J Microbiol Immunol Infect.
2009;42:86-91

Original Article

Bacterial contamination of patients' medical charts in a surgical ward and the intensive care unit: impact on nosocomial infections

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Received: December 30, 2007 Revised: June 27, 2008 Accepted: July 31, 2008

Background and purpose: The purpose of this study was to determine the degree of bacterial contamination of patients' files, and to compare the colonized bacteria between files from the surgical intensive care unit (ICU) and the surgical ward at the Wan Fang Hospital, Taipei, Taiwan.

Methods: 180 medical charts were randomly selected from the surgical ICU (n = 90) and the surgical ward (n = 90). The charts were sampled using sterile swabs moistened with sterile normal saline. The swabs were immediately transferred to trypticase soy broth and incubated aerobically for 48 h, then subcultured to separated sheep blood and eosin-methylene blue agars. Microorganisms were identified by the standard methods used in the microbiological laboratory.

Results: Ninety percent of charts in the surgical ICU (n = 81) and 72.2% in the surgical ward (n = 65) were contaminated with pathogenic or potentially pathogenic bacteria ($p = 0.0023$). Coagulase-negative staphylococci (CoNS) were the most commonly isolated bacteria, both in the surgical ICU (n = 40, 44.44%) and in the surgical ward (n = 48, 53.33%). Several bacteria isolated from the charts, including multidrug-resistant *Acinetobacter baumannii*, *Stenotrophomonas maltophilia*, and *Klebsiella pneumoniae*, had the same antibiogram as the same bacteria isolated from patients.

Conclusion: This study showed that the patients' charts in the ICU were usually contaminated with pathogenic and potentially pathogenic bacteria. Contaminated charts can serve as a source for cross-infection. Health care personnel should wash their hands before and after contact with the chart to reduce the nosocomial infection rate.

Key words: Cross infection; Intensive care units; Medical records

Introduction

Hospital-acquired infections (HAIs), or nosocomial infections, result in morbidity and mortality of hospital inpatients. The extended duration of hospital admission and extra drugs or medical management may contribute to additional costs for patient care. These factors increase the emotional stress of the patients and their families, and may lead to severe disability and reduce the patients' quality of life. At any one time, approximately 5% to 10% of patients have an infection acquired from a hospital after admission [1,2]. The emergence of antimicrobial resistance and nosocomial outbreaks are 2 of the most important issues associated with HAIs. Infections of the urinary tract, lower respiratory tract, blood, and surgical wounds are the most frequent type of nosocomial infections [2]. The highest prevalence of nosocomial infections occurs in busy areas of the hospital such as intensive care units (ICUs), and wards in which patients undergo invasive procedures and frequent handling of infected wounds, especially the surgical wards. More than 20% of all nosocomial infections are acquired in ICUs [3].

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The infection rates are higher among elderly, immunocompromised, and postoperative patients, as well as those with chronic disease, for whom underlying comorbid conditions remain uncorrectable, thus increasing their susceptibility to infection. In addition to host susceptibility, the source of the infectious agent and the transmission route are important elements in transmission of infection in a hospital setting. Prevention of HAIs is based on breaking the chain of infection.

HAIs are largely preventable with proper infection control implementation. The Centers for Disease Control and Prevention (CDC) has pointed out that "it is well documented that the most important measure for preventing the spread of pathogens is effective hand washing". Most guidelines recommended hand washing before and after contact with patients, before invasive procedures, and after contact with contaminated inanimate objects [1,4]. However, most health care personnel (HCP) do not wash their hands between contact with the medical charts and patients [5,6]. The patients, charts are common inanimate objects, which have the potential to be contaminated by pathogenic bacteria, and work as fomites in nosocomial infections.

To investigate the degree of contamination of patients' charts in a hospital setting, a cross-sectional study was performed to analyze the bacteria on the patients' charts and to compare the colonized bacteria between the surgical ICU and the surgical ward at Wan Fang Hospital, Taipei, Taiwan. Wan Fang Hospital is a teaching hospital and a tertiary care center located in northern Taiwan, which is managed by and affiliated to the Taipei Medical University. There are 740 beds, throughout 13 general wards and 4 ICUs, including medical, surgical, pediatric/neonatal, and emergency medical ICUs.

