Original Article

Surveillance of clean surgical procedures: An indicator to establish a baseline of a hospital infection problem in a developing country, Iran

H. Shojaei[1], S. Borjian[2], Pour J. Shooshtari[3], S. Shirani[4]

[1]Department of Microbiology and Research Center for Infectious Diseases, Isfahan University of Medical Sciences, Isfahan, [2]Department of Microbiology & Immunology, Shahrekord University of Medical Sciences, Shahrekord, [3]Kashani University Hospital, Shahrekord, [4]Research Center for Cardiovascular Diseases, Isfahan University of Medical Sciences, Isfahan, Iran

For correspondence:
Shojaei H, Department of Microbiology and Research Center for Infectious Diseases, Isfahan University of Medical Sciences, Isfahan, Iran, E-mail: shojaei@go.com

ABSTRACT

Objectives: To establish a baseline of a hospital's problem, it is recommended to conduct a surveillance of clean (class I) surgical procedures. The present study was conducted to determine the infection rate of clean surgical procedures and to estimate the magnitude of nosocomial infection in some Iranian university hospitals. **Materials and Methods:** A total of 845 clean surgical wound cases were screened for infection by standard microbiological investigations during a 9-month period of time. **Results:** The overall clean wound infection rate was found to be 4.9%, which is comparable to the expected infection rate of 0.8%. The most common organisms isolated were *Staphylococcus epidermidis* (74%), *Staphylococcus aureus* (17%) and *Enterobacter aerogenes* (5%). The *in-vitro* sensitivity of *Staphylococcus epidermidis* and *Staphylococcus aureus* to the common antimicrobial drugs showed that they were resistant to penicillin, ampicillin and amoxicillin. Our study revealed that the efficacy of prophylactic antibiotics in preventing wound infection after clean surgical procedures is unquestioned. **Conclusions:** Having considered the high rate of clean wound infection, a high rate of hospital infection in the region might be inferred. This study calls for the need of a more organized and effective infection control program that includes active infection surveillance in Iran.

Key words: Nosocomial infections, staphylococcal infections, wound infection.

How to cite this article:
Shojaei H, Borjian S, Shooshtari PJ, Shirani S. Surveillance of clean surgical procedures: An indicator to establish a baseline of a hospital infection problem in a developing country, Iran. Indian J Surg 2006;68:89-92.

Historically, surgeons and hospital epidemiologists have stratified operations into clean, clean contaminated and contaminated procedures on the basis of the expected quantity of bacteria introduced into the operative site during surgery. The risk of developing a wound infection is estimated 0.8, 1.3 and 10.2% for clean, clean contaminated and contaminated wounds respectively, when antibiotic prophylaxis is administered.[1-3]

Paper Received: December, 2005. **Paper Accepted:** March, 2006. **Source of Support:** Nil.

Although overall wound infection rates vary considerably, the clean-wound infection (class I) rate is relatively stable and provides a useful benchmark for determining the baseline of a hospital's problem and effects of infection control interventions.[2-5]

The present study was conducted in order to determine the infection rate of clean surgical procedures and to estimate the magnitude of nosocomial infection in some Iranian university hospitals.

MATERIALS AND METHODS

We initiated surveillance for clean surgical wound infections (Class I) in three small university hospitals, Shahrekord, Iran, using the 'US National Academy of Science and National Research Council in 1964' and the 'American Centers for Disease Control (CDC) in 1992' definitions of wound infection,[2-4] i.e, a nontraumatic wound in which no inflammation was encountered; no break-in technique occurred and respiratory, alimentary and genitourinary tracts were not entered.

A total of 845 surgical patients undergoing clean elective surgery were screened for infection by standard microbiological tests over a 9-month period of time. We indented to receive information about the overall clean wound infection rate, the procedure-specific infection rate and distribution of clean wound infections by pathogen and resistance pattern of antibiotics. The 1992 CDC definition requires a surgeon's diagnosis of infection and the culture of microorganisms from the wound; these were considered as two main criteria to include a patient with a possible wound infection in our study. Wounds that were inflamed and without discharge were considered possibly infected and observed until infected (produced pus) or resolved (not infected). If there was a question, the criterion was presence of at least 10 white blood cells per one high power field of microscopic investigation of the sample.[2]

For all patients who had undergone a clean surgical procedure, a questionnaire was completed that contained items such as date of admission to the hospital; principal diagnosis; underlying disease(s); remote infection site, if any; ward and service; age and sex; date of surgery and type of operation performed; length of surgery and any prophylactic antibiotic given.

