Quality improvement approach to reducing readmission for surgical site infection

KEY WORDS
- Surgical site infection
- Healing by primary intention
- Infection prevention

Surgical site infection (SSI) is the third most common healthcare-associated infection, yet is the most costly in terms of resources. **Objective:** To improve patient care experience, develop better links between acute and community care and reduce readmissions for SSI. **Methods:** To reduce cardiac SSI, a photo of the surgical wound was taken on the day of hospital discharge (Photo at Discharge = PaD), accompanied by individualised information for patients and carers. Patient feedback was sought via a postal questionnaire (85% return rate) and telephone follow-up. A prospective surveillance service monitored SSI rates on readmission. **Results:** Observational audit and SSI surveillance data collected over a 21-month period suggest PaD is associated with four times lower readmission rates for incisional SSI (p=0.0344). The potential savings are estimated at £15,000 per deep incisional SSI prevented. **Discussion:** PaD is associated with improved patient experience, a reduction in incisional SSI readmission rates and substantial associated savings. It has the potential to be applied in other surgical categories, and a similar approach for photo electronic assessment and documentation may be utilised for standard in-hospital wound care.

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Surgical site infection (SSI) constitutes 15.7% of all healthcare-associated infections (Health Protection Agency, 2012). In addition to higher rates of mortality and morbidity, and an increase in associated pain and upset for patients (Broex et al, 2009; de Lissovoy et al, 2009), SSIs are the most costly in terms of resourcing (Edmiston et al, 2015). Furthermore, patients with SSI are five times more likely to be readmitted to hospital (Pexton and Young, 2004).

Photography has been used to track chronic wound assessment and treatment (Vowden, 1995; Kantor and Margolis, 1998; Bello and Philips, 2000; Flanagan, 2003) but has not yet been applied to acute wounds for SSI prevention (Riley and Manias, 2004). Photographs enable a clear, objective assessment of acute, healing surgical wounds. This study aimed to develop a Photo at Discharge (PaD) scheme to reduce SSIs and improve patient care post discharge.

SITUATION AT THE TRUST

Despite reducing and maintaining cardiac SSI below the national benchmark of four per 100 operations for the past 4 years, the Royal Brompton and Harefield NHS Trust (RBHT) SSI rate for incisional infection readmission rate remained static, at around 0.9%. A root cause analysis for superficial (detected within 30 days) and deep (up to 1 year) incisional SSI identified key issues relating to the disease process. Issues often related to the day of discharge: there was limited evidence of wound assessment and documentation, and if a sternal wound swab was taken it was often lost to follow up. The RBHT review of SSI readmissions revealed that on the day of discharge there was often early evidence of infection, which did not always flag a request for medical review. This problem was often compounded by poor quality assessment and documentation, such as 'wound red' or 'wound oozing'. In turn, community carers had little to no information on the wound's appearance and would struggle to determine improvement or deterioration over the short term. The RBHT readmission costs for SSI over a 3-year period exceeded £1.6 million. Using 2010–2012 financial data, the average cost of a readmission for any

classification (superficial/deep/ organ or space) cardiac sternal wound infection is £25,164. The average cost of a superficial SSI ranged between £5,000 and £11,000 and the average readmission for deep incisional SSI is £15,538. An approach to reduce the incisional categories of SSI was needed, with organ/space SSI considered separately.

DEVELOPING PAD

Sixty per cent of cardiac SSIs occur within the first 30 days post surgery, as the average time for sternal wound infection to present is on day 10 for superficial SSI (interquartile range: 7–15 days) and day 14 (interquartile range: 9–26 days) for deep/organ-space SSI (Elgohari, 2015). As the median length of stay for coronary artery bypass graft patients is 7 days, it is essential that patients have the resources to identify wound concerns once they leave the hospital. The surveillance nurses and surgeons agreed that photographs be used by the patient and his/her carers to monitor wound changes. They completed online quality improvement modules and utilised the Institute for Healthcare improvement model (Langley et al, 2009) to plan and undertake the PaD scheme as part of RBHT's strategy to reduce patient harm by 50% over the next 3 years. PaD had a roadmap including tasks, drivers, monitoring status and steps. It was predicted that PaD would increase the quality of infection prevention and wound protection advice given to patients, as pictures linked with written text improve attention and comprehension (Delp and Jones, 1996; Houts et al, 2005; Reed and Card, 2016). The PaD scheme was designed to reduce the readmission rate for incisional SSI and improve three key areas:

