Incidence of Nosocomial Infections in a Big University Affiliated Hospital in Shiraz, Iran: A Six-month Experience

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Brief Communication

ABSTRACT

Background: Nosocomial infections (NIs) are one of the most important health issues, particularly in developing countries, because these infections cause high mortality and morbidity, and economic and human resource loss as a consequence. To date, most surveillance studies have been conducted in developed countries, and only a few have been performed in Iran. All of the few Iranian studies have been performed using paper-based collection forms, and none was conducted with the aid of an electronic patient data retrieving and collecting tool. The aim of this study is to determine the incidence of NIs in a big university hospital of Shiraz, with the help of specifically programmed surveillance software merging electronically the available patient data and the infection results input manually.

Methods: The study was conducted prospectively through 6 months from 21st March up to 22nd September 2006, in a 374-bedded educational hospital. All patients admitted during this period were included in the study and examined everyday for detecting four types of NIs: surgical site infection (SSI), urinary tract infection (UTI), pneumonia (PNEU), and blood stream infection (BSI). Centres for Disease Control and Prevention National Nosocomial Infection Surveillance system criteria were applied.

Results: 4013 patients were admitted in the hospital. The overall infection rate was 4.14, and UTI, SSI, BSI, and PNEU rates were 1.82, 1.22, 0.5, and 0.5, respectively, per 1000 patient days of admission.

Conclusions: The results of this study showed that the frequency of NI in the investigated hospital was not higher than in many other reported surveillance results from other countries. This, however, might be a bias as the administration of antibiotics was very high in this study and the quality of microbiological investigation might have influenced significantly, resulting in more false-negative results than expected. Overall, the use of the Iranian National Nosocomial Infection Surveillance System Software proved to be useful and allowed both rapid data collection and detailed data analysis.

Keywords: Iran, National nosocomial infection surveillance, nosocomial infections, surveillance

INTRODUCTION

Nosocomial infections (NIs) are one of the most important causes of mortality and morbidity in hospitals, which are more than expected regarding only patients' underlying illnesses.[1] These infections constitute an important health issue worldwide as they result in economic and human resource loss.[2-9] Surveillance of NIs is a practical way to confront this matter because it provides useful data to identify infected patients, determines the magnitude of the problem, and reviles the factors that contribute to NIs.[10] Many countries in the world implement NI surveillance systems to determine the incidence of infections, risk factors, unusual variation in the number of cases, and eventually facilitating the running of control programs.[11,12] As we are in the millennium of Health Information Technology (Health IT),[13] today, surveillance may be conducted using Electronic Health Records (EHRs), as EHRs can ease collection of surveillance data and assist infection control programs.[14] In addition, electronic data transfer is more rapid, efficient, and reliable[15] Although most surveillance studies have been conducted in developed countries,[16] only a very few have been performed in Iran. This study is the first Iranian hospital-wide prospective software based system for NIs, based on Centres for Disease Control and Prevention (CDC) National Nosocomial Infection Surveillance (NNIS) system criteria.

Iran, with a population of about 70 million, is one of the biggest countries in the Middle East. Shiraz is the capital of Fars province, the biggest province of southern Iran. Shiraz university hospitals are referral centres for approximately a quarter of patients in Iran.

In this study, we studied the feasibility of using a computer-based surveillance tool for surveillance of four major NIs: urinary tract Infection (UTI), blood stream infection (BSI), surgical site infection (SSI), and pneumonia (PNEU) in all patients who were admitted in this hospital during the study period.

METHODS

Setting

This study was done hospital-wide in all wards and intensive care units (ICUs) of an educational university hospital with a total of 374 beds and 77.5% annual bed occupation rate. Most of the NNIS operations like nephrectomy, cholecystectomy, herniorrhaphy, appendectomy, mastectomy, and splenectomy are being performed in the hospital.

Data collection

Data were collected prospectively through 6 months from 21st March up to 22nd September 2006 in all wards, ICUs, and Coronary Care Unit (CCU) of Shahid Faghihi hospital.

General patient data (name, date of birth, admission date, discharge date, gender, admitted ward) were retrieved from the Hospital Information System (HIS). All patients who were admitted in these wards were included in the study and followed until they left the hospital or died. According to the NI definition criteria in NNIS protocol, all patients who stayed more than 48 h and presented an infection after that time were labeled as nosocomial infected patients. Data of NI were collected from all patients who were admitted each day and followed with daily physical examination, review of laboratory data, patient's charts, chest radiographs, and interviewing the nurses and doctors in charge of patients. If a patient fulfilled the definitions for NI, the information was manually input into the surveillance software. NNIS system criteria were used to define four major NIs: UTI, PNEU, BSI, and SSIs.

