Wolters Kluwer

Medknow

Journal of Patient Safety & Infection Control

Official Journal of **Hospital Infection Society–India**

Volume 7 | Issue 1 | January-April 2019

ISSN 2214-207X

Available online at www.jpsiconline.com

Targeted infection control practices lower the incidence of surgical site infections following total hip and knee arthroplasty in an Indian tertiary hospital

Guda Vaishnavi, A V Gurava Reddy[1], Dinaker Manjunath[1], Ganesh Oruganti[1], Ramesh Reddy Allam[1,2]

GYD Diagnostics and Clinics, [1]Department of Infection Control, Sunshine Hospitals, Hyderabad, [2]Department of Health Research, SHARE INDIA, Medchal, Telangana, India

Abstract

Introduction: Deep surgical site infection (SSI) following total knee arthroplasty (TKA) or total hip arthroplasty (THA) is a devastating complication that occurs in approximately 2% of surgical procedures and accounts for 20% of healthcare-associated infections. Despite improvements in prevention, SSI remains a significant clinical problem. Prevention bundles are central to prevent SSI.

Methods: SSIs following TKA/THA are defined by centres for disease control and prevention (CDC) as infections occurring within 1 year post-surgery. Targeted surveillance using prevention bundles for SSIs was instituted among cohort of patients with primary hip and knee arthroplasties from January 2014 to September 2016. Secondary data analysis of the follow-up was done during the physiotherapy appointment and surgical site review visits by the infection control professionals. Infection control team instituted policies and capacity building of known risk factors, such as admitting patients only on day of surgery, pre-operative chlorhexidine bath, hair clipping, timing of antibiotic prophylaxis, glycaemic control, use of High-efficiency particulate air (HEPA) filters and reducing operation theatre traffic. We calculated the incidence, trend and post-operative follow-up of SSIs after universal implementation of bundles.

Results: Among 9666 patients with TKA or THA over 4 years, 8967 were successfully followed up for 1 year. Of the 8967 arthroplasties, 49 cases had SSIs (0.52%). TKA and THA contributed to 89% (42 of 47) and 11% (5 of 47) of the SSIs, respectively. The characteristics of SSIs were 83%, 15% and 2% superficial, deep and organ, respectively. Over the 4 years, the combined SSIs of TKA and THA decreased from 0.79% to 0.34% and the proportion of lost to follow-up decreased from 11.09% to 3.72%. Cases of SSI had co-morbidities such as hypertension, diabetes and others.

Conclusion: Targeted surveillance with adherence to infection control practices significantly reduces the incidence of SSI. Stringent documentation and follow-up of the patients post-surgery will ensure that the SSIs are monitored and attended to.

Keywords: Arthroplasty, infection control, lost to follow-up, surgical site infection, surveillance

Address for correspondence: Dr. Ramesh Reddy Allam, Deputy Director, SHARE INDIA, MIMS Campus, Ghanpur Village Medchal, Telangana, India.
E-mail: rame05allam@gmail.com

INTRODUCTION

Surgical site infection (SSI) is an infection of the incision or organ or space that occurs after surgery.[1] The prevention of SSI is increasingly important as the number of surgical procedures performed continues to rise.[2,3] SSI is an

Access this article online	
Quick Response Code:	Website: www.jpsiconline.com
	DOI: 10.4103/jpsic.jpsic_6_19

How to cite this article: Vaishnavi G, Gurava Reddy AV, Manjunath D, Oruganti G, Allam RR. Targeted infection control practices lower the incidence of surgical site infections following total hip and knee arthroplasty in an Indian tertiary hospital. J Patient Saf Infect Control 2019;7:20-4.

important cause of morbidity and mortality in surgical patients.[4] The overall crude incidence is about 2%–5% of all surgical procedures and accounts for approximately 20% of healthcare-associated infections.[5,6]

Total knee and total hip arthroplasties (TKA and THA) are two common surgeries that reduce pain and improve function and quality of life in patients with knee and hip disorders.[7] By 2030, it is projected that orthopaedic surgeons will perform more than 571,000 primary THAs and 3.48 million TKAs in the US alone.[8] From 2006 to 2026, the number of joint arthroplasties are expected to double. If the current infection rates are not decreased, the infection rate will proportionately double as well. It is estimated that 1%–2% of hip implants and 2%–4% of knee implants become infected.[9]

SSIs lead to a large number of post-operative complications and morbidities due to extended hospital stays, additional surgeries and permanent loss of the implant with shortening of the affected limb, deformities, amputation and death. This in turn costs patients both physically and financially. SSI, a potentially devastating complication of lower extremity total joint arthroplasty, is estimated to occur in 1%–2.5% of cases annually.[10] In addition, delayed wound healing may increase the risk for secondary infection.[11] Patients with an SSI have a 2–11 times higher risk of death compared with operative patients without an SSI.[12,13] Hence, the prevention of SSI becomes particularly important in elective clean surgeries such as TKA and THA.

