

## Risks for Surgical Site Infection after Infra-inguinal Bypass

N. AlMushcab<sup>1</sup>, R. Connolly<sup>2</sup>, P. Naughton<sup>3</sup>, D. Moneley<sup>3</sup>, S. McHugh<sup>3</sup>, F. Fitzpatrick<sup>1,4</sup>

1. School of Medicine, Royal College of Surgeons in Ireland, Dublin, Ireland

2. Department of Clinical Microbiology, Royal College of Surgeons in Ireland, Dublin, Ireland

3. Department of Vascular Surgery, Beaumont Hospital, Dublin, Ireland

4. Department of Microbiology, Beaumont Hospital, Dublin, Ireland

### Abstract

#### *Aims*

To define the burden of wound complications in patients with infra-inguinal bypass surgery.

#### *Methods*

A retrospective review of 50 consecutive patients from January 2012 to July 2017. Data collected included patient demographics, operative details, length of stay (LOS) and postoperative complications.

#### *Results*

The average age was 64 years (range 25-88 years) and 10 had a body mass index (BMI)  $\geq 25$  kg/m<sup>2</sup>. Pre-operative methicillin-resistant *Staphylococcus aureus* (MRSA) screening was performed in 17 patients (n=4 positive). Surgical antimicrobial prophylaxis (SAP) continued longer than 24 hours in 25. Surgical site infection (SSI) was the most common complication (n=10) and associated with female gender (p= 0.039), high BMI (p=0.017), shorter preoperative (p=0.039) and longer postoperative LOS (p=0.022). Three of 46 patients and four of 38 had graft occlusion at 30 days and one year respectively.

#### *Conclusion*

Pre-operative co-morbidity (e.g., BMI reduction), and MRSA screening optimization and SAP are areas identified for improvement.

**Keywords:** vascular surgery, infra-inguinal bypass, risk factors, wound complications, surgical site infection

### Introduction

Surgical site infections (SSIs) are among the most common hospital-acquired infections.<sup>1</sup> SSI are potentially preventable with implementation of preventative strategies reported to reduce SSI by up to 50%.<sup>2</sup> Lower limb vascular bypass surgery improves arterial circulation for patients with limb ischemia. Patients with peripheral vascular disease requiring bypass surgery frequently have co-morbidities and risk factors that make them more likely to develop post-operative complications and require subsequent medical or surgical intervention and hospital readmission.<sup>3</sup> Postoperative complications such as SSI result in significant patient morbidity (e.g., graft failure, limb loss) in addition to increased economic costs (e.g., increased length of stay (LOS), hospital readmission).<sup>4</sup> Previously, SSI rates of up to 30% have been reported in these patients.<sup>5</sup> A variety of patient risk factors for SSI have been described including gender,<sup>6</sup> older age,<sup>7</sup> high body mass index (BMI),<sup>8</sup> and diabetes.<sup>9</sup> In one report, of the 10.6% patients with SSI after

lower limb bypass surgery, patients with renal failure requiring dialysis, hypertension and a high body mass index (BMI)  $\geq 25 \text{ kg/m}^2$  were at increased risk of SSI.<sup>4</sup> SSI was associated with an increased risk of amputation and surgical reoperation, but did not impact the 30-day mortality

We retrospectively reviewed 50 consecutive adult patients who had infra-inguinal bypass surgery from January 2012 to July 2017. We aimed to define the burden of wound complications in our patients and identify potentially modifiable risk factors, to inform wound complication prevention quality improvement programmes.

## Methods

Beaumont Hospital, Dublin, is an 820-bed tertiary referral center in the Republic of Ireland with a number of regional and national specialties. A retrospective audit of 50 consecutive patients undergoing infra-inguinal bypass surgery over the five-year period from 27 January 2012 to 26 July 2017 was performed. The audit was approved by the hospital clinical governance committee (audit no. CA262). Audit data was collected from medical records and laboratory and radiology information systems and analyzed using an Excel® database (Microsoft Corp., Redmond, WA, USA).

The following pre-operative data was collected for each patient; demographics, co-morbidities, smoking status, BMI, anticoagulants or antiplatelet use, ankle brachial index (ABI), haemoglobin, limb status at pre-operative assessment clinic and methicillin-resistant *Staphylococcus aureus* (MRSA) status. Information was also collected on mode of admission, operative procedure and graft type, surgical antimicrobial prophylaxis (SAP), LOS and post-operative complications including seroma, lymph leak, haematoma, graft occlusion and SSI. Standardized SSI definitions were employed to categorize SSI.<sup>10</sup> Hospital SAP guidelines changed over the study period and recommended SAP for no longer than 24 hours with either co-amoxiclav or cefuroxime/metronidazole with the addition of teicoplanin if the patients was MRSA colonized or had a previous history of MRSA colonization.

Statistical analysis was performed using SPSS statistical software. Paired *t* tests, two-tailed and independent samples *t*-test as well as chi-squared tests were performed as appropriate, with *p* < 0.05 considered significant.