- Wound assessment and documentation at the point of discharge
- Patient experience of the discharge process
- Individual and patient-centred information for carers and community healthcare professionals.

On the day of discharge, the ward nurse takes a colour photograph of the patient's wound. This is inserted into a form containing evidence-based wound care information (*Figure 1*), including advice specific to the individual, improving documentation and information on wound status/appearance for community carers. A plan is also given for any outstanding microbiology results. A copy of the form is sent to the GP and patient/carer, and is uploaded to the electronic patient record. This is in line with National Institute for Health and Care Excellence (NICE) guidance on SSIs (NICE, 2008). PaD was created within the context of multiple projects to reduce SSI; it was deemed that PaD did not require ethics approval. Continuous, prospective SSI data were collected by the surveillance team using the 2013 Public Health England protocol.

Deterioration in the wound's condition can be assessed because the photo provides a baseline to evaluate changes against. As increasing patient knowledge at hospital discharge can result in improved clinical outcomes for conditions such as diabetes, stroke and chronic heart failure (Koelling et al, 2005; Forster et al, 2012; Haas et al, 2013); a similar effect for acute care patients was therefore anticipated.

Funding and support were supplied by the Collaboration for Leadership in Applied Health Research and Care Northwest London. Patient inclusion was voluntary. PaD was developed with due consideration of consent, privacy, dignity (which included the offer of chaperone and consideration of cultural preferences) and clinical governance issues. Readmission for SSI and patient satisfaction were used to measure the efficacy of the scheme.

PaD used expert opinion and best practice for SSI prevention as per the 2013 NICE Surgical Site Infection Quality Standards. Tests were initially carried out on a small scale at Hospital Site 1 using Plan, Do, Study, Act (PDSA) cycles, as the flexibility and adaptability of the approach was desirable (Langley et al, 2009). The photos were taken and uploaded to forms containing advice for two patients. The results of patient and surgeon feedback led to further gender- (i.e. support wear for female patients with sternotomy wounds) and site-specific (i.e. chest and leg wound) advice that was acted on. It was predicted the photo alone would be of sufficient to improve documentation; however, the small sample indicated that written assessment was still needed as some details, e.g. small, dissolvable sutures, were not evident in suitably-sized photos of the whole incision. Having addressed these issues, PaD was used for two further patients. A form was created in Microsoft Word that ensured the correct photo, patient and surgical team were given.

"Sixty per cent of cardiac surgical site infections occur within the first 30 days post surgery."

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Mr J Blogg XX-XXX consent (hardcopy) √
NHS NUMBER XXX XXX XXX

29/7//2015 no outstanding sternal swabs at discharge. Normal swelling at the top of wound (not hot/tender). Sternal wound is clean and dry on the day of discharge. Drain sutures to be removed DD/MM/YY and clips to legs to be removed DD/MM/YY.

Advice to J Blogg

*Full, daily shower with liquid soap. Water and liquid soap is fine to roll over wound bed, but avoid high temperatures and/or soaking the wound and do not rub wound. Pat the sternal wound dry with clean towel gently first, then dry rest of body. Incisions on the leg are also surgical wounds and need to be treated in the same manner, using a separate towel to dry.
*Wash hands frequently and avoid touching wound. A healing wound may be itchy (especially if there is hair regrowth) but avoid urge to scratch. Regular hand washing will reduce the risk of infection.
*Support your wound when coughing and if possible, turn your head so that coughing directly over the wound is avoided.
* The bottom of the wound is particularly vulnerable due to heat used during surgery. Good posture and regularly standing will reduce pressure on the area.
*Protect the sternal wound with careful movement; when possible please sleep on your back, avoid over-reaching/stretching (including during hair wash) and use your arms for balance when moving to standing position, rather than pushing /supporting weight.
*Increase walking distance as advised by team. .

