Risk factors for surgical site infections following clean orthopaedic operations

UOE Ikeanyi, CN Chukwuka, TOG Chukwuanukwu[1]

Departments of Orthopaedic Surgery, Federal Medical Centre, Umuahia, Nnamdi Azikiwe University Teaching Hospital, [1]Plastic Surgery, Nnamdi Azikiwe University/Teaching Hospital, Nnewi, Nigeria

Abstract

Background: Surgical site infections can follow clean orthopaedic operations and can cause serious morbidity, mortality and increased resource utilization. Despite this, there are few studies on risk factors for surgical site infections in the Nigerian orthopaedic literature. We conducted a prospective study to determine the host and environmental risk factors for surgical site infections following clean orthopaedic operations.

Materials and Methods: Consecutive patients who satisfied the inclusion criteria and were to undergo clean orthopaedic operations performed at the National Orthopaedic Hospital, Igbobi, Lagos from January 2007 to July 2008 were included. Patient's biodata, duration of preoperative hospitalization and other risk factors were analyzed. The risk factors for surgical site infection were determined with Chi square test.

Results: The overall rate of surgical site infection during the 18 months of the study was 9.9% (12 of 121). Independent risk factors for this were: Prolonged duration of preoperative hospital stay greater than 13 days (21% infection rate), increasing age greater than 60 years (31% infection rate), and use of implants and drains (only one un-drained wound was infected).

Conclusion and Recommendations: Patient's age, duration of preoperative hospitalization, type of surgery (implant or non-implant), and use of drains were the most significant risk factors affecting surgical site infection. It is recommended that preoperative hospital stay should be as short as possible and extra care/precautions taken when working on the elderly, using implants or requiring drainage.

Key words: Clean orthopaedic operations, risk factors, surgical site infection

Date of Acceptance: 15-Nov-2012

Introduction

Surgical site infection (SSI) may occur after orthopedic surgery.[1] SSI is when pus is present in the wound or there is a non-purulent discharge that yielded growth of pathogenic microorganisms on culture. In implant surgery when device is not exposed, infection is taken as superficial but when the implant is exposed, it is deep infection. The ASEPSIS scoring method has been shown to be very satisfactory for assessing SSIs.[2,3] SSI is among the commonest post-operative complications, usually accounting for 8-23% of post-operative complications. SSI consumes time, medical resources, and adversely affects post-operative morbidity, mortality, and cost.[4-11] In fact, according to Whitehouse *et al.*,[12] SSIs following orthopedic surgery prolonged the total hospital stay by a median of 2 weeks, doubled re-hospitalization rates, increased healthcare costs by 300%, and decreased overall physical and social functioning. There is paucity of data on SSI in Nigeria,[10,11] therefore studies on SSI need to be done in our region. The risk factors for SSI include the host factors such as age, sex, co-morbidities, and the environmental factors.[13-19] Host factors that increase susceptibility to infection provide enabling environment for

Address for correspondence:
Dr. TOG Chukwuanukwu,
Department of Surgery,
Nnamdi Azikiwe University/Teaching Hospital, Nnewi, Nigeria.
E-mail: drtchuks@yahoo.com

Access this article online	
Quick Response Code:	Website: www.njcponline.com
	DOI: 10.4103/1119-3077.116886
	PMID: *******

the pathogen to multiply. The environment includes the wards, theater air, personnel and the various instruments, and drugs like antibiotics. Several factors influence the rate of SSI, the bacterial load present in the wound at the time of operative procedure is probably the most important factor in the development of wound infection.[20,21] This means that intra-operative contamination is a major consideration in SSI. In other words, a study of environmental and host-related factors should help reduce SSI. Clean surgical cases, by definition, have very low bacterial contamination. Inferentially therefore, they should have very low or no cases of SSI.[8] Hence, factors that influence rate of SSI in clean cases are relevant and important factors that should be considered. Any study that unravels these factors could be exploited to positively influence the rate of SSI. This report describes the risk factors for SSI following clean operations performed by orthopedic surgeons over an 18 month period at a tertiary hospital.

