Original Article

Baseline assessment of intensive care-acquired nosocomial infection surveillancein three adult intensive care units in Malaysia

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Abstract

Background: Nosocomial infections (NIs) have a serious impact on patient outcomes in Intensive Care Units (ICUs).

Method: A prospective cohort-targeted comprehensive surveillance study on NI associated with usage of devices was conducted in three ICUs in Malaysia using a developed NI surveillance form. Patients who developed infection outside an ICU were excluded from the study.

Results: The device associated NI was 21.1%. The mean duration for development of NI was 10.0 ± 7.44 days in ICU. The major device-associated infections were nosocomial pneumonia (18.7%) followed by bacteremia (8.5%) and urinary tract infections (4.7%) respectively. NI incidence density rate was 20.6 per 1,000 patient-days. Bacteremia, urinary tract infection (UTI) and nosocomial pneumonia (NP) rates were 8.9, 4.7 and 20.5 per 1,000 patient-days, respectively. *Acinetobacter species*, *Klebseilla pneumoniae*, *Pseudomonas aeruginosa* and Methicillin-resistant *Staphylococcus aureus* were the predominant pathogens isolated from the NIs subjects during the study period in the three ICUs.

Conclusion: Analysis of the rate of the NIs associated with usage of devices in the three ICUs showed that it is highly correlated with the use of mechanical ventilation devices, followed by intravascular devices and usage of indwelling urinary catheters.

Key Words: Intensive Care Unit-acquired infections, Hospital–acquired infection (HAI) surveillance, Device use ratio, Device related infections

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Introduction

Nosocomial infections (NIs) in intensive care units (ICUs) are primarily device-associated infections caused by opportunistic organisms. Nosocomial infection is a major cause for concern in Malaysia and worldwide [1,2,3,6,20,21,22] with increasing morbidity and mortality. The rates of NIs vary widely among different countries and regions of the world [21,22]. The reporting of NIs is influenced by factors such as the efficiency of data collection, criteria for defining ICU NIs, surveillance systems, and tools used for interpretation of results and others.

A number of local studies have been conducted in the hospitals in Malaysia [1,6,9,13]. However, these studies are encumbered with different designs for data collection such as sampling method; inclusion and exclusion criteria; inaccessibility to details on various parameters; variation in the definition of NIs; different layout of units and suitable facilities; and inadequately trained staff with varying degrees of experience. These variances resulted in the observation of different risk factors and rates in Malaysia which were dependent on the individual hospitals and their own practices, policies, number of beds to staff ratio, and unique floras. These factors contributed to the gap that exists in the reporting of ICU NI rates in Malaysia. A surveillance protocol with well-defined criteria was developed for this study, in which ICU NI rates associated with usage of medical devices in adult ICUs were evaluated.

Materials and Methods

Study Design

A prospective cohort-targeted comprehensive surveillance study was conducted using modified daily NI surveillance forms associated with usage of devices in adult ICUs of three major hospitals in Malaysia. The number of ICU beds at these hospitals varied from six to sixteen. No nosocomial epidemic occurred during the study period.

Subject and sample size

Three hundred and sixty four (*n*=364) Malaysian patients admitted to ICU within a period of thirty months (910 days) were reviewed in the hospitals. The patients who participated in the study were between the ages of 18 to 80 years at time of admission during the study period of October 2003 until March, 2006. All patients were on the three devices, *i.e.*, mechanical ventilation devices, indwelling urinary catheters, and intravascular devices, at time of admission within the study period mentioned.

Setting

The hospitals selected for the study were Hospital Universiti Sains Malaysia, Hospital Ipoh in Northern Malaysia, and Hospital Terengganu in East Malaysia. Hospital Universiti Sains Malaysia is a teaching hospital for a tertiary institution whereas Hospital Ipoh and Hospital Terengganu are state hospitals under the purview of the Ministry of Health, Malaysia.

Criteria for Diagnosis

NI was diagnosed based on the criteria stated by the Centre for Disease Control and Prevention [4] and further confirmed with National Nosocomial Infection Surveillance System (NNIS, 2004) definitions [12]. Diagnosis of nosocomial pneumonia was confirmed based on microbiology culture results for tracheal aspirate, urine and/or blood samples as well as associated clinical, radiological and other laboratory test results that showed increased white cell counts in the full blood picture [3,11,12].

