Evaluating the implementation of GaitSmart across four pilot sites in Bedfordshire, Luton and Milton Keynes

Commissioned by Bedfordshire, Luton and Milton Keynes ICB

Work completed by Health Innovation East

Contents

Executive Summary

Background

Older people having falls is considered a global public health issue. According to the World Health Organisation falls are the second leading cause of unintended injury and accounts for 650,000 deaths worldwide. Innovations exist to mitigate the risk of falls by addressing the risk factors of falling in older people. GaitSmart is an automated, personalised rehabilitation programme that combines a gait analysis and exercise rehabilitation programme to address gait issues and increase mobility, and is recommended by the National Institute for Health and Care Excellence (NICE). Whilst evidence has demonstrated the clinical efficacy of GaitSmart in some populations, differences in implementation experiences and outcomes across different settings has not yet been explored. Bedfordshire, Luton and Milton Keynes (BLMK) Integrated Care Board (ICB) therefore commissioned Health Innovation East to conduct an evaluation of the 15-month implementation pilot of GaitSmart in primary care, secondary care and community settings.

Aim

This project aimed to evaluate the effectiveness of GaitSmart implementation at four different pilot sites to explore the impact on patient uptake, clinical outcomes, and patient and staff experience.

Methods

Patients were eligible to take part in the GaitSmart pilot if they were aged 18 years or older, had the mental capacity to consent to their participation and attended one of the following healthcare sites: *Bedford Hospital Falls*, *Keeping Well Clinic*, *Priory Gardens* Surgery and *Active Lifestyles* service in BLMK. Patients needed to be able to walk 10m turn and walk back (with or without a walking aid). The most commonly used GaitSmart protocol includes four Tests over a 12-week period, which was employed at three sites (*Bedford Hospital Falls, Keeping Well Clinic, Priory Gardens Surgery*). A 3-Test protocol was initially implemented within the *Active Lifestyles* service before moving to the 4-Test protocol later in the pilot. Various staff roles within the sites were trained to use GaitSmart.

The evaluation included quantitative datasets of GaitSmart clinical mobility outcomes (GaitSmart score, gait speed, average stride duration and joint angle) and data from staff and patient feedback via surveys. This included any patients in the pilot, and any staff who had been trained to use GaitSmart at the sites.

Data from Test 1 and Test 4 were used to assess differences in clinical outcomes. Aggregate data were examined descriptively using Microsoft Excel. The GaitSmart data was considered on a group level as well as at individual site level. The GaitSmart and survey data is presented across the 12-week, 4-Test protocol timeframe.

Baseline (Test 1) and post intervention (Test 4) patient surveys were used to explore experiences of GaitSmart, with Fear of Falling (FoF) amongst other self-reported patient outcomes. A staff survey explored staff experiences of implementing GaitSmart and their perceptions of its impact on patient outcomes. Further feedback was sought from implementation leads via a survey.

Findings

- **The clinical outcome measures of GaitSmart Score, gait speed, joint angle, and stride duration all increased between initiation and completion of the GaitSmart protocol for the total pilot population and across individual sites.** All four outcome measures improved in 48% of the patients, 90% of patients improved in at least one measure. Gait speed data shows that 60% of all patients (n=59/98) were at risk of adverse health outcomes, using the criteria of speed <0.8 m/s at Test 1, compared to 50% (n=49/98) at Test 4.

- **The findings suggested a range of factors that can influence uptake and drop off between Tests**, such as patients no longer feeling the need to attend following a positive result (high GaitSmart score) and patient characteristics, for example levels of mobility, health status or pre-existing medical conditions. The findings showed that:

    - *Bedford Falls*, a secondary care setting, recruited less individuals due to patient characteristics and suitability, however those that were recruited were more likely to complete the 4-Test protocol than those at other sites.
    - Preventative settings where some patients saw positive early mobility scores were more likely to see a reduction in uptake across the 4-Tests, perhaps reflecting the psychological benefits of initial patient engagement.

272 people completed Test 1, of these 184 completed Test 1 prior to December allowing time for completion of the full 4-Test protocol. 98 completed Test 4 (53% of the 184, 36% of the 272).

- **GaitSmart was considered acceptable by patients.** 92% of respondents suggested they would recommend it to others experiencing walking or rehabilitation difficulties. 76% of

patients reported that the GaitSmart programme led to either some or significant change in their mobility. Positive reflections were also shared on how Gaitsmart impacted their daily life, was easy to understand, and increased motivation to exercise.

- **There was variability in staff feedback across the different settings**. 50% of staff who conducted tests agreed or strongly agreed that GaitSmart should be continued in their service, 25% neither agreed nor disagreed and 25% disagreed or strongly disagreed. *Bedford Falls* staff suggested that an intervention prior to falling would be more appropriate for their patients. The two primary care settings, *Priory Gardens* and *Keeping Well*, were most likely to recommend GaitSmart be continued in their service.

Recommendations

1. **Adoption and spread of GaitSmart requires consideration of setting appropriateness.** Findings suggest use of GaitSmart in preventative settings to reduce risk of falls may be most effective.
2. **Consideration of context specific strategies to support meaningful patient engagement**. Different clinical populations, their eligibility and appropriateness for GaitSmart should inform commissioning and Test-protocol decisions.
3. **Sites implementing GaitSmart in future may benefit from adopting a flexible approach in relation to expectations for patients**. This allows for patients who have high positive GaitSmart scores in Test 1 or have particular characteristics that suggest follow up Tests may not be required or the 4-Test protocol is inappropriate. This also allows for resources to be focused on patients where there is greater need for ongoing GaitSmart use.
4. **Commitment to the protocol and adherence to exercises should be encouraged when recruiting patients to the 4-Test protocol** to maximise patient outcomes and efficiencies.
5. **Effective partnership collaboration** and ongoing support from innovators should continue to be prioritised via regular meetings and review of data, emerging findings and real-world challenges to support ongoing implementation and improvement.
6. **Further research is recommended to understand more fully the impacts of differing protocols,** for example 1-Test (single use of GaitSmart) or follow up Test (e.g. 2, 3 or 4-Test) in relation to patient outcomes, staff efficiencies and cost-effectiveness.

1. Introduction

1.1 Background

Bedfordshire, Luton and Milton Keynes (BLMK) Integrated Care Board (ICB) commissioned Health Innovation East to conduct an evaluation of the 15-month long GaitSmart implementation pilot. The evaluation aimed to evaluate GaitSmart implementation at four different pilot sites to explore the impact on patient outcomes, patient experience and staff experience. The evaluation findings and recommendations will be used to inform the future implementation of GaitSmart within BLMK and may support commissioning decisions in other ICBs.

Older people having falls is considered a global public health issue (1) due to the high prevalence and potential to cause disability and death. According to the World Health Organisation (WHO), falling is the second leading cause of unintended injury and accounts for 650,000 deaths worldwide (2). Approximately one third of people aged over 65 years, and half of those aged over 80 years, fall at least once a year (3). Of these, one third of older people sustain an injury (4) including brain contusions, dural haematomas, and joint dislocations, that can be life-threatening at worse or, most commonly, lead to long-term disability. An understanding of the factors that may predict falling in people at-risk provides an opportunity to develop interventions that aim to reduce the risk of falling. Evidence shows that falling is associated with postural instability (5) and balance impairments (6). Predictors of falling include variability in stride time while walking (7,8) and loss of two or more determinants of gait (9), e.g., pelvic rotation, pelvic tilt, knee and hip flexion, knee and ankle interaction, and lateral pelvic displacement. Gait speed, in particular, is explored in the literature as a predictor of adverse outcomes, including mortality, cognitive decline, mobility disability and predicting falls (10). The same systematic review suggests that older persons who walk at, or faster, than 1.0 meters/second (m/s) generally have lower risk of health events and better survival, whilst any gait speed below 0.7 m/s could lead to hospitalisation and falls (10).

Innovative attempts to address these risk factors through targeted physical rehabilitation strategies are increasing. GaitSmart is one such automated, personalised rehabilitation programme that combines gait analysis and an exercise rehabilitation programme to address gait issues and increase mobility. GaitSmart (Owned by Dynamic Metrics Limited (DML)) is a sensor-based digital technology that measures gait kinematics: the motion the lower limbs make whilst walking - this constitutes a 'Test' in this report. The Test provides a range of output values including: GaitSmart Score, joint angle, average stride duration and speed.

GaitSmart score is the culmination of all the sagittal movement and describes how well the hips and knees are moving.

GaitSmart is designed to be a 9-week or 12-week programme in which four Tests are completed with a three or four week gap between each Test. A new performance report is produced for patients at each Test. If patients demonstrate improvements in their performance, the personalised exercise programme is adjusted accordingly.

1.2 Evidence review

Demonstrating the clinical effectiveness of GaitSmart for multiple populations, 11 studies, including one randomised controlled trial, have been conducted with an accumulative total population of over 1,000 individuals (11). Following knee or hip surgery, the evidence indicates that GaitSmart is more effective than standard care at improving gait and increasing walking speed. It has been reported to be well-tolerated, and adhered to, by older people at-risk of falling (12–14). Open-label studies and case series evidence from across multiple NHS Trusts suggest that GaitSmart successfully improved gait kinematics and overall gait speed, leading to reduced falls, reduced Fear of Falling (FoF), an increased ability to engage with Activities of Daily Living (ADLs) (12,13,15), reduced frailty and less frequent use of walking aids (12) in people at greater risk of falling.

One early economic evaluation conducting cost-effectiveness analysis (16) demonstrated that GaitSmart is potentially cost saving compared to the standard care (SoC) treatment for improving movement in older people when considering risk of falling (incremental QALY=1.07; cost=-£2901.79) and FoF (incremental QALY=0.77; cost=-£4479.57). Return on investment analysis (16) indicated that for every pound invested into GaitSmart, cost savings were estimated to be £1.85/patient when considering risk of falling, and £11.16/patient when considering fear of falling. FoF is significant due to the greater risk of falls that accompanies it, requiring resources from across the system, which can be costly. FoF has been associated with the occurrence of falls in community-dwelling older adults; although this association was lower in multiple fallers (17). The probability of cost saving with GaitSmart was estimated to be 79.4% when accounting for FoF and 100% when considering risk of falls.

Since April 2024, GaitSmart has been recommended by NICE to treat people at risk of falls with gait or mobility issues (11). However, NICE recognised the need for additional research in larger populations and/or with comparator populations to provide evidence of patient protocol compliance and potential adverse effects of the technology.

Whilst data exists regarding the clinical efficacy of GaitSmart in some populations, variance in implementation experience and outcomes across different settings has not been explored. This real world evaluation provides the opportunity to consider GaitSmart in the context of primary care, secondary care, and preventative community health within the BLMK Integrated Care System (ICS).

1.3 GaitSmart implementation in BLMK

Any adult aged 18 years and older with the mental capacity to consent to their participation and with the ability to walk 10m turn and walk back (with or without a walking aid) were eligible to be involved in the GaitSmart implementation pilot in BLMK. Any healthcare professional or staff member was able to conduct a GaitSmart Test following training with DML. The GaitSmart pilot was delivered across sites within the ICS pathway, including primary care (*Keeping Well Clinic* and *Priory Gardens*), secondary care delivered on an outpatient basis (*Bedford Hospital Falls*) and within a community setting (*Active Lifestyles* service) (Figure 1).

Each of these pilot sites implemented GaitSmart in a context-specific way. The *Active Lifestyles* service only implemented GaitSmart in April 2024, initially on a small scale with a 3-Test, 12-week protocol before encouraging the more standard 4-Test, 12-week protocol. This was in contrast to the other sites who delivered the 4-Test, 12-week protocol from the outset. Each of the different pathways, including referral route, patient population, and exit routes are mapped and illustrated in Figure 2. Various staff roles in each of the sites carried out GaitSmart Tests with patients, these are also listed in Figure 2.