Materials and Methods

This prospective cohort study was carried out at the National Orthopaedic Hospital Igbobi, a 500-bed specialist hospital in Lagos, Nigeria. The hospital ethical committee approved the study. The operating theater complex comprised three suites of identical design and conventional ventilation system.[22] All patients undergoing clean surgical procedures with absence of co-morbidities such as diabetes mellitus, anemia, chronic renal failure, sickle cell disease, and any focus of infection were included if they consented. Relevant information obtained included patient's age, gender, duration of pre-operative hospitalization, antibiotics, duration of surgery, implant used, cadre of surgeon, use of wound drains, number of blood units transfused, and number of people present in the theater suite during the surgery. All surgeons wore double hand gloves for all cases. All cases had skin preparation with 4% chlorhexidine solution and 70% methylated spirit. Each patient received an intravenous antibiotic pre-operatively at induction of anesthesia. For non-implant cases, penicillin was used and for others it was either a cephalosporin or a quinolone. All implant cases were drained. All wounds were examined on the 5th and 14th post-operative days and on the day of discharge from the hospital by the same surgeon for uniformity of data collection. Subsequent inspections were done at each visit in outpatient clinics until the end of the 12th post-operative month. Infections were identified using accepted definitions.[2,3] Swabs taken from clinically infected wounds were subjected to microscopy and culture using standard laboratory methods[23] by the microbiology lab of the hospital. Analysis of data was done using Microsoft Excel program enhanced by Megastat statistical package. Measures of statistical location, like mean, were generated. Statistical analysis involved Chi-square test and Fisher Exact test as applicable. Frequency tables and relevant illustrative charts were drawn. *P* values less than 0.05 were considered significant.

Results

During the period of data collection (January 2007 to July 2008), a total of 577 orthopedic patients had surgical operations at National Orthopaedic Hospital, Lagos. Of these, 238 patients (41%) satisfied the inclusion criteria. However, only 121 patients (21%) adhered to the study protocol and were followed up satisfactorily. Out of the 121 clean cases, 72 (59.5%) were implant cases, whereas 49 (40.5%) were non-implant cases. The male:female population ratios for implant and non-implant cases were, respectively, 31:41 and 20:29 (the respective ratios 1:1.3 and 1:1.5). The age range of the study population was 1-90 years with a mean age of 33 ± 21 years. There were 51 (42.1%) males and 70 (57.9%) females with a male:female ratio of 1:1.4. A total of twelve patients had wound infection giving an incidence of 9.9%.

Type of surgery

All infected patients were implant cases. Therefore, the incidence of infection for implant surgery was 16.7%.

Age

The incidence of wound infection was noted to be increased with increasing age from this study. The age group below 41 years showed an infection rate of 5.9%. In the 41-60 years group, there were 23 patients and 3 (13%) had infection. There were 13 patients above 60 years, 4 (31%) of them were infected. $P = 0.04$. This is shown in Figure 1.

Sex

Out of 70 female patients, eight developed infection, whereas four out of 41 male patients were infected. This is shown in Table 1.

Duration of pre-operative hospitalization

Of the 13-day cases, none had post-operative wound infection. Sixty-eight patients stayed for up to 7 days and

