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Digital health coaching to improve patient preparedness for elective lower limb arthroplasty: a quality improvement project

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ABSTRACT

Major surgery carries high risks with comorbidities, frailty and health risk behaviours meaning patients are often unprepared for the physiological insult. Since 2018, the Prepwell programme at South Tees Hospitals NHS Foundation Trust has supported patients to improve their preoperative health and fitness. In April 2020, the face-to-face service was suspended due to the pandemic, leading to the team implementing a three-tiered remote digital support pathway, including digital health coaching via a mobile phone application.

Methods Patients scheduled for elective lower limb arthroplasty were offered 8 weeks of digital health coaching preoperatively. Following consent, participants were assigned a personal health coach to set individual behaviour change goals supported by online resources, alongside a digitally delivered exercise programme. Participants completed self-assessment questionnaires at Entry to, and Exit from, the programme, with outcome data collected 21 days postoperatively. The primary outcome was the change in Patient Activation Measure (PAM).

Results Fifty-seven of 189 patients (30.2%) consented to referral for digital health coaching. Forty participants completed the 8-week programme. Median PAM increased from 58.1 to 67.8 (p=0.002). Thirty-five per cent of participants were in a non-activated PAM level at Entry, reducing to 15% at Exit with no participants in PAM level 1 at completion. Seventy-one percent of non-activated participants improved their PAM by one level or more, compared with 45% for the whole cohort. Median LOS was 2 days, 1 day less than the Trust's arthroplasty patient population during the study period (unadjusted comparison).

Conclusions Digital health coaching was successfully implemented for patients awaiting elective lower limb arthroplasty. We observed significant improvements in participants' PAM scores after the programme, with the largest increase in participants with lower activation scores at Entry. Further study is needed to confirm the effects of digital health coaching in this and other perioperative groups.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Patients undergoing major surgery are at high risk of complications which is associated with significant morbidity postoperatively. Prehabilitation has been shown to reduce this in face-to-face settings, but there is limited research for digitally enabled multimodal prehabilitation.

WHAT THIS STUDY ADDS

⇒ Digital health coaching can deliver multimodal prehabilitation to patients and improve patient activation prior to surgery. Patients find digital health coaching to be a supportive and a useful tool in preparing for surgery.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Digital health coaching could be implemented into a wider spectrum of surgical specialties with research needed to assess the benefits in these patients.

PROBLEM

Up to 40% of patients undergoing major surgery suffer a complication leading to an increased risk of perioperative death,[1] increased length of hospital stay (LOS),[2] greater critical care utilisation and increased risk of hospital readmission.[3 4] Longer term consequences include loss of independence, reduced quality of life and reduced life expectancy.[1]

Individual risk is multifactorial, with poorly optimised comorbid disease, frailty and health risk behaviours (eg, physical inactivity, smoking, alcohol excess, suboptimal nutrition) being major contributors. People from areas of greater socioeconomic deprivation appear to be at a disproportionately higher risk due to the greater prevalence of health risk behaviours and the associated chronic disease burden.[5]

South Tees Hospitals NHS Foundation Trust delivers perioperative care to over 1.5 million patients, many living in areas with higher levels of deprivation and poorer health

outcomes compared with the national average.[5 6] The Prepwell prehabilitation programme commenced face-to-face delivery in 2018 and achieved excellent patient engagement, behaviour change and feedback in the first 2 years.[7] Approximately 50% of eligible patients were unable or unwilling to participate in the programme due to travel requirements, work and other commitments. From April 2020, consequent to the COVID-19 pandemic, face-to-face delivery was no longer feasible and an alternate form of remote prehabilitation was required. The Prepwell team developed and implemented a three-tier (Universal, Targeted and Complex) digital prehabilitation programme offering patients support ranging from a website with bespoke perioperative materials (www.prepwell.co.uk) to personalised 1:1 digital health coaching.[8]

Specific aims

The primary aim of this project was to evaluate the feasibility and impact of 1:1 digital health coaching delivered via mobile phone app on patient activation and behaviour change before lower limb primary arthroplasty surgery. Secondary evaluation included impact on self-reported quality of life and a cost-consequence analysis for implementation and future scalability.