Definitions

The NNIS system describes an NI as a localized or systemic infection which is caused by an infection agent or its toxins. In addition, this infection should not be present or be in incubation period at the time of admission. This means that infection should be apparent at least 48 h after admission. In present study, NNIS system criteria were used to define four major NIs. SSIs were defined as infections occurring within 30 days after the operative procedure and involving the site of incision, with at least one of the following: Purulent discharge from the site of incision or diagnosis of infection by the surgeon or attending physician, and its categorization was considered. A case of UTI was defined as a patient with the following signs or symptoms with no other recognizable cause: Fever (temperature >38°C), urgency, frequency, dysuria, or suprapubic tenderness; and positive dipstick for leukocyte esterase and/or nitrate, physician diagnosis of UTI, or both. A case of PNEU was

defined as a patient who had rales or dullness to percussion on physical examination of the chest; a chest radiographic examination showing new or progressive infiltrate; consolidation, cavitations, or pleural effusion; or new onset of purulent sputum or change in character of sputum. A case of BSI was defined as a patient who had at least one of the following clinical signs or symptoms with no other recognized cause: Fever (temperature >38°C), hypotension (systolic pressure ≤90 mm Hg), or oliguria (<20 cm³/h); blood culture not done or no organisms or antigen detected in blood; and no apparent infection at another site and physician instituted treatment for sepsis. Moreover, blood cultures were obtained on clinical suspicion of systemic infection and were processed following standard microbiological methods. BSI was also labeled if the patient had a recognized pathogen cultured from one or more blood cultures and organism cultured from blood and which was not related to an infection at another site.

Data management and statistical analysis

Chi square, *t*-test, and Fisher exact test were used when comparison was needed. One-tailed *P*-value of 0.05 was considered significant. The Iranian NNIS System Software is a web-based application written in Java (J2EE), using ZK, Hibernate, and Jasper Reports, which was prepared by a team of computer programmers with the First author (MA) as the head.

RESULTS

During the study period, 4013 patients were admitted to the hospital wards. The median length of hospital stay was 4 days (range: 0–163 days).1868 (46.5%) of the patients were females with a mean age of 41.86±21.24 years (median=41) and 2145 (53.5%) were males with a mean age of 44.09±23.03 years (median=44). The youngest person was 1 year old and the oldest 99 years old. Median length of hospital stay was 4 days for non-infected patients and 17.5 days for infected patients, showing a significantly different length of stay between these two groups (*P*<0.001).

According to NNIS definitions, with the exception of starting treatment by a physician, 43 cases of UTI, 29 cases of SSI, 13 cases of BSI, and 13 cases of PNEU were detected overall, with

a total infection rate of 4.14, and UTI, SSI, BSI, and PNEU rates were 1.82, 1.22, 0.5, and 0.5 per 1000 patient days, respectively.

UTI, SSI, BSI, and PNEU rates were 1.07%, 0.72%, 0.32%, and 0.32%, respectively.

With the inclusion of nosocomially infected patients according to physician diagnosis and administering antibiotics, the overall infection rate was 78.2% (91.5% in surgical wards, 73.2% in medical wards, 36.9% in CCU, 24.4% in oncology ward, and 81% in ICUs); the infection rates classified by different wards are shown in Table 1.

UTI rates in CCU and ICUs were significantly more frequent than in other wards (*P*<0.000), but there was no difference between CCU and ICU (*P*=0.41). BSI rate was more frequent in oncology wards compared to surgical wards (*P*<0.000), gynecology wards (*P*<0.005), and ICU (*P*<0.03), while the frequency was statistically equal in oncology, CCU, and medical wards. PNEU rate was significantly more frequent in ICUs than in all other wards. In surgical and medical ICUs, device-associated hospital-acquired infections have been documented. Infection rates and device utilization ratio are summarized in Table 2.

DISCUSSION

The results of this study showed that in many comparable instances, there was no significant difference in the frequency of NI in the investigated Iranian hospital and US hospitals following NNIS system according to the NNIS system results published in 1992–2004. However, the following aspects need attention and are thus highlighted. Firstly, NI detection was based on clinical grounds in most of our cases, possibly missing patients with subclinical infections. Secondly, Iranian physicians

Table 1: Infection rates (%) in different hospital wards

Wards	UTI rate (%)	BSI rate (%)	PNEU rate (%)	SSI rate (%)
CCU	6.13	0.38	0.00	0.00
Medical	1.27	0.34	0.81	0.00
Oncology	0.32	1.92	0.00	0.00
Surgical	0.10	0.00	0.00	1.33
Gynecology	0.0	0.00	0.00	0.65
ICUs	5.28	1.21	2.43	0.40