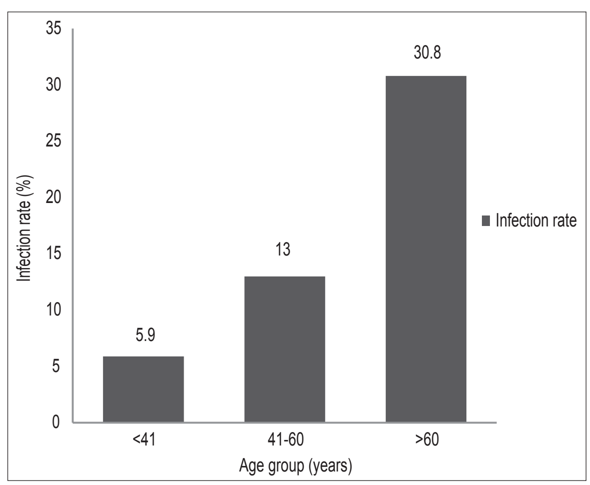

Figure 1: Relationship between age group and infection rate

4 (6%) were infected. Twenty-one patients stayed for 8 to 13 days; 4 (19%) were infected. Nineteen patients stayed for more than 13 days; 4 (21%) were infected. This is shown in Figure 2. Therefore, out of 81 patients that stayed for 7 days or less before surgery, four were infected; out of 40 that stayed beyond 1 week, eight were infected. $P = 0.012$ and odd ratio = 4.81. The figure also shows no infection in day cases.

Number of people during surgery

An infection rate of 7.1% was recorded when there were less than six people in the theater with a rate of 10.05% when more than 10 people were in theater [Figure 3]. $P = 0.93$.

Transfusion

Figure 4 shows an infection rate of 3.7% (three out of 82 patients) when no blood was transfused, 12.7% (one of eight patients) when autologous blood was transfused, and 25.8% (eight out of 31 patients) when homologous blood transfusion was done.

Duration of surgery

Surgical operations (21) lasting less than 45 min had no infection; those (54) exceeding one and half hours had infection rate of 16.7% [Figure 5]. $P = 0.08$.

Use of drain

Only one non-drained wound was infected. The remaining infections were in drained wounds [Table 2]. It is worthy to note that all implant cases had wound drain.

Antibiotic used

Each patient received one of the three antibiotics pre-operatively as shown in Table 3. Penicillin was used only for non-implant cases. Infection rates associated with antibiotics used were: Cephalosporins (cefuroxime [9.6%] and ceftriaxone [8.8%]), quinolone (ciprofloxacin [16%]), and penicillin (amoxicillin + clavulanate [0] and ampicillin + cloxacillin [0]).

Table 1: Sex distribution of infected patients

Sex	Total cases	Infected cases	%
Female	70	8	11.4
Male	51	4	7.8

(P=0.51)

Table 2: Drains and wound infection

Use of drain	Infected	No infection	%
Drain	11	58	15.9
No drain	1	51	1.9

(P=0.01)

Table 3: Antibiotics and infection rate

Pre-operative antibiotic	Infected	Not infected	Infection (%)
Cephalosporin	8	78	9.3
Quinolone	4	21	16
Penicillin	0	10	0

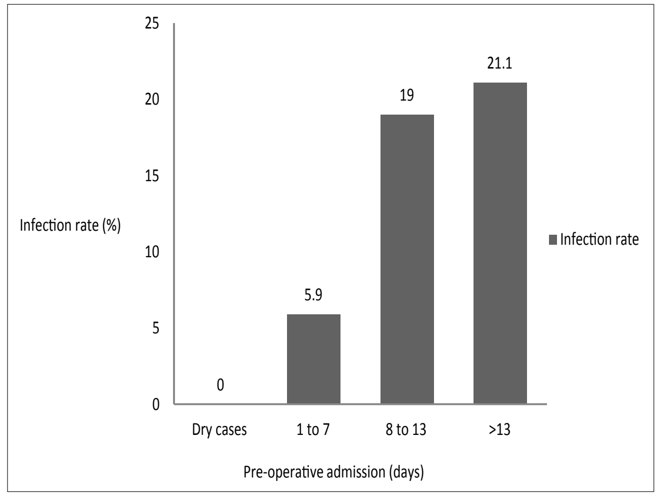

Figure 2: Relationship between infection rate and duration of pre-operative admission