Of note, patients attending the *Bedford Falls* clinic had more complex needs, often neurological, and therefore this pathway had a smaller sample of potentially eligible patients. Staff implementing GaitSmart at *Priory Gardens* focused on engaging the NHS Health Check population for the first 13 months of the pilot, before widening out the opportunity to participate in the pilot to the broader surgery population in January 2025. *Keeping Well Frailty Clinic* expanded their cohort in June 2024 to include self-referred GP patients with a FoF. One site, *New Meppershall Care Home*, started the pilot but found that too few patients were eligible due to not being able to walk unaided and left the pilot after 3 months; they have not been included in the evaluation.
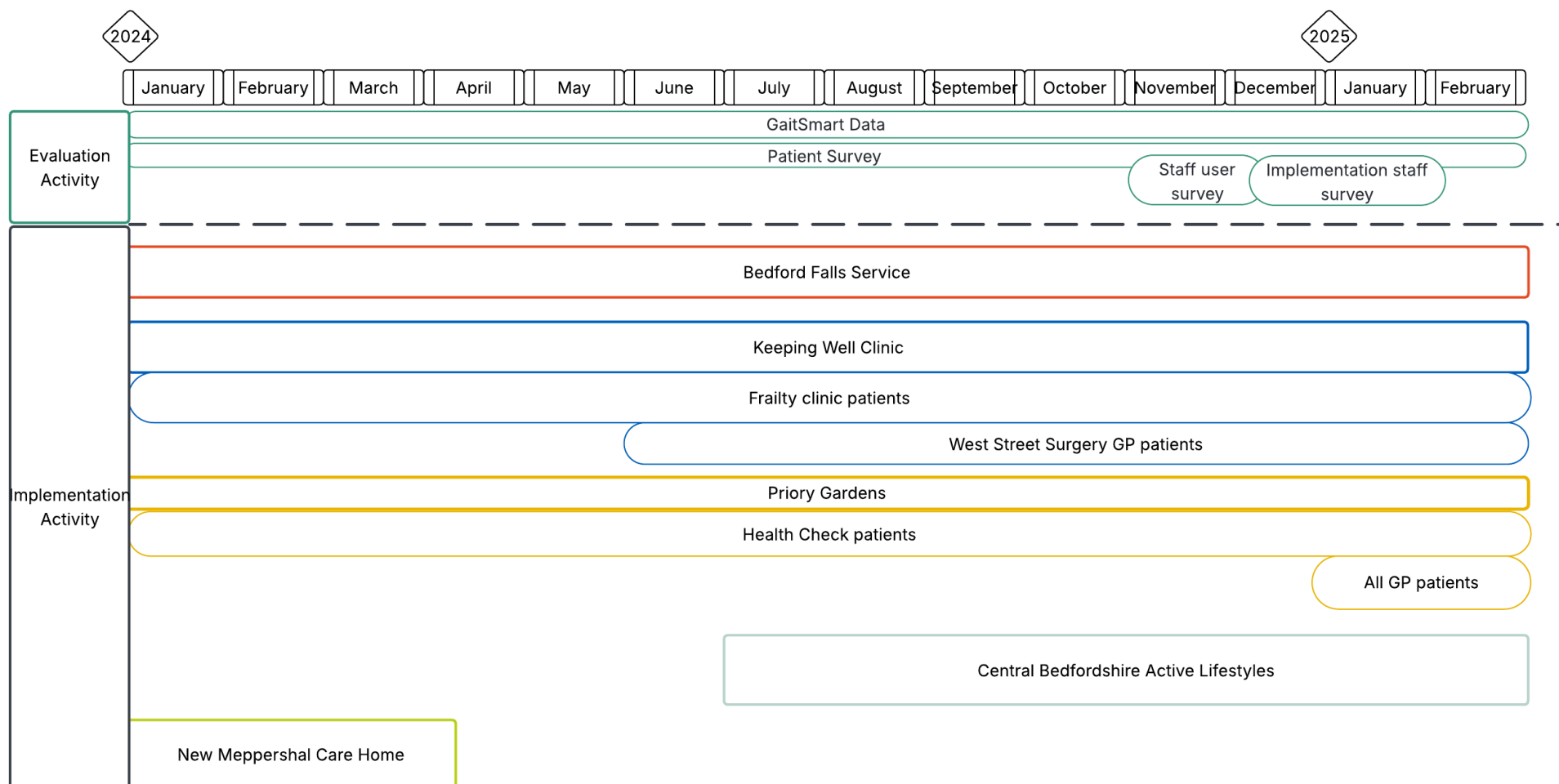
Figure 1: A timeline of GaitSmart implementation during the BLMK pilot
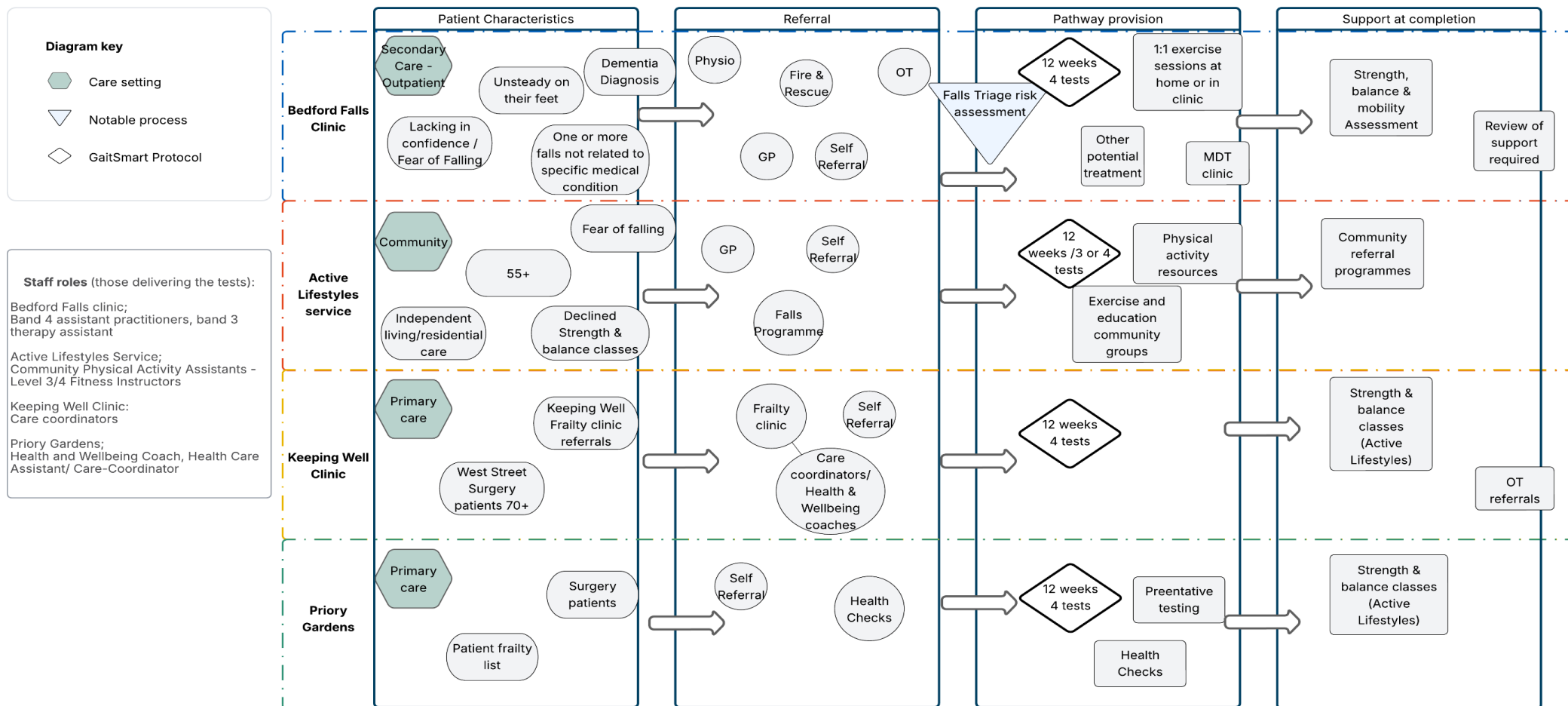
Figure 2: Pathway characteristics map of each pilot site

2. Aim

The aim of this evaluation was to assess the impact of GaitSmart implementation, patient experience and staff experience across the four pilot sites in BLMK.

Four key evaluation questions guided this evaluation:

1. How does uptake of GaitSmart differ between the sites?
2. What are the outcomes related to risk of patient falls that may help inform the future adoption and spread of GaitSmart by BLMK ICB?
3. What does patient feedback tell us about the acceptability, usability and patient experience of using GaitSmart, and any benefits thereafter?
4. What does staff feedback tell us about the acceptability, usability, and any challenges or benefits of implementation?

3. Methods

The data sources in this evaluation were the quantitative datasets of GaitSmart clinical patient outcomes, a patient survey, a site staff survey, and an implementation leads staff survey. Data collected over a 15-month period between December 2023-February 2025 was used to address evaluation question one, two, and three. The data required to understand staff feedback and address evaluation question four was collected between November 2024–January 2025.

3.1 Data collection

3.1.1 GaitSmart Data

Any GaitSmart data (evaluation questions 1 and 2) were automatically collected by the GaitSmart platform. The complete GaitSmart dataset was exported into Excel by DML, anonymised and condensed to a simplified dataset required to answer the evaluation questions. It was then shared with Health Innovation East for analysis.

3.1.2 Patient Surveys

Survey data relating to evaluation question 3 was collected using Zoho Surveys by Health Innovation East. The patient surveys were collected at Test 1 (baseline) and Test 4 to provide pre- and post- measures. The two surveys were available on the GaitSmart tablet, and

these surveys formed part of the patient's GaitSmart appointment slot. Practitioners encouraged patients to complete the surveys during visits and provided support when required, survey completion was therefore dependent on time available to the staff and patients, as well as patient consent.

The patient surveys included the Short Falls Efficacy Scale International (Short FES-I). This measures "fear of falling" or "concerns about falling", and is suitable for use in research and clinical practice, as recommended by the World Falls Guidelines (18). The Short FES-I is a 7-item measure; each item is measured from 1 (no concern about falling) to 4 (severe concern about falling), with a maximum total score of 28. Total scores can be categorised as follows; Low concern=7 to 8, Moderate concern=9 to 13, High concern=14 to 28. The 7 Short FES-I was included at the baseline and follow-up survey. Not every question was required to be answered and patients could choose not to.

The first survey also included three questions about confidence walking and the number of falls respondents have had in the last 4 weeks and 6 months. The final survey had 20 questions about the number of falls they have had since starting the program, how they found different aspects of the GaitSmart test and report, such as exercises and understanding of the report, as well as any perceived impacts from completing the protocol such as impacts on mobility, motivation and confidence walking.

3.1.3 Staff Surveys

Two staff surveys were designed to address evaluation question 4, and responses collected using Zoho Surveys by Health Innovation East. The first survey was shared with staff who had been using GaitSmart in their settings. This survey sought to explore the usability and acceptability of GaitSmart as well as any reflections on implementation.

The second staff survey went to the project implementation team, site leads and ICB colleagues, who had supported the implementation of the GaitSmart system in their service and had attended project group meetings but may not have delivered the GaitSmart Tests within their role. The aim of this was to explore the process of implementation across sites considering barriers and facilitators in particular, to support potential future adoption and spread strategies across the system. All staff surveys have been given a unique respondent identifier for reporting purposes.

Both surveys allowed staff to choose not to answer a question. This survey was conducted between December 2024 and February 2025.

3.2 Data analysis

3.2.1 Principles for inclusion

To be included in the analyses, the Test data needed to be collected within the timeframe of the evaluation period (December 2023-February 2025). If the participant had less than four Tests, this was included only in the uptake and demographics analysis and non-matched GaitSmart data analysis (Sections 4.1 and 4.2.1). If a data point existed, but no Test could be attributed to it, this data point was excluded from the analyses. If a participant completed more than the standard 4-Test protocol, for example, completed 5, 6 or 7 Tests, these Tests were excluded from the analysis and the participant's Test 1, 2, 3 and 4 were included. Figure 3 shows how the data set was cleaned and by whom.

3.2.2 Challenges in the dataset

Upon receipt of the dataset, Health Innovation East began to query the dataset. This process included the identification of potential 'dummy' data, such as 'training' runs where site staff had delivered Tests to colleagues in order to practice the correct use of the equipment. To ascertain which data belonged to 'training' runs or participants' data, staff were asked to probe the patient list of names and highlight anyone they did not recognise as a patient. This led to DML removing 36 data points; 29 participants at Test 1 and seven data points at Test 2. Following this a new data set was provided to Health Innovation East.

A further 110 data points were removed by Health Innovation East as these were collected outside of the evaluation data collection window (later than February 2025). Of these 110 data points 17 were unique patients, some of whom completed two or three Tests after February 2025.

There remained 24 data points, involving 22 participants that had no associated 'Test number' (blank lines in the spreadsheet), which were also excluded from the analysis.

Descriptive calculations were completed in Microsoft Excel and focused on reporting of percentage changes and trends in GaitSmart outputs.