UTI: Urinary tract infection; BSI: Blood stream infection; PNEU: Pneumonia

Table 2: Infection rates and device utilization ratio

Type of ICU	Number of UTI	Device-days	UTI rate per 1000 device-days	Urinary catheter utilization ratio	NNIS Percentiles				
					10%	25%	50%	75%	90%
Surgical	6	823	7.3	0.51	1.4	2.3	3.8	6.5	8.8
					0.65	0.76	0.86	0.92	0.96
Medical	7	1050	6.7	0.84	0.7	2.5	4.7	7.1	9.5
					0.58	0.65	0.76	0.83	0.88
Type of ICU	**Number of BSI**	**Device-days**	**BSI rate per 1000 device-days**	**Central line utilization ratio**	**10%**	**25%**	**50%**	**75%**	**90%**
Surgical	1	1387	0.72	0.86	0.0	2.0	3.4	5.9	8.7
					0.34	0.52	0.63	0.72	0.81
Medical	2	286	7	0.23	0.5	2.4	3.9	6.4	8.8
					0.31	0.37	0.52	0.64	0.75
Type of ICU	**Number of PNEU**	**Device-days**	**PNEU rate per 1000 device-days**	**Ventilator utilization ratio**	**10%**	**25%**	**50%**	**75%**	**90%**
Surgical	2	387	5.1	0.24	2.2	4.7	8.3	12.2	17.9
					0.19	0.31	0.46	0.53	0.65
Medical	2	694	2.9	0.56	0.5	2.1	3.7	6.2	8.9
					0.22	0.32	0.46	0.57	0.67

UTI: Urinary tract infection, BSI: Blood stream infection, PNEU: Pneumonia

believed that they might not have reliable laboratory investigation methods and that such laboratory reports might contain many false-negative results. Finally, administration of prophylactic antibiotics was routine for surgical patients, which can obscure infection presentation. Apart from all the points mentioned above, the most important cause of possible false low infection rates might be inappropriate administration of broad-spectrum antibiotics for every febrile patient as the treatment before finding the underlying cause.

By use of the surveillance software, if we could have classified all patients staying longer than 48 h in the hospital and receiving antibiotic administration as "nosocomially infected," the overall rate of NI would have been 78.2% (91.5% in surgical ward, 73.2% in medical wards, 36.9% in CCU, 24.4% in oncology ward, and 81% in ICUs).

This observed frequency of SSI which was 1.22 per 1000 patient days in our study is lower than that reported in many similar studies from different countries (e.g. in Santa Cruz, Bolivia, 12%;[6] in a single hospital in the USA, 8.6%;[17] in Spain, 10.5%;[18] in Brazil, 16.6%;[19] in Italy, 2.9–10.6%;[20,21] and in Tanzania, 24%[22]). However, as mentioned earlier, the most important cause which seems to be responsible for this significant difference

is the high rate of administration of antibiotics in all of our surgical wards (91.5%). Rational use of antibiotics covers surgical infections, and reduces the number of hospital days as well as antibiotic use for therapeutic purposes and the sepsis-related mortality rate.[23-27] However, inappropriate use of antibiotics is still a worldwide problem.[28] We showed in a previous study that antibiotics were administered inappropriately for 98% of procedures in Shiraz university hospitals that did not have indication for antibiotic prophylaxis, which supports our current results.[23]

Our findings indicate that urinary tract is the most frequent site of NI (5.28%) in our area, which is in line with another study conducted in the same hospital.[29]

A study in 12 hospitals in Germany showed the following: SSI rate, 32.3%; UTI, 31.9%; PNEU, 18.8%; and BSI, 3.6% during 2 months,[12] which were all higher than the rates found in our present study in Iran. It must be mentioned that the encompassed population in the German study was bigger, and also, the microbiology laboratory reports were reviewed and used to document all infections.

Giovanni Battista Orsi and colleagues[4] conducted a study in a big hospital in Rome and found the BSI rate to be 2%, which is higher

than what we have obtained in our present study. Although their criteria were not according to NNIS definitions and they sent blood culture from any patient with signs of sepsis before antibiotic administration, it shows that appropriate cultures from suspicious patients before starting treatment, accompanied with reliable laboratory findings, help significantly to detect and document NIs.