## Results

Of the 50 patients, the average age was 64.38 years (range 25-88 years) and 38 were male. A minority (n=7) were non-smokers. The majority (n=43) had a history of ischemic heart disease, 14 had diabetes, eight renal disease, three a previous cerebrovascular accident and ten a BMI  $\geq 25 \text{ kg/m}^2$ . Most received antiplatelet therapy, anticoagulant therapy or both pre-operatively (n=14, n=9 and n=20 respectively).

Two thirds of patients (n=33) were not screened for MRSA pre-operatively, four of 17 screened pre-operatively were MRSA positive and three who had previously screened negative became MRSA colonized post-operatively. Pre-operative limb status included short-distance claudication (n=15), critical limb ischemia (n=14) and tissue loss (n=16); details were not available for the remaining five patients. There was no significant difference in pre-operative MRSA screening between these patient categories. The majority of patients were admitted electively for surgery (n=38). The mean pre-operative LOS was 4.9 days (range 0-7 days), 5.1 days (range 0-14 days) and 5.2 days (range 1-21 days) for patients with short-distance claudication, critical limb ischemia and tissue loss respectively.

Sixteen patients had above-knee and 34 below-knee femoropopliteal bypasses with synthetic grafts implanted in 27 patients. All patients received SAP within 60 minutes of skin incision. Twenty-two patients received single-dose SAP, while SAP extended beyond 24 hours in 25 patients. Co-amoxiclav was the most commonly prescribed antimicrobial (n=19), either alone (n=17) or in combination with a glycopeptide (n=2), followed by cefuroxime (n=15), which was prescribed alone (n=5), in combination with metronidazole (n=4), with metronidazole and a glycopeptide (n=4) or with co-amoxiclav or flucloxacillin (n=1 each). A glycopeptide alone was prescribed in eleven patients. The remainder received various other combinations of antimicrobials which included piptazobactam (n=2) and levofloxacin, ciprofloxacin and clindamycin (n=1 each).

Pre-operative limb status did not impact on post-operative LOS; 14.3 days (range 3-19 days), 14.7 days (range 6-40 days), 15 days (range 6-58 days) for patients with short-distance claudication, critical limb ischemia and tissue loss respectively.

SSI was the most common post-operative complication (n=10, nine superficial incision and one deep incisional SSI), followed by hematoma (n=6), seroma (n=5), and lymph leak (n=2). At one-year follow-up review, four patients had

graft occlusion. (Table 1) Of the patients with SSI, six had critical limb ischemia, two claudication and two had tissue loss pre-operatively. Wound microbiology was predominantly polymicrobial (n=6 patients) and included Enterobacteriaceae (n= 12 swabs), *Pseudomonas aeruginosa* (n=2 swabs) and *Enterococcus faecium* (n=4 swabs, including two vancomycin-resistant isolates). Three of 46 patients for whom data was available had graft occlusion at 30 days (of whom none had SSI). Four of 38 had graft occlusion at one year (of whom one had SSI). Table 1 summarizes factors associated with SSI which included female gender (p= 0.039), BMI>25 kg/m<sup>3</sup> (p=0.017), shorter preoperative (p=0.039) and longer postoperative LOS (p=0.022).

**Table 1: Factors associated with surgical site infection (SSI) in 50 consecutive patients with infra-inguinal bypass surgery from 27 January 2012 to 26 July 2017**

	SSI (n=10)	No SSI (n=40)	P value (bold indicates statistical significance)
Age > 65 years	4	25	0.453
Gender: female	5	7	<b>0.039</b>
BMI* >25	3	7	<b>0.017</b>
Diabetes	5	9	0.115
<b>Mode of admission</b>			0.710
- Elective <sup>†</sup>	8	30	
- Non-elective admission	2	10	
<b>Pre-operative limb status</b>			
Short distance claudication	1	14	0.362
Critical limb ischaemia	5	9	0.115
Tissue loss	3	13	0.167
<b>Operative factors</b>			
Intra-operative blood transfusion	4	12	0.229
Operation duration >3 hours	5	15	0.639
SAP <sup>‡</sup> >24 hours	4	18	0.197
<b>Femoropopliteal bypass type</b>			0.700
- Above knee	6	10	
- Below knee	4	30	
<b>Graft type</b>			0.610
- Venous	5	17	
- Synthetic	5	22	
- Unknown	0	1	
<b>SSI</b>			
- Superficial incisional	9	0	
- Deep incisional	1	0	
- Organ space	0	0	
<b>Length of stay – days (d)</b>			
- Overall: mean 18.75 (range 4-70 d)	22.5 (7-70 d)	19.48 (4-59 d)	<b>0.001</b>
- Pre-operative: mean 4.9 (range 0-20d)	3.1 (0-16 d)	5.2 (0-21 d)	<b>0.039</b>
- Post-operative: mean 14.4 (range 4-58d)	28.9 (7-54d)	14.5 (3-58 d)	<b>0.022</b>
<b>Graft occlusion at follow up review</b>			
- at 30 d (3/46 grafts occluded)	0	3	0.431
- at 1 year (4/38 grafts occluded)	1	3	0.732

## Discussion

In a five-year retrospective study of 50 consecutive patients undergoing infra-inguinal bypass surgery, SSI was the most common complication and was associated with female gender, BMI and LOS. The association between female gender and SSI has been previously described.<sup>5,11</sup> One large study which included 27,703 patients with infra-inguinal bypass surgery reported that females were more likely to acquire an SSI post discharge than males.<sup>8</sup> This may be because gender influences cellular immunity after surgical stress.<sup>12</sup> However, we also identified potentially modifiable areas

for improvement, which included pre-operative BMI reduction, pre-operative MRSA screening and standardization of SAP choice and duration.