The final data set for analysis included 701 data points for 272 unique patients.
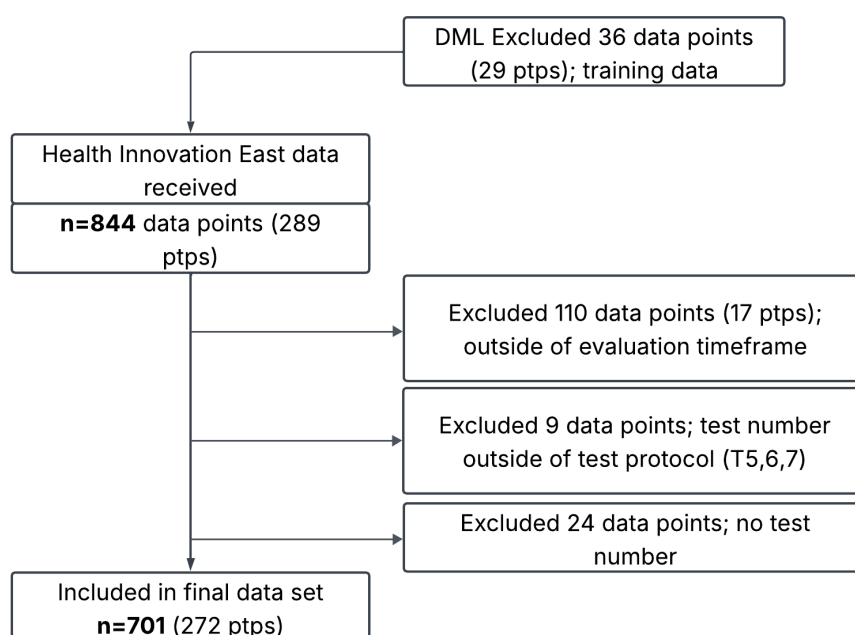
Figure 3: Flow diagram for GaitSmart data inclusion and exclusion

3.2.3 Survey data

Data cleaning identified that some of the surveys had been completed by patients outside of the intended time point, deviating from the protocol. For example, patients at Test 2 or Test 3 completed a survey, however the protocol required surveys to only be completed at Test 1 (baseline) or Test 4 (post intervention). It was also possible that in some instances the Test 1 GaitSmart survey link was used for a Test 4 survey and vice versa. This led to a large data validation exercise in which DML attempted to match surveys to GaitSmart Tests using time stamps. The methodology for this and data querying can be found in Appendix 1. No surveys were removed without being individually reviewed by two Evaluation Team members. Figure 4 shows a flow diagram of patient surveys collected and included within this report. Please note the Test 1 and Test 4 surveys are not identical, therefore any responses moved from Test 1 to Test 4 will have only resulted in a partial completion of the Test 4 survey (surveys available from Health Innovation East on request).

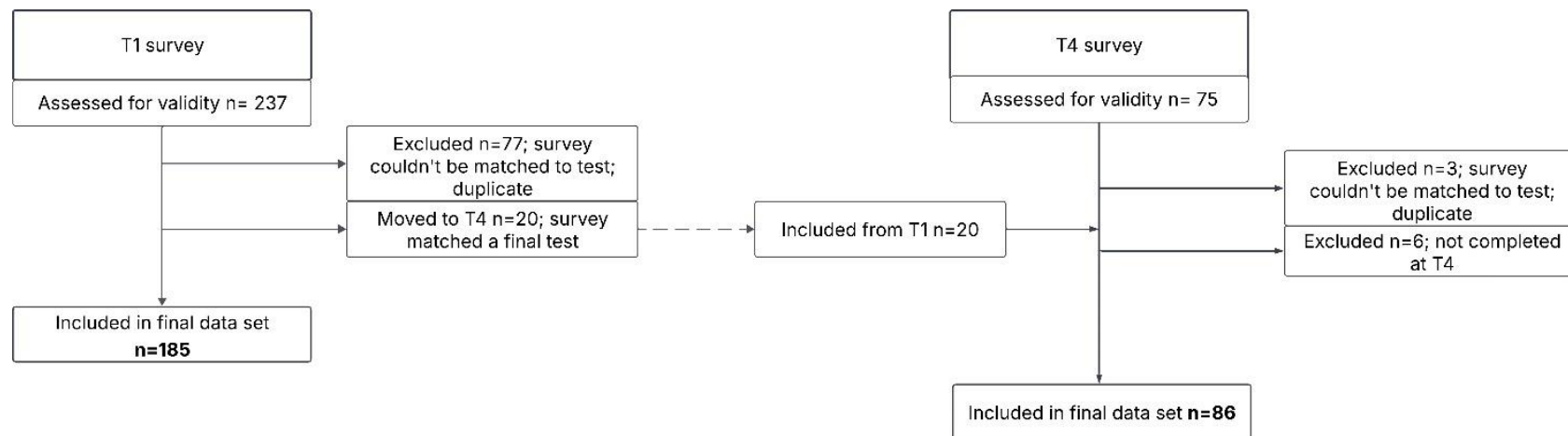**Figure 4:** Flow diagram for patient survey inclusion and exclusion

The survey datasets were downloaded in Microsoft Excel (xml) format. Survey data was descriptively analysed and figures were created in Microsoft Excel. Survey data was aggregated for analysis purposes, so group scores are reported instead of individual matched data. Direct comparisons between first and final surveys can therefore not be drawn because patients who completed the first survey may not have completed the last survey, and vice-versa.

4. Findings

4.1 How does uptake of GaitSmart differ between the sites?

4.1.1 Patient uptake

Patient uptake, utilising GaitSmart data, was defined as the number of patients who completed a Test at each protocol stage across the pilot period (January 2024 – February 2025). All Test 1s from this period are reported, including those who did not complete the 4-Test protocol. It should therefore be noted that any patients who completed Test 1 between December 2024 – February 2025 are included in these numbers and will not have had time to complete the 12-week, 4-Test protocol within the data collection window. Over the 15-month pilot, a total of 272 individuals completed a first GaitSmart Test (Test 1) and 98 completed Test 4 (Figure 5, Table 1).
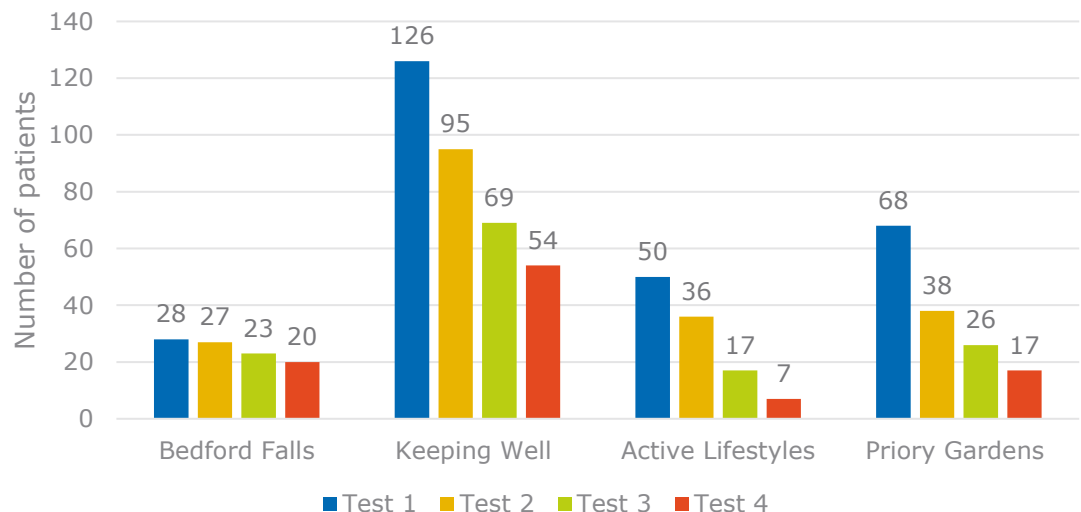

Figure 5: Number of Tests completed at each site, per Test stage

Table 1 provides a detailed breakdown by site of outcome measures across the protocol. This shows that *Keeping Well Clinic* recruited 126 patients to Test 1 over the pilot period, accounting for 43% of all patients within the pilot. Of these patients, 42% (n=54/126) completed the 4-Test GaitSmart protocol. *Priory Gardens* completed a Test 1 with 68 patients, and 25% (n=17/68) of these went on to complete Test 4. The *Active Lifestyles* service commenced the protocol (Test 1) with 50 patients, and 14% of these (n=7/50) completed Test 4. This was the lowest rate of Test 1 to Test 4 uptake at any site, and may be explained by the 3-Test protocol that was initially implemented in this setting. *Bedford Hospital Falls* completed 28 Tests 1s, and 71% (n=20/28) of these completed Test 4. This was the highest percentage of Test 1 to Test 4 completions of all sites and accounts for the smallest proportion of Test 1 patients (10%, n=28/272) but the second highest proportion of Test 4 patients (20% n=20/98).

All sites reported patient drop-offs across the 12-week protocol (Figure 5), resulting in 36% (98/272) patients overall completing the 4-Test protocol. Following Test 1, 28% (n=76/272) of patients did not return to complete Test 2. A further 31% (n=61/196) of patients, did not go on to complete Test 3, and a further 27% (n=37/135) did not complete Test 4. It should be noted that any patients who completed Test 1 between December 2024 – February 2025 are included in these numbers and will not have had time to complete the 12-week, 4-Test protocol within the data collection window.

Section 4.2.1 assesses the clinical scores of patients across the protocol phases allowing for some independent inferences about drop out to be made.

Table 1: Total cohort GaitSmart Test measures by site and Test number. GaitSmart score provides an overall understanding of how well the lower limbs are moving in the gait cycle. Gait speed is shown in meters per second. Average stride duration is shown in seconds per stride. Joint angle ° is the sum of both hip and knee angles.

	Test 1	Test 2	Test 3	Test 4
GaitSmart Score *All sites total*	69(6-100) N=272	73(5-100) N=196	72(9-100) N=135	73(11-100) N=98
Keeping Well Clinic mean (range)	69(6-100) N=126	71(5-100) N=95	72(9-100) N=69	72(11-100) N=54
Bedford Hospital Falls mean (range)	66(22-100) N=28	72(39-100) N=27	70(30-100) N=23	70(32-100) N=20
Active Lifestyles mean (range)	70(9-100) N=50	74(9-100) N=36	69(14-100) N=17	78(39-100) N=7
Priory Gardens mean (range)	72(9-100) N=68	73(18-100) N=38	75(20-100) N=26	76(28-100) N=17
Gait Speed (meters per second) *All sites total*	0.75(0.22-1.18) N=272	0.79(0.19-1.51) N=196	0.80(0.28-1.51) N=135	0.81(0.30-1.24) N=98
Keeping Well Clinic mean (range)	0.73(0.22-1.18) N=126	0.74(0.19-1.18) N=95	0.76(0.28-1.12) N=69	0.80(0.30-1.24) N=54
Bedford Hospital Falls mean (range)	0.74 (0.51-1.18) N=28	0.79 (0.52-1.18) N=27	0.82(0.4-1.18) N=23	0.79(0.57-1.16) N=20
Active Lifestyles mean (range)	0.75(0.29-1.16) N=50	0.82(0.31-1.12) N=36	0.81(0.35-1.12) N=17	0.81(0.57-1.06) N=7
Priory Gardens mean (range)	0.80(0.25-1.41) N=68	0.84(0.34-1.51) N=38	0.87(0.33-1.51) N=26	0.84(0.45-1.17) N=17
Average Stride Duration (stride time per second) *All sites total*	1.22(0.9-2.05) N=272	1.19(0.84-1.81) N=196	1.17(0.8-1.76) N=135	1.16(0.86-1.75) N=98
Keeping Well Clinic mean (range)	1.23(0.9-2.05) N=126	1.20(0.99-1.81) N=95	1.19(0.96-1.68) N=69	1.16(0.89-1.75) N=54
Bedford Hospital Falls mean (range)	1.21(0.99-1.62) N=28	1.19(0.99-1.58) N=27	1.17(0.8-1.44) N=23	1.16(1.01-1.43) N=20
Active Lifestyles mean (range)	1.18(0.93-1.56) N=50	1.18(0.95-1.81) N=36	1.17(0.84-1.76) N=17	1.14(1-1.31) N=7
Priory Gardens mean (range)	1.18(0.9-1.66) N=58	1.16(0.84-1.6) N=38	1.18(0.86-1.74) N=26	1.16(0.86-1.56) N=17
Joint Angle ° *All sites total*	169.1(183.4-248) N=272	177.34(78.53-240.9) N=196	178.14(112-235) N=135	173.33(113.6-234) N=98
Keeping Well Clinic mean (range)	174(83.4-239.6) N=126	177.8(89.8-221) N=95	180.6(112-229) N=69	180.1(113.6-229) N=54
Bedford Hospital Falls mean (range)	169.1(126.9-204.1) N=28	174.8(134.03-216.6) N=27	178.4(117.09-210) N=23	173(125.7-210) N=20
Active Lifestyles mean (range)	175.1(115.5-248) N=50	177.9(103.9-226.7) N=36	169.4(113.5-213) N=17	178.4(139.6-208) N=7
Priory Gardens mean (range)	175(91.81-240.2) N=68	177.43(78.53-240.9) N=38	183.8(141.8-235) N=26	179(136.5-234) N=17