Instrument and Validation

A preliminary NI surveillance (data collection) form was developed, based on a literature review. The NI surveillance form addressed demographic data; history of illness; clinical evidence of infections and results of microbiology laboratory investigations (culture results and sources of infection); and X-ray findings. The form was reviewed for content validity by a five-member team of experts at Universiti Sains Malaysia, Health Campus, pilot tested and finalized for accuracy, clarity and practicality based on the feedback.

Procedure

This form was used for the prospective ongoing data collection from case records, laboratory reports, results of clinical findings, and direct observation by the researchers. The patients were followed up daily, from the time of admission until discharged, for early signs of clinical and laboratory evidence of infection as well as for confirmation of the 'first positive culture" from tracheal aspirate, urine and/or blood samples. The patients were followed up to the ward for 48 hours post ICU discharge to include NI manifestations that occurred in the wards.

Ethical Approval

Ethical approval was obtained from the three hospitals studied. The Ethics and Research Committee, Universiti Sains Malaysia, approved the study in October, 2003. Informed consent was obtained from the patients' close relatives (husband, wife or parents).

Statistical analysis

Data entry and analysis were done using SPSS version 12.0.1 for Windows. Standard deviations and means were calculated as required for numerical variables. Frequency and percentages were calculated for categorical variables. NI incidence density rate was calculated as being the number of NI/patient-days and then multiplied by 1,000.

Results

Characteristics of Subjects

Three hundred and sixty four (*n*=364) subjects were reviewed. A total of 128 subjects with no signs of infection at the time of admission were studied. The characteristics of the subjects are as shown in Table 1.

Table 1. Characteristics of Cohort Patients and Nosocomial Infection Rates in 3 Adult ICUs in Malaysia.

Characteristics (*n*=128)	**N** (%)	**Mean** (SD)	**Median** (IQR)
Patients	128		
Age	-	40.7 (16.18)	42.0 (30)
Sex			
Male	96 (75.0)	-	-
Female	32 (25.0)	-	-
Race			
Malay	75 (58.0)	-	-
Chinese	23 (18.0)	-	-
Indian	24 (19.0)	-	-
Others	06 (50.0)	-	-
Severity Illness Scores			
SAPS II SCORE (admission)	-	47.8 (15.46)	46.0 (24)
TISS SCORE (admission)	-	49.5 (12.30)	49.0 (17)
APACHE III (admission)	-	77.2 (30.78)	78.5 (46)
Conscious Level			
Glasgow coma score 8 and below	76 (59.4)	4.5 (2.05)	3.0 (04)
Glasgow coma score 9-14	33 (25.8)	-	-
Glasgow coma score 15	19 (14.8)	15.0 (0.00)	15.0 (00)

Incidence of ICU-acquired Nosocomial Infections associated with usage of devices are shown in Table 2. A combined data calculation of the three hospitals for incidence of ICU-acquired nosocomial infection in the cohort group was found to be 21.1% (*n*=27) within a mean average stay of 12.0± SD=6.7 days in ICU while 10.2% (*n*=13) of the subjects developed hospital-acquired infections (outside ICU) and 68.7% (*n*=88) did not develop any infection. There were 1,253 peripheral line-days with a mean duration of 9.8 ± 5.5 days. The mean durations of central venous catheter (CVC), urinary catheter, and ventilator utilization were 9.6 ± 6.3 days, 10.0 ± 6.2 days and 9.0 ± 6.0 days, respectively. The minimum duration for occurrence of the first NI infection episode was 10.0 ± 5.0 days for bacteremia, 10.0 ± 4.9 for nososcomial Pneumonia (NP), and 11.0 ± 5.7 for urinary tract infection (UTI).

Table 2. Device use ratios and Device Related Infection ratios.

Variables	Patient-days	Device utilization days	Device utilization rates[a]	No of DRI	Rate of DRI[b]
CVC-related Bacteremia	1312	1230	0,94	11	8.9
Catheter related UTI	1312	1269	96.7	6	4.7
VAP	1312	1172	89.3	24	20.5

DRI= device related infections; [a]Device-utilization days / 1,000 patient-days; [b]DRI per device-utilization days.