The association between a high BMI and SSI in vascular surgery has been noted by other authors,<sup>4</sup> yet effective methods to reduce BMI pre-operatively remain elusive and behavioural interventions have had limited success to date.<sup>13</sup> Implementation of BMI reduction strategies in our patient cohort could be achieved either by an interdisciplinary team at the pre-operative assessment stage or with the patient's primary care provider as part of ongoing management. This requires further evaluation in our patient cohort as part of an SSI reduction strategy as interventions to reduce BMI would not only reduce post-operative complications but also limit other complications in this high-risk group.

Patients with SSI have a longer duration of hospital stay,<sup>14</sup> and extended LOS is associated with an increased risk of hospital-acquired infection.<sup>15</sup> Interestingly, patients without SSI had a longer pre-operative LOS, which may suggest improved SSI risk factor management, however greater patient numbers would be required to confirm this as it may alternatively reflect the larger pool of patients in the non-SSI group. Pre-operative LOS is likely influenced by patient factors (e.g., management of co-morbidities) and hospital processes (e.g., theatre slot and/or critical care bed availability). A significant proportion of patients in our cohort were over 65 years, with comorbidities that may have presented challenges for pre-operative optimisation outside the hospital setting. Yet, with the majority electively admitted, there is an opportunity to identify patient subgroups suitable for outpatient pre-operative evaluation and co-morbidity optimisation. This strategy has been previously associated with decreased pre-operative LOS and cost savings without increased mortality.<sup>16</sup> Quality improvement methodology could be employed to safely re-evaluate the patient pathway and referral process as part of our SSI prevention program.<sup>17</sup>

Although pre-operative MRSA colonization is a well-described SSI risk factor and pre-operative MRSA decolonization reduces SSI,<sup>18</sup> the majority of our patients were not screened pre-operatively which most likely reflects resource limitations of the current pre-operative assessment process. Establishment of a pre-operative MRSA screening programme needs to be closely linked with a pre-operative MRSA decolonization programme, and requires evaluation of laboratory and personnel resources to support this process, consideration of decolonisation and patient communication pathways and close communication with hospital patient-flow departments to ensure correct patient placement of colonised patients.

While all patients received appropriately timed SAP, a range of regimens was employed which may partly be due to the change in hospital SAP guidelines over the study period. The relatively high number of glycopeptides prescribed most likely reflects the absence of a systematic pre-operative MRSA screening programme and an attempt to cover MRSA in patients receiving vascular grafts where their MRSA status is unknown. However, over half of SAP prescriptions continued for longer than the recommended 24 hours. Extended SAP duration increases the risks of adverse effects (e.g., *Clostridium difficile* infection) and the emergence of antimicrobial resistance.<sup>19</sup> A focus on SAP duration is therefore warranted to prevent any unintended consequences of inappropriately extended SAP regimens. We have previously optimised SAP in orthopaedic surgery using an interdisciplinary improvement approach.<sup>20</sup> and are currently attempting to standardize SAP regimens in our vascular population with a similar programme.

Limitations of this study include the retrospective nature of the study and the size of our patient cohort. Because of the retrospective design, causality between LOS and infection cannot be inferred. While prospective audit would have been preferred, this would have taken significant time to reach a similar number of patients in our patient cohort. Hence, the retrospective design to provide timely baseline information to identify future priorities. Larger numbers would be required to demonstrate associations between patient and/or healthcare processes and other complications such as seromas, hematomas and lymph leaks. However, we have identified a number of potentially modifiable areas for improvement to target in our SSI prevention program.

In summary, pre-operative assessment with a focus on BMI reduction and co-morbidity optimization, coupled with a standardized approach to MRSA screening and SAP, could result in significant improvements in patient outcomes and minimize SSI risk.

**Acknowledgements:**

The authors wish to thank Dawn Shoebridge and the staff in medical records for assistance with accessing medical records.

**Financial Support:**

Nadeen AlMushcab was supported by The Royal College of Surgeons in Ireland, Research Summer School.

**Conflicts of Interest Statement:**

The authors have no conflicts of interest to declare.

**Corresponding Author:**

Nadeen AlMushcab,  
School of Medicine,  
Royal College of Surgeons in Ireland,  
123 York street,  
Dublin 2,  
Ireland  
Tel: +353 877903293  
Email: [nadeenalmushcab@rcsi.ie](mailto:nadeenalmushcab@rcsi.ie)

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