Original article

Patient experiences with a smartphone application dedicated to postoperative recovery after elective arthroplasty

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ABSTRACT

Introduction: In the rapidly evolving landscape of digital health technologies, the widespread use of smartphones has paved the way for innovative applications designed to enhance healthcare experiences. This introduction underscores the global prevalence of smartphone users and their potential in healthcare, particularly exemplified by therapeutic apps such as the 'Post Op' smartphone application. Focused on postoperative support, this app prioritises user-friendly design, data recording, and adherence to national standards. The study aims to evaluate the app's success in achieving these objectives, highlighting its continuous improvement based on real user feedback and its potential impact on improving patient experiences and recovery processes.
Methods and materials: A cohort of elective joint arthroplasty procedure patients at Kettering General Hospital (KGH), spanning a timeframe of one to 12 months post-surgery were surveyed over the telephone regarding their experience of the 'Post Op' smartphone utilising a custom, well-structured standardised questionnaire.
Results: The study surveyed 42 consecutive patients who had undergone elective joint arthroplasty procedures at Kettering General Hospital, including 22 total hip replacement (THR) and 20 total knee replacement (TKR) patients. The respondents, with a median age of 66 years, provided overwhelmingly positive feedback about the 'Post Op' smartphone application. On a scale of 1–6, the mean ease-of-use score was 5.31, with only two THR patients providing lower scores due to difficulties with photography. However, the app's overall functionality, particularly in uploading photos, received a mean score of 4.78. Despite some technical issues, 97.6 % of respondents would recommend the app, emphasising its positive impact on confidence in the recovery and reducing unnecessary healthcare visits. Narrative responses highlighted the app's simplicity, support, and prompt communication with healthcare teams. Overall, the feedback indicates a high level of satisfaction with the 'Post Op' application among elective arthroplasty patients, showcasing its potential benefits for postoperative care.
Conclusion: The study provides valuable insights into the impact of the 'Post Op' smartphone application on postoperative care, acknowledging both its successes and areas for enhancement. Further research and iterative improvements are crucial for optimising patient experiences and ensuring the app aligns effectively with healthcare needs.

1. Introduction

As of 2021, the global count of smartphone users reached 5.22 billion, and 65 % of individuals aged over 65 were using smartphones.[1,2] Numerous potential benefits exist for mobile devices in the healthcare sector, such as facilitating appointment scheduling, delivering test results, and serving as a valuable source of information and instructions.[3–5] With the widespread adoption of smartphones, developers have swiftly created therapeutic apps, such as the 'Post Op' (https://postop.ai/) smartphone application, designed to assist patients recovering at home after surgery. A robust well-developed app can help in early discharge, reduce face-to-face follow-ups, and aid clinicians in picking up surgical complications earlier.[6,7] They can also improve communication between clinicians and patients. Previous cost analysis

has shown that the use of smartphone apps, such as 'Post Op'in the post-operative period has the potential to save over £60,000 per 100 patients.[8] This is when taking into consideration costs associated with avoidable presentations to the accident and emergency department, costs borne by patients, environmental costs, and costs related to antibiotic tolerance and resistance as a result of late recognition of surgical site infections.

Ensuring data security and preserving patient privacy are imperative. A recent assessment of 5000 healthcare apps by The Organisation for the Review of Health and Care Apps revealed that 80 % failed to meet essential security standards.[9–11] Challenges in overseeing and regulating these apps persist.[10,12] The National Institute for Health and Care Excellence (NICE) has established evidence standards for digital health technologies, offering guidance to technology developers, research funders, and commissioners intending to integrate these products into the United Kingdom's health and social care system.[9–11]

We conducted a trial of the 'Post Op' smartphone application, specifically designed to enhance the patient experience while strictly adhering to national security standards and regulations. This app was introduced at Kettering General Hospital to support patients post-surgery upon their discharge. Emphasising user-friendly design, the app aims to achieve two primary objectives. Firstly, it seeks to provide reassurance to patients following early discharge. Secondly, it facilitates the clinical team in offering ongoing support. Additionally, the app allows for the recording of data, including Patient Reported Outcome Scores (PROMS) and Surgical Site Infection (SSI) information. Ensuring compliance with accessibility guidelines, the app is designed to be useable by patients with impairments, with the goal of delivering the best possible user experience.

