}\right)^{1/4}\right) - 1 =$$

$$\left((100\%/68\%)^{\frac{1}{4}}\right) - 1 = 10.18\%$$

- The time taken to submit a referral before Bleepa was 10 minutes (Unity Insights, 2023b)
- The time taken to submit a referral using Bleepa was 4.14 minutes (Unity Insights, 2023b)
- The time taken to respond to a referral without using Bleepa from referral submission to review was 2.10 days Beattie (2020)
    - Here, it was assumed that the clinical review was concluded when the last message was sent using Bleepa
- The median time taken to respond to a referral using Bleepa from the first referral message to the first response message was as follows (Unity Insights, 2023c):
    - Respiratory = 0.28 days

- The median time taken was used here instead of the mean to avoid the impact of any outliers skewing the average. Further clarification can be seen in 'Appendix I: Quantitative insights'.

- The clinical time per user per referral before Bleepa was 5.4 minutes
- The clinical time per user per referral using Bleepa was 1.0 minute.
- The average number of staff users on Bleepa per referral was as follows (Unity Insights, 2023c):
  - ROH Gastroenterology = 4.0 messages
  - ROH Cardiology = 3.5 messages
  - ROH Respiratory = 3.9 messages
  - FGH Gastroenterology = 3.9 messages
- The number of staff by job role who completed Bleepa referrals was as follows (Unity Insights, 2023b):
  - Foundation doctor FY1 = 22
  - Foundation doctor FY2 = 8
  - Consultant/associate specialist = 18
  - Proportions of staff by job role was intended to be split out using NHS Workforce Statistics, however Bleepa users were predominantly junior doctors and NHS Workforce Statistics displayed large proportions of consultants in NCA NHS Foundation Trust (NHS Digital, 2022):
    - Foundation doctor FY1 = 95
    - Foundation doctor FY2 = 71
    - Consultant = 797
    - Associate specialist = 23
- The cost per hour of a foundation doctor FY1 (2021/22) was £44 (Personal Social Services Research Unit, 2021)
- The cost per hour of a foundation doctor FY2 (2021/22) was £50 (Personal Social Services Research Unit, 2021)
- The cost per hour of an associate specialist (2021/22) was £137 (Personal Social Services Research Unit, 2021)
- The cost per hour of a medical consultant (2021/22) was £143 (Personal Social Services Research Unit, 2021)
- Weighted average cost of staff (2021/22) £81 (calculation)

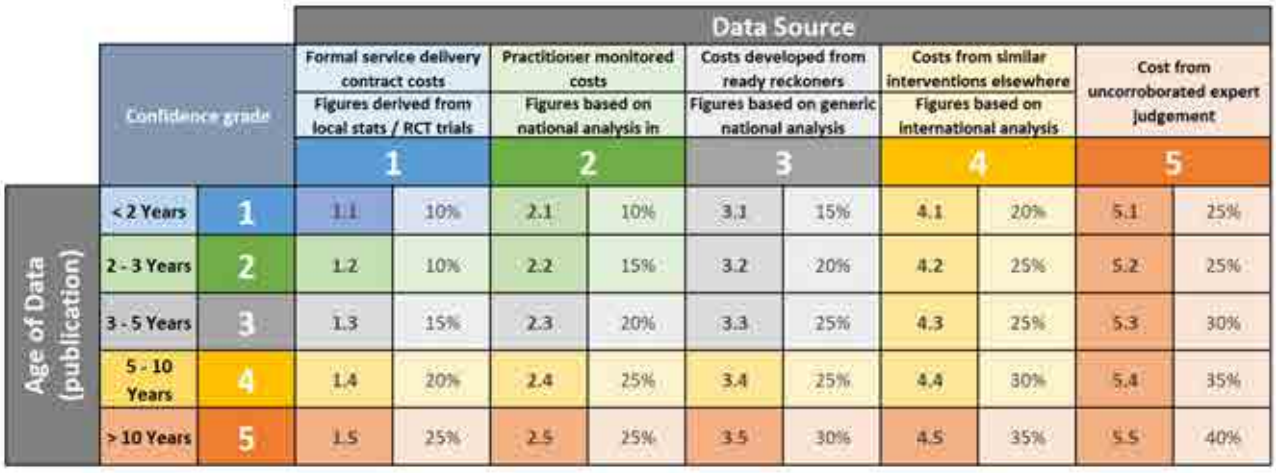
- The cost of one bed day (2021/22) was as follows (Harvey Walsh Ltd, 2023):
    - ROH Gastroenterology = £576
    - ROH Cardiology = £584
    - ROH Respiratory = £501
    - FGH Gastroenterology = £817
- NCA specific cost of Bleepa per year was £106,822 (Bleepa, 2023b)
- The on prem implementation cost of Bleepa per trust was £45,819 (Bleepa, 2023b)
- The on prem platform cost of Bleepa per year per trust was £175,082 (Bleepa, 2023b)
    - Additional costs due to storing the data on the premises was not modelled due to uncertainty surrounding such figures; clear figures were unable to be identified
- The Cloud-hosted implementation cost of Bleepa per trust was £21,900 (Bleepa, 2023a)
- The Cloud-hosted platform cost of Bleepa per year per trust was £241,624 (Bleepa, 2023a)