Table 1: Components of SSI prevention bundle

Stage of surgery	Components of bundle
Pre-operative measures	Admission to hospital on day of surgery Pre-operative chlorhexidine (CHG) bath Optimization of glycaemic control
Intraoperative measures	Cutaneous preparation universal use of chlorhexidine (CHG) - alcohol (2% CHG and 70% isopropyl alcohol) based, for surgical site preparation (povidone-iodine skin preparation was completely stopped during the period of targeted surveillance) Hair clipping of surgical site with battery operated trimmer and shaving was stopped. Timing of antibiotic prophylaxis: 30-45 min. Injection with ceftriaxone+sulbactam based on optimal $t_{½}$ and protein binding, and hospital antimicrobial susceptibility pattern and HICC recommendation considering high prevalence of ESBL strains. No more than 2 doses were given Controlled staff traffic volume Use of HEPA filters
Post-operative measures	Antibiotic prophylaxis stoppage after 1 dose Early mobilisation and discharge Post-surgical follow-up counselling

HICC: Hospital infection control committee, ESBL: Extended-spectrum beta-lactamase, CHG: Chlorhexidine gluconate, HEPA: High-efficiency particulate air

CDC definition of SSI with regard to TKA and THA considers one of the following criteria: purulence of synovial fluid or growth of the same microorganism in two or more deep samples or acute inflammation in histopathological examination or presence of a sinus tract communicating with the prosthesis over a period of 1 year post-surgery. The time period of such an infection is up to 1 year after surgery.[14]

It has been estimated that approximately half of SSIs are preventable by the application of evidence-based strategies. Good patient preparation, meticulous aseptic practice, attention to surgical technique and timing of antimicrobial prophylaxis are the keys to prevent SSI.

The objective of the study was to demonstrate reduction in the incidence of SSIs following TKA and THA (unilateral and bilateral) surgeries by universal implementation of the 'prevention bundles' in a tertiary hospital.

METHODS

Study setting

Sunshine Hospital is a multi-speciality 500+-bedded hospital and is globally promoted for joint replacements. The number of surgeries vary from 30 to 50 per day. The hospital is accredited by the National Board for Accreditation of Hospitals (NABH).

Study design, population and inclusion criteria

Secondary data analysis was done on all patients who had either a TKA and/or THA arthroplasty between 1 January 2013 and 30 September 2016 at the Sunshine Hospitals Hyderabad, Telangana State, India, were included in the analysis. The cohort was followed up until 1 year after surgery. SSIs were diagnosed based on the clinical (with signs of inflammation as confirmed by a physician) or microbiological evidence from culture. Patients who had repeat surgery or debridement during the same period were excluded.

Intervention design

The SSIs recorded before January 2014 were considered as baseline during which the prevention bundles were not implemented fully. A structured SSI prevention bundles intervention package was introduced to reduce SSIs during 2014–2016. Th SSIs recorded during 2014-2016 were considered as end line results.

Intervention

Before January 2014, the hospital did not have a structured SSI prevention plan. In 2014, the Hospital Infection Control

Committee (HICC) organised the implementation strategy to prevent SSIs under four known concepts: engage, educate, execute and evaluate.[15] The HICC provided a clear and effective communication pertaining to the reasons why the SSI implementation strategies are important for patient care to the hospital staff and management and obtained support for SSI reduction from senior leadership. Several one-to-one and group education sessions were conducted. Continuing education programmes and capacity building through demonstrations and case-based learning were conducted across various categories of healthcare workers, which included consultants, resident doctors, nurses, house-keeping staff and operation theatre support staff of the hospital.

Targeted surveillance for the prevention of SSIs among TKA and THA patients was implemented from January 2014. The targeted surveillance for the prevention of SSI included the implementation of bundles [Table 1].

Diagnosis of surgical site infections and follow-up

The diagnosis of SSI was made based on the CDC recommendation. Patient case records, temperature logs and microbiology culture reports were reviewed for documented evidence of the SSI. Follow-up was done on week 2, 4, 12, 36 and 52 Post surgery. Telephonic reminders were sent to patients who missed appointments for follow-up.

