Postoperative wound surveillance using patient smartphones: Learning from a large London maternity service

Surgical site infections (SSIs) and wound dehiscence are significant complications following caesarean sections (C-sections), impacting patient recovery and healthcare costs. Traditional surveillance methods post-discharge have limited engagement and delayed complication reporting. This study evaluated the effectiveness of a digital surveillance programme using patient smartphones for monitoring wound healing after a C-section, aiming to enhance patient engagement and timely data collection on SSIs, surgical wound dehiscence (SWD), and antibiotic use. Launched in April 2022 at Guy's and St Thomas' NHS Foundation Trust, the programme used Isla Care Limited platform for patients to submit weekly updates and photos of their wounds. Engagement rates and incidence of SSIs, SWD, and antibiotic usage were analysed among 4,038 participants. Transitioning to digital surveillance improved patient response rates from 56.2% to 84.4%. The reported SSI and SWD rates were 10.5% and 13.6%, aligning with expected outcomes. Digital surveillance markedly improved patient engagement and the timeliness of reporting, supporting its broader application in postoperative care to reduce complications and enhance safety and recovery.

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- Wound dehiscence monitoring
- Patient engagement

Caesarean sections (C-sections) are the most commonly performed obstetric operations worldwide (Jauniaux and Grobman, 2016). Maternal and infant safety has improved considerably due to this surgical approach (Ranaei-Zamani et al, 2024); however, after surgery, there is a risk of surgical site infection (SSI). Mojtahedi et al (2023) reported that the pooled global incidence of post-C-section SSIs was 5.63%, ranging from 1.1% in Denmark to 27.1% in Tanzania. The researchers found the most frequently associated pathogens were *Staphylococcus aureus* and *Escherichia coli* (Mojtahedi et al, 2023). Most SSIs are superficial incisional infections, affecting the skin and subcutaneous tissue. More serious infections, such as endometritis, affect approximately 2-16% of women after a C-section (Kawakita and Landy, 2017). More than a decade ago, a prospective cohort study in England found that almost one in ten women developed an SSI after a C-section, and 0.6% required readmission (Wloch et al, 2012). The annual cost of C-section SSIs is estimated at £5 million, although this figure is likely to be higher (Guest et al, 2023).

SSIs can significantly compromise patient outcomes, leading to increased morbidity, prolonged hospital stays, and increased healthcare costs (World Health Organization, 2018). Furthermore, SSIs can negatively impact the psychological and emotional wellbeing of new mothers, potentially affecting mother–infant bonding and increasing the risk of postpartum depression and anxiety (O'Dea et al, 2023). This highlights the need for prevention to minimise infection rates and enhance recovery outcomes. Surveillance is considered an evidence-based approach to reducing SSIs. It involves the ongoing, systematic collection, analysis, and interpretation of health data, and facilitates providing feedback to key stakeholders (UK Health Security Agency [UKHSA], 2013).

Guy's and St Thomas' NHS Foundation Trust (GSTT) is a large, tertiary hospital in Central London. The maternity service delivers over 6,000 babies each year (Care Quality Commission, 2022), with a C-section rate of approximately 49% (April 2023–March 2024 internal data). Post-discharge surveillance (PDS) commenced in 2010. It consisted of using postal questionnaires and telephone surveys, resulting in a response rate of 91.5% for the highest performing quarter in 2019 (Jakes et al, 2020). However, the unpublished PDS rates for the full calendar year in 2019 and 2020 were much lower at 53% and 59.8%, respectively. Post-Covid, only postal questionnaires continued, and the patient

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response rate fell to 37.7% (848/2420), with monthly rates ranging from 18.7% to 41.5% (Morais, 2022).

In April 2022, a new digital post-discharge surveillance was introduced via Isla Care Limited, using patient smartphones (Alwis et al, 2022). The aim of this retrospective study was to evaluate the post-discharge surveillance program, to determine success in patient response rates using their smartphones after C-section surgery, identify gaps in the uptake of remote digital wound monitoring based on patient demographics and provide information on healing outcomes in the community.