BACKGROUND

The 'average' major surgical patient in the UK has two chronic health conditions,[2] with 87% having an associated health risk behaviour.[7] The COVID-19 pandemic has negatively impacted population health, increasing the incidence of social isolation and health risk behaviours,[9–12] and prolonging waiting times for elective surgery,[13] with an unprecedented 7 million people now awaiting elective surgical care.[13]

Preparing patients preoperatively (prehabilitation) is an effective way of improving perioperative outcomes through support to increase physical and mental resilience for surgery,[14] reducing perioperative morbidity by up to 50%.[15] Behaviour change interventions are more effective during the preoperative window with evidence supporting sustained benefits for up to 12 months after surgery.[16 17]

To capture this 'teachable moment' patients must have the appropriate support, skills, knowledge and confidence. Patient Activation Measure (PAM) is a validated tool used in healthcare settings to measure this.[18] Participants complete a questionnaire which produces a score on a 0–100 scale, enabling people to be divided into one of four levels: level 1 (≤47), level 2 (47.1–55.1), level 3 (55.2–67) or level 4 (≥67.1), before further categorising people as 'activated' (levels 3 and 4) and 'non-activated' (levels 1 and 2). The PAM score measures activation at that point in time as a stand-alone questionnaire, and can be repeated at intervals to measure change if an intervention has been performed. Higher levels of activation (evidenced by higher PAM scores) correlate with improved healthcare outcomes, reduced resource utilisation, enhanced self-management and better patient experience,[19] with lower levels of pain and higher patient satisfaction demonstrated following joint arthroplasty.[20] Intervening to increase a person's activation improves engagement and health outcomes. The goal of any intervention is therefore to have as many people as possible in an activated state on completion to facilitate the best chance of optimal outcome.

In the UK, prehabilitation is commonly delivered face to face, with a focus on exercise training, nutrition and well-being.[21] Very few studies have reported outcomes from a personalised, digitally delivered programme targeting multiple behaviours adapted to patient need.[22] Digital interventions are being increasingly recommended to facilitate healthcare delivery and support perioperative care.[23–25] They have matched face-to-face delivery in supporting behaviour change in other healthcare settings such as cardiac rehabilitation and diabetes management.[26] The authors have recently published a proposed framework for delivery of digital prehabilitation, setting out future requirements and strategies for scalable implementation.[27] One major concern is the risk of digital exclusion in our target population (predominantly older adults). However, this group is becoming increasingly engaged with digital technology, with 75% of adults aged 65–74 years reporting they regularly use the internet.[28]

MEASUREMENT

We completed a mixed methods prospective observational study using validated patient-reported outcome measures to determine change across two time points. Participants' hospital notes were reviewed at 21 days to collect postoperative outcome data—postsurgical care location, LOS and perioperative complications.

Measures

The primary outcome was the change in PAM[18] from Entry to Exit.

Secondary outcome measures were assessed via self-completed questionnaires and included:

1. Changes in participant physical function (Duke Activity Scoring Index, DASI).[29]
   a. DASI gives an estimated VO_2max (the maximum amount of oxygen the body can use during exercise) and an estimated metabolic equivalents score.
2. Physical activity.
   a. Participants were categorised into Sport England physical activity levels depending on their estimated weekly active minutes: active (>150 min/week), fairly active (30–149 min/week) and inactive (<30 min/week).[30]
3. Health status (EuroQoL 5-Dimension 5-Level).[31]
   a. EuroQoL 5-Dimension 5-Level (EQ-5D-5L) can be used to calculate an index value between 0 and 1, where 0 equals a perceived state of health equiva-

lent to being dead and 1 equals a perceived state of full health.[32]
4. Smoking status (self-reported cigarettes per day).
5. Alcohol consumption (self-reported units per week).
6. Participant satisfaction was assessed via qualitative feedback on completion of the programme.

A healthcare cost analysis was performed based on delivery costs and outcome data collected at 21 days.

Analysis

Participant characteristics and outcome data were collected at the defined points. Parametric, continuous data were summarised using mean, IQR and SD; non-parametric, continuous data were analysed using median, IQR and SD; and categorical data were analysed using frequency (n) and percentage (%). Paired samples (Entry and Exit data from each participant) were analysed using statistical testing. Parametric data were compared using the paired Student's t-test. Non-parametric data were compared using the Wilcoxon signed-rank test. Data classified as parametric met the following assumptions: dependent variable was continuous, independent variable had two matched groups, the difference was approximately normally distributed and tested using Shapiro-Wilk test and there are no significant outliers identified. No missing data were imputed.