RESULTS

A total of 845 clean surgical wound patients undergoing clean operations admitted to three surgical wards of university hospitals were investigated. The patients' median age was 32.6 years and 239 (28.3%) of the patients were female.

The most frequent clean operations were repairs of inguinal hernias, 430 cases (51%); and orthopedic surgeries, 118 cases (14%). The most frequent operations carried out were on patients belonging to the age groups of less than 18 (35%) and 19-40 years (23.1%).

Out of 845 clean operations, 41 patients developed postoperative clean wound infections (4.9%, Table 1). The highest rate of infection occurred after bilateral occlusion of fallopian tube procedures (6.5%) and repairs of inguinal hernias (6%) and the least rate of infection occurred after tumor removal operations (0.9%). The clean wound infection was highest in the age group of over 40 years (6.5%) and in those procedures that lasted over half an hour (5.4%). The average length of hospitalization for the infected clean wound cases was 2.3 days, which was one day longer than the noninfected clean surgery procedures.

In 37 (90.2%) of the 41 infected clean wounds, pus was or had been issuing from the wound and in 4, in spite of infection, no pus was present at the incision site. There was a significant correlation between the presence of pus and development of infection in clean wound surgeries ($P<0.001$).

The most common organisms isolated after clean surgery were *Staphylococcus epidermidis* (74%), *Staphylococcus aureus* (17%) and *Enterobacter aerogenes*, 5% [Figure 1]. Most of the *Staphylococcus epidermidis* strains were isolated from infections following repairs of inguinal hernias procedure. The *in vitro* sensitivity testing of *Staphylococcus epidermidis* and *Staphylococcus aureus* to the common antimicrobial drugs showed that they were resistant to penicillin, ampicillin and amoxicillin.

Of the 531 (62.8%) patients who had received prophylactic antibiotics either prior or immediately after operations, surgical clean wound infection developed in 29 (5.4%). The corresponding rate for those patients who had not received prophylactic antibiotics was 16.8%. The cephalosporin prophylaxis, namely, cephalothin (83%) and cephalexin (17%) were the drugs of choice administered for the clean operative procedures. There was a significant correlation between clean wound infection and administration of prophylactic antibiotics ($P<0.001$). However, no relationship could be revealed between clean wound infection and factors such as the number of surgeons that participated in surgery, type of medical devices used and the kind of health care given to the patients.

DISCUSSION

Surgical wound infection surveillance is an essential

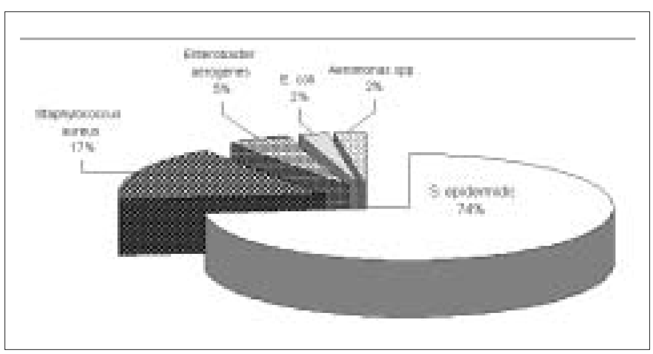

Figure 1: The bacterial species isolated from the clean wound infection

Table 1: Frequency of occurrence of clean wound infection

Clean surgical procedure	Frequency	Frequency of wound infection	Infection rate
Inguinal hernia repair	430	26	6
Various fractures	118	5	4.2
Tumor removal	107	1	0.9
Bilateral occlusion of fallopian tubes	31	2	6.5
Breast surgery	22	1	4.5
Miscellaneous procedures	137	6	4.4
Total	845	41	4.9

part of an effective hospital infection control. Such a program should provide accurate analysis of pathogens and their antibiograms.[1] To establish a baseline of what a hospital's problem may be and to intelligently speak of the wound infection rate, it would be helpful to conduct a surveillance of 'clean' (class I) surgical procedures.[1-5]