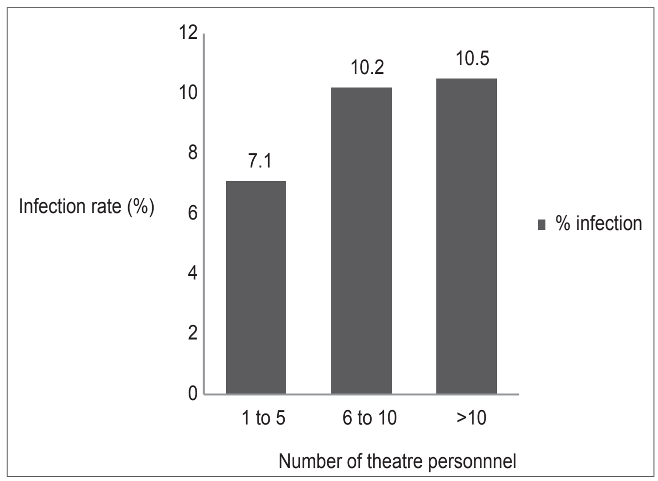

Figure 3: Population of theater personnel and infection rate

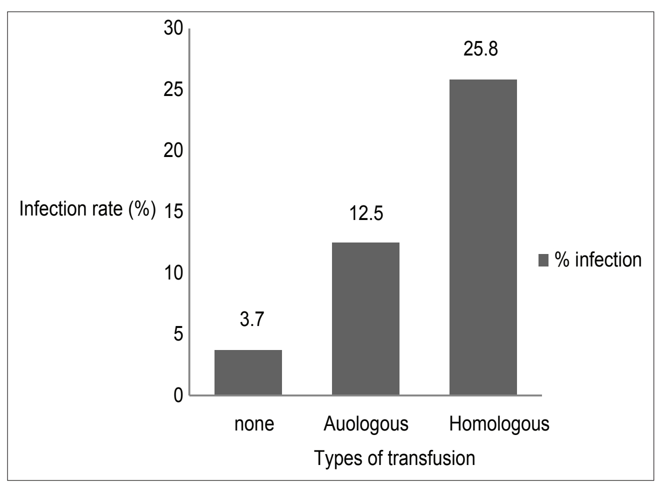

Figure 4: Blood transfusion and infection rate

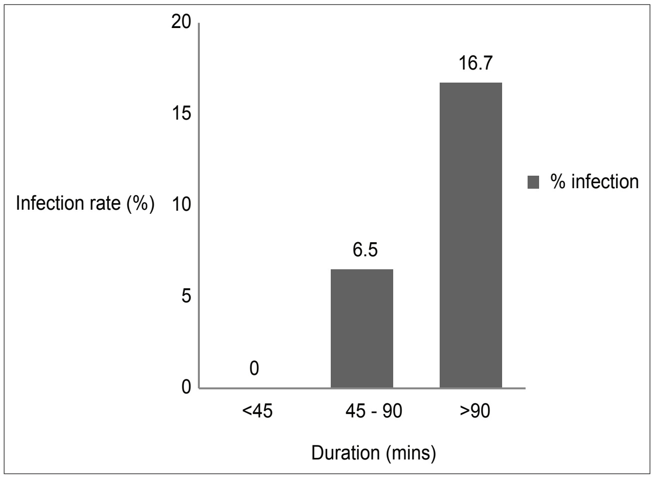

Figure 5: Duration of surgery and infection rate

Discussion

This study revealed that four factors were significantly associated with increased post-operative infection rate. These factors, in increasing significance, were increasing age of patient, prolonged length of pre-operative hospital stay, use of implant, and wound drain. Patient's sex, ward admission, operating room, use of tourniquet, homologous blood transfusion, theater population, surgeon, and duration of surgery did not have significant influence on infection rate. Age was found to be a significant influence on the rate of infection in this study. This is in keeping with several previous studies.[1,8,24-29] It is possible that the increased infection rate observed with increasing age in this study was due to the occurrence of other risk factors observed with aging, like reduction in immunity, which were not entertained in this study.[30] The longer the duration of pre-operative hospital stay, the higher the rate of infection in this study. This influence was statistically significant. In fact, patients with more than 1 week pre-operative hospital stay were almost 5 times more likely to develop infection than those that stayed for less. Previous studies had shown the same trend.[8,27-29,31] The reason for this observation is probably because increased pre-operative stay causes skin colonization by bacteria that are resistant to antimicrobials used for pre-operative prophylaxis.[32] In this study, only implant cases were associated with infection; no infection occurred in non-implant cases. All implant cases were associated with the use of drains. The use of foreign bodies (implants and wound drains used together) had the most significant influence on wound infection. However, the influence of wound drain and the influence of implant on wound infection were not separated in this study because of study design. Therefore, another study, like a controlled study on the use of drains versus no drains in implant surgery, could further explain the influence of wound drain on infection in implant surgery. Many other studies, both experimental and clinical showed that the presence of foreign implants greatly increased the incidence of infection.[21,33,34] Apart from disturbing tissue perfusion, foreign bodies increase the possibility of infection by reducing the ability of leukocytes to kill bacteria. This is because bacteria can form biofilms on their surface.