11.8. Appendix H: Sensitivity analysis methodology

This section depicts the steps required to conduct sensitivity analysis.

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 (Figure 37).



			Data Source									
	Confidence grade		Formal service delivery contract costs Figures derived from local stats / RCT trials		Practitioner monitored costs Figures based on national analysis in		Costs developed from ready reckoners Figures based on generic national analysis		Costs from similar interventions elsewhere Figures based on international analysis		Cost from uncorroborated expert judgement	
			1		2		3		4		5	
Age of Data (publication)	< 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%

Figure 37: Unity Insights' sensitivity confidence grades.

Table 20 demonstrates the average cost of one bed day in ROH and the difference in time taken to respond using Bleepa in ROH.

Table 20: Example of sensitivity range allocation.

Variable	Sensitivity Grading	Range Applied	Lower range estimate	Base-case/ mean estimate	Upper range estimate
Average cost of one bed day ROH	2.1	+/- 10%	£504	£560	£616

Variable	Sensitivity Grading	Range Applied	Lower range estimate	Base-case/ mean estimate	Upper range estimate
Difference in time taken to respond to a referral using Bleepa compared to the baseline (days)	3.2	+/- 20%	0.12	0.15	0.18

Step two: Allocation of a distribution shape

All data has a shape to its distribution (Figure 38). If there is an 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.