Ethical considerations

Surgery Hero meets the standards for NHS Data Security Protection Toolkit and this project has complied with all General Data Protection Regulation requirements and NHS trust information governance policies. The Surgery Hero app has been designed and built in accordance with NHS Digital Clinical Safety standards (DCB 0129 and DCB 0160).

Healthcare professionals from the Prepwell team performed a detailed risk assessment of all participants at the outset and were available for advice to participants and the Surgery Hero coaches as required. All health coaches had 2 years of minimum experience in a patient-facing role and had completed a Personalised Care Institute-accredited core health coach training course meeting the NHS England commissioning guidance. A deliberately conservative strategy to recruitment was adopted given that the health coaching app had previously not been extensively evaluated in a clinical population.

DESIGN

The Complex tier was delivered in collaboration with industry partner Surgery Hero (formerly Sapien Health),[33] who recently launched their personalised 1:1 digital health coaching application. The application is accessible on a smart mobile phone or tablet device, and specifically targets perioperative lifestyle and well-being improvement in patients waiting to undergo surgery.

Participants were provided with a link via text and email to download the application in which they could access a health programme supported by an in-app real-life

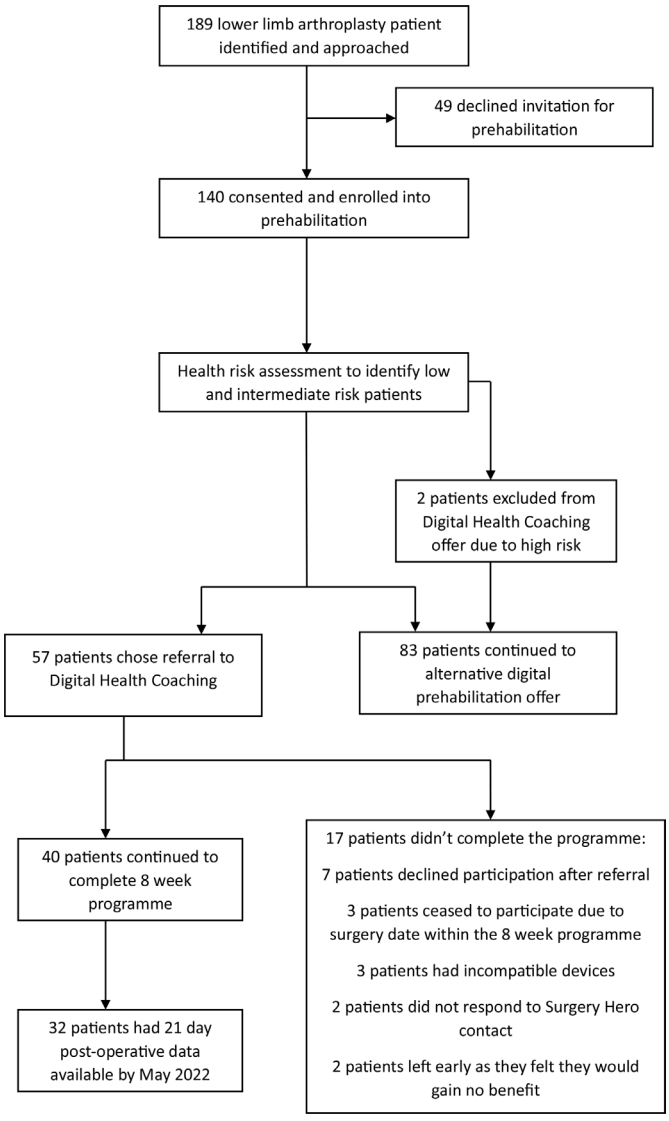

Figure 1 Participant recruitment to digital health coaching.

trained health coach. The programme offered 8 weeks of progressive support for a range of lifestyle factors and well-being. A 30 min 'welcome call' to set initial goals and support general usability was followed by a weekly 20 min follow-up call reviewing progress and enabling progressive target setting. Participants could also 'chat' with their coach via the app if they had further questions.