Methods

Surveillance

Image-based surveillance using patient smartphones was introduced at Guy's and St Thomas' NHS Foundation Trust in the maternity service (C-section) in April 2022 through Isla Care Limited ('Isla'). Isla is a secure, browser-based digital health intervention used for remote post-surgical monitoring. The patient questionnaire was based on a modified UKHSA 'Surgical Wound Healing Post Discharge Questionnaire' (Rochon et al, 2023). All surveillance activities were conducted under strict ethical guidelines to ensure the protection and privacy of patient data. Appropriate permissions were obtained.

Outcome measures

Response rates

Once at home, participants receive weekly invitations to submit information about their wounds in response to pre-programmed SMS text messages. Patients/nominated carers were also able to provide information between scheduled requests if they observed any changes in their wound. Patient engagement was defined as at least one patient submission to the Isla platform up to 30 days after their operation.

Sub-analysis – patient characteristics

Between January and August 2023, data on patients who responded or did not respond was collected from Isla, along with information on patient characteristics. This data was collected from Badgernet (Client Version 3.0.3.0), and included age, body mass index (BMI), diabetic status, smoking status, operative urgency and average distance (one-way) from hospital. Data on ethnicity and Index of Multiple Deprivation (IMD) were obtained from NHS England Hospital Episode Statistics (HES). Baseline characteristics were presented descriptively by group, using t-tests for continuous variables, and chi-squared tests for categorical variables. For IMD and ethnicity, further testing using Multiple Log regression was performed, using R Version 4.2.1. For the purposes of this study, statistical significance was established at a *p*-value <0.05.

Patient-reported surgical site infection

PDS SSIs were classified according to the definitions provided by the UK Health Security Agency (UKHSA). The criteria for patient-reported SSIs are as follows: presence of pus discharge and antibiotics; two clinical signs of inflammation and antibiotics; or two or more clinical signs of inflammation accompanied by wound dehiscence.

Patient-reported antibiotics for the wound

Patients were asked: 'Since leaving the hospital, have you received new antibiotics for your wound?' Responses were categorised as follows: 'Yes (currently receiving)' – these were included in the antibiotic data and counted only once. Responses of 'Yes (now completed)' and 'No' were excluded from the antibiotic data count.

Patient reported surgical wound dehiscence

Patients were asked to report if any part of the wound edges had separated or gaped open. A 'Yes' response was counted once. Responses of 'No' or unanswered queries were consistently excluded from the SWD data.

Results

Between April 2022 and March 2024, 5,845 women were eligible for post-discharge surveillance. A total of 5,677 were enrolled on the Isla wound monitoring programme – 178 women were not enrolled (5 as there was no contact number, and the remainder due to technical issues with either issues with the new electronic patient record [EPR] system or the Isla upload process). A total of 4,038 women submitted information on wound healing after C-section in the community using their smartphones (no standard equipment or calibration stipulated).

Sub-analysis of patient characteristics

A total of 1,715 patients were included in the January–July 2023 sub-analysis [Table 1]. There was no significant difference seen in age, smoking history, diabetic status, BMI, mean distance to travel to hospital, or between White and Asian, or White and Other ethnic groups. However, there was a significant difference with patients from higher levels of deprivation (score above the median). Similarly, when IMD was treated as a categorical outcome, there was

Scan the QR code above to access the Isla Health website

Table 1. Comparison of variables for Isla responders and non-responders			
Variable	Responders (*n*=1246)	Non-responders (*n*=469)	*p*-value
Age (years) mean, [range]	34.7 [19-54]	34.1 [19-58]	0.069
Smoking history	196 (70.3%)	83 (29.7%)	0.319*
Diabetes history	192 (71.4%)	77 (28.6%)	0.715*
BMI	116 (71.6%)	46 (28.4%)	0.077
Emergency	698 (70.7%)	289 (29.3%)	**0.033***
IMD	648 (74.7%)	209 (25.3%)	**0.036**
Distance	603 (74.9%)	202 (25.1%)	0.545