Data collection

Infection control nurse was part of the HICC. The infection control nurse was responsible for training the other nurses in the hospital on the implementation of prevention bundles. The HICC developed a checklist to capture the findings of the infection prevention targeting THA and TKA. The formats were digitised every week. The checklist consisted of demographic data, operative notes, indwelling drains and catheters, antibiotics administration and any cultures. Follow-up data were collected at the physiotherapy, dressing and post-operative outpatient departments during the follow-up visit. The physiotherapists were all equally trained to inspect the surgical site, as per the SSI follow-up checklist. Data quality checks were performed by reviewing the source registers and case sheets.

Data analysis

The incidence was calculated using the number of SSI as numerator and duration of follow-up (in years) as denominator. Incidence rates before 2013 and after 2013 were compared to observe the effect of implementing prevention bundles. To assess whether there is significant decrease in incidence post-intervention, a z-test was used. Values were considered statistically significant if $P < 0.005$. We used SPSS v. 16 (SPSS Inc., Chicago, IL, USA) for data analysis.

Human subject protection

Approval for the study was obtained from the Sunshine Hospitals, Ethics Committee (SS/2018/IEC272).

RESULTS

During the period 1st January 2013 to 30th September 2016, 9666 patients underwent arthroplasty. More than 80% of the patients were over 50 years of age. About 55% of the patients were females. Of the total 9666 arthroplasty surgeries, 97.58% (9432 of 9666) of them were TKA while the remaining were THA, 5.52% (534 of 9666). The cohort was followed up for 1 year where 8967 were successfully followed. The overall lost to follow-up rate was 7.49% (724 of 9666). The incidence of SSI was 0.52% (49 of 8967). TKA and THA contributed to 89% (42 of 47) and 11% (5 of 47) of SSIs, respectively. Superficial, deep and organ SSIs were 83%, 15% and 2%, respectively [Table 2].

The incidence of SSIs was 0.79% in 2013 and after the intervention was 0.58%, 0.39% and 0.34% from 2014 to 2016, respectively. The reduction in SSI rates after the intervention was statistically significant (Z-value = 8.84, $P < 0.0001$). The calculated lost to follow-up rates were 11.09% in 2013 to 3.72% in 2016. The incidence of SSI decreased from 0.79% in the pre-implementation phase (2013) to 0.39% in the implementation phase [Figure 1]. Of the 47 infected cases, specimens from 32 patients were sent for culture. Of the 32 specimens, 20 had bacterial growth and predominantly showed growth of methicilllin sensitive satphylococcus aureus (MSSA) (9) [Table 3]. Cases of SSI had co-morbidities such as hypertension, diabetes and others.

Post hoc sample size adequacy assessment

A *post hoc* sample size calculation was done with the results available from our study. To detect a 50% reduction in

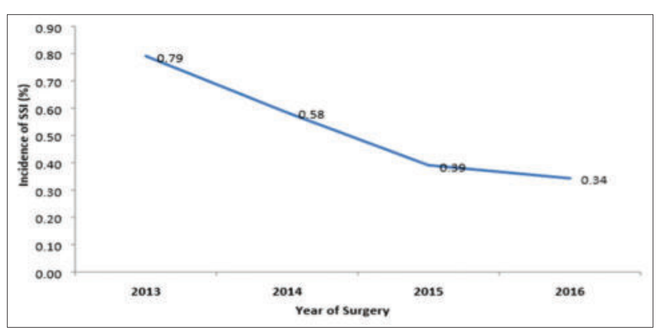

Figure 1: Incidence of surgical site infections after total knee arthroplasties and total hip arthroplasties during 2013–2016

Table 2: Incidence of surgical site infections

Variables	2013	2014	2015	2016	Total	%
Age group (years)						
≤20	8	2	4	1	15	0.16
21-30	18	18	13	15	64	0.66
31-50	220	190	210	228	848	8.77
>50	2314	2031	2216	2178	8739	90.41
Gender						
Female	1762	1521	1624	1631	6538	67.64
Male	798	720	819	791	3128	32.36
Conducted						
Number of TKAs	2413	2137	2318	2280	9432	97.58
Number of THAs	147	104	125	142	534	5.52
Total replacements	2560	2241	2443	2422	9666	
Patient follow-up						
# of LFUs	284	185	140	90	724	7.49
# of patients followed-up	2276	2056	2303	2332	8967	
Incidence of SSI						
# new infected cases-TKA	17	7	11	7	42	89.36
# new infected cases-THA	1	2	1	1	5	10.64
Total new infected cases	18	9	12	8	47	0.54
Characteristics of SSI-TKA						
Superficial	15	4	10	6	35	83.33
Deep	1	3	1	1	6	14.29
Organ/space	1	0	0	0	1	2.38
Characteristics of SSI-THA						
Superficial	1	1	1	1	4	80
Deep	0	1	0	0	1	20
Organ/space	0	0	0	0	0	0