One concern cited in the literature for mobile-based health interventions is the low acceptance and use of mobile phones in the elderly.[12] This is often as mobile phone applications are more difficult to navigate for the elderly in comparison to the younger population as aging impacts visual[13,14] and hearing abilities, coordination,[15] and ability to process information.[12,16,17] The elderly population is often the patient demographic group that requires meticulous follow-up and faces higher rates of complications.[18,19] Thus, in this paper, we have selected a cohort of the elderly population (aged >65 years) to identify and mitigate the potential barriers the patients may face.

Despite being relatively new, the app undergoes continuous development and improvement. Real end-user feedback from patients helps ensure that the app meets the needs of both patients and healthcare professionals. This iterative process allows designers to address any issues or concerns, enhancing the overall user experience. The app incorporates a feedback feature to capture immediate responses, suggestions, and ideas from users. This study aims to assess the success of these objectives of the Post Op app.

2. Material and methods

We conducted a survey involving a cohort of forty-two consecutive patients who had undergone elective joint arthroplasty procedures at Kettering General Hospital (KGH), spanning a timeframe of one to 12 months post-surgery. The survey was administered over the telephone, utilising a custom, well-structured standardised questionnaire. This questionnaire comprehensively addressed aspects such as the app's usability, accessibility, clarity of information, and its perceived value in the user's recovery process.The survey employed a Likert scale ranging from one to six for nominal scores, where one denoted the worst possible performance and six indicated the best.

Patients were explicitly informed that their participation was entirely voluntary, and strict measures would be taken to maintain the confidentiality of their data. The project was registered at Kettering General Hospital NHS Foundation Trust (Reference number: T&O/SE/2023-24/22) as a service evaluation project.

2.1. Survey results were collated and underwent both quantitative and qualitative analysis

2.1.1. Post Op application

The Post Op app is a unique application launched in 2019 to connect patients to their operating teams in the postoperative period. The app focuses on the patient experience journey rather than the healthcare provider, thus making patients active participants in their recovery process. As seen in the 'Post Op' user interface in Fig. 2, the app shifts the focus of data collection on patients by asking them to red flag symptoms (for surgical site infections), advice on wound care, prompting them to engage in physiotherapy exercises, enabling them to upload pictures of their wounds for review, and liaising any concerns.

The app development follows GDPR guidelines and is hosted on Microsoft Azure, which has the highest levels of data protection. The patients can download the mobile application, Post Op, from Apple and Android stores, after a clinician invitation. The information available on the app's user interface is dictated by clinical need and is at the discretion of the operating team. The data is protected through access precautions, including 2-factor authentication (FA). The web application accessed by clinicians is also protected through role-based access and 2 FA. This is illustrated in Fig. 3 which is the user interface for clinicians. The data is available on a web-enabled dashboard that allows for real-time monitoring of patients. Integration is possible through open APIs to the tech stack, which is firmly embedded in the Microsoft Azure system.

3. Results

Forty-two consecutive patients who had undergone elective joint arthroplasty procedures at Kettering General Hospital (KGH), spanning a timeframe of one to 12 months post-surgery were surveyed. Of these, twenty-two patients had undergone a total hip replacement (THR), and twenty patients had undergone a total knee replacement (TKR). There were 31 female respondents and 11 male respondents. The median age of respondents was 66 years (range: 47–82, IQR: 12).