[35] The increase in the number of personnel in theater during surgery was associated with increase in infection rate but this was statistically significant. Olsen, *et al*. found that infection rate was increased when two or more residents were involved in the operative procedures.[18] This may also reflect the fact that the procedure itself is complex and therefore possesses other infective risk factors. However, it had been shown that the greater the number of people in theater, the greater the number of bacteria cultured from the theater air.[36,37] High-operating room traffic is known to increase the rate of infections.[38] In fact, Babkin, *et al*. found that the rate of SSIs associated with left knee replacements was 6.7 times higher than that associated with right knee replacement performed during the same period and in the same operating rooms.[39] Homologous blood transfusion, in this study, was associated with increased infection rate when compared with autologous transfusion. This had been shown in other studies, and the explanation usually given was that homologous blood transfusion tended to reduce immunity.[40-45] This study revealed increased infection rate as the duration of surgery increased. This was the same as the finding of other studies.[27] Studies from other centers in Nigeria showed that 2 h is the critical time.[10,11] Prolongation of operation time means prolonged tissue desiccation, surgical trauma, blood loss (with possible blood transfusion), and exposure time to bacteria. Some workers have shown that surgeons with most surgical experience and responsibility had the lowest infection rate.[19,27,46-48] Consultants are generally more experienced, they are faster (shorter duration of surgery), and are better tissue handlers.

The overall incidence of 9.9% for SSI found in this study is similar to the findings of other studies in Nigeria.[9-11,49]

Conclusion

The incidence of post-operative wound infection in clean cases in our series was 9.9%. For the implant cases alone, the incidence was 16.7%. The most significant factors affecting rate of infection were patients age, duration of pre-operative hospitalization, type of surgery (implant or non-implant), duration of surgery >90 min, and use of drains.

Recommendation

We recommend that the duration of pre-operative hospitalization should be as short as possible. To this end, pre-operative investigations and patient work up, if possible, should be done on outpatient basis before admission. Surgical operations should proceed as fast as possible and the use of drains restricted to only when absolutely necessary.