The mean duration of ICU was 11.6 ± 6.7 days. NI incidence density rate was 20.6 per 1,000 patient-days. Clinical diagnosis of sepsis was made in 13 patients (10.2%). Although 44 patients had clinical signs of infection and sepsis, only 27 subjects (out of 44 subjects) with positive cultures were confirmed as NI. The reasons for admission of the subjects with ICU-acquired NIs were respiratory arrest, multiple trauma, respiratory condition, cardiac arrest, hypertension, head injury with cerebral haemorrhage, diabetes mellitus and cancer. The death rate was 21.1% while the survival rate was 78.9%. Only 3.1% of death was caused by sepsis or severe NIs.

Bacterial Patterns of ICU-acquired Nosocomial Infection associated with usage of intravascular devices

Bacteremia

Bacteremia was found in 8.5% (*n*=11) of the patients within an average duration of 10.0 (5.0) days in ICU. Bacteremia rate was 8.9 per 1,000 patient-days. The most common Gram negative organisms cultured were *Escherichia coli* (*n*=1), *Klebseilla pneumoniae* (*n*=1), Extended Spectrum Beta Lactamase *Klebseilla pneumoniae (n=2)* and *Acinetobacter species* (*n*=2) whereas the Gram positive organisms showed methicillin-resistant *Staphylococcus aureus* (MRSA) (*n*=3) as the common causative organism. MRSA was also found simultaneously both in the blood and central venous cannula tip, urine and tracheal aspirate specimens.

Nosocomial Pneumonia

Nosocomial pneumonia was noticed in 24 patients (18.7%) within an average duration of 10.0 (SD=4.85) days' stay in ICU. Pneumonia rate was 20.5 per 1,000 patient-days. The most common organisms cultured from tracheal aspirates were *Acinetobacter species* (*n*=5), *Klebseilla pneumoniae* (*n*=12), *ESBL Klebseilla pneumoniae* (*n*=1) and *Pseudomonas aeroginosa* (*n*=5).

Twenty-four patients were clinically diagnosed based on progressive infiltrate in chest X-rays, leucocytosis, pyrexia above 38.5^{o}C, purulent secretion and creps in lungs. Ten patients out of the 24 had bacteraemia with the same type of organisms as the tracheal aspirate which satisfied the criteria for diagnosis of ventilator-associated pneumonia (VAP).

Nosocomial Urinary Tract Infection

Nosocomial urinary tract infection was detected in six subjects (4.7%) within a mean duration of 11.0 (SD=5.65) days. UTI rate was 4.7 per 1,000 patient-days. The organisms found in urine specimens were *Klebseilla pneumoniae* (*n*=1), *Pseudomonas aeroginosa* (*n*=1), *Pseudomonas stutzeni* (*n*=1), other *coliforms* (*n*=1), and *Candida albicans* (*n*=2).

Discussion

In the current study, the overall incidence of NI of the cohort group (21.1%) was similar to that found in other hospitals [16,22] but lower compared to the studies done in the Hospital Universiti Kebangsaan Malaysia (1988-1999) [13], University of Geneva Hospitals [(which showed the overall incidence of 23%) 20], and a study in North India with an incidence rate of 33.5% [21]. The results were within published reported rates of 12.2–39.0% [22].

Analysis for the incidence of NIs associated with the usage of devices with duration of stay in ICU revealed the mean length of stay in ICU to be 10 days. This observation was different from the Indian study [20] where the mean length of stay was 13 days. The present observation was also higher than that noticed in the study from the USA where the incidence of NI in an adult ICU was shown to be 16.2 per 1000 days of stay

in the ICU [17]. It has been stated in the literature that a longer length of stay in the hospital concurrent with the use of medical devices doubles the risk of NI per week of stay. The higher incidences of ICU NIs noted within this study period could be due to the strict inclusion criteria, shorter duration of follow-up, and smaller sample size.

The risk for infection varies vastly and could be related to an immunocompetent individual patient's resistance to intrinsic and extrinsic risk factors. Further studies need to be done to verify this observation.