PLEASE USE THIS PHOTO TO MONITOR for any signs of infection, including new or increasing heat, redness, pain or swelling around the wound or any gaping or fluid leaking from the wound. Sternal 'clicking' or high temperature should also be reported.

Please contact your GP or Mr Surgeons' secretary (01895 XXXX) immediately if you think your wound might be infected. Treating an infection early helps stop it from becoming worse or lasting longer than it should. If your doctor suspects you have an infection, take the antibiotics as advised. If you don't take antibiotics at the right time or complete the course of antibiotics there is a risk that the bacteria will become stronger and harder to treat. **This information does not replace advice or assessment by surgical team or other Health Care Worker.**
Copy of this information to the patient. Electronic copy on EPR.

Consent for photo_____(pt signature)

BHIS

Figure 1. Example of PaD documentation created

Studying the results from a further five patients, the surveillance team expanded the project to three surgical teams in July 2014. The PDSA cycle was a week long and documentation was maintained by the surveillance nurse.

Feedback on the improved version of PaD was sought in December 2014. Ninety-five questionnaires were posted and 81 anonomysed replies were returned, 64 with comments. Examples of patient feedback are given in *Box 1*. Most patients indicated that the scheme was 'very useful.' Dominant themes when comments were analysed were that PaD:

- Allowed the individual to observe and compare healing over time, providing them with reassurance/confidence to care for their wound (56%)
- Acted as a prompt to seek medical review and provided an aftercare/reference point for the GP or community nurse (29%)
- Enabled the individual to care for his or her own wound with confidence.

Eight patients did not feel the scheme was useful. Many commented that they felt their wound healed without any problems, however, could see the benefit of PaD for other patients.

Having learnt from increasing patient numbers, it was predicted that errors would be reduced if an electronic PaD system was developed to automate the forms. With support from the medical director, an electronic system was created using Dendrite's software. The Intellect WEB system enables local clinical teams to design and customise databases and the facility to automate clinical documents. Eight iterative cycles were used to develop and refine the data fields and design, two of which had unexpected outcomes: printers could not be connected to a wireless device (iPad), and multifunctional colour printers were not always available within 100 m of computers on the wards.

Despite some printing issues, once the PaD data registry was established with automated forms and uploaded to electronic patient records, a ward staff training programme was implemented at hospital site 1. Patients were considered suitable for PaD if discharge was ≤20 days post surgery to home or another hospital facility. In addition to surveillance nurses, staff nurses were trained as the PDSA cycles identified that a significant number of patients were discharged outside of core surveillance hours. There was a sharp increase in cardiac surgical patients receiving PaD following discharge nurse and ward staff training. A target of

Box 1. Examples of patient feedback

"I had a possible wound infection and the GP practice nurse found it very useful to compare."
"District nurse thought it was wonderful — never seen it before."
"It was useful as I could show my GP."
"Helpful as it meant I knew the wound was healthy leaving hospital and I was keen to keep it that way. The process encourages a healthy approach to life after leaving Harefield."
"The photo, information and instructions were great supportive assistance… It gave a sense of security and eliminated worry while recovering."
"It gives a clear knowledge of what I am supposed to do after the surgery and how to care for my wound."
"Anything that keeps a check on infections has to be good…"
"Provided information on […] appearance which was not entirely evident from my perspective."
"Highly recommended!"
"Great idea, please keep it up as I found it most helpful."

