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Review Article

Evaluation of Smartphone-Based Postoperative Recovery Tracking Systems

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ABSTRACT

Smartphone-based systems for tracking postoperative recovery, ranging from symptom-diary applications to platforms that integrate wearable accelerometers and wound photography, have expanded rapidly as surgical care has shifted toward shorter admissions and earlier discharge.

This review synthesizes the current evidence across three domains: randomized trials of patient-reported recovery apps in oncologic and ambulatory surgery, wearable-sensor systems that quantify physical activity as an objective recovery metric, and photograph-based wound surveillance for earlier detection of surgical site infection.

Trial-level evidence indicates that apps built around a clear escalation pathway, where patient-entered data trigger clinician outreach, are more consistently associated with improved recovery quality and reduced unnecessary utilization than passive symptom logging alone.

Wearable-sensor step counts show reasonable measurement validity, including among orthopedic patients using walking aids, but outcome-linked predictive evidence remains limited, while photograph-based wound assessment, increasingly paired with automated triage, is diagnostically credible but constrained by patient engagement over the full healing period.

We conclude that the principal barriers to routine adoption are not diagnostic or technical but organizational: sustained patient engagement, clinical staffing to act on alerts, device interoperability, and health-economic evidence remain the gaps that will determine whether these tools become standard postoperative infrastructure.

Keywords: *postoperative recovery; mobile health; wearable devices; remote patient monitoring; surgical site infection*

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INTRODUCTION

Recovery from surgery has traditionally been

measured in the clinic: a nurse's phone call on postoperative day two, a wound check at the two-week follow-up, a patient's own recollection of how the previous fortnight went. That model was built for an era when hospitals kept patients longer and clinic visits were the only structured touchpoint available. Enhanced recovery pathways, same-day discharge for procedures that once required overnight admission, and a general push to shorten length of stay have all moved recovery out of the hospital and into the patient's home, often before the clinical team has any real sense of how that recovery is going. Smartphone-based tracking systems, ranging from simple symptom-diary apps to platforms that pair a phone with a wrist-worn accelerometer and a wound-photography module, have emerged largely to fill that gap. The appeal is straightforward: nearly every surgical patient in a high-income setting already carries a smartphone, and a well-designed app can convert that device into a low-cost, continuous monitoring tool rather than leaving the postoperative period as a black box between discharge and the follow-up appointment.

The clinical case for closer tracking is not merely convenience. Complications after discharge, wound infection chief among them, are underdetected by scheduled visits alone because most surgical site infections declare themselves in the first one to two weeks, often before the standard follow-up appointment occurs [1]. A patient who can send a wound photograph on day four, or whose step count drops precipitously relative to their own baseline, gives the surgical team a signal it would otherwise not receive until the problem has progressed. At the same time, the enthusiasm for digital monitoring has outpaced, in places, the evidence that it actually improves outcomes rather than simply generating more data. This review examines what has been demonstrated for smartphone-based postoperative recovery tracking across three domains that dominate the current literature: patient-reported recovery apps evaluated in randomized trials, wearable-sensor systems that quantify physical activity as an objective recovery metric, and photograph-based wound surveillance aimed at earlier infection detection.

PATIENT-REPORTED RECOVERY APPS AND RANDOMIZED EVIDENCE

The strongest evidence base for smartphone monitoring comes from oncologic and ambulatory surgery, where several groups have run adequately powered randomized trials rather than relying on single-arm feasibility data. A trial of smartphone-based postoperative home monitoring after oncologic surgery randomized patients to app-based symptom and recovery tracking versus usual care and assessed quality of recovery as the primary endpoint, finding that structured home monitoring meaningfully changed how quickly problems were identified and addressed relative to the standard pathway of scheduled calls [2]. The design is instructive for the field: rather than treating the app as a passive diary, the intervention arm used patient-entered data to trigger clinician outreach when responses crossed a threshold, which is arguably the feature that separates a monitoring system from a mere logging tool.