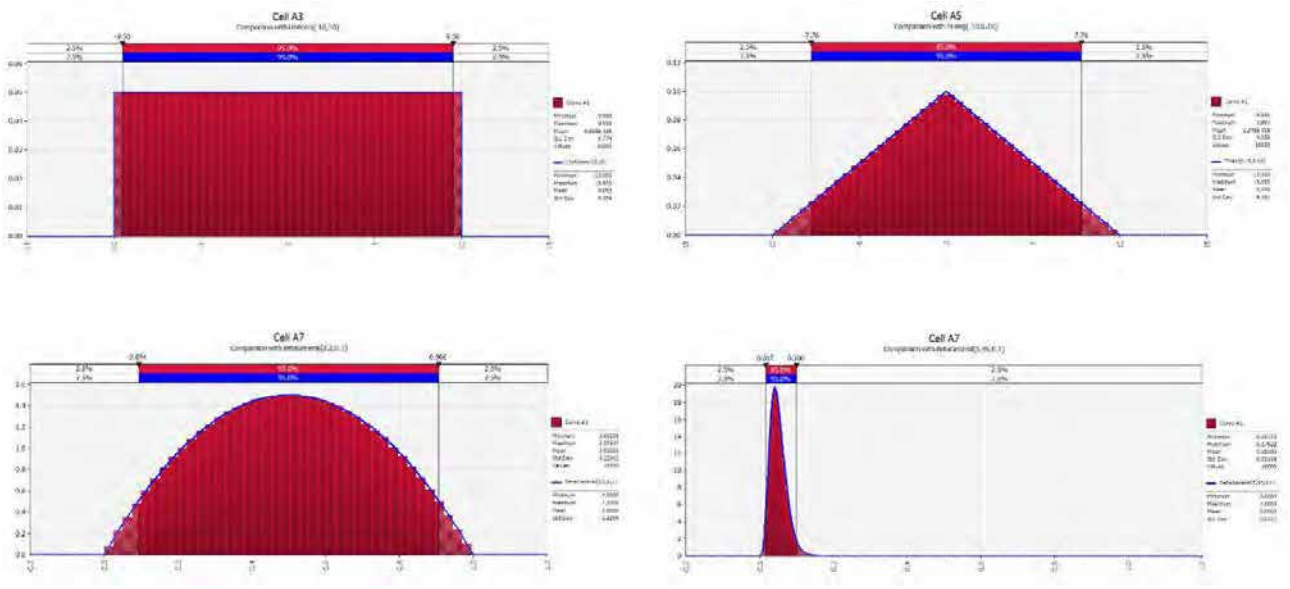


Figure 38: Typical distribution shapes for top-left: rectangular distribution, top-right: triangular distribution, bottom-left: beta distribution for percentages around 50%), bottom-right: beta distribution for percentages near 0% or 100%.

If there is reason to believe the distribution meets the statistical qualities required to be defined as normal, Poisson, and so on, then these can be applied. In this study, triangular distributions were generally applied as this best reflected the ranges used and diminishing probabilities of more extreme ends. Where a different distribution was been used, it was explicitly noted in the text.

Step three: Random selection of values within the range

The model selected at random a value for each variable from within the range between the upper and lower estimate and calculated 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 given in Table 21 using a rectangular distribution. These deliver estimates lying between £61.20 and £109.80. The draw was repeated thousands of times. In this evaluation, 10,000 runs were used as standard.

Table 21: Example of random variation within Monte Carlo simulation.

Variable	Draw 1	Draw 2	Draw 3	Draw 4	Draw 5
Average cost of one bed day ROH	£510	£535	£560	£585	£610
Difference in time taken to respond using Bleepa ROH (days)	0.120	0.135	0.150	0.165	0.180
Reduced **length of stay** for ROH per referral	£61.20	£72.23	£84.00	£96.53	£109.80

Creating 10,000 estimates allowed the creation of a distribution of possible outcomes from the draws made. From this distribution, the range within which it was expected 90% of the

observations from the draws to fall could be computed. This is the 90% confidence interval, illustrated in Figure 39.