**Chi-squared test*

Table 2. Ethnicity for Isla responders and non-responders January–August 2023			
Variable	Responders (*n*=1179)	Non-responders (*n*=437)	*p*-value
White	616	193	Reference
Black, Black British, Caribbean or African	241	122	<0.001
Asian or Asian British	167	55	0.777
Mixed or multiple ethnic groups	76	38	0.030
Other ethnic group	79	29	0.495

a significant difference seen when comparing the highest and lowest deciles (0.0487), but no significance when comparing the lowest deprivation (10) with other ranks (data not shown), i.e. those with the highest deprivation are 66% less likely to respond than those with the lowest deprivation. Table 2 shows a significant difference between White and Black groups (<0.001) and White and Mixed groups (0.0298). There were no significant differences between White and Asian, or White and Other ethnic groups. The odds of Black and Mixed groups are 0.6 times (or 60%) lower than that of White groups, i.e. less likely to respond.

Patient response rates

Overall, Figure 1 shows a positive trend in patient engagement: – 27% of patients submitted once; the remaining responders (73%) submitted on two or more occasions (range 2-12).

Patient-reported outcomes

Over the 24-month period, the patient reported SSI rate was 10.5%, with monthly rates ranging between 4.7% and 14.4%. The average self-reported antibiotic rate was 10.4%, and the overall rate for surgical wound dehiscence was 13.5%, [Figure 2].

Discussion

This study included 4,038 women using their smartphones to monitor their wounds in the community after a C-section. The average response rate was 84.4% after process improvements were implemented, aligning with published data for digital postoperative wound monitoring (McLean et al, 2023). This is a significant improvement on the hospital service's traditional approach. Further work is planned to include email or telephone follow-up, rather than solely using SMS text follow-up. To our knowledge, this is the largest published study using patient smartphones for SSI surveillance in the UK in routine practice. A systematic review by McLean et al (2023) identified fourteen studies that used digital health interventions for wound monitoring, published in English (full text) globally; the median number of participants was 44.5.