All participants completed a PAM assessment, brief medical history, quality of life assessment (EQ-5D) and details of any health risk behaviours (Entry assessment). The Surgery Hero team then created a personalised programme based on participant goals, including improvements to mindset and behaviour, relaxation, nutrition, sleep optimisation, alcohol moderation, smoking, physical activity and exercise, and weight management. The app home page displayed the participant's main goals and an action plan to help them achieve this.[33] Participants could mark their completed goals and see a summary of their achievements. Participants were also able to track their health metrics, such as steps and

Table 1 Participant self-reported characteristics at service Entry (n=40)

Characteristic	Summary
Age, years	
Mean (SD)	63 (10.4)
Range	33–83
Female sex, n (%)	27 (67.5)
Ethnicity, n (%)	
White British	39 (97.5)
Other	1 (2.5)
Marital status, n (%)	
Married	31 (77.5)
Widowed	4 (10)
Single	3 (7.5)
Cohabiting	2 (5)
Employment status, n (%)	
Full-time	9 (22.5)
Part-time	6 (15)
Self-employed	4 (10)
Retired	16 (40)
Unemployed	4 (10)
Voluntary work	1 (2.5)
Arthroplasty, n (%)	
Hip	20 (50)
Knee	20 (50)
Comorbidity, n (%)	
Hypertension	13 (32.5)
Angina	1 (2.5)
Heart failure	1 (2.5)
Arrhythmia	4 (10)
Cardiomyopathy	2 (5)
PVD	1 (2.5)
Asthma	2 (5)
Sleep apnoea	1 (2.5)
Diabetes	2 (5)
OA	29 (72.5)
Inflammatory arthritis	6 (15)
Hearing impairment	7 (17.5)
Visual impairment	8 (20)
Memory impairment	2 (5)
Cancer	6 (15)
Anxiety	5 (12.5)
Depression	7 (17.5)

OA, osteoarthritis; PVD, peripheral vascular disease.

physical activity, weight, number of cigarettes smoked, or alcohol consumed, as well as how they felt mentally and physically. On finishing the programme, the PAM, quality of life and risk behaviour questionnaires were completed (Exit assessment) enabling comparison to the Entry assessment.

STRATEGY

Recruitment commenced in April 2021, with data collection completed in May 2022. Patients awaiting primary hip and knee arthroplasty were identified via the Trust's Digital Joint School platform.[34] Eligible patients were invited to join the Prepwell prehabilitation programme via a letter and were then contacted via a follow-up phone call. Patients agreeing to participate were consented and enrolled. A detailed health and well-being assessment was performed by the Prepwell team with patients categorised as low, intermediate or high risk based on comorbidities, functional status and health risk behaviours. Low and intermediate-risk patients were eligible for and offered digital health coaching, with their details forwarded to the Surgery Hero team if they accepted. High-risk patients, and those declining digital health coaching, were offered support through the other tiers of the programme working with the Prepwell team.

Exclusion criteria included:

- Patients stratified as high risk—see above.
- Inability to speak or read English—at the time of the project the app and content were unavailable in other languages.
- Inability to access the Surgery Hero app on a mobile or tablet device.

RESULTS

Between April 2021 and May 2022, a total of 189 primary arthroplasty patients were referred for prehabilitation. Figure 1 summarises participant recruitment.

Table 1 shows the characteristics of the 40 participants who had complete data sets at Entry.

Participant Entry and Exit results are summarised in table 2.

Primary outcome: PAM

The change from Entry to Exit in PAM score is demonstrated in figure 2. A Wilcoxon signed-rank test demonstrated a statistically significant change in PAM (p=0.002). The number of participants in the 'activated' group increased from 25 (65%) at Entry to 34 (85%) at Exit (Wilcoxon signed-rank test, p=0.024), demonstrating a positive response to the programme. Of the 14 (35%) non-activated participants at Entry, 10 (71%) became activated at Exit. From the whole group, 18 (45%) improved their PAM by one level or more. This was increased in the non-activated group where 71%[10] improved their PAM by one level or more.

Secondary outcomes

Health risk behaviours

Smoking

None of the participants were smokers at Entry or Exit.