Table 2: Characteristics of GaitSmart patients at sites across the protocol

Characteristics		Test 1 n=272	Test 2 N=196	Test 3 N=135	Test 4 n=98
Mean patient Age (Range)	*All sites total*	75 (21-96)	75(35-96)	77(61-96)	78(47-96)
		N=272	N=196	N=135	N=98
	Keeping Well	78(21-96)	78(61-92)	80(49-96)	79(61-96)
	Bedford Falls	75(46-92)	75(46-96)	77(61-92)	77(49-92)
	Active Lifestyles	72(35-93)	71(35-86)	70(35-86)	70(47-85)
	Priory Gardens	72(51-96)	70(51-87)	75(56-87)	76(56-87)
Percentage of female patients (N)	*All sites total*	66(177/269)	64(123/193)	66(88/133)	65(62/96)
	Keeping Well	62(78/126)	60(57/95)	65(45/69)	64(35/54)
	Bedford Falls	60(15/25)	63(15/24)	62(13/21)	61(11/18)
	Active Lifestyles	78(39/50)	78(28/36)	82(14/17)	71(5/7)
	Priory Gardens	66(45/68)	60(23/38)	62(16/26)	65(11/17)
Percentage of patients using walking aids (N)	*All sites total*	25(69/272)	18(36/196)	21(28/135)	19(19/98)
	Keeping Well	28(35/126)	25(24/95)	20(14/69)	24(13/54)
	Bedford Falls	29(8/28)	30(8/27)	39(9/23)	20(4/20)
	Active Lifestyles	30(15/50)	28(10/36)	12(2/17)	14(1/7)
	Priory Gardens	16(11/68)	11(4/38)	12(3/26)	6(1/17)
Percentage of patients with pre-existing MSK medical condition* (N)	*All sites total*	54(148/272)	52(101/196)	48(65/135)	48(47/98)
	Keeping Well	40(50/126)	38(36/95)	36(25/69)	33(18/54)
	Bedford Falls	93(26/28)	100(27/27)	100(23/23)	100(20/20)
	Active Lifestyles	98(49/50)	89(32/36)	71(12/17)	86(6/7)
	Priory Gardens	34(23/68)	16(6/38)	19(5/26)	18(3/17)

*Pre-existing conditions included: balance, condition(osteoporosis, polio, sciatica, scoliosis), fall, fracture, joint replacement, neurological condition, osteoarthritis, prosthesis, hospitalisation

4.1.2 Patient demographics

Table 2 shows the characteristics of GaitSmart patients across sites included in the analysis. This data includes the full cohort, and therefore Test 1 data shows all who presented at Test 1, not only those who completed Test 4.

The average age of patients across all sites at Test 1 was 75 years (range: 21-96). The *Active Lifestyles* site average age was 72 years (range: 35-93), whilst *Keeping Well* site average age was 78 years (range: 21-96).

Table 2 also shows that the majority of patients who completed Test 1 were female (66%, n=177), this majority remained over the 4-Tests.

Twenty five percent (n=69/272) at Test 1 reported using a walking aid, such as a crutch, walking stick, walker or walking frame (Table 2). A total of 38% (n=35/126) who attended the *Keeping Well Clinic* used a walking aid, accounting for just over half of all walking aid users at Test 1. Meanwhile, 66% of patients (n=45/68) at *Priory Gardens* reported walking with an aid. Of those who completed the Test 4 19% (n=19/98) of patients indicated using a walking aid, a 6% reduction on those at Test 1. At Test 4 the *Keeping Well* cohort had 24% (13/54) of their patients using walking aids, at *Bedford Falls* 20% (n=4/20), *Priory Gardens* 6% (n=1/17) and *Active Lifestyles* 14% (1/7) respectively. Reporting of walking aid use was reliant on staff member completion on behalf of the patient at each Test.

Table 2 also displays that 54% (n=148/272) of all patients at Test 1 reported a pre-existing musculo-skeletal medical condition (MSK), such as a neurological disorder, joint replacement, osteoarthritis or a prosthesis. These selections were based on a drop-down list provided by DML and reporting was reliant on staff member completion on behalf of the patient. This proportion was 6% lower at Test 4 (n=47/98, 48%). A high percentage of patients at *Active Lifestyles* (98%, n=49/50) and at *Bedford Falls* (93%, n=26/28) reported having a pre-existing MSK condition at Test 1. At Test 4 100% of patients at *Bedford Falls* reported an MSK condition and 86% (n=6/7) at *Active Lifestyles*. The two primary care sites had 33% (*Keeping Well,* n=18/54) and 18% (*Priory Gardens,* n=3/17) of patients reporting a pre-existing condition at Test 4.

4.2 What are the quantitative outcomes related to risk of patient falls that may help inform the future adoption and spread of GaitSmart by BLMK ICB?

4.2.1 All patients

The data presented within Table 1 includes all GaitSmart patients at each site, regardless of whether they completed a final Test. This means that individuals who completed Test 1, 2 or 3 are included. Data is therefore not matched, for example those included in Test 1 data may not have been included in Test 3 or 4 data and therefore cannot be directly compared.

The data shows that mean GaitSmart score was highest at A*ctive Lifestyles* for two of the four Tests, Test 2 (Score=74, Range: 9-100) and Test 4 (Score=78, Range: 39-100)), alongside *Priory Gardens* (Test 1 Score=72, Range: 9-100; Test 3 Score=75, Range: 20-100). Meanwhile, *Priory Gardens* patients consistently scored highest on Speed (Test 1 (.80 m/s; Range: 0.25-1.41), Test 2 (.84 m/s, Range: 0.34-1.51), Test 3(.87 m/s, Range: 0.33-1.51) and Test 4 (.84 m/s, Range: 0.45-1.17)). Mean average stride duration was shortest in both *Active Lifestyles* (1.18, Range: 0.93-1.56) and *Priory Gardens* (1.18, Range: 0.9-1.66) at Test 1 and *Priory Gardens* at Test 2 (1.16, Range: 0.84-1.6), *Bedford Falls* (1.17; Range: 0.8-1.44) and *Active Lifestyles* (0.17, Range: 0.84-1.76) at Test 3 and *Active Lifestyles* at Test 4 (1.14, Range: 1-1.31). Mean joint angle score was largest at *Active Lifestyles* for Test 1 (175.1, Range: 115.5-248) and Test 2 (177.9, Range: 103.9-226.7), *Priory Gardens* for Test 3 (183.8; Range: 141.8-235) and *Keeping Well* (180.1, Range: 113.6-229) at Test 4. No tests of statistical significance have been run on these means, these are purely descriptions of raw data.

4.2.2 Protocol completers

Table 3 provides GaitSmart Test measures by sites and Test number for the total number of patients who completed the full 4-Test protocol, to allow for direct group comparison at Test 1 and Test 4. A total of 98 patients completed the Test 4 protocol. No tests of statistical significance have been run on these means, these are purely descriptions of raw data.

Table 4 shows the percentage of patients whose score increased between Test 1 and Test 4, by site. The vast majority (90%, n=88/98) of patients improved at least one of their scores between Test 1 and Test 4, 48% (n=47/98) improved in all four outcome measures. *Keeping Well* had the highest proportion of patients (56%, n=30/54) improve all four outcomes

(GaitSmart Score, speed, average stride duration and joint angle), followed by *Active Lifestyles* (43%, n=3/7), *Bedford Falls* (40%, n=8/20) and finally *Priory Gardens* (35%, n=6/17).

Table 3: Protocol completion cohort GaitSmart Test measures by site and Test number. In this table, patients were compared between T1 and T4 (same patients).

	Test 1	Test 2	Test 3	Test 4
GaitSmart Score *All sites total mean (Range)*	65(6-100) N=98	70(5-100) N=98	72(14-100) N=98	73(11-100) N=98
Keeping Well Clinic mean (Range)	65 (6-100) N=54	70(5-100) N=54	72(14-100) N=54	72(11-100) N=54
Bedford Hospital Falls mean (Range)	66 (22-98) N=20	71(42-100) N=20	70 (30-100) N=20	70(32-100) N=20
Active Lifestyles mean (Range)	72 (27-100) N=7	74(30-100) N=7	70(17-100) N=7	78(39-100) N=7
Priory Gardens mean (Range)	64 (25-100) N=17	68(30-100) N=17	77(43-100) N=17	76(26-100) N=17
Gait Speed (m/s) *All sites total*	0.72 (0.36-1.13) N=98	0.75(0.19-1.14) N=98	0.79(0.28-1.20) N=98	0.81 (0.3-1.08) N=98
Keeping Well Clinic mean (Range)	0.69 (0.51-1.16) N=54	0.73(0.19-1.09 N=54	0.77(0.28-1.20) N=54	0.80 (0.3-1.24) N=54
Bedford Hospital Falls mean (Range)	0.72 (0.22-0.99) N=20	0.79(0.58-1.14) N=20	0.82(0.60-1.18) N=20	0.79 (0.57-1.16) N=20
Active Lifestyles mean (Range)	0.73 (0.29-1) N=7	0.72(0.40-0.98) N=7	0.79(0.42-1.03) N=7	0.81 (0.57-1.06) N=7
Priory Gardens mean (Range)	0.75 (0.25-1.17) N=17	0.76(0.44-1.14) N=17	0.82(0.33-1.18) N=17	0.84 (0.45-1.17) N=17
Average stride duration *All sites total*	1.22 (0.92-2.05) N=98	1.19(0.84-1.81) N=98	1.17(0.80-1.68) N=98	1.16 (0.86-1.75) N=98
Keeping Well Clinic mean (Range)	1.25 (0.94-2.05) N=54	1.21(0.99-1.81) (N=54	1.18(0.96-1.68) N=54	1.16 (0.89-1.75) N=54
Bedford Hospital Falls mean (Range)	1.20 (0.99-1.44) N=20	1.18(0.99-1.58) N=20	1.16(0.80-1.39) N=20	1.16 (1.01-1.43) N=20
Active Lifestyles mean (Range)	1.18 (1.10-1.33) N=7	1.18(1.08-1.32) N=7	1.16(1.05-1.39) N=7	1.14(1-1.31) N=7
Priory Gardens mean (Range)	1.19 (0.92-1.66) N=17	1.18(0.84-1.49) N=17	1.15(0.86-1.48) N=17	1.16 (0.86.-1.56) N=17
Joint Angle *All sites total*	168.64 (4.35-212.55) N=98	174.10(89.76-232.97) N=98	177.23(112.02-235.93) N=98	178.37 (113.56-234.67) N=98
Keeping Well Clinic mean (Range)	169.57 (94.35-212.55) N=54	175.79(89.76-221.75) N=54	179.37(112.02-222.30) N=54	180.07 (113.56-229.38) N=54
Bedford Hospital Falls mean (Range)	168.60 (126.99-199) N=20	173.86(134.03-216.14) N=20	170.41(117.09-212.84) N=20	173.33 (125.17-210.27) N=20
Active Lifestyles mean (Range)	167.84 (115.49-204.20) N=7	173.44(120.28-201.93) N=7	170.10(113.54-202.93) N=7	178.36 (139.66-208.67) N=7
Priory Gardens mean (Range)	166.06 (121.05-209.87) N=17	169.29(90.41-232.97) N=17	181.43(146-235.93) N=17	178.87 (136.55-234.64) N=17

Table 4: percentage of patients whose score increased between Test 1 and Test 4, by site. In this table, patients were compared between T1 and T4 (matched patients).

	GaitSmart Score	Speed	Average Stride duration	Joint Angle	All measures
Improvement % *All sites*	70 N=69/98	76 N=74/98	72 N=71/98	77 N=75/98	48 N=47/98
Keeping Well Clinic	78 N=42/54	81 N=43/54	85 N=46/54	80 N=43/54	56 N=30/54
Bedford Hospital Falls	60 N=12/20	65 N=13/20	60 N=12/20	75 N=15/20	40 N=8/20
Active Lifestyles	43 N=3/7	71 N=5/7	57 N=4/7	100 N=7/7	43 N=3/7
Priory Gardens	71 N=12/17	71 N=12/17	53 N=9/17	59 N=10/17	35 N=6/17

4.2.2.1 GaitSmart Score

GaitSmart score is the culmination of all the sagittal movement and describes how well the hips and knees are moving.