When questioned about the app's ease of use on a scale of 1–6, our group of 42 patients provided a mean score of 5.31 (THR patients: 5.18; TKR patients: 5.45). Two patients, both with THR, rated it at 1, citing difficulties with photographing. Despite these low scores, the mean score for the ease of uploading photos was 4.78 as per Fig. 1. One of these two patients who rated it at 1 replied "no" when asked if they would recommend the app. However, the remaining 41 patients,
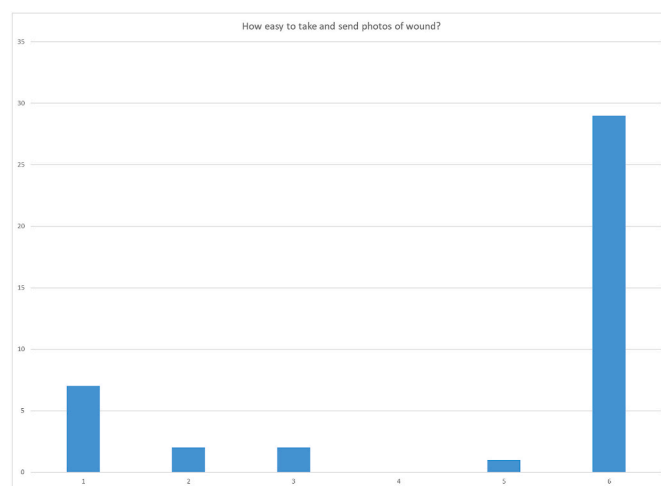
Fig. 1. A breakdown of the responses to the question of how easy patients found the app for sending photos of their wound (1 being difficult, 6 being easy).
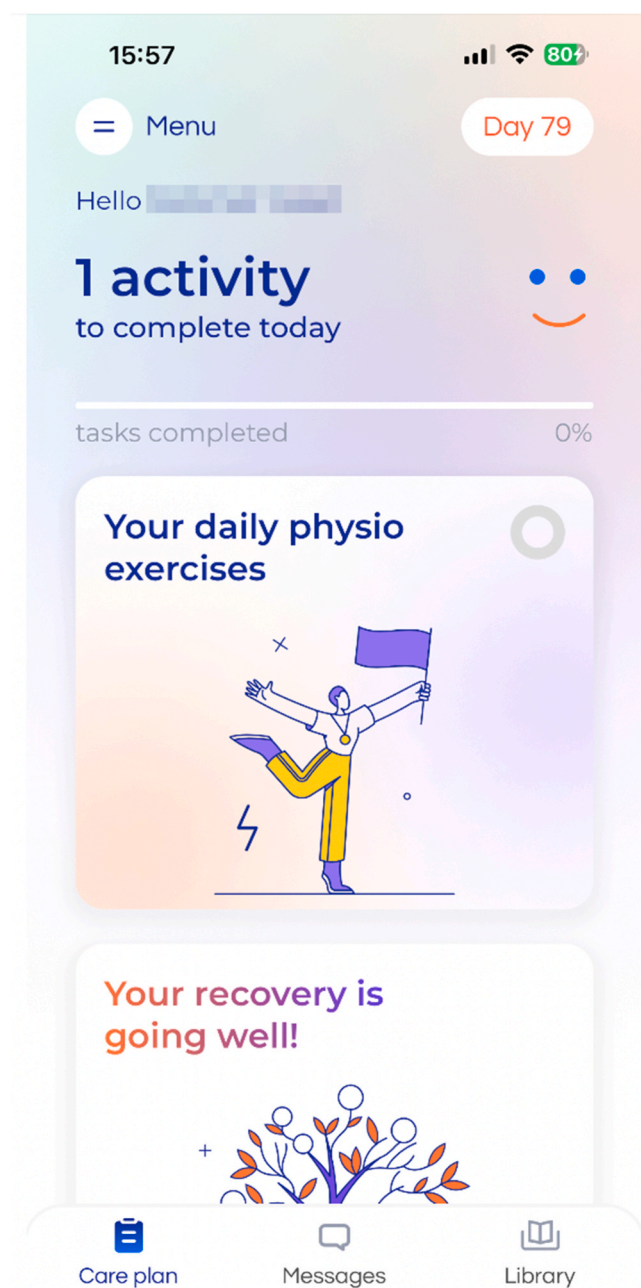
Fig. 2. Patient user interface of the smartphone application, 'Post Op', dedicated to postoperative recovery after Elective Arthroplasty.

accounting for 97.6 % of respondents, all answered "yes." Some added suggestions for improvement, but most expressed strong enthusiasm, with comments like "yes, definitely" or "yes, absolutely." Two patients gave it a score of 2 due to technical issues but still intended to recommend it once their problems were resolved, which were subsequently communicated to the software engineers.

Out of the 42 patients, 34 reported that the app boosted their confidence in recovery, and the same number reported that it helped them avoid unnecessary visits to their primary care physician or the emergency room. Four patients sought medical attention from their GP, and another four attended A&E due to concerns.