Table 2 Outcome measures of participants at programme Entry and Exit

	Entry (n=40)	Exit (n=36)
BMI, kg/m^2, mean (SD)	30.3 (5.4)	29.5 (5.1)
Alcohol, n (%)		
0 unit	10 (25)	11 (30.6)
1–14 units	25 (62.5)	21 (58.3)
15–30 units	5 (12.5)	4 (11.1)
Sport England criteria, n (%)		
Active	23 (57.5)	22 (61.1)
Fairly active	6 (15)	5 (13.9)
Inactive	11 (27.5)	9 (25)
Resistance training	11 (27.5)	23 (57.5)
DASI, mean (SD, range, IQR)		
VO_2max, mL/kg/min	22.04 (5.4, 9.6–32.4, 8.1)	19.74 (5.67, 9.6–31.4, 7.74)
	Entry (n=40)	**Exit (n=40)**
PAM, median (SD, range, IQR)	58.1 (12.1, 39.4–100, 12.1)	67.8 (10.96, 51–100, 12.5)
Level 1, n (%)	3 (7.5)	0
Level 2, n (%)	11 (27.5)	6 (15)
Level 3, n (%)	20 (50)	20 (50)
Level 4, n (%)	6 (15)	14 (35)

BMI, body mass index; DASI, Duke Activity Scoring Index; PAM, Patient Activation Measure; VO_2max, maximal amount of oxygen utilisation during exercise.

Physical activity

A Wilcoxon signed-rank test demonstrated no statistically significant difference in Sport England activity levels (p=0.603). There was a statistically significant increase in resistance exercise at Exit (Wilcoxon signed-rank test, p<0.001).

EuroQoL 5-Dimension

The mean index value at Entry was 0.492 (SD 0.23) and at Exit this was 0.514 (SD 0.22) (Wilcoxon signed-rank test, p=0.164). This demonstrates no statistically significant difference in self-reported quality of life.

Duke Activity Scoring Index

A paired Student's t-test of participant Entry and Exit demonstrated a statistically significant decrease (p≤0.001) in participant self-reported physical function.

Surgical outcome data

Hospital records at 21 days were available for 32 participants. Median LOS was 2 days (range 1–6 days, IQR 2). All participants received ward-level care postoperatively and all participants were discharged home independently. Twenty-eight (87.5%) participants had no documented complications, four (12.5%) showed evidence of a minor deviation from normal practice requiring a change in pharmacological therapy postoperatively.

Analysis of 1813 patients on the National Joint Registry undergoing primary arthroplasty at South Tees during the study period demonstrated a median LOS of 3 days (IQR 3).

Cost analysis

Face-to-face prehabilitation delivery in the Prepwell programme was approximately £400 per patient (based on an 8-week programme).[7] The cost of the digital health coaching programme for this project was £151 per patient for 8 weeks—£100 fixed cost for Surgery Hero and £51 for 1 hour of band 6 staffing time to analyse participant health assessment, perform risk assessment and support enrolment. The estimated cost of one patient staying in a ward for 1 day was calculated at £424. A median LOS reduction of 1 day compared with National Joint Registry data for South Tees represents a cost saving of £273 per patient. With South Tees Hospitals performing around 1600 lower limb arthroplasties each year, if scaled up this would represent a cost saving of £436 800 if all patients successfully completed the programme and results were replicated.

Patient satisfaction

Twenty-two participants supplied free text comments about their experiences. Themes were identified from the comments.

Participants found digital health coaching helpful and supportive, and provided them with encouragement: 'terrific support and encouragement', 'I thrived and with the help, good advice and fantastic support'.