The GaitSmart score for 70% (n=69/98) of all patients increased between Test 1 and Test 4 (Table 4). The proportion of patients who improved their GaitSmart score differed across sites: *Keeping Well* 78% (n=42/54), *Priory Gardens* 71% (n=12/17), *Bedford Falls* 60% (n=12/20) and *Active Lifestyles* 43% (n=3/7).

4.2.2.2 Gait Speed

Changes in gait speed were investigated for each site (Table 3). Here, we describe the proportion of patients who showed an improvement, no change, or decline in their gait speed per site. Cut-points of gait speed at usual pace and risk of adverse outcomes based on a systematic review (10) are as follows: Healthy Older population >1.0ms, Cognitive decline within 5 years <1.05ms, Mobility and ADL disability in 2 years and adverse health outcomes 0.8ms, Hospitalisation and new falls predicted at <0.7ms. This means that someone who walks at, or faster than 1 meter per second is considered a healthy older adult, and at lower risk of health events based on the research available. Whereas someone who walks at 0.7 meters per second or slower, are at risk of hospitalisation and new falls.

At Test 4, 76% (n=74/98) of patients had higher gait speed than at Test 1 (Table 4). 81% (n=44/54) of *Keeping Well clinic* patients increased their Gait speed, *Active Lifestyles* 71% (n=5/7) and *Priory Gardens* had 70% (n=12/17) and *Bedford Falls had* 65% (n=13/20) of patients improve their speed.

The data shows that 60% of all patients (n=59/98) were at risk of adverse health outcomes (<0.8 m/s) at Test 1, compared to 50% (n=49/98) at Test 4 (Figure 6).
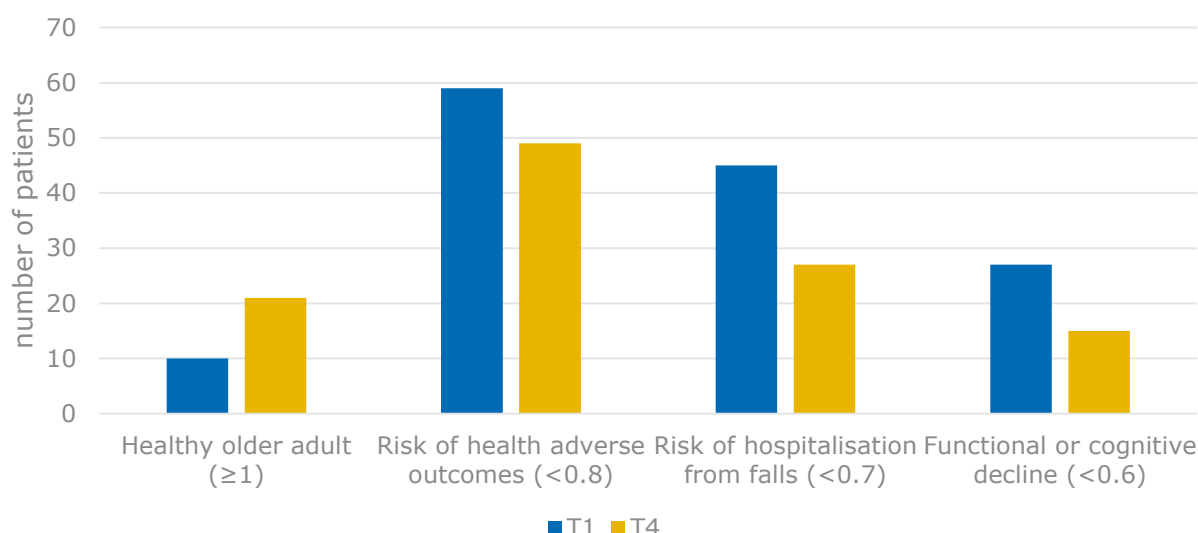
Figure 6: Number of patients who met cut-points of gait speed and risk of adverse outcomes found in literature (10)

4.2.2.3 Average stride duration

Average stride duration depicts how long, on average, it takes to complete strides. Group changes in average stride duration were investigated for each site (Table 3). 72% of patients (n=71/98) improved their stride duration (i.e., took faster strides) (Table 4). *Keeping Well* (85%, n=46/54) had the largest proportion of improvers, followed by *Bedford Falls* (60%, n=12/20), *Active Lifestyles* (57%, n=4/7) and *Priory Gardens* (53%, n=9/17).

4.2.2.4 Joint Angle

Joint Angle, measured as a sum of knee and hip angles, was investigated for each site (Table 3). Across all patients who completed the 4-Test protocol (n=98), 77% (n=75) showed an increase in joint angle. All patients at *Active Lifestyles* improved their Joint Angle (100%, n=7/7), whilst 59% (n=10/17) of patients at *Priory Gardens* increased their joint angle, 80% (n=43/54) at *Keeping Well* and 75% (n=15/20) of patients at *Bedford Falls* (Table 4).

4.2.2.5 Falls

The patient survey was used to gather information on patient falls. These groups cannot be directly compared as different patients completed the Test 1 and Test 4 surveys. These are group averages spanning different time periods and so no inferences can be made about any change over time.

At Test 1, 38% (71/185) of patients reported having had a fall six months prior to Test 1, accounting for a total number of 154 falls. Additionally, 12% (23/185) reported having had a fall four weeks prior, with a total number of twenty seven falls. At Test 4, 14% (9/66) of patients who answered the question reported having a fall since initiating the 12-week GaitSmart protocol, with a total number of 15 falls.

4.3 What does patient feedback tell us about the acceptability, usability and patient experience of using GaitSmart, and any benefits thereafter?

Figure 4 shows the sample included in the survey analysis. Test 1 (pre-intervention) survey had 185 valid responses. Test 4 (post-intervention) survey included 86 valid responses.

However, the 86 Test 4 survey responses included 20 that had completed 'first' survey at this time point (Figure 4) and could only respond to questions relating to Short FES-I, falls and confidence. Of the remaining 66 responses, 61 answered all questions in the full final survey in line with the 4-Test protocol.

The different (unmatched) respondents at Test 1 and Test 4 means that any differences between the groups cannot be directly compared and inferences not made. Therefore the total number of responses to questions differed, and so percentages are presented alongside the number (n) of responses to that question for clarity in the sections below.

4.3.1 Acceptability

The majority of patients (92% n=56/61) within the Test 4 survey stated that they would recommend GaitSmart. Meanwhile, 5% (n=3/61) of patients indicated they were neither likely nor unlikely to recommend GaitSmart and 3% (n=2/61) indicated they were unlikely or extremely unlikely to recommend GaitSmart (Figure 7).
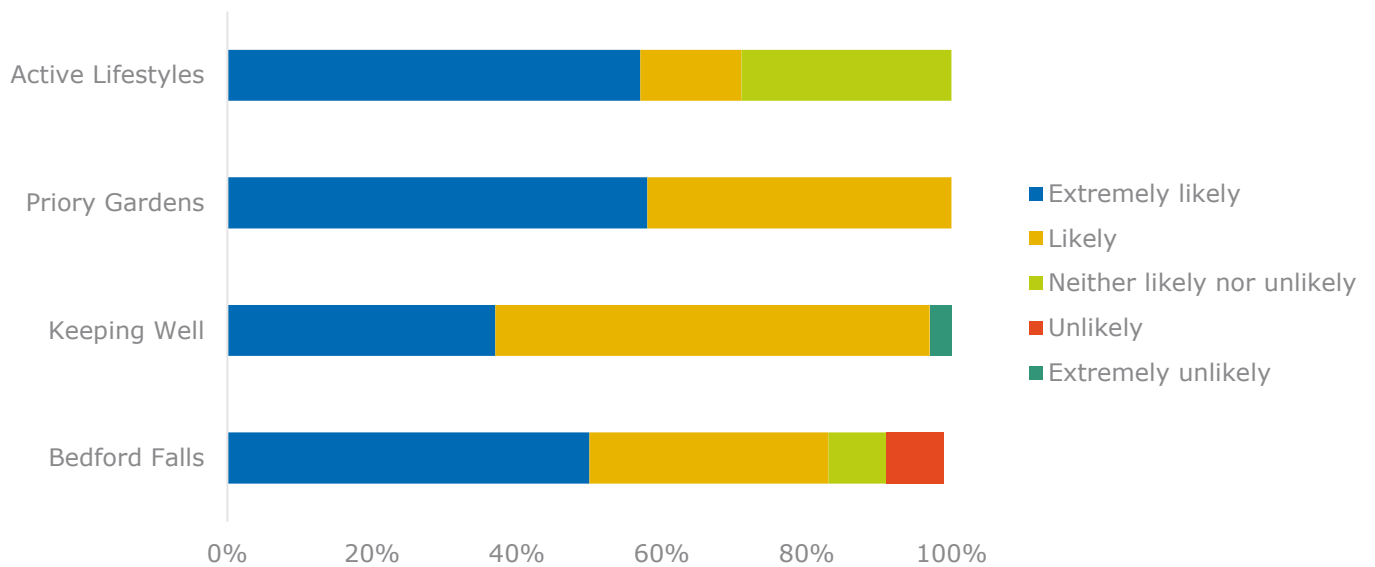
Figure 7: Likelihood of patients recommending GaitSmart to someone with issues walking or rehabilitating

4.3.2 Usability

Upon completion of the GaitSmart test, a report is produced on the tablet. The report, explained by the staff member who delivers the test, provides an overview of the test results via numbers and images.

Patients were asked how they found using GaitSmart through a range of questions (Figure 8). 79% (48/61) indicated that they found the GaitSmart report either 'Very easy' or 'quite easy' to use and 89% (54/61) patients found the descriptions very or quite easy to follow. 69% of patients (42/61) reported that the exercises were very or quite easy to complete.
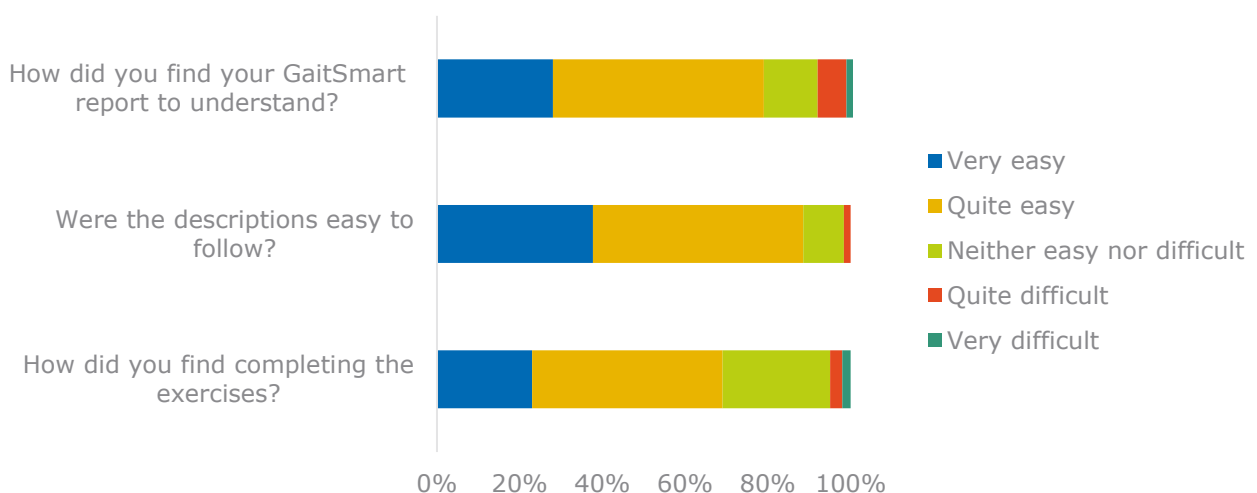

Figure 8: Patient experience of using GaitSmart

When asked '*which part of your report/s were most useful to you?'* 42% (n=45/106) of the multiple choice answers selected the Traffic Light Coding System, 31% (n=33/106) selected the exercises and 25% (n=27/106) stated they found the GaitSmart score most useful to them. One person selected 'other' but a follow-up description was not provided. Within this question it was possible to select more than one answer.