The questionnaire encouraged respondents to provide narrative responses about both positive and negative aspects of the app. Numerous comments highlighted the simplicity of use, such as "Someone always there to talk to without having to leave the house - really helpful," "Very

clear to use. Very easy." and "Good prompt for exercise. Very easy to use." The app was perceived as a valuable tool for self-care, offering reassurance and support.

In 38 cases, the app was used to send questions to the healthcare team, with a mean satisfaction level of 5.37 out of 6 for both response timing and content.

While the majority (71.4 %, 30/42) found it simple to upload wound images, a minority faced significant challenges, resulting in a mean rating of 4.78. Despite some challenges, the overall satisfaction rate with the app was reasonable. The unique feature of sending questions to the healthcare team was well-received.

In summary, the feedback from the 42 patients on the use of the 'Post Op' smartphone application was predominantly positive, encompassing both quantitative and qualitative data.

4. Discussion

This study aims to assess elective arthroplasty patients' perspectives on the novel 'Post Op'' smartphone application and their experiences. We have demonstrated that the use of the 'PostOp' smartphone app was well received by most patients in this cohort using our survey.

In recent decades, there has been a consistent push to minimise patients' hospital stays, coinciding with a reduction in acute hospital bed numbers. Forty years ago, patients would often be admitted a day or more before surgery and anticipated a prolonged stay. Nowadays, numerous elective procedures, including THRs and TKRs, are performed as day cases in many UK units. Even when patients don't return home on the day of surgery, their hospital stay after THR or TKR is typically limited to just a day or two. While valid health and economic reasons support these changes, a potential drawback is that patients might feel unsupported and anxious when left alone at home shortly after surgery. As these patients transition to the community, their care should ideally be managed by community nurses or general practitioners. However, these healthcare providers are already stretched thin and may lack the familiarity and experience in dealing with early postoperative patients compared to the hospital team.

The development of the 'Post Op' smartphone app aimed to provide support during the initial stages of postoperative care, and our survey results indicate that this goal has been largely achieved. If a patient has concerns about their wound healing, the surgical team can review images and postoperative scores, such as the visual analogue pain score. In our unit, there is a dedicated phone held by an arthroplasty nurse and is available 24/7. This is a pre-existing service that is already available for general practitioners, emergency practitioners, and ward staff to access. The arthroplasty nurses can then appropriately reassure the patient about their healing progress or advise them to attend the next available orthopaedic clinic, possibly a fracture clinic. A 10-year retrospective cohort study in the United Kingdom has previously reported that 3.9 % of patients undergoing joint arthroplasty visited ED in the 90 days following discharge to seek medical attention.[17] However, none of the patients in our cohort required an ED visit and/or admission. Given the strain on A&E departments throughout the UK, any measure that reduces the number of postoperative patients seeking emergency care due to worries is likely to be highly valued by the already stressed personnel.

There were numerous key learning points from the 'Post Op' smartphone application cohort. The findings from this cohort study revealed several noteworthy aspects. The app's ease of use received positive feedback, with a mean score of 5.31 out of 6, indicating that most patients found it user-friendly. Significantly, 80.9 % of patients reported increased confidence in their recovery, and a similar proportion believed the app reduced the need for visits to their primary care physician or the emergency room. This positive impact not only enhances the overall healthcare experience but also has substantial implications for optimising healthcare resources.