Over the 2-year period, approximately one in 10 patients reported an SSI and

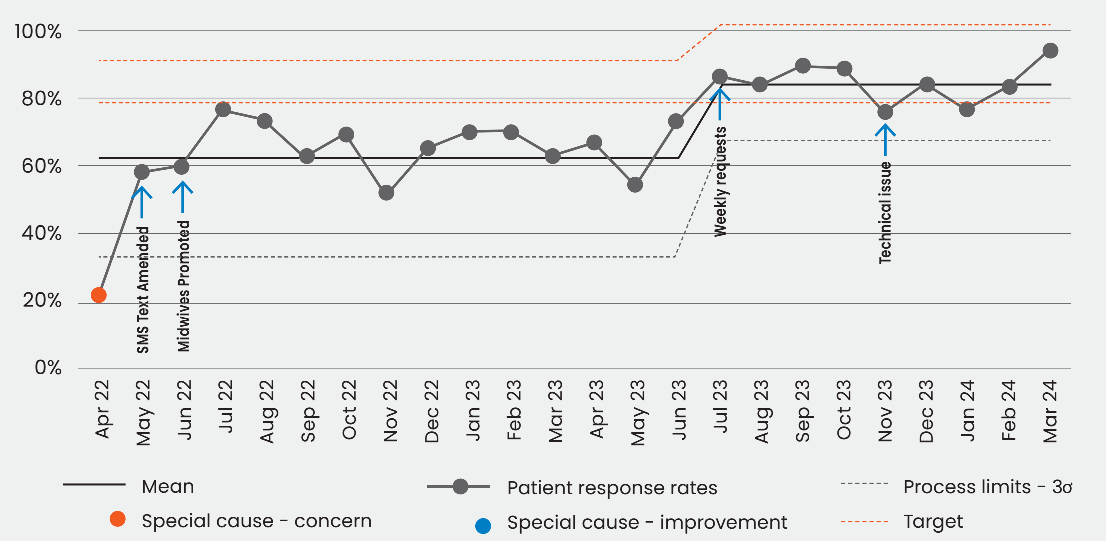

Figure 1

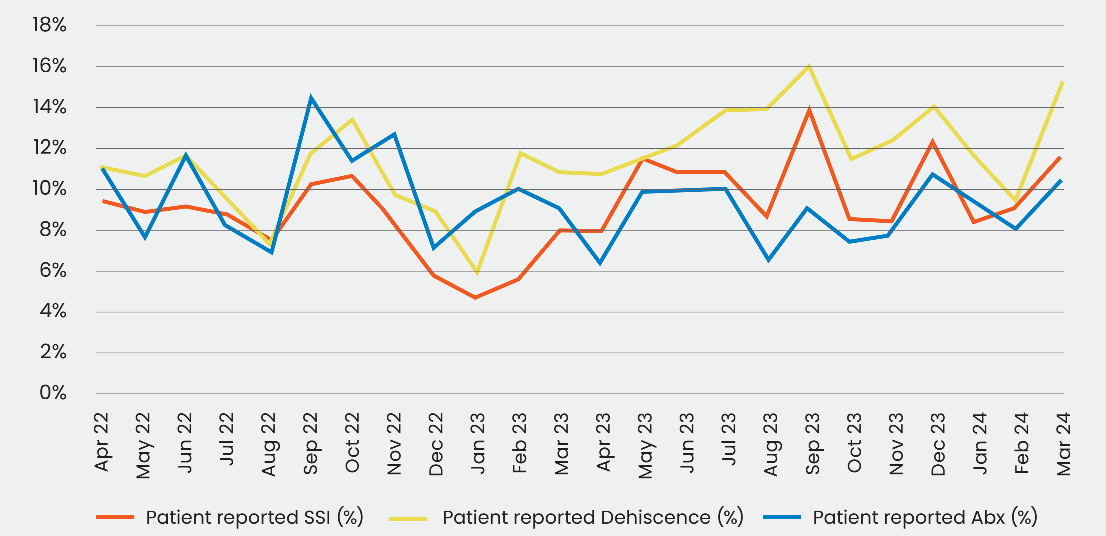

Figure 2

Figure 1. Patient response rates to Isla April 2022–March 2024.

Figure 2. Patient-reported outcomes April 2022–March 2024.

needed antibiotics for their wound after leaving the hospital. Confirmatory analysis of patient-reported outcomes using Isla was previously reported to be approximately 97% (Rochon et al, 2024). The SSI rates align with the 8-12% typically reported in the literature (Leth et al, 2009; Dahlke et al, 2013). A key strength of this work is that it also provides trends for SWD using patient-reported outcomes. Dehiscence rates in this study appeared elevated, with 13.5% of patients reporting some gaping or opening of the incision.

There is no 'gold standard' for collecting data on SWD (Morgan-Jones et al, 2023) and, to date, we are not aware of published data using patient smartphones for this outcome. Our rate of SWD is higher than the previously published rates of 1.9%–7.6% (World Union of Wound Healing Societies, 2018) and warrants clinical investigation. Recommendations arising include working with the multidisciplinary team to closely review case mix, infection prevention practices and surveillance methodology, reviewing dressing protocols [Box 1], and patient education.

Rochon et al (2024) found that ethnicity did not affect patient engagement with smartphone-based surveillance in cardiac surgery. However, like Castillo et al (2017), our study highlights significant differences in the likelihood of using smartphones for postoperative wound monitoring between specific ethnic groups. We plan to explore issues such as technological access, digital literacy, cultural perceptions, privacy concerns, and language barriers, systematically addressing these areas so that clinical practice can become more inclusive and effective in utilising technology to enhance postoperative care for diverse populations.