References

1. Oguntibeju OO, Nwobu RA. Occurrence of *Pseudomonas aeruginosa* in post-operative wound infection. Pak J Med Sci 2004;20:187-91.
2. Ashby E, Haddad FS, O'Donnell E, Wilson AP. How will surgical site infection be measured to ensure "high quality care for all"? J Bone Joint Surg Br 2010;92:1294-9.
3. Wilson AP, Treasure T, Sturridge MF, Grüneberg RN. A scoring method (ASEPSIS) for postoperative wound infections for use in clinical trials of antibiotic prophylaxis. Lancet 1986;1:311-3.
4. Leape LL, Brennan TA, Laird N, Lawthers AG, Localio AR, Barnes BA, *et al*. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. N Engl J Med 1991;324:377-84.
5. 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.
6. Haley RW, Schaberg DR, Crossley KB, Von Allmen SD, McGowan JE Jr. Extra charges and prolongation of stay attributable to nosocomial infections: A prospective interhospital comparison. Am J Med 1981;70:51-8.
7. Coello R, Glenister H, Fereres J, Bartlett C, Leigh D, Sedgwick J, *et al*. The cost of infection in surgical patients: A case-control study. J Hosp Infect 1993;25:239-50.
8. Cruse PJ, Foord R. The epidemiology of wound infection. A 10-year prospective study of 62,939 wounds. Surg Clin North Am 1980;60:27-40.
9. Ekenze SO, Ikechukwu RN, Oparaocha DC. Surgically correctable congenital anomalies: Prospective analysis of management problems and outcome in a developing country. J Trop Pediatr 2006;52:126-31.
10. Ameh EA, Mshelbwala PM, Nasir AA, Lukong CS, Jabo BA, Anumah MA, *et al*. Surgical site infection in children: Prospective analysis of the burden and risk factors in a sub-Saharan African setting. Surg Infect (Larchmt) 2009;10:105-9.
11. Thanni LO, Aigoro NO. Surgical site infection complicating internal fixation of fractures: Incidence and risk factors. J Natl Med Assoc 2004;96:1070-2.
12. Whitehouse JD, Friedman ND, Kirkland KB, Richardson WJ, Sexton DJ. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital: Adverse quality of life, excess length of stay, and extra cost. Infect Control Hosp Epidemiol 2002;23:183-9.
13. American Academy of Orthopaedic Surgeons Patient Safety Committee, Evans RP. Surgical site infection prevention and control: An emerging paradigm. J Bone Joint Surg Am 2009;91:2-9.
14. Fletcher N, Sofianos D, Berkes MB, Obremskey WT. Prevention of perioperative infection. J Bone Joint Surg Am 2007;89:1605-18.
15. Moucha CS, Clyburn T, Evans RP, Prokuski L. Modifiable risk factors for surgical site infection. J Bone Joint Surg Am 2011;93:398-404.
16. Bosco JA 3rd, Slover JD, Haas JP. Perioperative strategies for decreasing infection: A comprehensive evidence-based approach. J Bone Joint Surg Am 2010;92:232-9.
17. Jämsen E, Huhtala H, Puolakka T, Moilanen T. Risk factors for infection after knee arthroplasty. A register-based analysis of 43,149 cases. J Bone Joint Surg Am 2009;91:38-47.
18. Olsen MA, Nepple JJ, Riew KD, Lenke LG, Bridwell KH, Mayfield J, *et al*. Risk factors for surgical site infection following orthopaedic spinal operations. J Bone Joint Surg Am 2008;90:62-9.
19. Willis-Owen CA, Konyves A, Martin DK. Factors affecting the incidence of infection in hip and knee replacement: An analysis of 5277 cases. J Bone Joint Surg Br 2010;92:1128-33.
20. Lawal OO, Adejuyigbe O, Oluwole SF. The predictive value of bacterial contamination at operation in post-operative wound sepsis. Afr J Med Med Sci 1990;19:173-9.
21. Elek SD, Conen PE. The virulence of Staphylococcus pyogenes for man; A study of the problems of wound infection. Br J Exp Pathol 1957;38:573-86.
22. Laurence M. Ultra-clean air. J Bone Joint Surg Br 1983;65:375-7.
23. Cheesbrough M. District Laboratory Practice in Tropical Countries. Part 2. 2nd ed. Cambridge: Cambridge University Press; 1999. p. 36-70.
24. Moylan JA, Kennedy BV. The importance of gown and drape barriers in the prevention of wound infection. Surg Gynecol Obstet 1980;151:465-70.
25. Davidson AE, Clark C, Smith G. Postoperative wound infection: A computer analysis. Br J Surg 1971;58:333-7.