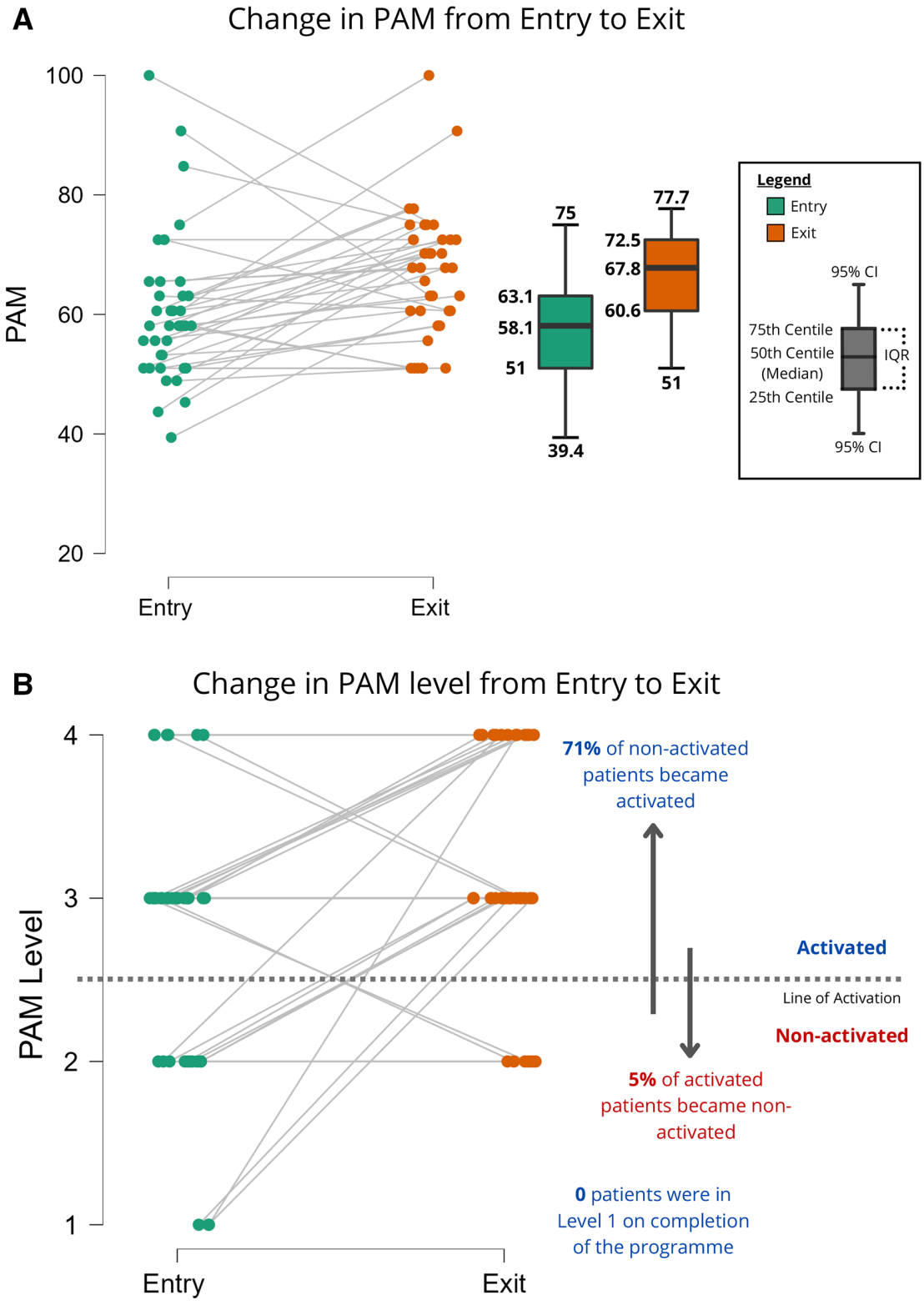

Figure 2 A) PAM scores at Entry and Exit. B) PAM level at Entry and Exit

Participants felt it prepared them for their upcoming surgery, improved confidence and allowed them to regain control of their health: 'giving me the confidence and desire to take control of my life again', 'It has changed my mindset in a way which I did not believe previously possible'.

The materials provided through the app were informative and allowed participants to make informed decisions and find solutions to their own health problems: 'found it very informative', 'very helpful to have someone to listen to me and provide information that helps me form a decision'.

The health coach was good at listening, calm and sensitive to participants' problems when raised: 'My coach was very easy to talk to, caring, understanding and very helpful', 'My coach was tremendous and with a calm and sensitive approach'.

One participant raised difficulties with entering data into the application and another wanted access to the application after programme completion and after surgery to help with rehabilitation.