Table 1. Culture-positive sternal wound swabs checked

Measure	Snapshot start	Snapshot end	Team responsible	Number of culture positive sternal swabs [outpatient status at review]	Number of patients requiring new therapy or change of therapy required within 5 days of discharge
Micro results at discharge	01/08/2014	31/0/2015	Pharmacists	11	*2
	19/06/2015	03/07/2015	Advanced nurse practitioners	11	0

Table 2. Details of culture-positive cases identified

PaD	Yes	No
Sex	Female	Female
Age	71	34
SWS result date	08/08/2014	06/09/2014
Micro	*Staph. aureus*	*Staph. aureus*
WCC on discharge	7.7	10.7
CRP on discharge	44	62
Diabetic/steriods/ double IMAs	n/a	n/a
WBC at 6 weks	6.9	7.3
Days from discharge	3	4
Therapy	New	New
If change in therapy, what was this to	New diagnosis	New diagnosis
Action taken	Flucloxacillin prescribed	Flucloxacillin started
Number of days	4	1
Treatment discussed with	Pharmacist	Pharmacist
Patient contacted by	CNS	CNS
Antibiotic recommended	Flucloxacillin prescribed	Flucloxacillin started
Antibiotic issued by	GP	Hospital
Seen	Yes	Yes
Readmitted to hospital	No	No

all cardiac surgical patients was set in October 2015 (to be achieved by March 2016). Staff engagement was essential to achieving the target. A small test of change via an online snapshot for staff nurse feedback indicated that most strongly agreed that 'PaD is easy to incorporate into the nurse discharge process' and all strongly agreed that 'PaD was a useful initiative for their patients and carers'. A PaD training manual was developed and tested by studying staff nurses using the manual, and acting on staff suggestions to improve clarity or meaning. The final version was uploaded to the RBHT intranet. Expanding the group able to provide PaD quickly improved compliance, as surveillance nurses were only available 8 hours a day, Monday to Friday, with no cover during periods of annual leave. Interestingly, the increase in PaD use was largely due to the discharge team involvement as despite also working Monday to Friday, they had a later finish time than surveillance nurses.

At hospital site 2, PaD was introduced in 2014 via a Brompton and Harefield Infection Score (BHIS) (Rajaet al, 2015) intervention package. A few high-risk patients received PaD and in July 2015, the scheme was up-scaled. The outcome was 70% of cardiac surgical patients received PaD on weekdays. SSI readmission rates and patient satisfaction were again used to assess the scheme. Site 2 initially trialled PaD with 12 patients and sought feedback as to whether they found the scheme 'very useful', 'useful' or 'not useful': nine patients found the initiative 'very useful' and three found it 'useful'.

Outpatients' microbiology results were checked by the multidisciplinary team to determine whether PaD had improved action on the results of sternal wound swabs taken at discharge. Checks over 8 months show no difference in therapy

"Based on patient feedback and findings, the authors recommend Photo at Discharge (PaD) as a standard approach."

requirement between the intervention group (PaD) and non-intervention group (*Table 1*). Only two patients required a change in antibiotics based on sternal swab culture taken on the day of discharge (one received PaD and one did not), see *Table 2*.

The plan was to train staff at site 2 using the same approach as site 1; however, during the study cycle the only team member able to undertake PaD training was the surveillance nurse. Other staff did not have the time/resources to produce a PaD, so a smart device with wireless connectivity was set up to address the issue. Unfortunately, the device was not compatible with the RBHT's multipurpose printers and so the training plan was abandoned.

RESULTS

Observational audit data on 3,259 (cardiac, non-transplant) procedures over a 21-month period (May 2014 to February 2016) on SSI and PaD use were collected. A total of 39 patients developed incisional SSI that was detected on readmission. From January 2015, there was a downward trend in SSI rate. In October 2015, compliance with the scheme increased (i.e. the majority of patients received PaD). PaD was associated with four times lower readmission rates for SSI (Fisher's test, two-tailed p-value 0.0344) (*Table 3*). At RBHT, the average cost of readmission for the management of a deep incisional SSI was £15,538 (12 cases between January 2012 and March 2014 costing £2,542–£33,737 each), so there are potential savings associated with the scheme.