As shown in Tables 2, in surgical ICUs, central line utilization ratios were very high (above NNIS 90%), but the BSI rates ranged between 75 and 90 NNIS percentiles. Despite using more central lines in our center, the BSI rate was lower; but it needs to be mentioned that in surgical ICU, two patients were admitted only for hyperalimentation with no underlying condition justifying intensive care. Omitting those patients, the ratio would have decreased from 0.86 to 0.77, which again is between the 75 and 90 NNIS percentiles. In surgical ICUs, other ratios (catheter and ventilator) were low (percentile and between 10 and 25 NNIS percentile, respectively), but the infection rates were high, suggesting that in our hospital the patients are given suboptimal invasive device care. Yet, in medical ICUs, UTI and PNEU rates were lower than their utilization ratios. An important reason of this could be that it was not possible to document many of these infections because of using empirical antibiotic treatment for febrile patients before finding the cause, and unreliable laboratory findings, as mentioned earlier.

NI rates were reported previously in two Shiraz hospitals, including our hospital.[30] Among 478 cardiothoracic ICU patients, UTI, BSI, and PNEU rates was 2.9, 1.7, and 3.2 per 1000 device-days, respectively. The rates are lower compared to our findings in surgical ICUs, except for BSI rates. Data were collected during the year 2000. This difference is partly explained by lack of or unsuccessful implementation of infection control strategies in our hospital during these 6 years.

Regarding the Middle East reports, among 337 Israeli adult general ICU patients, the rate of UTI reported was 14 per 1000 patients. The rates for BSI and PNEU were 12 and 20 per 1000 patients, respectively.[31] In Saudi Arabia, ventilator-associated PNEU rate of 16.8 infections per 1000 patients was reported.[32]

In the present study, we focused on physician diagnosis and clinical criteria for reporting NI.

These criteria are included in NNIS system for NI diagnosis. Although we have reviewed the laboratory results of any sample which had been sent routinely from suspicious patients, we do not consider this as a limitation of our study. As mentioned earlier, the rate of inappropriate administration or overuse of antibiotics is very high in our area. Consequently, microbiological findings were not valid because empirical treatment had already started before taking samples. Moreover, our laboratory findings are not accurate and contain many false negatives.

In summary, the results of this study showed that the frequency of NI in the investigated hospital was not higher than that in many other reported surveillance results from other countries. This, however, might be a bias as the administration of antibiotics was very high in this study, and the quality of microbiological investigation might have been influenced significantly, resulting in more false-negative results than expected. Overall, the use of the Iranian NNIS System Software proved to be useful and allowed both rapid data collection and detailed data analysis.

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REFERENCES

1. Herwaldt LA, Cullen JJ, Scholz D, French P. A prospective study of outcomes, healthcare resource utilization, and costs associated with postoperative nosocomial infections. Infect Control Hosp Epidemiol 2006;27:1291-8.

2. Mylotte JM, Graham R, Kahler L, Young BL, Goodnough S. Impact of nosocomial infection on length of stay and functional improvement among patients admitted to an acute rehabilitation unit. Infect Control Hosp Epidemiol 2001;22:83-7.

3. Hollenbeak CS, Murphy D, Dunagon WC. Non random selection and the attributable cost of surgical site infections. Infect Control Hosp Epidemiol 2002;23:177-82.

4. Orsi GB, Stefano MD, Noah N. Hospital acquired, laboratory confirmed blood stream infection: Increased hospital stay and direct costs. Infect Control Hosp Epidemiol 2002;23:190-7.

5. Smith TL, Pullen GT, Crouse V, Rosenberg G, William RG, Blood stream infections in pediatric oncology outpatients: A new health care systems challenge. Infect Control Hosp Epidemiol 2002;23:239-43.

6. Soleto L, Pirard M, Boelaert M, Peredo R. Incidence of surgical site infections and the validity of the national nosocomial infections surveillance system risk index in general surgical ward in Santa Cruz, Bolivia. Infect Control Hosp Epidemiol 2003;24:26-30.

7. Rosenthal VD, Guzman S, Migone O, Safdar N. The attributable cost and length of hospital stay because of nosocomial pneumonia in intensive care units in 3 hospitals in Argentina: A prospective, matched analysis. Am J Infect Control 2005;33:157-61.

8. 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.

9. Meric M, Willke A, Caglayan C, Toker K. Intensive care unit acquired infections: Incidence, risk factors and associated mortality in a Turkish university hospital. Jpn J Infect Dis 2005;58:297-302.

10. Garcia ML, Peyro R, Cortina M, Crespo MD, Tobias A. Nosocomial infection surveillance in a surgical intensive care unit in Spain,1996-2000: A time-trend analysis. Infect Control Hosp Epidemiol 2006;27:54-9.

11. Gasrmeier P, Brauer H, Forster D, Dietz E, Daschner F, Ruden H. A quality management project 8 selected hospitals to reduce nosocomial infections: A prospective, controlled study. Infect Control Hosp Epidemiol 2002;23:91-7.