LESSONS AND LIMITATIONS

Digital health coaching was able to successfully deliver remote health behaviour support to participants preoperatively with high levels of patient-reported satisfaction. We demonstrated statistically significant improvements in PAM levels, indicating positive changes in participants' confidence, knowledge and skills to manage their own health needs. Participants who had the lowest PAM scores on entering the programme (non-activated) had a greater increase in their PAM score compared with the group as a whole, with 71% of this group moving to an activated group on programme completion. No patients remained in the highest risk category (group 1) on completion of the programme. This is an important finding given the correlation with adverse health outcomes in people who undergo surgery in a non-activated state. This improvement is in line with improvements seen in PAM after prehabilitation for cancer treatment.[35]

Our participants demonstrated a statistically significant increase in resistance training and small non-statistically significant improvements in their other health behaviours throughout the programme, particularly relating to aerobic activity and alcohol consumption. Enhanced recovery and prehabilitation programmes have previously demonstrated that a combination of small changes can lead to significant improvements in overall outcomes often termed 'aggregation of marginal gains'.[36] In tandem with this, we would expect participants to have reported a higher functional capacity with a higher VO_2max; however, the self-reported DASI scores on Exit from the programme did not support this. In rationalising this finding, we hypothesise that participants initially overestimated their functional capacity at Entry assessment, however, after undertaking a structured exercise programme completed a more accurate assessment of their functional capacity at Exit, leading to a reduction in DASI score. This possibility is supported by studies that have demonstrated discrepancies between physician and patient assessment of functional capacity where patients may tend to overestimate their physical capacity.[37] There have also been reported limitations in using the DASI score to assess functional capacity.[38] To overcome this limitation, it may be appropriate in future projects to measure functional capacity objectively as we did in our original face-to-face programme, where we observed clinically significant improvements in 6 min walk distances.[7] With improvements in wearable digital technology this can be achieved remotely, although it is important to note there may be limitations in accuracy of measurements.[39] Further research would be warranted to find a way to accurately measure functional capacity remotely.

Our outcomes also support the potential for healthcare savings in patients receiving digital health coaching compared with face-to-face or no support. Compared with our 'control' cohort of patients from the National Joint Registry (unmatched, demographics unknown), there was a 1-day reduction in LOS in those receiving digital health coaching. If scaled to all 1600 patients undergoing arthroplasty at the Trust annually, this would represent a potential cost saving of up to £437 000. With our earlier face-to-face prehabilitation delivery we observed a median LOS of 4 days (IQR 3–5) in arthroplasty patients, 2 days longer than participants in the current project.[7] This finding, coupled with the higher cost of face-to-face prehabilitation delivery (£249 higher per patient for 8-week programme), would also represent a substantial potential cost saving if replicated at scale. It is important to note, however, that we acknowledge that there are many other factors which may affect the interpretation and applicability of these findings. The LOS comparison was not adjusted for potential confounding factors such as patient clinical risk status between the various groups for data we present here. The subsequent cost analysis also uses modelled data from these unmatched patient populations, including the exclusion of high-risk patients from the current project. These are two of several factors which may influence outcomes and skew LOS. We therefore cautiously present these results as having the 'potential' to generate healthcare savings.

The majority of patients (74%) (see figure 1) approached consented to being involved in a digital prehabilitation programme, which is consistent with other prehabilitation interventions.[40] The digital health coaching participants were majority female (67.5%). In the participants who chose the alternative Targeted interactive computer-based programme, 46% were female. This may demonstrate a preference for digital health coaching in females. The digital health coaching participants were also younger (mean age 63 years) compared with those who chose the alternative computer-based offer (mean age 66.6 years). App-based digital interventions accessible through a mobile phone may therefore be more appealing to younger patients. This is consistent with outcomes from our institution's Digital Joint School work where older patients preferred to access their programme on a larger computer screen.[34] Older patients are at increased risk of digital exclusion, feeling less confident in using a mobile phone application to access healthcare. As healthcare moves forward with an increasing emphasis on digital delivery, we need to consider ways to educate and assist older people in using technology, such as paper user guides, and having family and friends to assist.[28] Further work is needed to explore the barriers to participation in digital prehabilitation.

EQ-5D scores were relatively unchanged after the programme. Orthopaedic patients undergoing primary arthroplasty tend to have significant levels of pain as well as difficulties in mobility.[41] We expected pain to continue or increase throughout the programme due to disease progression, which may have negatively affected the EQ-5D scores at Exit as well as physical activity levels throughout.[42] With small participant numbers it is difficult to assess if pain has impacted the EQ-5D results, and further research would be required to identify if this is a significant component.