In the present study, the clean wound infection rate was seen as a surveillance indicator because it was already reported as the most valuable and sensitive reflection of surgical care and of hospital infection status.[2,6-8]

The overall clean wound infection varies from 1-2.6% in developed countries to 7.3-8% in developing countries.[9-14] According to a study performed at time (1960-1961) when antibiotic prophylaxis, if administered, was usually initiated postoperatively, the infection rate for clean wounds was 5.1% and based on a prospective single-center study of 20.000 wounds in which a fall in infection rates over a 5-year period was attributable to an increasing use of preoperative antibiotics, it was 0.8%.[15] In the current study, the clean wound infection was found to be 4.9%, which corresponds to the rate reported in the literature.[1] However, when viewed with the fact that 62.8% of the patients had received antibiotics either preoperatively or postoperatively, the revealed infection rate could be of great concern. This simply means the patients who are admitted to a university hospital in the region studied in my country have a much greater chance of acquiring a hospital infection than the patients admitted to a hospital in a developed country.

Antibiotic prophylaxis has become the standard care not only in operations characterized by high infection rates but also in the vast majority of clean surgical procedures, including those that use foreign materials, grafts or prosthetic devices as well as non-implant surgery.[16-19] While use of antibiotics in clean implant surgery is undisputed, it is still controversial in clean non-implant surgery and in clean elective surgery.[16,17] Moreover, issues regarding the optimal choice, frequency and duration of antibiotic prophylaxis are unresolved.[1]

In the current study, we found a significant correlation between administration of antibiotics and prevention of wound infection. Therefore, our result is in accordance with other studies that recommend antibiotic prophylaxis for some clean procedures, such as operations in which an intravascular prosthesis or prosthetic joint is inserted or in which a surgical site infection poses a catastrophic risk.[16-19]

The most common clean wound pathogens in our study were *Staphylococcus epidermidis* and *Staphylococcus aureus*, which are in agreement with the literature.[1] The *Staphylococcus epidermidis* strains isolated in the current study were resistant to penicillin, a feature that might help to differentiate them from normal flora of the skin. However, in all cases of wound infection that *Staphylococcus epidermidis* was isolated, the presence and amount of drainage or purulent discharge was supportive of the infection.

In our study, most infections occurred in the age group of over 40 years, which indicates the role of immunity system in control or development of infection.[1]. In addition, we found that the average length of hospitalization in terms of clean wound infection cases was one day longer than a similar patient without infection, which is in line with the findings of other investigators.[1,17,20,21]

Rey *et al* have recently reported that the development of surgical site infection was significantly associated with the duration of surgery and presence of surgical drains.[22] Our result was in line with Ray's findings in terms of surgical drains, though we did not find a significant correlation between the duration of surgery and clean wound infection.

Recently, it has been reported that risk of surgical wound infection is increased by smoking, higher body mass index, presence of malignancy, hematoma formation, increasing numbers of people in theater, adherent dressing usage and higher times to suture removal.[23] Since our study did not include such items, we are not able to answer these questions.

CONCLUSION

Prior to this study, there was no standard data collecting or reporting of surgical wound infection at the university hospitals. Therefore, the data provided with this study can help the authorities to get a more evidence-based insight into the magnitude of hospital infection in the existing hospital settings. The current study can also help the managerial system in the university hospitals take serious steps towards the establishment of a well-organized hospital infection control committee to monitor the trend of nosocomial infection and to carry out interventional projects to tackle the problem. In summary, we may conclude that the problem of hospital infection in our country is quite serious and merits attention of health system authorities. Moreover, the current study showed that the clean wound infection is a very good indicator that can sensitively indicate the overall status of hospital infection and therefore, it can be used as a surveillance yardstick to evaluate the current situation as well as the efficacy of a hospital control program.