Iterative cycles of PDSA were used to develop the PaD form and content, IT database and training manual. Training needs identified included: associated clinical governance, privacy and dignity, the consent process and photo quality. At hospital site 2 it was not possible to train other staff members in PaD, and the team agreed better stakeholder engagement would have made a difference. Despite this setback, RBHT benefits from an engaged multidisciplinary approach to reducing SSI, has an active Surgical Site Surveillance Team with clinical informatics skills and a positive approach to the implementation of quality improvement projects.

Table 3. Readmission for surgical site infection in patients with and without PaD

	No PaD	PaD	Total
Total cardiac patients	2669	590	3259
Readmission incisional SSI	37	2	39
Incisional SSI rate	1.39	0.34	

DISCUSSION

PaD is a low-cost intervention (a colour print out costs 7 p), but requires coordination/resources and staff buy-in, particularly during the roll-out phase. The authors strongly recommend that PaD forms are generated from an electronic database such as Dendrite system as other approaches, e.g. manual cut-and-paste in Word documents, are time consuming and carry a high risk of error and loss of image fidelity. If a continuous programme is not feasible, PaD could be used:

- If there is an incidence of SSI above Public Health England benchmarks
- Following changes in practice (e.g. a new wound closure material or dressing management)
- As a validation exercise for a surveillance programme.

Based on patient feedback and findings, the authors recommend PaD as a standard approach. This recommendation builds on studies demonstrating the need for appropriate discharge planning (Pieper et al, 2007; Pompeo et al, 2007; Zeng-Treitler et al, 2008; Lees, 2013; Goodman, 2016). The majority of patients found the scheme 'very useful', with most feeling PaD increases their ability to care for their wound confidently. Approximately 30% of patients indicated that they had used the photo to seek medical review of the wound. It is interesting to note that few patients (two) required a change in antibiotic based on the wound swab taken at discharge; this number was much lower than predicted.

In addition to PaD, patients deemed at high risk of SSI using the BHIS for coronary artery bypass graft surgery were given antimicrobial wash and/or wipe products to use at home. As applicable, female patients were given an extra bra and/or gauze, with instructions to change regularly to prevent moisture build up under the bust. Surgical teams at site 2, where the BHIS intervention

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package was developed to target patients at the highest risk of infection, included PaD as part of an overall strategy. There was a successful reduction in SSI in this patient group; however the package was not applied to non-coronary artery bypass graft patients (i.e. valve only patients).

Significant RBHT support at site 1 enabled the PaD project to be scaled up. Medical director support, quick electronic system turn around, Matron/senior sister support for staff nurse training and mentoring with key stakeholders resulted in a successful PDSA approach. Site 1 is successfully embedding PaD as part of the standard discharge process. At hospital site 2, PaD was introduced via the BHIS improvement project, but a failure to study the resource requirement or identify senior nurse resistance to roll out resulted in the project.Currently there is no further dissemination planned at site 2 but PaD is still applied as part of the BHIS intervention package. Strong Heart Division support for the initiative will likely direct further work, with greater attention to learning from the later stages in the PDSA cycles.

CONCLUSION

SSIs are linked with significant clinical and economic burden. RBHT analysis identified that wound assessment at the point of discharge is important for quality improvement. PaD demonstrates the benefit of digital photography in multidisciplinary care and electronic patient records. The surveillance nurses are now applying lessons learnt in PaD to develop a similar approach to in-hospital wound documentation. The PaD scheme demonstrates reduced risk of readmission for incisional SSI and is strongly supported by patient feedback. PaD is fit for purpose and the quality improvement methodology was successfully applied to infection prevention processes at one hospital site, with important learning on outcomes at a second site. WUK

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"Surgical site infections are linked with significant clinical and economic burden."