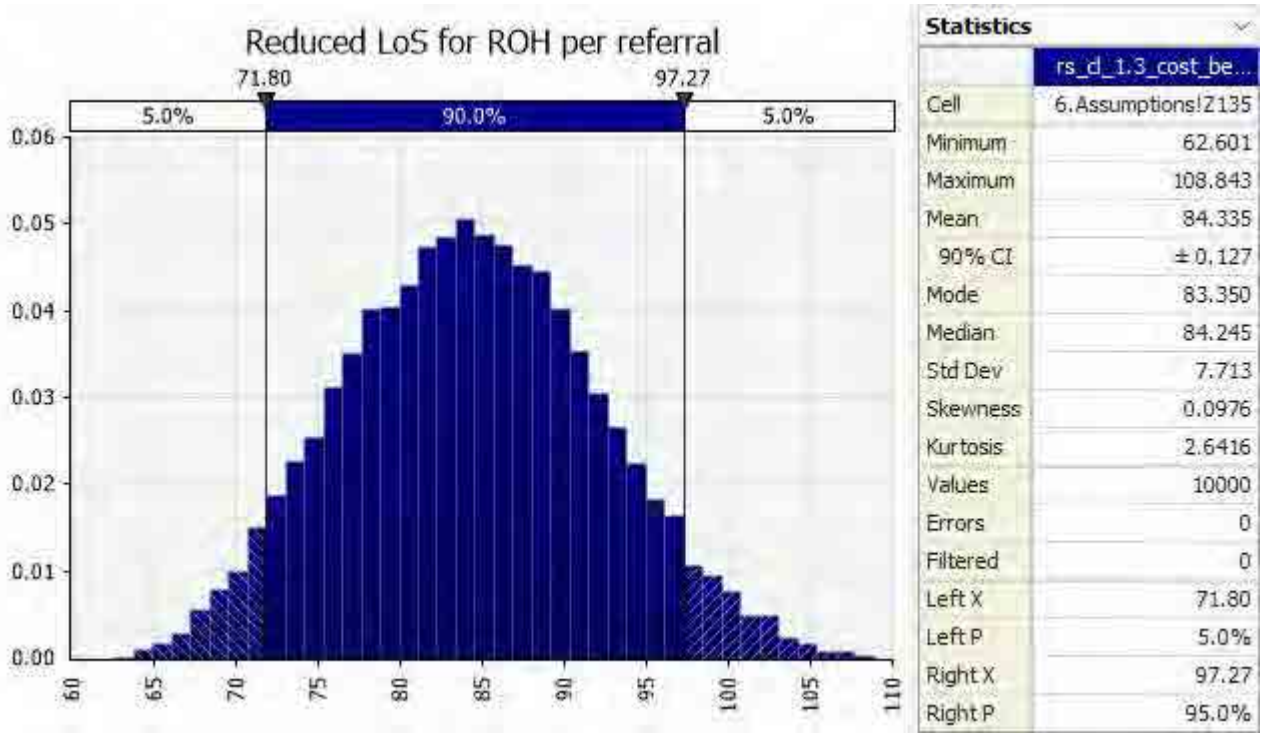


Figure 39: Illustration of sensitivity analysis.

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 was used to provide the maximum and minimum ranges for the data input in the sensitivity analysis. Where no confidence interval was provided, the quality of the data was graded in a similar way to optimism bias to express the degree of certainty that Unity Insights had in the estimates.

11.9. Appendix I: Quantitative insights

To understand whether a mean or median calculation would be a better estimate of response times in Bleepa, the distribution of response times was analysed. Such findings are displayed in Figure 40.