TKAs: Total knee arthroplasties, THAs: Total hip arthroplasties, SSI: Surgical site infection, LFUs: Lost-to-follow-ups

Table 3: Type of organisms isolated from surgical site infections (*n*=32)

Type of organism	Number of isolates
MSSA	9
MSSA	3
E. coli	1
K. pneumoniae	3
E. coli + MSSA	4
No bacterial growth	12

S. aureus: *Staphylococcus aureus*, *E. coli*: *Escherichia coli*, MSSA: Methicillin-resistant *S. aureus*, *K. pneumoniae*: *Klebsiella pneumoniae*

incidence from the baseline of 0.79%, with 80% power at 5% level of significance and assuming an average dropout rate of 10% over time, a sample size of 7979 patients would be required. This study used a much larger sample of 9666 patients.

DISCUSSION

The incidence of SSI in the present study was <1% (0.79–0.34), which is below the reported worldwide incidence of 2.6%–41.9%.[15] Our study is consistent with SSI which was more common in patients of over 55 years of age.[16] This study clearly demonstrated a significant reduction of SSI in knee and hip arthroplasty patients, after strict implementation of the 'prevention bundles' through targeted surveillance.[17,18] The SSIs from either the TKA or TKA are lower in the baseline too. The lower incidence rates in the baseline could be possibly due to smaller number of trained surgeons operating, and there was an on-going surveillance on hand-washing and environmental measures before the implementation of bundles.

It is however difficult to conclude as to which of the interventions in the prevention bundles were the most effective. Behavioural change pertaining to practise of pre-operative admission to the hospital on the day of surgery and shaving of hair instead of clipping or trimming was a challenging during the implementation process. Timing of antibiotic prophylaxis and cessation of prophylaxis after one dose was followed in true spirit as the senior staff had control over the dosage and prescription.

Additional interventions may have resulted in further reduction in the incidence of SSI; these include minimising the use of peri-operative blood and blood products, prevention of hypothermia by the way of warming blankets, smoking cessation, continued screening and treatment of nasal staphylococcal carriers. Certain additional 'patient-related' factors such as age, nutritional status, obesity, smoking and altered immune response as well as 'operation-related' factors such as duration of surgical scrub, skin anti-sepsis, duration of operation and sterilisation of instruments could also contribute to the SSI.[19] Infected cases in this study had primarily co-morbidities such as hypertension, diabetes and others. The infected cases had longer stay than the un-infected cases. With an aim to decrease the SSIs, the surgeries could be posted when co-morbidities are under-control in all elective cases.

Various studies[11,20,21] have clearly demonstrated that a surveillance system reporting of SSI to surgeons can reduce SSI. The cost reduction due to reduced infections was calculated to exceed the cost of surveillance (which includes organised control activities, adequate number of trained infection control staff and a system for reporting new cases of SSI) after 2 years.[22,23]

Limitation of the study

The follow-up was up to 80% although a near 100% follow-up would have been ideal. Probable reasons for 'lost-to-follow-up' were patients from remote/change of residence and change of contact details. Availability of modern tele-medicine facilities can narrow this gap in future studies.