Qualitative feedback from patients provided valuable insights into the elements they found most beneficial. Additionally, communication
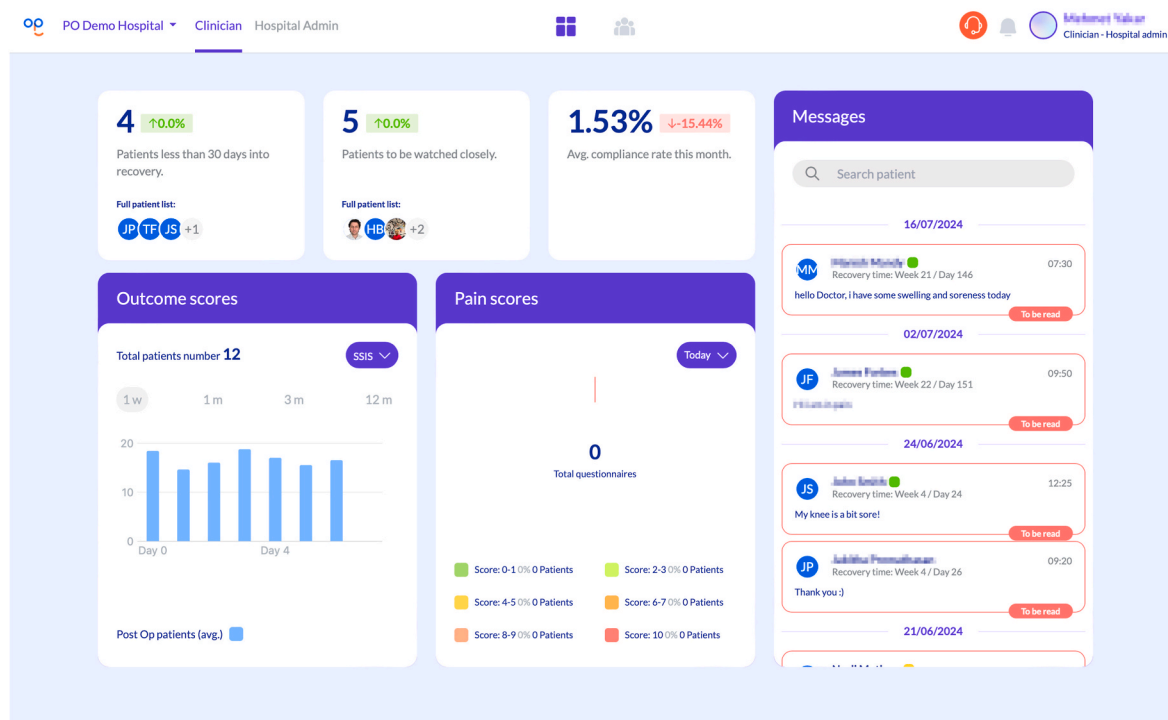
Fig. 3. Clinician user interface of the smartphone application 'Post Op'.

within the clinical team received high satisfaction, as indicated by a mean score of 5.47 out of 6, highlighting the importance patients place on prompt and effective interactions with their healthcare providers.

The timing of the survey was considered carefully, aiming to balance allowing sufficient time for app utilisation in rehabilitation while ensuring the feedback remained fresh in patients' memories. The design of a specific questionnaire addressed crucial topics such as ease of use, satisfaction with features, perceived contribution to recovery, and potential challenges. This approach, including open-ended questions for qualitative comments, provided a comprehensive understanding of patient experiences.

The study included 42 patients who underwent Total Hip Replacement (THR) and Total Knee Replacement (TKR) procedures, offering real-world insights into relatively standardised surgeries. The mean value was chosen for nominal scores, and qualitative analysis was suggested for open-ended queries due to the small sample size.

Documentation of the installation process, involvement of the extended scope nurse practitioner, and the telephone survey methodology was carried out. Results were analysed, and considerations for app improvement were made based on patient feedback.

The study's scope, focusing on a small cohort in one specialty, emphasises the need for further research across diverse settings to validate findings. Concerns regarding the timely response to queries and the difficulty in uploading photographs were communicated to app developers, highlighting the importance of continuous improvement.

Our research sheds light on the significant role that technology, particularly the Post Op app, a patient experience tool, can play in the evolving landscape of modern healthcare, where there is a concerted effort to minimise the duration of hospital stays. The study brings forth key insights and recommendations.

Firstly, the 'Post Op' smartphone app effectively acts as a bridge between hospital care and home recovery, offering crucial support and reassurance to patients, thereby mitigating post-surgery anxiety. Secondly, in terms of the response time of clinical teams, it is vital for these teams to establish a clear protocol for addressing questions raised through the app, especially during non-standard working hours and staff absences. Sensitivity to the immediate needs of patients is paramount for

building trust and ensuring their overall well-being. Furthermore, enhancing the postoperative patient experience has the potential to reduce the number of patients seeking emergency care after surgery. This is particularly valuable in the current challenging healthcare environment, aiding emergency care facilities in efficiently managing patient volumes. The findings from this investigation are promising, and there are plans to conduct similar studies on a larger scale across diverse hospitals and fields to validate the utility of the 'PostOp' smartphone application in various healthcare settings.