4.3.3 Impacts and benefits

4.3.3.1 Fear of falling

Figure 9 shows how FoF differed between Test 1 (n=185) and Test 4 (n=86) for patients based on the *high, medium* or *low* categories. Survey responses to the Short FES-I indicate that the proportion of those categorised as having a *high* FoF was 28% (n=24/86) at Test 4 compared to 37% (n=69/185) at Test 1. Moreover, as a group, those categorised with a *low* FoF at Test 1 was 26% (n=49/185) and 22% at Test 4 (n=19/86). Those categorised with a *medium* FoF was 36% (n=67/185) at Test 1 and 50% (n=43/86) Test 4. A breakdown of Short FES-I levels of concern across sites is provided in Appendix 2.
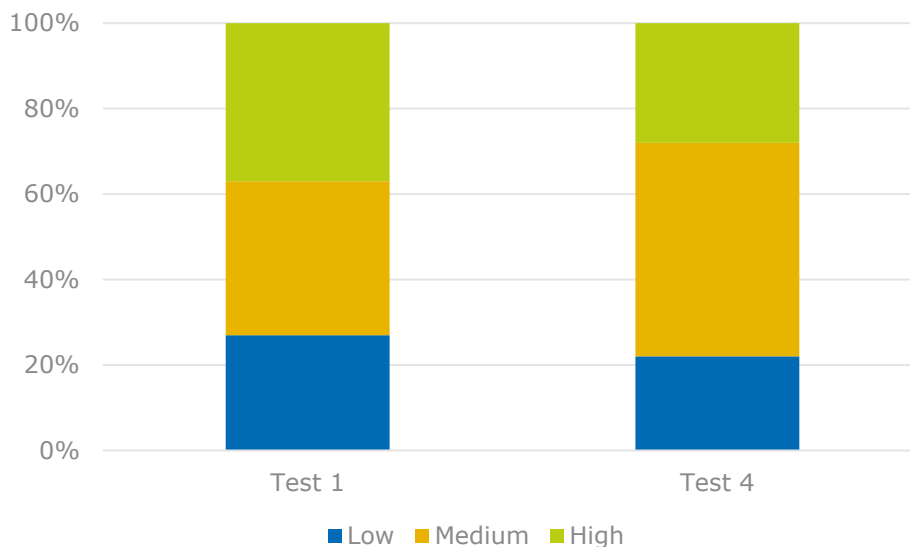

Figure 9: Fear of falling at Test 1 (n=185) and Test 4 (n=86)

4.3.3.2 Confidence

There was a 15% increase between Test 1 (54%, n=99/185) and Test 4 (69%, n=56/81) survey responses of patients indicating they felt more confident walking (Figure 10). Furthermore, responses for 'disagree' or 'strongly disagree' dropped by 6% between Test 1 and 4.
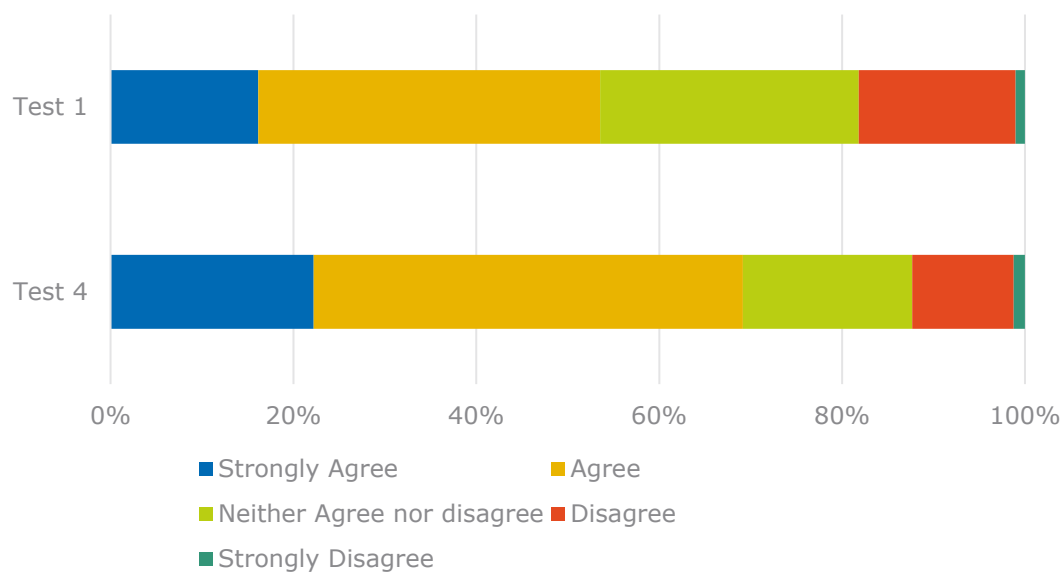
Figure 10: *Walking confidence at Test 1 and Test 4*

4.3.3.3 Motivation

Most respondents at Test 4 (74%, n=45/61) noticed that seeing the reports increased their motivation to exercise.

4.3.3.4 Impact on day-to-day life

A multiple choice question collated answers to GaitSmart's impact on day-today life; at Test 4, 87% of responses (n=86/109) said that GaitSmart had impacted their day-to-day life. Figure 11 illustrates the most frequently selected impacts, including 'ability to perform day to day activities' (24%, n=26/109), 'state of mind, emotional health and/or wellbeing' (21%, n=23/109) and 'quality of life, lifestyle and/or social life' (20%, n=22/109).
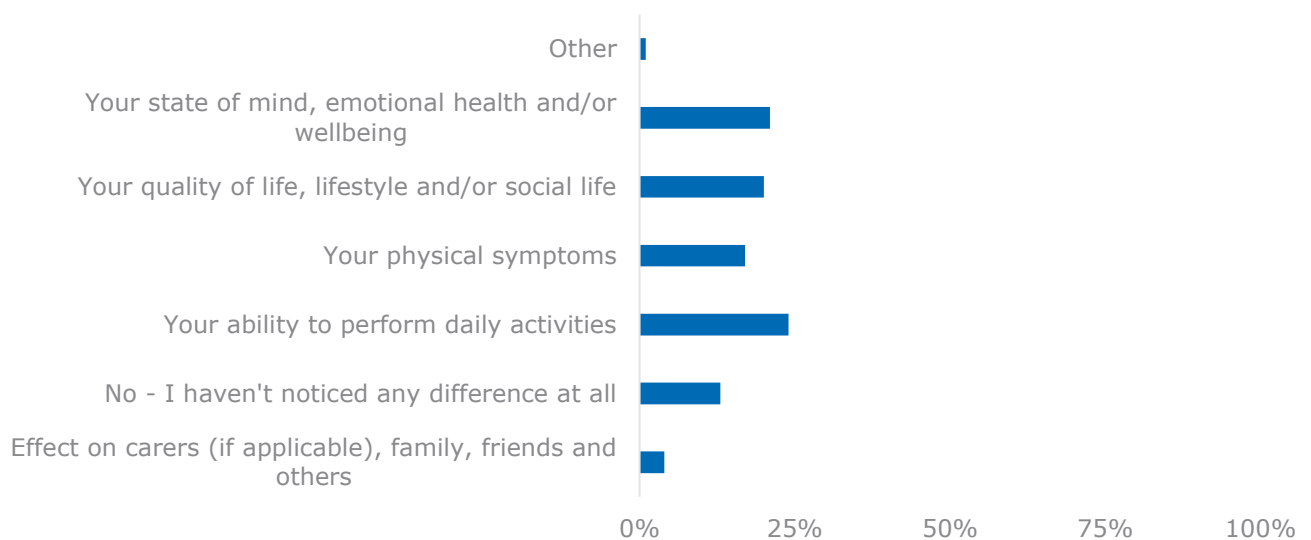
Figure 11: Self-reported GaitSmart impact on patients day-to-day life

4.3.3.5 Mobility

The majority of patients (76%, n=46/61) felt that the GaitSmart programme led to either some (56%, n=34/61) or significant (20%, n=12/61) change in their mobility (Figure 12). The proportion of those felt they have either some or significant changes in their mobility across sites was; *Active Lifestyles* 86% (n=6/7), *Bedford Falls* (75% n=9/12), *Priory Gardens* (75%, n=9/12) and *Keeping Well* (73%, n=22/30). *Bedford Falls* patients were most likely to report no improvement (17%, n=2/12) and *Active Lifestyle* patients were the most likely to report significant improvement (43%, n=3/7).
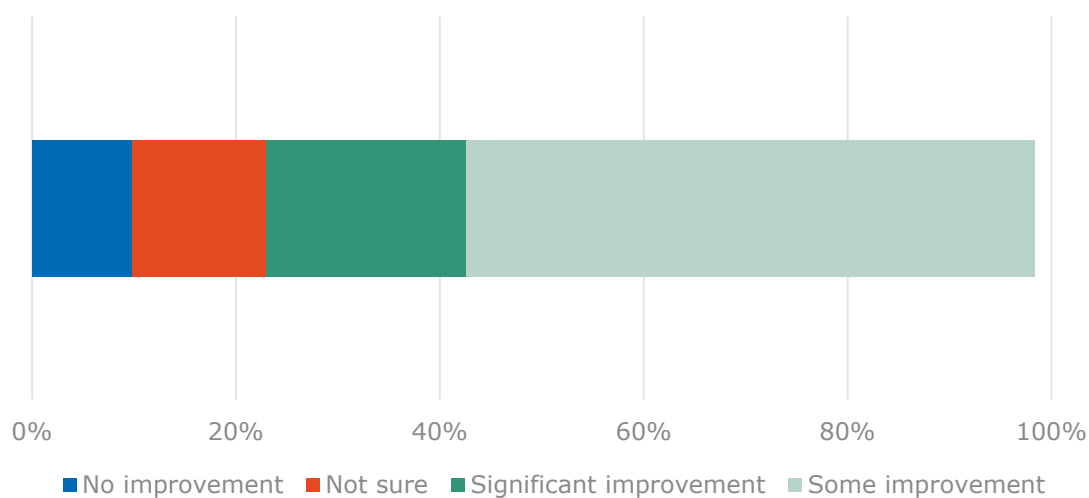

■ No improvement ■ Not sure ■ Significant improvement ■ Some improvement

Figure 12: patient reported change in mobility

4.4 What does staff feedback tell us about the acceptability, usability, and any challenges or benefits of implementation?

The staff survey data included a total of 17 surveys: 13 survey responses from staff delivering GaitSmart Tests and 4 from implementation leads. The number of responses received for the staff survey at each site were as follows: *Bedford Hospital Falls* clinic n=4/13 (31%), *Priory Gardens* n=3/13(23%), *Keeping Well* n=2/13 (16%) and *Active Lifestyles* n=4/13 (31%). It was possible for staff to choose not to answer every question.

4.4.1 Usability

Sixty nine percent (n=9/13) of respondents either agreed or strongly agreed with the statement '*The GaitSmart assessment was easy to administer*', whilst 31% of respondents (n=4/13) neither agreed nor disagreed. Those who neither agreed nor disagreed shared mixed views around the ease of applying the device straps, sometimes due to the Velcro coming loose. Respondents also reported that the tablet could be slow and would often stop working or lose connection, sometimes requiring a duplication of the whole assessment.