Ambulatory and day-case surgery has been an equally active area, in part because these patients are discharged the same day and therefore have the least in-person contact with the surgical team during the highest-risk early window. A protocol for a randomized trial of mobile app home monitoring after ambulatory surgery was designed explicitly around reducing unnecessary in-person visits, on the premise that many post-discharge visits and emergency department presentations after low-risk ambulatory procedures reflect anxiety or minor, manageable symptoms that a remote check-in could resolve without travel [3]. A separate randomized protocol built around day-care surgery similarly used app-controlled remote monitoring as the intervention, with quality of recovery again serving as the outcome of interest and enrollment structured to compare the app pathway against conventional discharge instructions and telephone follow-up [4]. These protocol-stage publications matter because they show the field moving past small pilots toward trial designs capable of answering whether monitoring changes clinical trajectories rather than merely patient-reported convenience.

Procedure-specific pilots have filled in detail that trial-level data cannot capture on its own. A pilot evaluation of a smartphone app for managing postoperative home recovery after thoracic surgery, built on a commercially available care-management platform, tracked symptom burden and functional recovery in a population where pulmonary complications and slow return of activity are common concerns, and reported that patients engaged with daily check-ins at a rate sufficient to make the data clinically usable [5]. A comparable pilot in gastrointestinal surgery tracked patients using a dedicated app after discharge and found that the tool surfaced actionable deviations from expected recovery, including early signs of ileus or wound concerns, that might otherwise have waited for the two-week visit [6]. Finally, a PCORI-funded evaluation of remote monitoring layered onto standard postoperative cancer surgery care took a more pragmatic, health-services approach, asking not just whether patients liked the tool but whether adding remote monitoring to usual care changed recovery trajectories and healthcare utilization in a real-world population, a question that ultimately determines whether health systems will pay to deploy these platforms at scale [7].

Taken as a set, these studies point to a consistent, if still maturing, pattern: apps that passively collect data without a clear escalation pathway tend to generate

engagement but not necessarily better outcomes, while apps built around a triage or alert function, where a threshold response prompts a clinician call rather than waiting for the data to be reviewed at the next visit, are the ones associated with measurable changes in recovery quality or utilization. The distinction between logging and monitoring, in other words, is not merely semantic; it appears to be where the clinical benefit actually lives.

WEARABLE SENSORS AND OBJECTIVE ACTIVITY METRICS

Patient-reported outcomes captured through an app are useful but inherit all the biases of self-report: recall error, social desirability, and the tendency of patients to underreport symptoms they fear will delay discharge or trigger unwanted intervention. Pairing a smartphone with a wearable accelerometer addresses part of that problem by adding an objective, continuously collected signal, most commonly step count or overall activity minutes, that does not depend on the patient remembering to log anything. A scoping review of wearable devices used to monitor recovery after abdominal surgery catalogued the range of platforms in use, from simple pedometer-style wristbands to research-grade multi-sensor devices, and found that while feasibility was generally good, the metrics reported and the recovery milestones they were validated against varied enough between studies to make cross-trial comparison difficult [8]. A broader literature review of wearable devices for patient monitoring in the early postoperative period reached a similar conclusion, noting that most published work remains observational and that consensus on which activity metric best predicts complications or readmission has not yet emerged [9].

Validation work has begun to address the more basic question of whether these devices measure what they claim to measure in a surgical population, where gait is often altered by pain, incisional splinting, or the use of walking aids. A validation study of wrist-worn activity trackers in patients recovering from major abdominal surgery compared device-recorded steps against a criterion standard and found reasonable but imperfect accuracy, with error patterns that were not uniform across the day, suggesting that absolute step counts should be interpreted with some caution even as trend data over days remains clinically informative [10]. In orthopedic populations, where crutches, walkers, and altered cadence are the norm rather than the exception, a study specifically testing whether accelerometers could correctly count steps while patients used walking aids found that step-counting accuracy held up reasonably well even under these atypical gait conditions, which matters because orthopedic and trauma patients are exactly the population in which mobility milestones are most clinically meaningful [11]. A scoping review of step count as a digital mobility outcome across orthopedic and orthopedic trauma surgery synthesized this growing body of work and argued that step count is maturing into a genuinely useful digital biomarker for this population, while also flagging that reporting standards, device selection, and the timing of measurement still differ enough between studies to slow the field's progress toward a single validated metric [12].