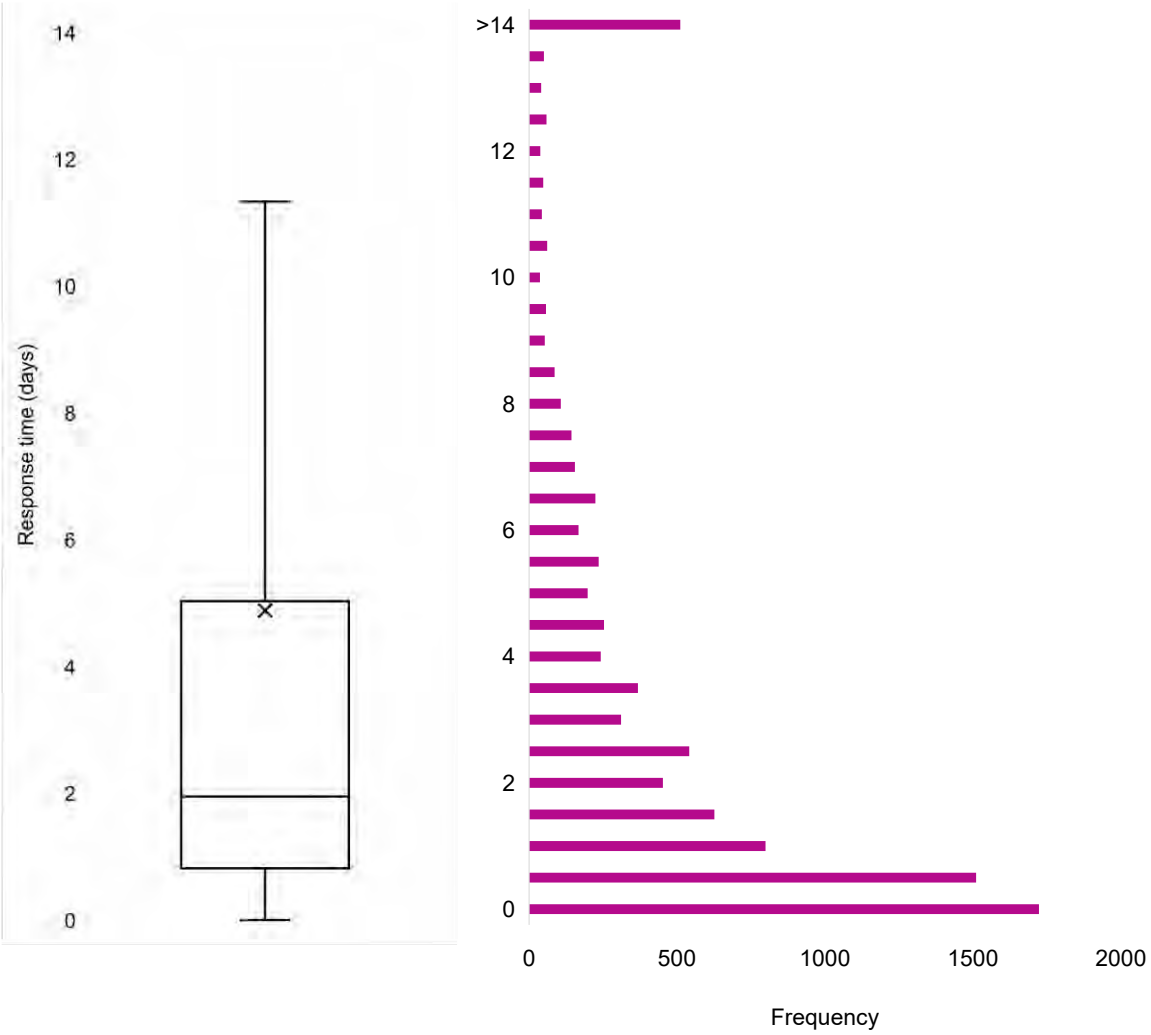


Figure 40: Box plot (left) and histogram (right) of time, in days, between first message and last message on Bleepa referrals. The "*x*" denotes the mean on the box plot. Both visuals utilise the same y-axis for comparison.

The box plot demonstrates that the mean diverged substantially from the median and sat close to the 75th percentile. The histogram indicates that this resulted from several substantial outliers in the data. These outliers were expected to be primarily caused by data quality issues or have causes unrelated to Bleepa, such as a mistake in data entry or a clinically delayed transfer of care. While a

mean could be calculated by excluding outliers, this would exclude a substantial proportion of the dataset with genuine data points on the lower side of the response time distribution (see histogram). As a result, the median (denoted by the middle horizontal line in the box plot) was assumed to be a preferable alternative estimate of the average for response times and more representative of the response time that would be expected across a sample of patients.

11.10. Appendix J: Qualitative insights

Table 22 depicts the different hospitals and specialties that survey respondents worked at.

Table 22: Breakdown of the hospitals and specialties survey respondents worked at.

Specialty	Frequency
ROH	
Respiratory	13
General Medicine	4
Geriatric Medicine	3
Acute Internal Medicine	3
Gastroenterology	3
General Surgery	3
Cardiology	1
Rheumatology	1
Endocrinology and Diabetes	1
Intensive Care Medicine	1
FGH	
Respiratory	4
Acute Internal Medicine	4
Geriatric Medicine	3
Neurology	3
Gastroenterology	1
General Medicine	1
Endocrinology and Diabetes	1

11.11. Appendix K: Forecast modelling insights

This section depicts further forecast modelling insights from Section 5.

Scenario 2b: Sensitivity analysis

The sensitivity analysis assessed how various sources of uncertainty within the model contributed to the model's overall uncertainty. Figure 41 depicts the NPV sensitivity analysis using @RISK software to represent the most likely outcomes as well as the potential range of results at a 90% confidence interval based on 10,000 simulations.