Nosocomial pneumoniae (VAP) were the major and most prominent nosocomial infections observed related to usage of mechanical ventilation systems with endotracheal tubes. This observation is similar to that of a study conducted in the USA [17]. The incidence was higher compared to a study from Hospital Universiti Kebangsaan Malaysia (UKM) [13] and was lower than that reported in the USA study [18] and the Indian study [21].

A higher incidence of bacteremia was noticed among patients treated with central venous lines and those with indwelling catheters from that reported from UKM (1988-1999) and a USA study [17]. The organism isolated belonged to both Gram negative and positive groups. The main Gram negative organisms cultured were *Klebseilla pneumoniae, Pseudomonas aeruginosa* and *Acinetobacter species.* The major organisms isolated were *Acinetobacter species* in the UKM study and *Pseudomonas aeruginosa* in the American study. The main Gram positive organism isolated in this study was Methicillin-resistant *Staphylococcus aureus* (MRSA) compared to presence of *Staphylococcus aureus* in the UKM and Pakistan studies [10].

In the current investigation, a predominance of *Klebseilla pneumoniae* was observed in tracheal aspirate, blood and urine, whereas *Acinetobacter species* was isolated only in tracheal aspirate and blood. The Gram positive organism MRSA was found in blood, tracheal aspirate, and urine. These results in comparison with other reports show that the flora is probably unique to each ICU. The standards of practices followed in the ICUs could be contributing to the nature of the flora and the infection rate.

Another feature of importance observed in this study was the lack of correlation between the culture results for bacterial isolation and the clinical symptoms such as fever, leucocytosis, purulent sputum, and infiltrate on chest radiograph. As few as ten patients could be diagnosed as ventilated associated pneumonia based on the Center for Disease Control's criteria of correlation between culture positive and clinical symptoms. This has been observed by other investigators [2,3,8] suggesting that clinical symptoms and chest radiographs alone were non-specific parameters for diagnosis of VAP [5,11]. It has to be confirmed with laboratory cultures.

Kollef had stated that early onset VAP is often related to *Staphylococcus aureus, Haemophilus influenzae*, and *Streptococcus pneumoniae*; however, in our study only *Staphylococcus aureus* was found in early onset of ventilator-associated pneumonia [8].

Compared with device-associated infection rates reported by the NNIS [24], our UTI and pneumonia rates were respectively lower or similar to the other mentioned studies [23,24].

Despite the lower device-related infection findings in the current Malaysian study, incidence of device-associated infection rates in ICU further showed that management of ventilated patients with intravascular devices and indwelling urinary catheters needs to be improved. Furthermore, due to the limited therapeutic options, prevention and infection control measures are essential in the management of patients in ICU.

Conclusion

This preliminary study on incidence of NIs rates due to the usage of devices in ICUs of 3 major hospitals in Malaysia showed that the incidence of NI was high even though it was within the reported range (12.2–39.0%) of other published studies. Furthermore, the device-related infections were high in comparison to other studies. This could be due to the small sample size, strict inclusion and exclusion criteria, specific sites of study, and our diagnostic criteria. However, the incidence rate can vary according to different locations or country of study, length of stay in ICU, and risk factors.

The knowledge, attitude and practice in relation to infection control measures and recruitment of new staff could also influence the rate. All these may possibly contribute to the slightly high incidence rates of NI in our three centres. There is a need for further study on risk factors, including the development of predictive models to group patients with similar risks, in Malaysia.

This study preferably should be performed on large cohorts, taken from more ICUs in Malaysia, using standardized criteria for data collection and having diagnosis of NI related to the mentioned devices used in ICU for further confirmation of the efficacy of the surveillance method used in our study as well as

developing a calculator for assessing early risk of NI in ICU.