26. Wukich DK, Lowery NJ, McMillen RL, Frykberg RG. Postoperative infection rates in foot and ankle surgery: A comparison of patients with and without diabetes mellitus. J Bone Joint Surg Am 2010;92:287-95.
27. Ridgeway S, Wilson J, Charlet A, Kafatos G, Pearson A, Coello R. Infection of the surgical site after arthroplasty of the hip. J Bone Joint Surg Br 2005;87:844-50.
28. Fascia DT, Singanayagam A, Keating JF. Methicillin-resistant *Staphylococcus aureus* in orthopaedic trauma: Identification of risk factors as a strategy for control of infection. J Bone Joint Surg Br 2009;91:249-52.
29. Lucet JC, Chevret S, Durand-Zaleski I, Chastang C, Régnier B, Multicenter Study Group. Prevalence and risk factors for carriage of methicillin-resistant *Staphylococcus aureus* at admission to the intensive care unit: Results of a multicenter study. Arch Intern Med 2003;163:181-8.
30. Chandra RK. Nutrition, immunity, and infection: Present knowledge and future directions. Lancet 1983;1:688-91.
31. Blam OG, Vaccaro AR, Vanichkachorn JS, Albert TJ, Hilibrand AS, Minnich JM, *et al*. Risk factors for surgical site infection in the patient with spinal injury. Spine (Phila Pa 1976) 2003;28:1475-80.
32. Hanseen AD, Osmon DR, Nelson CL. Prevention of deep peri-prosthetic joint infection. J Bone Joint Surg 1996;78:458-71.
33. Petty W, Spanier S, Shuster JJ, Silverthorne C. The influence of skeletal implants on incidence of infection. Experiments in a canine model. J Bone Joint Surg Am 1985;67:1236-44.
34. Gristina AG, Costerton JW. Bacterial adherence to biomaterials and tissue. The significance of its role in clinical sepsis. J Bone Joint Surg Am 1985;67:264-73.
35. Beer KJ, Lombardi AV Jr, Mallory TH, Vaughn BK. The efficacy of suction drains after routine total joint arthroplasty. J Bone Joint Surg Am 1991;73:584-7.
36. Ritter MA, Eitzen H, French ML, Hart JB. The operating room environment as affected by people and the surgical face mask. Clin Orthop Relat Res 1975;111:147-50.
37. Letts RM, Doermer E. Conversation in the operating theater as a cause of airborne bacterial contamination. J Bone Joint Surg Am 1983;65:357-62.
38. Allo MD, Tedesco M. Operating room management: Operative suite considerations, infection control. Surg Clin North Am 2005;85:1291-7.
39. Babkin Y, Raveh D, Lifschitz M, Itzchaki M, Wiener-Well Y, Kopuit P, *et al*. Incidence and risk factors for surgical infection after total knee replacement. Scand J Infect Dis 2007;39:890-5.
40. Lemos MJ, Healy WL. Blood transfusion in orthopaedic operations. J Bone Joint Surg Am 1996;78:1260-70.
41. Steinitz D, Harvey EJ, Leighton RK, Petrie DP. Is homologous blood transfusion a risk factor for infection after hip replacement? Can J Surg 2001;44:355-8.
42. Newman JH, Bowers M, Murphy J. The clinical advantages of autologous transfusion. A randomized, controlled study after knee replacement. J Bone Joint Surg Br 1997;79:630-2.
43. Edwards C, Counsell A, Boulton C, Moran CG. Early infection after hip fracture surgery: Risk factors, costs and outcome. J Bone Joint Surg Br 2008;90:770-7.
44. Escalante A, Beardmore TD. Risk factors for early wound complications after orthopedic surgery for rheumatoid arthritis. J Rheumatol 1995;22:1844-51.
45. Gordon SM, Culver DH, Simmons BP, Jarvis WR. Risk factors for wound infections after total knee arthroplasty. Am J Epidemiol 1990;131:905-16.
46. Syahrizal AB, Kareem BA, Anbanadan S, Harwant S. Risk factors for infection in total knee replacement surgery at hospital Kuala Lumpur. Med J Malaysia 2001;56:5-8.
47. Mishriki SF, Law DJ, Johnson MG. Surgical audit: Variations in wound infection rates of individual surgeons. J R Coll Surg Edinb 1991;36:251-3.
48. Mackay DC, Harrison WJ, Bates JH, Dickenson D. Audit of deep wound infection following hip fracture surgery. J R Coll Surg Edinb 2000;45:56-9.
49. Onche I, Adedeji O. Microbiology of post operative wound infection in implant surgery. Nig J Surg Res 2004;6:37-40.

How to cite this article: Ikeanyi U, Chukwuka CN, Chukwuanukwu T. Risk factors for surgical site infections following clean orthopaedic operations. Niger J Clin Pract 2013;16:443-7.

Source of Support: Nil, **Conflict of Interest:** None declared.