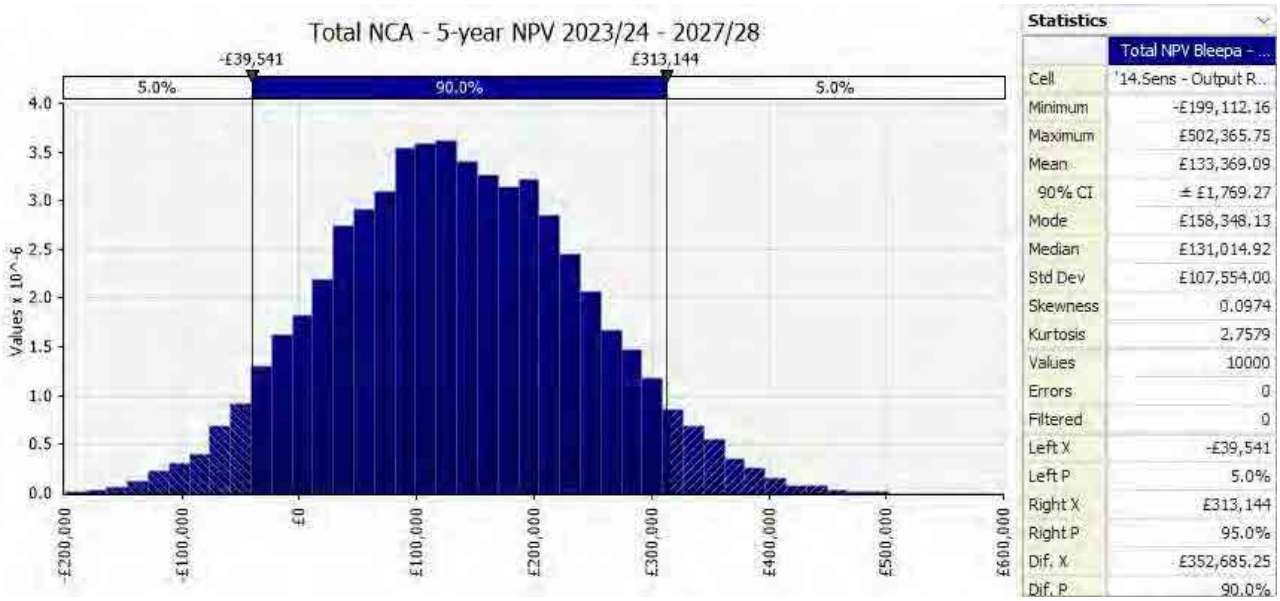


Figure 41: NPV sensitivity analysis for scenario 2b.

The sensitivity analysis for scenario 2b indicated that, within a 90% confidence interval, the modelled NPV falls between -£40k and £313km, with an expected value (in other words, a mean) of £133k. The 90% confidence interval range of £353k was representative of the uncertainty in the assumptions used for the modelling.

The tornado chart in Figure 42 illustrates the individual impact of each variable input on the overall NPV. Each comparison fixes all other assumptions to the expected mean and uses the minimum/maximum values of the highlighted input to show the overall impact on the NPV. This has been completed for the pilot analysis to identify which influencing factors affect the value of the Bleepa the most. The results depicted that the LoS associated with clinical response time saving had the greatest effect on the evaluation. The difference in time taken to respond to a referral using Bleepa in NCA has the second highest influence on the NPV.