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References

1. Abdul Rahman MD, Wong YH, Sivalal S (1994) Health Systems Research on Nosocomial Infection Control 1990-1992. Ministry of Health Report, Malaysia.
2. Chastre J, Fagon JY (2002) Ventilator-associated pneumonia. American Journal of Respiratory and Critical Care Medicine, 165 (7): 867-903.
3. Chinsky KD (2002) Ventilator-associated Pneumonia: Is There Any Gold in These Standards? Chest 2002, 122 (6): 1883-1885.
4. Centers for Disease Control and Prevention (1994) Guidelines for prevention of nosocomial pneumonia. Infection Control and Hospital Epidemiology 1994, 5: 587-627.
5. Croce MA, Fabian TC, Waddle-Smith L, Maxwell R (2001) Identification of early predictors for post-traumatic pneumonia. American Surgeon, 67 (2): 105-10.
6. Hughes AJ, Ariffin N, Huat TL, Abdul Molok H, Hashim S, Sarijo J, Abdul Latif NH, Abu Hanifah Y, Kamarulzaman A (2005) Prevalence of nosocomial infection and antibiotic use at a University Medical Center in Malaysia. Infection Control Hospital Epidemiology, 26 (1): 100-4.
7. Haley RW (1995) The scientific basis for using surveillance and risk factor data to reduce nosocomial infection rates. Journal Hospital Infection, 1995; 30 (1): 3-14.
8. Kollef MH (1999) The prevention of ventilator-associated pneumonia. The New England Journal of Medicine, 340 (8): 627-634.
9. Lim VKE (1998) Disinfection and the Control of Nosocomial Infection. Department of Microbiology and immunology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, Kuala Lumpur, Malaysia Available:http://mma.org.my/mjm/4_nasocomial_95.htm Accessed 23 October 2003.
10. Mahmood A (2001) Blood-stream infections in a medical intensive care unit: Spectrum and antibiotic susceptibility pattern. Journal of the Pakistan Medical Association, 51 (6): 213-5.
11. Mayhall CG (2001) Ventilator-Associated Pneumonia or Not? Contemporary Diagnosis. Emerging Infectious Disease, 7(2): 200-204.
12. National Nososcomial Infectious Surveillance (NNIS) System Report, data summary from January 1992 thorough Jun, 2004, issued October 2004. American Journal of infectious Control 2004, 32 (8): 470-485.
13. Rozaidi SW, Sukro J, Dan A (2000) The incidence of nosocomial infection in the intensive care unit, Hospital Universiti Kebangsaan Malaysia: ICU acquired nosocomial infection surveillance program 1998-1999. Faculty of Medicine, Hospital Universiti Kebangsaan Malaysia, Cheras, Kuala Lumpur, Malaysia.
14. Russel E (1998) A lack of attention to infection control procedures. Nursing Times, 94 (40): 45.
15. Schmid MW (2002) Preventing Intravenous Catheter-Associated Infections: An Update. Infection Control Today, Virgo Publishing Inc.
16. Trilla A (1994) Epidemiology of nosocomial infections in adult intensive care units. Intensive Care Medicine, 20:1-4.
17. Richards MJ, Edwards JR, Culver DH, Gaynes RP (2000) Nosocomial infections in combined medical-surgical intensive care units in the United States. Infection Control Hospital Epidemiology, 21 (8): 510-5.
18. Laporan Tahunan (2005) Hospital Ipoh Kementerian Kesihatan, Official Report of Malaysian Government.
19. Sax H, Hugonnet S *et al*. (2001) Variation in nosocomial infection prevalence according to patient care settings: a hospital-wide survey. Journal of Hospital infection, 48:27-32.
20. Agarwal R, Gupta D, Ray P, Aggarwal AN, Jindal SK (2006) Epidemiology, risk factors and outcome of nosocomial infections in a Respiratory Intensive Care Unit in North India. Journal of Infection, 53, 98-105.
21. Laupland, KB *et al.* (2005) Intensive care unit-acquired urinary tract infections in a regional critical care system. Critical Care, 9, R60-5.
22. Orsi, GB (2006). Hospital-acquired infection surveillance in a neurological intensive care unit. Journal of Hospital Infection, 64, 23-29.
23. Rosenthal VD, Guzman S, Crnich C (2004) Device-associated nosocomial infection rates in intensive care units of Argentina. Infection Control Hospital Epidemiology, 25 (3), 251-5.
24. Rosenthal V D, Maki D G, Salomao R, Moreno C A, Mehta Y, Higuera F, Cuellar L.E, Arikan O A, Abouqal R, Leblebicioglu H (2006) Device-associated nosocomial infections in 55 intensive care units of 8 developing countries. Ann Intern Med, 145 (80): 582-91.

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Conflict of interest: No conflict of interest is declared.