When responding to the statement '*The GaitSmart report was easy to explain to the patient*' 46% (n=6/13) either agreed or strongly agreed, whilst 31% of respondents (n=4/13) disagreed (Figure 13)*.*
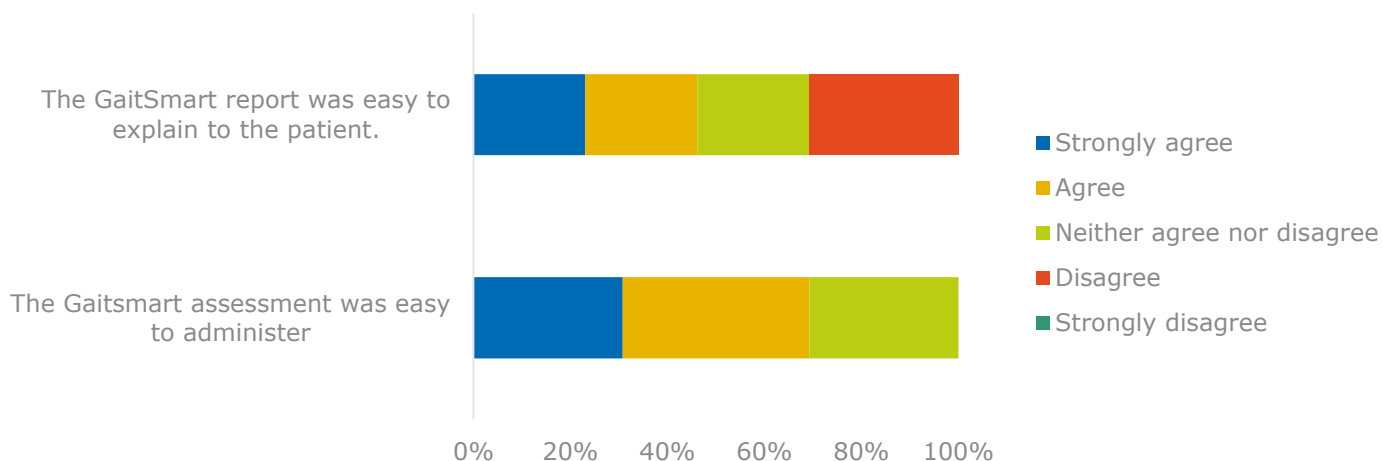

Figure 13: Staff experience of using GaitSmart with patients

4.4.2 Capability

The vast majority (92%, n=12/13) of respondents either agreed or strongly agreed *w*ith the statement '*I had the skills/knowledge to administer the GaitSmart Test'* , one

responded 'neither agree nor disagree' (Figure 14). All respondents (n=13/13) felt that they had the confidence to complete the Test and most (84%, n=11/13) felt that they had the time to complete the Test.
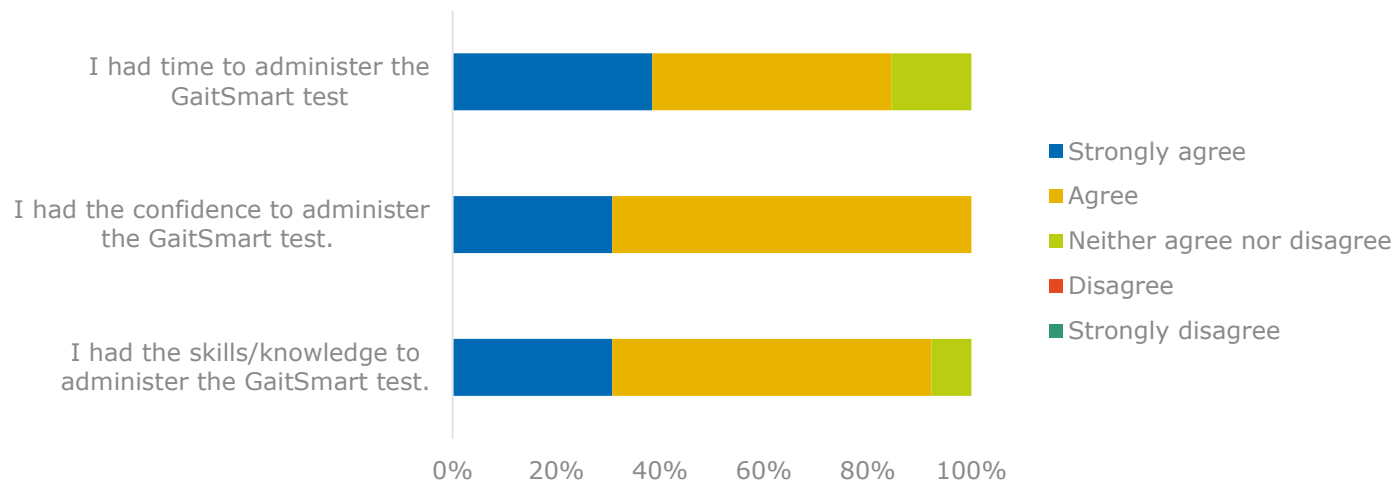

Figure 14: Staff capability and confidence to administer the Test

4.4.3 Perceived patient impact

Staff were also asked about their perception of GaitSmart on patient outcomes (Figure 15). Most (54%, n=7/13) respondents either agreed or strongly agreed with the statement '*Patients gained confidence whilst using GaitSmart'*. One respondent (8%) disagreed with the statement.

Some respondents (46%, n=6/13) reported that the GaitSmart report motivated patients to complete their exercises, a further 46% (n=6/13) neither agreed nor disagreed, and one (8%) disagreed. A smaller proportion of staff (38%, n=5/13) agreed that GaitSmart enhanced the time they spent with patients.
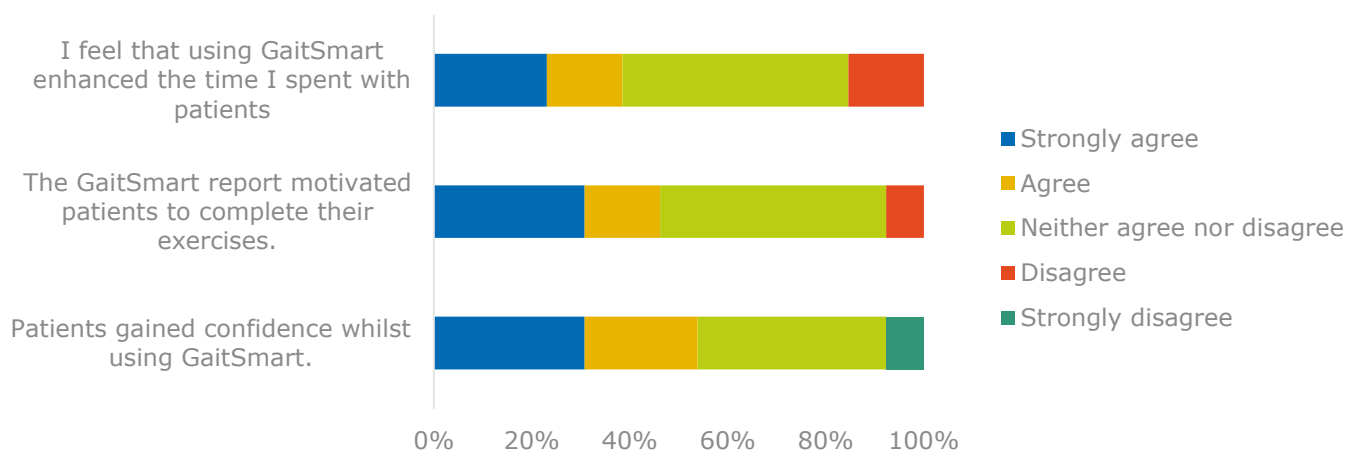
Figure 15: Staff perceived impact of GaitSmart on patients

4.4.4 Staff recommendation

50% (n=6/12) of staff who conducted Tests would responded that they would recommend GaitSmart to be continued in their service (Figure 16). 25% neither agreed nor disagreed (n=3/12) and 25% either disagreed (n=2/12) or strongly disagreed (n=1/12). One staff member did not answer the question.
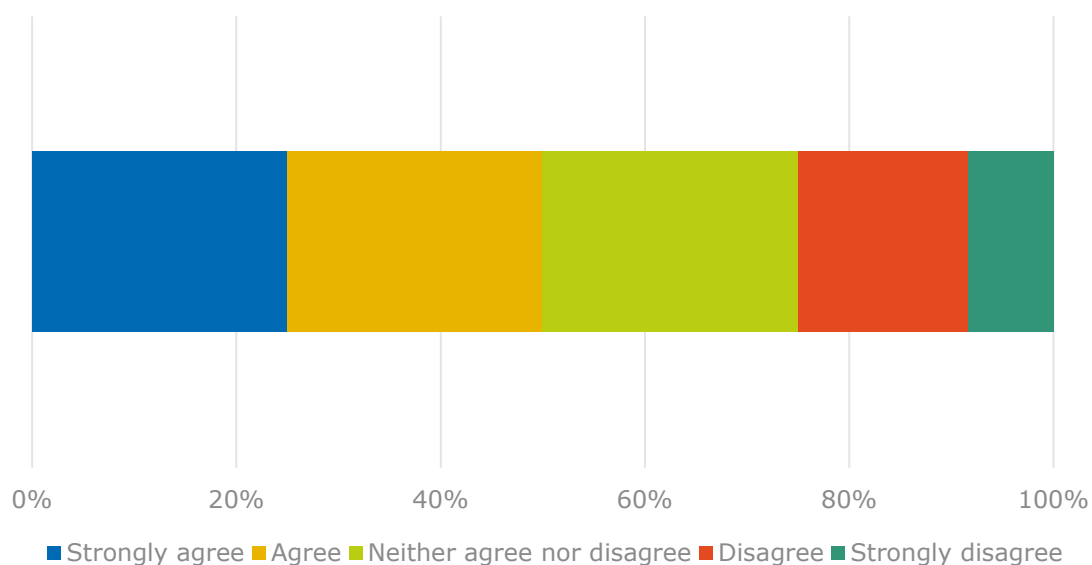

Figure 16: Staff agreement on recommending that GaitSmart continues in their service

Bedford Falls staff (100%, n=3/3) did not agree that GaitSmart be continued in their service, and suggested that an intervention prior to falling would be more appropriate for their patients.

Staff from the two primary care settings, *Priory Gardens* and *Keeping Well*, mostly supported GaitSmart implementation in their service with 80% (n=4/5) stating they strongly agree or agree and only one response of 'neither agree nor disagree'. Staff from the community setting, *Active Lifestyles*, either selected agree or strongly agree (50%, n=2/4) or 'neither agree nor disagree' (50%, n=2/4).

4.4.5 Challenges and benefits of implementation

A large proportion (83%, n=10/12) of staff reported experiencing benefits whilst using GaitSmart. Staff recognised the benefits of using GaitSmart for those patients who completed the exercises, with many stating improvements in mobility. Staff also reported the GaitSmart Traffic Light System as an enabler for patient understanding of their performance.

One implementation lead reported that implementing the GaitSmart intervention enabled staff to develop stronger relationships with patients, leading to internal and external referrals to support additional health and welfare needs. It was reported that GaitSmart particularly provided positive psychological reinforcement to those patients who received higher GaitSmart scores; '*we have had patients attend and are relieved and happy when they receive a 100% score. This positive reinforcement is fantastic.' (*P15)

Another patient benefit identified from secondary care, was that it provided '*some extra options for patients'.* (P14)

The majority of staff (83%, n=10/12) completing Tests reported encountering challenges whilst using GaitSmart. The most commonly cited challenge was that '*The tablet didn't work or froze'* (P10), often resulting in completion of the Test being delayed. Some staff mentioned issues with the device straps and also '*felt it wasn't a good use of our time when patients hadn't been doing the exercises' (P9)*. The innovator, DML, was said to '*have been great to work with, responsive, approachable and very supportive to the sites'* (P4) particularly in relation to these issues. A minority of staff reported observing a reduction in GaitSmart scores despite observing visible improvements in practice. Additionally, challenges identified by implementation lead colleagues included not always having the physical space available to complete the assessments; experiencing time constraints in completing the appointments scheduled which also made the surveys more challenging to complete; and sharing equipment across sites.

In regards to implementation approach the feedback highlighted that '*cohesive team approach with the ICB, innovators, Health Innovation East and the clinical sites has been key'*. (P17)

Specifically this included a monthly meeting to monitor the data, share challenges and successes to assist with problem solving where required.

Staff also reported that in the early stages '*finding leaders that have the energy and passion to be trail blazers and try something new is essential.*' Followed by an honest reflection *that 'It wasn't easy to find those leaders initially, who would be a pilot site for GaitSmart'. (P17)*

Within sites the importance of a strong team was also highlighted as an enabler '*We have had a fantastic team that has driven patients to the pilot study and our care coordinator has become more confident and efficient in the delivery as time has gone on. Our patients have been extremely responsive and this in itself had helped with the implementation and the achievement to date.*' *(P15)*

5. Discussion

5.1 Uptake

There was variability in uptake of GaitSmart and Test-protocol completion across the four sites. For example, *Bedford Hospital Falls* had the lowest number of patients over the 15-month pilot period, having 28 patients at Test 1 compared to 50 at *Active Lifestyles*, 68 at *Priory Gardens* and 126 at *Keeping Well*. There was also variability in completion rates of the full 4-Test protocol. The findings suggest these differences may be explained by differences in site patient group characteristics, as discussed below.

Staff feedback explains that the cohort of patients eligible for GaitSmart at *Bedford Falls Hospital*, where uptake was lowest, was limited due to complex health needs, often neurological. 93% (n=26/28) of those who were eligible to be involved in GaitSmart at the site had a pre-existing medical condition and 39% (n=8/28) used a walking aid. As a result, staff in this secondary care setting suggested that GaitSmart was better suited to prevention focused settings; and were less likely to recommend the continuation of GaitSmart in their service than staff at sites with higher uptake.