ACKNOWLEDGMENT

The authors would like to thank the Deputy for Research & Technology, Iranian Ministry of Health & Medical Education, for supporting financially the current study.

REFERENCES

1. Talbot TR, Kaiser AB. Postoperative infections and antimicrobial prophylaxis. *In*: Mandell GL, Bennett JE, Dolen R, editors. Principles and practice of infectious diseases. 6th ed. Churchill Livingstone: New York; 2004. p. 3533-47.
2. Palmer MB. Infection control. WB Saunders Co: Philadelphia; 1984. p. 1-11.
3. Wilson AP, Gibbons C, Reeves BC, Hodgson B, Liu M, Plummer D, *et al*. Surgical wound infection as a performance indicator: agreement of common definitions of wound infection in 4773 patients. BMJ 2004;25:720.
4. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. Infect Control Hosp Epidemiol 1992;13:606-8.
5. Hiestand S, Farr J. Infection control and the future. Continuing and emerging trends. Todays OR Nurse 1991;13:9-14.
6. Reilly JS. The effect of surveillance on surgical wound infection rates. J Tissue Viabil 1999;9:57-60.
7. Cruse P. Wound infection surveillance. Rev Infect Dis 1981;3:734-7.
8. Gross PA. Striving for benchmark infection rates: progress in control for patient mix. Am J Med 1991;16:16S-20S.
9. Wallace RB. Public health and preventive medicine. 14th ed. Appleton & Lange: Stamford, Connecticut; 1998. p. 273-9.
10. Weusteub AR. Infection control in hospital. *In*: Braunwald E, Fauci SA, Kasper LD. *et al*. *Harrison's principles of internal medicine*. McGraw-Hill: New York; 2001. p. 853-6.
11. Noman TA, Raja'a YA, Assiraji HM, Assofi YA. Rate of wound infection after clean surgery. Saudi Med J 2001;22:58-60.
12. Creamer E, Cunney RJ, Humphreys H, Smyth EG. Sixteen years' surveillance of surgical sites in an Irish acute-care hospital. Infect Control Hosp Epidemiol 2002;23:36-40.
13. Knight R, Charbonneau P, Ratzer E, Zeren F, Haun W, Clark J. Prophylactic antibiotics are not indicated in clean general surgery cases. Am J Surg 2001;182:682-6.
14. Reilly JS, Baird D, Hill R. The importance of definitions and methods in surgical wound infection audit. J Hosp Infect 2001;47:64-6.
15. Ad Hoc Committee of the Committee on Trauma, National Research Council Division of Medical Sciences. Postoperative wound infections: The influence of ultraviolet irradiation of the operating room and of various other factors. Ann Surg 1964;160:2.
16. Mini E, Nobili S, Periti P. Does surgical prophylaxis with teicoplanin constitute a therapeutic advance? J Chemother 2000;12:40-55.
17. Gupta R, Sinnett D, Carpenter R, Preece PE, Royle GT. Antibiotic prophylaxis for post-operative wound infection in clean elective breast surgery. Eur J Surg Oncol 2000;26:363-6.
18. D'Escrivan T, Lemaire JS, Ivanov E, Boulo M, Soubrier S, Mille FX, *et al*. Surgical antimicrobial prophylaxis: compliance to guidelines and impact of targeted information program. Ann Fr Anesth Reanim 2005;24:19-23.
19. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Infect Control Hosp Epidemiol 1999;20:247-77.
20. Rangel-Frausto M S, Morales-Garcia D, Baez-Martinez R, Ibarra-Blancas J, Ponce de Leon-Rosales S. Evaluation of a nosocomial infection surveillance program. Salud Publica Mex 1999;41:S59-63.
21. O'Donoghue MA, Allen KD. Costs of an outbreak of wound infections in an orthopaedic ward. J Hosp Infect 1992;22:73-9.
22. Rey JE, Gardner SM, Cushing RD. Determinants of surgical site infection after breast biopsy. Am J Infect Control 2005;33:126-9.
23. Reilly J. Evidence-based surgical wound care on surgical wound infection. Br J Nurs 2002;11:S4,S6,S8,S10,S12.