In England, although centres have indicated that C-sections would be a priority for

Box 1. Incisional negative pressure wound therapy (iNPWT)

The cost and management for surgical wound complications are often managed in the community (Guest et al, 2020). iNPWT, delivered by devices such as PICO™ single-use negative pressure wound therapy (sNPWT; Smith+Nephew) can be used as part of a bundle or package to help prevent issues post-surgery, and particularly as an active treatment for patients at home or in the community when an SSI or SWD has occurred or is at risk. It is important to recognize that not all sNPWT products are the same, as they may have different modes of action (MOA), so caution should be taken when assuming evidence applies universally to all products that claim to provide this therapy In a recent study by Groenen et al (2023), a meta-analysis was conducted, which included 57 RCTs involving 13,744 patients. The study found a significant reduction in SSI with high-certainty evidence. Trial sequential analysis of the data indicated that these results were unlikely to change with future evidence. Using NPWT in conjunction with a clinical pathway has demonstrated a reduction in time and costs for healthcare organisations. This approach has led to either complete healing or a reduction in wound surface for SWD cases that were previously identified as non-healing (Hughes et al, 2021). Our existing system using Isla will allow us to monitor the impact of new products, or changes in practices or processes to reduce or manage SSI or SWD with a joined up approached to integrated care and communications between surgical and community settings.

surveillance (Troughton et al, 2018), they are not currently included in the national surveillance scheme. C-section surveillance is mandatory in Scotland, Northern Ireland, and Wales (Health Protection Scotland, 2014; Public Health Agency Northern Ireland, 2014; Public Health Wales NHS Trust, 2021).

Monitoring wound infection rates allows hospitals to recognise their successes in preventing and treating infections and identify areas needing improvement. This monitoring is crucial for providing the best possible care. However, it often only focuses on infections identified during the initial hospital stay or upon readmission, a significant limitation as most infections occur after the patient leaves the hospital (Guest et al, 2023).

This work did not include clinical evaluation (i.e. comparison with in-person review), which is an important limitation, as although digital methods have good specificity, studies suggest variable sensitivity for remote wound assessment (McLean et al, 2023).

There are several other limitations to this study. Despite including diversity monitoring, the subgroup analysis was restricted to an eight-month period in 2023, which included both 30-day and weekly submission schedules. In addition, it was not possible to determine the underlying cause of the dehiscence.

Blencowe et al (2019) have pointed to the quality of wound closure (such as suture tension and apposition of the margins) as contributing to the breakdown of the wound. However, we were not able to take this into account or other factors such as underlying comorbidities or possible mechanical strains affecting healing.

Finally, the focus of the work was, by necessity, on using a new form of image-based surveillance, with weekly requests from July 2023. For this reason, although there is novel data on trends presented from patients on SWD and antibiotics, interventions were not introduced to reduce these rates. A dressing trial was conducted in November and December 2023 (not of iNPWT), but this did not impact on rates. The introduction of a new ‘Central Digital Wound Hub’ with dedicated staff in April 2024 will allow us to improve the quality of care and deliver better outcomes. For example, proactively following up wound specimen results and acting on findings.

Conclusion

The integration of digital surveillance technologies for post-discharge monitoring of SSIs following C-sections represents a significant advancement in maternal healthcare. SSIs remain a considerable challenge post-C-section, impacting not only the physical health of new mothers but also their psychological wellbeing and the broader healthcare system.

By using image-based surveillance, this study not only followed the incidence of SSIs but also gathered data on antibiotic usage and surgical wound dehiscence (SWD), highlighting the potential of such technologies to provide comprehensive postoperative care. This study lays a foundational step towards this future, advocating for expanded surveillance measures and more targeted, effective interventions that can be tailored to the unique needs of diverse populations.

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