The feedback provided, addressing challenges related to uploading photographs and other improvement areas, has been instrumental in refining the app. This ensures ongoing relevance and adaptability to the evolving needs of patients. While the app offers substantial assistance, recognizing the role of community nurses and general practitioners is crucial for further enhancing postoperative care through effective coordination. To enhance the effectiveness of this digital health technology, it is essential to provide training and education to clinical staff about the app's features and the importance of prompt communication.

As the healthcare industry undergoes rapid changes, the 'Post Op' smartphone app represents a positive step forward. The app does not aim to completely replace physical follow-ups. But rather, optimise postoperative care, and allowing continuous engagement with stakeholders, including patients, clinical staff, and developers, is necessary.

In response to the relatively modest number of patients facing challenges with the app, additional support mechanisms have been implemented. These include technical support hotlines, alternative communication channels, and the establishment of a feedback system to address unique difficulties faced by individuals. User education, whether through initial training or user-friendly tutorials, is also crucial for overcoming early challenges, particularly for first-time app users.

4.1. Limitations

Several limitations are inherent in this study. The absence of a control group is a notable constraint, preventing the opportunity for a comparative analysis between patients utilising the 'Post Op' smartphone application and those not using it. To conduct such an analysis

would necessitate meticulous matching of patients based on their surgical procedures, demographics, and smartphone skills. However, due to the intricacies involved in achieving this level of precision in matching, we deemed it impractical at this stage. However, we aim to compare recovery and satisfaction patterns in any future research to offer a clearer picture of the app's effectiveness over traditional care methods. Furthermore, despite the encouraging findings, the results lack generalizability due to the small size of the cohort, the focus on specific general surgical procedures, and the reliance on a single clinical staff member. A comprehensive understanding of the app's usefulness would necessitate future research involving larger, more diverse patient populations, encompassing multiple clinical teams across various medical specialties. Finally, this study did not use a validated questionnaire for collecting patients' perspectives.

5. Conclusion

The 'Post Op' smartphone application has demonstrated excellent support for most patients during the early postoperative period, potentially reducing the need for frequent contact with general practitioners or emergency departments. While a small number of patients encountered issues with certain app features, their overall condition did not worsen, and the app efficiently met the needs of most patients in this critical recovery phase.

Continuous improvement and a patient-centric approach are essential strategies to maximise the positive impact of the 'Post Op' smartphone application, ensuring no patient feels neglected. Survey results indicate that most patients found the app simple to use, boosting their self-assurance during recovery and minimising visits to primary care physicians or emergency rooms. Narrative responses emphasise the support felt by the clinical team and the quick feedback obtained. Challenges in uploading photographs suggest an area for improvement, but the app's overall potential for enhancing postoperative care is evident, with 80 % of patients expressing a positive response.

By serving as a virtual link between patients and their clinical team, the 'Post Op' smartphone application addresses the risk of patients feeling abandoned after hospital discharge, bridging the gap between the hospital and the patient's home. Supporting patients during home recovery aligns with global healthcare goals of reducing hospital stays.

Crucially, efforts should be made to ensure that patients facing difficulties with the app can access alternative support systems without feeling inferior. Training or technical support may be beneficial to mitigate these challenges and enhance the overall user experience.

CRediT authorship contribution statement

Abdul-Rahman Gomaa: Conceptualization, Methodology, Investigation, Writing – original draft, Project administration. **Momna Sajjad Raja:** Formal analysis, Writing – review & editing. **Sara Monteiro:** Data collection. **Sriram Srinivasan:** Supervision, Writing – review & editing. **Srinivasan Shyamsundar:** Supervision, Writing – review & editing. **Hamidreza Khairandish:** Supervision, Writing – review & editing. **Faizal Rayan:** Conceptualization, Methodology, Writing – review & editing, Supervision.

Ethics statement

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Faizal Rayan reports a relationship with Post Op that includes: board membership and equity or stocks. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. AI tool (Grammarly) was used for language and grammar.

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