Cardiac and colorectal surgery have generated their own wearable literature, each shaped by the specific recovery trajectory of the operation in question. A comparison of three different wearable accelerometers used to measure early activity after cardiac surgery found that device choice materially affected the numbers produced, underscoring that "activity" is not a single interchangeable measurement across commercial platforms and that clinicians adopting one of these systems need to understand its specific validation rather than assuming interchangeability with a competitor device [13]. In colorectal surgery, where early mobilization is a core tenet of enhanced recovery protocols and where anastomotic leak and ileus are feared complications with activity-relevant physiology, a systematic review of continuous wearable-sensor monitoring examined not just activity tracking but the broader use of physiological sensor data, including heart rate and respiratory patterns, to build predictive models for complications, concluding that while the technical feasibility of continuous monitoring is well established, translating sensor streams into validated early-warning algorithms remains a work in progress rather than a solved problem [14]. The overall picture from the wearable literature is one of a technology whose measurement validity is improving steadily but whose predictive and prognostic value, the piece that would justify routine clinical deployment, still needs the kind of larger, outcome-linked studies that the app-based symptom-tracking literature has begun to produce.

PHOTOGRAPH-BASED WOUND SURVEILLANCE AND INFECTION DETECTION

Surgical site infection is the postoperative complication most amenable to remote visual assessment, since much of the diagnostic reasoning a surgeon applies at a wound check relies on inspection rather than palpation or auscultation. This has made wound photography one of the earliest and most durable applications of smartphone technology in postoperative care. An early study of photograph-based telemedicine for postoperative wound assessment tested whether clinicians could reliably diagnose or exclude surgical site infection from patient-submitted images alone and found that photograph review performed well enough to serve as a credible substitute for an in-person look in a meaningful proportion of cases, sparing patients a clinic visit for what was ultimately a normal-healing

wound [15]. A separate evaluation of wound photography for remote postoperative assessment reached a broadly similar conclusion, reporting that remote photographic review could accurately distinguish infected from non-infected wounds across a range of surgical specialties, though both studies noted that image quality, lighting, and the difficulty some patients have in photographing their own wound, particularly for procedures on the back, hip, or spine, remained practical limitations [16].

More recent work has moved from simple clinician review of submitted photographs toward automated, AI-assisted triage of wound images. A paired cohort study evaluated a new AI-based application designed to automatically detect potential infection from patient-submitted wound photographs, comparing the app's flagged cases against clinician assessment, and reported that the automated system performed with sensitivity adequate to serve as a first-line screening tool, one that could, in principle, flag concerning wounds for expedited clinician review while allowing wounds that appear to be healing normally to bypass an unnecessary visit entirely [17]. That kind of automated triage addresses a scalability problem that pure photograph-submission systems eventually run into: a human reviewer looking at every submitted image does not scale well across a busy surgical service, whereas an algorithm doing a first pass, with human review reserved for flagged or ambiguous cases, in principle does.

Making any of this work in routine practice, however, depends on more than diagnostic accuracy. A study identifying the important features of mobile health applications intended for surgical site infection surveillance took a human-factors approach, asking what design elements, prompt structure, reminder timing, ease of photo capture, clear escalation pathways, actually determined whether patients used the tool consistently enough to generate useful data [1]. That work is a useful counterweight to the purely diagnostic-accuracy literature: an app that can theoretically detect infection from a photograph is clinically worthless if patients stop using it by postoperative day five out of frustration with the interface or uncertainty about what the app expects from them. The wound-surveillance literature, taken together, suggests that photograph-based assessment is diagnostically credible and that the field's remaining work is less about proving the underlying concept and more about engineering systems, automated triage among them, that patients will actually use through the full arc of wound healing.