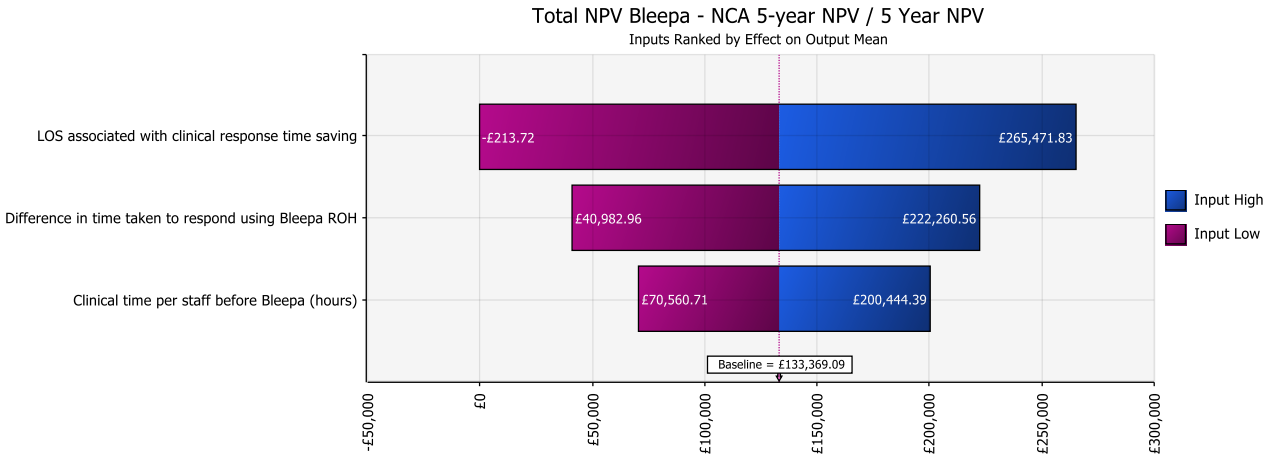


Figure 42: Tornado chart depicting key factors which influence the overall NPV value. The key indicates the expected change in outcomes when each factor is changed according to the minimum and maximum within the stipulated sensitivity range. The baseline figure is representative of the output mean.

Scenario 3b: Sensitivity analysis

The sensitivity analysis assessed how various sources of uncertainty within the model contributed to the model's overall uncertainty.

Figure 43 depicts the NPV sensitivity analysis using @RISK software to represent the most likely outcomes as well as the potential range of results at a 90% confidence interval based on 10,000 simulations.