CONCLUSION

The implementation of prevention bundles to prevent SSI through targeted surveillance is a definite cost-effective intervention, especially for patients undergoing TKA and THA, and clearly reduces the incidence of SSI following TKA and THA. Despite the relatively low SSI incidence following orthopaedic surgery and specifically arthroplasty, preventive methods, specifically those targeting *Staphylococcus aureus*, would serve to minimise costs and improve patient outcomes. The introduction of preventive measures and surveillance coincided with a significant reduction in SSIs following TKA and THA in our institution. Strict evaluation for co-morbidities and surgery after controlled co-morbidities could be a possible solution to decrease SSIs in elective cases.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. National Healthcare Safety Network, Centers for Disease Control and Prevention. Surgical Site Infection (SSI) Event; January, 2017. Available from: http://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf. [Last accessed on 2017 Dec 05].
2. Cullen KA, Hall MJ, Golosinskiy A. Ambulatory surgery in the United States, 2006. Natl Health Stat Report 2009;11:1-25.
3. DeFrances CJ, Podgornik MN. 2004 national hospital discharge survey. Adv Data 2006;(371):1-19.
4. Klevens RM, Edwards JR, Richards CL Jr., Horan TC, Gaynes RP, Pollock DA, *et al.* Estimating health care-associated infections and deaths in U.S. Hospitals, 2002. Public Health Rep 2007;122:160-6.
5. Anderson DJ, Podgorny K, Berríos-Torres SI, Bratzler DW, Dellinger EP, Greene L, *et al*. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol 2014;35 Suppl 2:S66-88.
6. Astagneau P, Rioux C, Golliot F, Brücker G; INCISO Network Study Group. Morbidity and mortality associated with surgical site infections: Results from the 1997-1999 INCISO surveillance. J Hosp Infect 2001;48:267-74.
7. Singh JA. Epidemiology of knee and hip arthroplasty: A systematic review. Open Orthop J 2011;5:80-5.
8. Fiedler E. Primary, Revision THA, TKA Expected to Surge by 2030. Academy News: The Annual Meeting Edition of the AAOS Bulletin; 22-25 March, 2006. Available from: http://www2.aaos.org/aaos/archives/acadnews/2006News/sat/c25_2.htm. [Last accessed on 2018 Feb 13].
9. Knobben BA, van Horn JR, van der Mei HC, Busscher HJ. Evaluation of measures to decrease intra-operative bacterial contamination in orthopaedic implant surgery. J Hosp Infect 2006;62:174-80.
10. Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol 2011;32:101-14.
11. Gottrup F, Melling A, Hollander DA. An overview of surgical site infections: Aetiology, incidence and risk factors. EWMA Journal 2005;5:11-5.
12. Engemann JJ, Carmeli Y, Cosgrove SE, Fowler VG, Bronstein MZ, Trivette SL, *et al.* Adverse clinical and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection. Clin Infect Dis 2003;36:592-8.
13. Kirkland KB, Briggs JP, Trivette SL, Wilkinson WE, Sexton DJ. The impact of surgical-site infections in the 1990s: Attributable mortality, excess length of hospitalization, and extra costs. Infect Control Hosp Epidemiol 1999;20:725-30.
14. Berríos-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, *et al.* Centers for disease control and prevention guideline for the prevention of surgical site infection, 2017. JAMA Surg 2017;152:784-91.
15. Al-Mulhim FA, Baragbah MA, Sadat-Ali M, Alomran AS, Azam MQ. Prevalence of surgical site infection in orthopedic surgery: A 5-year analysis. Int Surg 2014;99:264-8.
16. Kaye KS, Schmit K, Pieper C, Sloane R, Caughlan KF, Sexton DJ, *et al.* The effect of increasing age on the risk of surgical site infection. J Infect Dis 2005;191:1056-62.
17. Skråmm I, Saltytė Benth J, Bukholm G. Decreasing time trend in SSI incidence for orthopaedic procedures: Surveillance matters! J Hosp Infect 2012;82:243-7.
18. Huotari K. Surveillance of Surgical Site Infections Following Major Hip and Knee Surgery in Finland. Publications of the National Public Health Institute. 2007.
19. Peel TN, Dowsey MM, Daffy JR, Stanley PA, Choong PF, Buising KL. Risk factors for prosthetic hip and knee infections according to arthroplasty site. J Hosp Infect 2011;79:129-33.
20. McKibben L, Horan T, Tokars JI, Fowler G, Cardo DM, Pearson ML, *et al.* Guidance on public reporting of healthcare-associated infections: Recommendations of the Healthcare Infection Control Practices Advisory Committee. Am J Infect Control 2005;33:217-26.
21. Haley RW, Culver DH, White JW, Morgan WM, Emori TG, Munn VP, *et al.* The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. Am J Epidemiol 1985;121:182-205.
22. Wilson AP, Hodgson B, Liu M, Plummer D, Taylor I, Roberts J, *et al.* Reduction in wound infection rates by wound surveillance with postdischarge follow-up and feedback. Br J Surg 2006;93:630-8.
23. McCarty DJ, Tull ES, Moy CS, Kwoh CK, LaPorte RE. Ascertainment corrected rates: Applications of capture-recapture methods. Int J Epidemiol 1993;22:559-65.