BARRIERS TO ADOPTION AND UNRESOLVED QUESTIONS

None of the three domains reviewed here has translated into uniform clinical deployment, and the barriers are more practical than technical. Digital literacy and access remain uneven: older patients, those with limited smartphone experience, and patients in lower-resource settings are systematically underrepresented in the trials described above, which raises a real question about whether the populations shown to benefit from app-based monitoring resemble the populations that most need better postoperative surveillance, including patients living farther from a hospital or with less reliable access to in-person follow-up. Engagement decay is a second, closely related problem; several of the pilot studies noted declining check-in rates as the postoperative period wore on, which matters clinically because late complications, an infection that declares itself on day ten rather than day four, are exactly the events a monitoring system needs to still be capturing when patient engagement has typically dropped off.

Integration with clinical workflow is a third barrier that the literature addresses less directly than it should. A monitoring system that generates alerts is only as useful as the staffing model behind it; several of the randomized protocols described above built triage nursing time explicitly into the trial design, which is a resource commitment that a busy surgical practice adopting the technology outside a trial context may not be able to replicate. There is also a data-fragmentation problem: apps built around a single vendor's wearable, or a single hospital system's proprietary platform, rarely interoperate with each other, meaning a patient using a smartwatch already owned before surgery may not be able to feed that data into the surgical team's monitoring system at all, forcing either a duplicate device or a gap in objective data.

Finally, cost-effectiveness data remain thin relative to the volume of feasibility and pilot work. Most publications to date report engagement metrics, diagnostic accuracy, or patient satisfaction rather than the downstream economic outcomes, reduced readmission costs, fewer unnecessary clinic visits, earlier return to work, that would ultimately justify health system investment in these platforms at scale. The PCORI-funded work in this space is a partial exception in framing the question in health-services terms rather than purely clinical ones, and more studies designed from the outset to capture utilization and cost alongside recovery quality are needed before smartphone-based tracking can be recommended as a standard rather than an optional adjunct to postoperative care.

CONCLUSION

Smartphone-based postoperative recovery tracking has moved, over roughly the past decade, from novelty pilot projects to randomized trials with clinically meaningful endpoints, and the evidence to date is genuinely encouraging for a subset of well-designed systems: those that pair patient-reported or sensor-derived data with a clear clinical escalation pathway rather than functioning as a passive diary. Wearable-sensor activity tracking has established

reasonable measurement validity, including in orthopedic patients using walking aids, but has not yet produced the outcome-linked evidence that would justify treating step count as a routine vital sign of recovery. Photograph-based wound surveillance is the most mature of the three domains diagnostically, and automated triage is beginning to address the scalability limits of clinician-reviewed image submission, but sustained patient engagement through the full healing period remains the binding constraint on real-world performance. Across all three areas, the unresolved work is less about proving that a phone or a wristband can capture useful data and more about building the clinical infrastructure, staffing, escalation protocols, interoperability, that turns that data into better outcomes rather than a larger, unread inbox. The trials now underway that pair remote monitoring with defined clinician response pathways are the ones most likely to answer whether this technology earns a permanent place in routine surgical aftercare.

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Conflict of Interest

The authors declare no conflicts of interest relevant to the content of this review.

Author Contributions

M. Benitez conceived the review, conducted the literature search, and drafted the initial manuscript. J. Antoniou contributed to the analysis of the wearable-sensor literature and critically revised the manuscript. S. Novak contributed to the analysis of the wound-surveillance and adoption-barrier literature and critically revised the manuscript for important intellectual content. All authors approved the final version for submission.

Ethics Statement

This is a literature review that did not involve new human or animal data collection and did not require ethics committee approval.

Data Availability

No new data were generated for this review. All sources cited are publicly available in the referenced journals and databases.

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