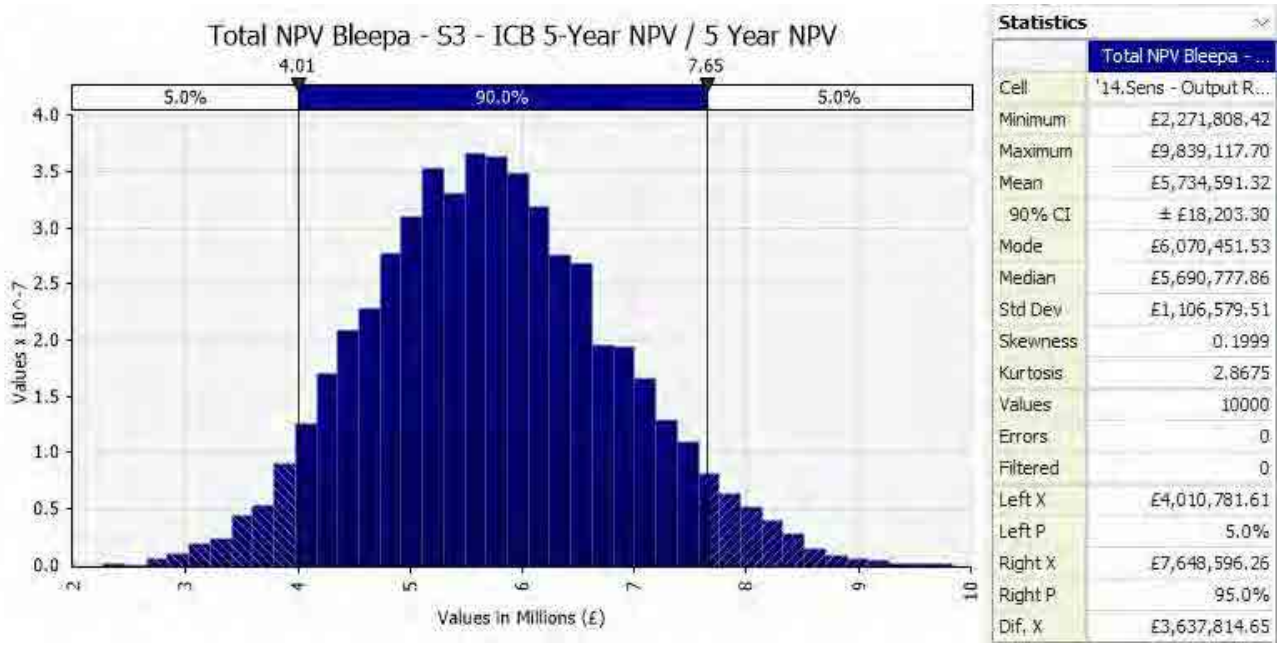


Figure 43: NPV sensitivity analysis for scenario 3b.

The sensitivity analysis for scenario 3b indicated that, within a 90% confidence interval, the modelled NPV falls between £4.0m and £7.7m, with an expected value (in other words, a mean) of £5.7m. The 90% confidence interval range of £3.6m was representative of the uncertainty in the assumptions used for the modelling.

The tornado chart in Figure 44 illustrates the individual impact of each variable input on the overall NPV. Each comparison fixes all other assumptions to the expected mean and uses the minimum/maximum values of the highlighted input to show the overall impact on the NPV. This has been completed for the pilot analysis to identify which influencing factors affect the value of the Bleepa the most. The results depicted that the difference in time taken to respond to a referral using Bleepa in NCA had the greatest effect on the evaluation. The LoS associated with clinical response time saving across the ICB has the second highest influence on the NPV.

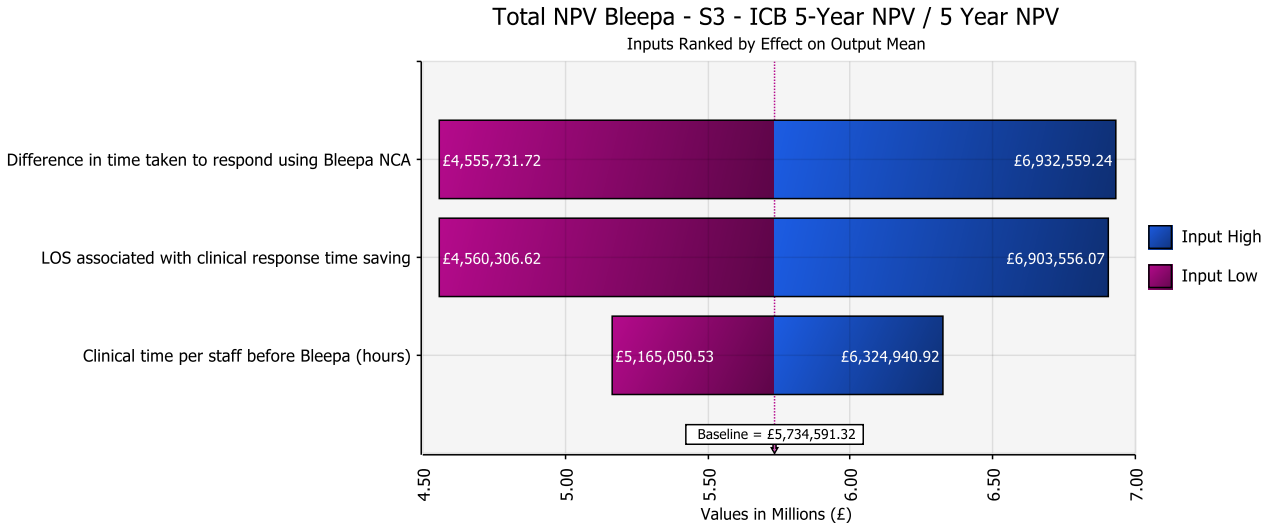


Figure 44: Tornado chart depicting key factors which influence the overall NPV value. The key indicates the expected change in outcomes when each factor is changed according to the minimum and maximum within the stipulated sensitivity range. The baseline figure is representative of the output mean.

Unity Insights

Analytics and evaluation for positive change

unityinsights.co.uk