12. Burns SJ, Dippe SE. Post operative wound infection detected during hospitalization and after discharge in a community hospital. Am J Infect Control 1982;10:60-5.

13. Tokars JI, Richards C, Andrus M, Klevens M, Curtis A, Horan T, *et al*. The changing face of surveillance for health care-associated infections. Clin Infect Dis 2004;39:1347-52.

14. Atreja A, Gordon SM, Pollock DA, Olmsted RN, Brennan PJ. Opportunities and challenges in utilizing electronic health records for infection surveillance, prevention and control. Am J Infect Control 2008;36(3 Suppl):S37-46.

15. Edwards JR, Pollock DA, Kupronis BA, Li W, Tolson JS, Peterson KD, *et al*. Making use of electronic data: The National Healthcare Safety Network eSurveillance Initiative. Am J Infect Control 2008;36(3 Suppl):S21-6.

16. Mayhall GC. Hospital epidemiology and infection control. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2004. p. 1659-702.

17. Medina-Cuadros M, Sillero-Arenas M, Martinez-Gallego G, Delagado Rodriguez M. Surgical wound infection diagnosed after discharge from hospital: Epidemiologic differences with in hospital infections. Am J Infect Control 1996;24:421-8.

18. Santos KR, Fonseca LS, Bravo neto GP, Gontijo filho PP. Surgical site infection: Rates, etiology and resistance patterns to antimicrobials among strains isolated at Rio de Janeiro university hospital. Infection 1997;25:217-20.

19. Moro ML, Morsillo F, Tangenti M, Mongardi M, Pirazzini MC, Ragni P. Rates of surgical site infection: An international comparison. Infect Control Hosp Epidemiol 2005;26:442-8.

20. Prospero E, Cavicchi A, Bacelli S, Barbadoro P, Tantucci L, D'Errico MM. Surveillance for surgical site infection after hospital discharge: A surgical procedure-specific perspective. Infect Control Hosp Epidemiol 2006;27:1313-7.

21. Fehr J, Hatz CH, Soka I, Kibatala P, Urassa H, Smith T, *et al*. Risk factors for surgical site infection in a Tanzanian district hospital: A challenge for the traditional national nosocomial infection surveillance system index. Infect Control Hosp Epidemiol 2006;27:1401-4.

22. Huotari K, Lyytikainen O. Impact of postdischarge surveillance on the rate of surgical site infection after orthopedic surgery. Infect Control Hosp Epidemiol 2006;27:1324-9.

23. Askarian M, Moravveji AR, Mirkhani H, Namazi S, Weed H. Adherence to American Society of Health-System Pharmacists Surgical Antibiotic Prophylaxis Guidelines in Iran. Infect Control Hosp Epidemiol 2006;27:876-8.

24. Nichols RL. Preventing Surgical Site Infections: A Surgeon's Perspective. Emerg Infect Dis 2001;7:220-3.

25. Zelenitsky SA, Ariano RE, Harding GK, Silverman RE. Antibiotic pharmacodynamics in surgical prophylaxis: An association between intraoperative antibiotic concentrations and efficacy. Antimicrob Agents Chemother 2002;46:3026-30.

26. Vaisbrud V, Raveh D, Schlesinger Y, Yinnon AM. Surveillance of antimicrobial prophylaxis for surgical procedures. Infect Control Hosp Epidemiol 1999;20:610-3.

27. Zoutman D, Chau L, Watterson J, Mackenzie T, Djurfeldt M. A Canadian survey of prophylactic antibiotic use among hip- fracture patients. Infect Control Hosp Epidemiol 1999;20:752-5.

28. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Centers for disease control and prevention (CDC) Hospital infection control practices advisory committee. Am J Infect Control 1999;27:97-132.

29. Hassanzadeh P, Motamedifar M, Hadi N. Prevalent bacterial infections in intensive care units of Shiraz

University of medical sciences teaching hospitals, Shiraz, Iran. Jpn J Infect Dis 2009;62:249-53.

30. Askarian M, William C, Assadian O. Nosocomial infection rates following cardiothoracic surgery in Iran. Int J Infect Dis 2006;10:185-7.

31. Finkelstein R, Rabino G, Kassis I, Mahamid I. Device-associated, device-day infection rates in an Israeli adult general intensive care unit. J Hosp Infect 2000;44:200-5.

32. Memish ZA, Cunningham G, Oni GA, Djazmati W. The incidence and risk factors of ventilator-associated pneumonia in a Riyadh hospital. Infect Control Hosp Epidemiol 2000;21:271-3.

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