Although 75% of *Bedford Falls* patients self-reported improvements in their mobility, they were also the most likely to report no improvements (17%). However, the patients recruited at *Bedford Falls* were more likely to complete the full 4-Test protocol, and GaitSmart data showed that 40% of patients at *Bedford Falls* improved on all four clinical gait measures, compared to 56% at *Keeping Well*, 43% at *Active Lifestyles* and 35% at *Priory Gardens*. Uptake across the four Tests is perhaps a positive indicator of the more succinct recruitment approach and potentially more concerted compliance to the protocol from staff at *Bedford Falls*. On the other

hand, both *Priory Gardens* (75%) and *Active Lifestyles* (86%) saw high drop off between Tests 1 and 4. This is likely to reflect the 3-Test protocol *Active Lifestyles* were initially implementing in their community setting, before shifting towards the 4-Test model. There are a range of other factors that could influence drop off between Tests such as no longer feeling the need to attend following a positive result or otherwise; being unable to book an appointment; or having completed their first Test in January and therefore not having time to complete any more than their second Test before the data collection for this report closed. The benefits of encouraging uptake across the 4-Test protocol is highlighted within the matched data set of GaitSmart Scores, which showed scores did not increase linearly at each timepoint at all sites, for example *Bedford Falls* and *Active Lifestyles* both saw a decrease in GaitSmart score between Test 2 and Test 3 before increasing again at Test 4. This suggests that adherence to the 4-Test protocol is beneficial to enhanced mobility scores.

Overall, uptake of Tests reduced at each time point across all sites, although it should be recognised that the reasons for this are varied, including insufficient time for some patients to complete the full 4-Test protocol within the pilot data collection period after completion of their first test. *Priory Gardens* and the *Active Lifestyle Service* saw fewest of their Test 1 cohort return at Test 4; both of these site cohorts had the highest levels of mobility based on the four clinical metrics gathered at Test 1 and therefore may have seen patient attrition as a result of feeling reassured that they do not need a mobility intervention.

5.2 Outcome measures

The data also showed differences in outcome measures across the four sites. Two key considerations should be given to the gait metric outcome results. The first is that improvements in group gait metrics within the matched cohorts were not always linear at individual sites, though it was when examining the whole patient cohort. This may suggest that patient progress across the protocol is context, and patient, specific. Furthermore, whilst the vast majority (90%, n=88) of patients improved at least one of their scores between Test 1 and Test 4, 49% (n=48) improved all four outcome metrics measured.

At Test 1 (full cohort, Table 1) *Priory Gardens* patients scored the highest on three GaitSmart Test metrics (GaitSmart Score, speed and average stride duration). Data shows that those within this cohort, as a whole group i.e., not just the protocol completers, consistently (Test 1, 2, 3, 4) walked the fasted (m/s) (highest gait speed) over the 10m Test distance. The group average at *Priory Gardens*, was above 0.8 m/s, which is considered a threshold indicator for healthy adult population (11). They also reported the lowest rates (34%) of pre-existing medical conditions.

At *Priory Gardens* 56% of those who completed Test 1 (n=68) went on to complete Test 2 (n=38), accounting for the highest decrease across sites at this time point. The characteristics of the *Priory Gardens* group at Test 1, along with the decline in uptake along the protocol perhaps reflects the preventative approach the site took by offering the intervention to Health Check patients, before widening this to the GP practice cohort in the last two months of implementation. It is possible that this may evidence a self-selecting cohort of patients at *Priory Gardens* based on gait functionality, whereby patients who receive high scores on their first visit tend not to attend future Tests, perhaps feeling reassured or that the intervention is unnecessary. Additionally, those who completed the full protocol had lower scores initially and therefore saw large improvements by Test 4. However, it is also worth noting that both *Priory Gardens* and *Active Lifestyle* service had a lower proportion of patients with pre-medical conditions attending Test 4 compared to Test 1 (21% and 86% reduction respectively).

5.3 Feedback

On protocol completion patient feedback was reported as generally positive. Patients reported feeling more confident in walking at the end of the intervention. The majority (92%) of patients who responded to the final survey reported that they would recommend GaitSmart to someone having issues with walking or rehabilitating.

Staff feedback from the primary care sites (*Keeping Well Clinic* and *Priory Gardens Surgery*) in particular highlighted the beneficial role GaitSmart played for patients psychologically, in alleviating concerns they may have had of falling prior to returning a high Test score. This may be another factor that fed into reduced uptake across the protocol, in that when fears were alleviated they no longer felt the need to continue the protocol.

Across all sites self-reported, unmatched, FoF categorised as high was 37% at Test 1 and 28% at Test 4. Scores showed variability in FoF across the Test protocol, with findings suggesting a range of reasons for this variability, for example, those who dropped out between Test 1 and 4, and may have had a low FoF, alongside high gait measures, thus leaving those with a higher FoF to complete all 4 Tests, resulting in an increase in those categorised as 'medium'. Staff survey data also highlighted the protective and psychological impact GaitSmart can have on those who complete a GaitSmart Test, suggesting that those who have a high GaitSmart score may be more likely to only complete one Test. This should be considered within adoption and spread approaches, recognising that FoF is associated with falls in community dwellers (17), and is therefore an important factor, alongside mobility, when considering eligible patient cohorts.

Staff feedback regarding GaitSmart implementation was mixed across sites; 50% of staff who completed Tests with patients indicated that they would like to continue using GaitSmart in their service. Most staff (83%) recognised the benefits of using GaitSmart; in particular improvements in GaitSmart scores for those who committed to completing the exercises. While staff reported having the skills and confidence required to deliver GaitSmart Tests, some technological challenges arose in particular with the hardware provided which impacted the efficiency of the Testing process. 83% of staff completing Tests reported challenges with using GaitSmart, including straps failing to remain in place, the tablet freezing and patients not completing exercises. However, the innovator was praised for their responsiveness and support in rectifying any challenges sites faced. The collaborative approach with the ICB, innovators, Health Innovation East and the clinical sites was said to be key in supporting effective, adapted implementation across contexts.

5.4 Strengths and limitations

Strengths

A key strength of this evaluation was its use of objective clinical measures to assess the clinical mobility impact of GaitSmart alongside staff and patient user self-reported outcomes and feedback. This mixed methods evaluation used several different quantitative and qualitative data sources to formulate a comprehensive data set from which robust findings could be generated. Another strength of this evaluation was the deployment of GaitSmart in a range of healthcare settings across a diverse patient population.

Limitations

Whilst the quantitative data underwent rigorous automated and manual cleaning, Health Innovation East could not guarantee that the dataset was entirely free from errors. However, to mitigate the risk of potential errors, data analyses were independently duplicated and no anomalies were identified in the final cleansed datasets. The patient survey data set is unmatched in that those who completed the first (Test 1) survey may not have completed the final (Test 4) survey and vice versa, this means that direct comparisons cannot be made between the two.

6. Conclusion

This evaluation has identified several benefits in the implementation of GaitSmart within primary, secondary outpatient and community health settings, with some variability across sites. Clinical outcome measures including GaitSmart Score, gait speed, joint angle and stride

duration increased over the course of the GaitSmart 12-week protocol, both as a whole patient cohort, and across individual sites. Both staff and patients reflected positively on elements of GaitSmart, including usability and the Traffic Light System, which was reported to support patients' understanding of their mobility. Uptake of Tests varied across sites and time points within the protocol, and appears to be influenced by patient characteristics such as levels of mobility, and health status or pre-existing medical conditions. Triangulation of the data from patients, staff and outcome measures across sites suggests that implementing GaitSmart within the BLMK system may be most beneficial within a preventative approach.

7. Recommendations

The insights from the evaluation have highlighted the following recommendations to help inform the future adoption of GaitSmart:

- **Adoption and spread of GaitSmart requires consideration of setting appropriateness.** Findings suggest use of GaitSmart in preventative settings to reduce risk of falls may be most effective.

- **Consideration of context specific strategies to support meaningful patient engagement**. Different clinical populations, their eligibility and appropriateness for GaitSmart should inform commissioning and Test-protocol decisions.

- **Sites implementing GaitSmart in future may benefit from adopting a flexible approach in relation to expectations for patients**. This allows for patients who have high positive GaitSmart scores in Test 1 or have particular characteristics that suggest follow up Tests may not be required or the 4-Test protocol is inappropriate. This also allows for resources to be focused on patients where there is greater need for ongoing GaitSmart use.

- **Commitment to the protocol and adherence to exercises should be encouraged when recruiting patients to the 4-Test protocol** to maximise patient outcomes and efficiencies.

- **Effective partnership collaboration** and ongoing support from innovators should continue to be prioritised via regular meetings and review of data, emerging findings and real-world challenges to support ongoing implementation and improvement.

- **Further research is recommended to understand more fully the impacts of differing protocols,** for example 1-Test (single use of GaitSmart) or follow up Test (e.g. 2, 3 or 4-Test) in relation to patient outcomes, staff efficiencies and cost-effectiveness.

Acknowledgements

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Appendices

Appendix 1: Survey data cleaning methodology

Intro

Survey data and Test data are two independent data sets. Through monitoring the number of responses two data quality questions have arisen:

Questions

Are final survey responses in the first survey data collection?

Are survey responses in the incorrect site/association?

Aim: Create a data-led evaluation criteria/process.
1. Provide Test-survey "match". Matching the survey to the previous Test conducted at the site.

2. Provide time-difference between the matched results.

3. Provide TestNumber, a surrogate of the stage at which the patient is in the 4 Test protocol.

4. Provide counts of surveys and Tests completed at the site.

Method

Mapping of Association/Site Names.

'Bedford Hospital Falls Service': 'Bedford Hospital Falls',

'Central Beds Active Lifestyles - self-referral': 'Physical Activity for Central Bedfordshire team ',

'Central Beds Active Lifestyles - health referral': 'Physical Activity for Central Bedfordshire team ',

'Keeping Well Clinic (at Grove View)': 'Keeping Well Clinic Dunstable ',

'Priory Gardens Health Check': 'Priory Gardens Surgery - Grove View Health Hub - BLMK',

'West Street surgery': 'Keeping Well Clinic Dunstable '

Dataset Merge to match Surveys and Tests

> Documentation:
> https://pandas.pydata.org/docs/reference/api/pandas.merge_asof.html

Match on Datetime

pd.merge_asof(survey_df.sort_values('survey_datetime'),

> Test_df.sort_values('Test_datetime'),

> by="Association"

> left_on='survey_datetime',

> right_on='Test_datetime',

> direction='backward')

Variables

Primary data

Response ID   = Survey Data

_id   = Test Data

Test_datetime   = Test Data

Survey_datetime = Survey Data

Please select which site you received your GaitSmart assessment/s = Survey Data

Association   = Test Data

Metrics

Time_diff = Time between survey and matched Test

TestNumber   = Indicated 1st 2nd 3rd or 4th Test

Test number is a count of the patient's Tests in date order, to indicate where they are in our "four stage protocol". If there are two Tests on the same date, a Test Number is assigned to the Test with the greater GatiSmart Score.

Test and Survey Counts

Test1Completed   = Count of Test 1's completed at Association prior to Survey.

Test2Completed   = Count of Test 2's completed at Association prior to Survey.

Test3Completed   = Count of Test 3's completed at Association prior to Survey.

Test4Completed   = Count of Test 4's completed at Association prior to Survey.

survey_count_association_x   = No. Surveys completed at Association Prior to Survey.

Data-led evaluation criteria/process

    i) Mark Tests for investigation:

        a) TestNumber equals 4.

        b) Time difference (days) greater than 0.

2. Evaluate marked Tests:

    a. Has no. Tests 1's and Test 4's changed?

        (i) Test1's has __not__ increased and Test 4's __has__ increased__.__

            Suggest*: exclude from first survey responses and include in final survey data.*

    b. If the time difference is greater than 1

    Suggest*: date diff exceeded max.*

Coded Logic:

It applies these in order

if time_diff > 1. Then suggestion = "remove - datetime diff exceeded 1"

If Test1 has not increased and Test4 has increased. Then suggestion = "exclude from first survey data & include in final"

If anything else (all other scenarios). Then suggestion = "manual check advise

Appendix 2: Short FES-I results by site and Test

Please note, there were 3 surveys that did not specify a site, and therefore are included in the overall responses, but not site breakdown.

	Concern	Test 1	Test 4
All Responses N (Mean, Range)		12(185, 7-26)	12(86, 7-23)
	Low N (%)	49 (26)	19(22)
	Moderate N(%)	67(36)	43(50)
	High N (%)	69 (37)	24(28)
Priory Gardens	Low N (%)	3(11)	4(33)
	Moderate N (%)	8(29)	6(50)
	High N (%)	17(61)	2(17)
Keeping Well	Low N (%)	30(31)	8(16)
	Moderate N(%)	33(34)	25(50)
	High N (%)	35(36)	17(34)
Bedford Falls	Low N (%)	1(6)	2(17)
	Moderate N(%)	10(56)	6(50)
	High N (%)	7(39)	4(33)
Active Lifestyles	Low N (%)	15(37)	3(33)
	Moderate N(%)	16(39)	5(56)
	High N (%)	10(24)	1(11)