There are several limitations that are important to acknowledge from this work. The nature of the project as a quality improvement initiative meant that we had a relatively small sample size of patients from a single surgical specialty, with no matched control group. Although these factors mean our results need to be interpreted with a degree of caution, we believe our findings provide a useful addition to the literature, while providing important feasibility data for future projects to build on. We excluded high-risk patients as we deliberately chose a 'safety first' approach given the exploratory nature of the project. Despite this, we would expect similar if not greater improvements in higher risk patient populations. The fact that higher risk patient groups have lower levels of activation,[18] and our observation that this group achieved greater benefits overall, is likely to support this interpretation. Expanding to higher risk groups in future is feasible with a high degree of assessment and monitoring to ensure patient safety. Patients consenting to digital health coaching may be more likely to be engaged with health optimisation and digital health compared with those who decline participation, a factor which may skew results. This would limit its implementation in a less engaged population. Patients without compatible smartphone devices were excluded from the programme, therefore usability for participants who are not digitally enabled was not assessed. Although we acknowledge the need to support patients who may be at risk of digital exclusion to avoid inequality of access, a full discussion of this topic is beyond the scope of this manuscript. Only 55% of participants who completed the programme provided written feedback regarding their experiences and satisfaction. This limits the identification of common themes to improve participant experience while using the app.

The programme was delivered by recruiting patients from the Tees Valley and North Yorkshire regions which represents a predominantly white British population demographic. Despite this, we would anticipate that digital health coaching could be successfully delivered in other geographical areas. This assessment is supported by the relatively successful uptake of the programme in the Tees Valley which has some of the highest levels of deprivation (and associated risk of digital exclusion) in England.[5] The successful uptake in patients from North Yorkshire was also encouraging given the large geographical area of the county, making programmes like digital health coaching an ideal resource to support patients remotely while minimising travel inconvenience. Assessment of digital health coaching resources in non-English-speaking patients is a limitation of this work and will be a critical next step when resources are available.

CONCLUSIONS

Our team has demonstrated that a health coaching app can be implemented successfully to support patients undergoing orthopaedic surgery. Programme adaptation may be required for implementation in other surgical specialties, such as shorter duration in patients undergoing cancer surgery. We plan to expand the surgical specialties referred to digital health coaching to further investigate this. By collaborating with Surgery Hero we have minimised the impact of programme delivery on our NHS team, while successfully demonstrating the benefits of working collaboratively with an industry partner to support patients preoperatively. This creates a delivery model which can be scaled successfully within the wider NHS at a time when there are significant workforce challenges. Collaborations of this nature are likely to be crucial to enable recovery from the current elective care backlog, while maintaining high standards of support for patients in future.

Contributors JD, EC, AN, RHa and GD contributed to the idea and design of the intervention as part of the Prepwell programme. JD scripted the protocol with contribution and review from GD, GAT, EC and AN. EC and AN were involved in recruitment, consent and enrolment onto the intervention. MB and RHu designed and implemented the Surgery Hero digital health coaching platform including delivery to participants and collection of PAM data. AN and EC collected data and performed risk assessments. JG and SM performed cost analysis for the intervention. NP, JD and GAT performed data analysis and interpretation. NP, GAT and GD wrote the manuscript in consultation with all other authors listed. GD is guarantor of the project.

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Competing interests GD provides consultancy advice to Surgery Hero (formerly Sapien Health). GD and JD have received a national open grant award from Sport England for research to develop a digital prehabilitation platform for patients before surgery. GD holds an honorary chair at Teesside University (Middlesbrough, UK) and is clinical lead for South Tees prehabilitation strategy and implementation. MB and RHu are co-founders of Surgery Hero and have roles as the chief executive officer and chief medical officer, respectively.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and this quality improvement project was approved by South Tees Hospitals NHS Foundation Trust Research and Development Department as part of the existing Prepwell project registered with the Trust. The Research and Development Department deemed additional ethical approval was not necessary. Participant consent was obtained at enrolment into the Prepwell programme and for subsequent referral to Surgery Hero. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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