Methods

Sample collection

Samples were collected from the patients' medical charts from a 28-bed surgical ICU and a 43-bed surgical ward at Wan Fang Hospital. The samples were randomly collected from 180 charts, including 90 charts in the surgical ICU and 90 charts in the surgical ward, from October to December 2006. As most of the patients would be in hospital for less than 2 weeks, the samples were randomly collected at 2-week intervals to avoid repetition of sampling.

Sampling and identification

The samples were collected with sterile cotton swabs from the entire outer surface of the selected charts by an experienced medical technician using a standard collection protocol. The cotton swabs were moistened in sterile normal saline before sampling of the charts, and the sampled swabs were placed into sterile transport containers. There was no spillage or contamination of the samples during transport. The sampled swabs were immediately inoculated into a trypticase soy broth and incubated aerobically for 48 h, then subcultured to biplate media, which was composed of sheep blood agar and eosin-methylene blue agar. The isolates from the cultures were identified using standard microbiological and biochemical laboratory techniques at the hospital's microbiological laboratory. The laboratory was validated by the College of American Pathologists Laboratory Accreditation Program. The disk diffusion test was used for the measurement of antimicrobial susceptibility according to the Clinical and Laboratory Standards Institute recommendations.

Measurement

The data were integrated and analyzed after all of the samples were collected and the isolates were identified. The prevalence rates of contaminated charts in the surgical ICU and the surgical ward were analyzed. Review of the records in the sampled charts showed that the patients had had infection episodes during the 3-month study period. The isolates of the patients with infection during the investigation were assessed retrospectively and compared with the isolates from the patients' charts. The isolates were classified as Gram-positive or Gram-negative pathogens, and pathogenic or potentially pathogenic organisms. Gram-positive bacilli were deemed to be environmental flora.

Statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows (SPSS, Chicago, IL, USA). The comparison of chart contamination between the surgical ICU and the surgical ward was performed using Pearson's chi-squared test, and the statistical significance level was set at 0.05.

Results

Of the 180 patients' charts sampled, 146 (81.1%) were contaminated by pathogenic or environmental bacteria. Of the 90 charts sampled in the surgical ICU, 81 (90.0%)

Table 1. Comparison of contamination rates of patients' charts between the surgical intensive care unit and the surgical ward (n = 180).

Variable	Surgical intensive care unit (n = 90) No. (%)	Surgical ward (n = 90) No. (%)
Charts with pathogenic isolates	81 (90.0)[a]	65 (72.2)
1 isolate/chart	64	58
2 isolates/chart	17	7
Total isolates	98	72
Charts with environmental bacteria	6	24
Charts without isolates	3	1

[a] $p = 0.0023$.

were contaminated with pathogenic or potentially pathogenic bacteria. Of the 81 contaminated charts, 64 (79.0%) were monomicrobial and 17 (21%) were contaminated by 2 different bacterial species. Of the 90 charts sampled in the surgical ward, 65 (72.2%) were contaminated with pathogenic or potentially pathogenic bacteria. Of the 65 contaminated files, 58 (89.2%) were monomicrobial and 7 (10.8%) were contaminated by 2 different bacterial species. The contamination rates are summarized in Table 1.

Thirty of the 180 charts were contaminated with environmental flora only, and the ratio was higher in the surgical ward (24/90, 26.67%) than in the surgical ICU (6/90, 6.67%). Only 4 (2.2%) charts were uncontaminated by either pathogenic or environmental bacteria (Table 1).

170 pathogenic or potentially pathogenic bacteria were isolated from the charts. Coagulase-negative staphylococci (CoNS) other than *Staphylococcus epidermidis* were the most commonly isolated bacteria in both the surgical ICU (n = 40, 44.44%) and the surgical ward (n = 48, 53.33%). Of the 81 contaminated charts in the surgical ICU, 98 pathogenic bacteria were isolated (Table 2, Fig. 1). After CoNS, the most commonly isolated bacteria were *Enterococcus faecalis* (n = 11), *S. epidermidis* (n = 10), *Acinetobacter baumannii* (n = 9), and *Staphylococcus aureus* (n = 9); 5 of the *S. aureus* were methicillin resistant. In the surgical ward, 72 pathogenic bacteria were found on 65 contaminated charts (Table 2, Fig. 2). The prevalence of Gram-positive bacteria colonization (n = 59, 65.6%) was significantly higher than that of Gram-negative bacteria (n = 13, 14.4%) in the surgical ward. CoNS remained the most commonly colonized bacteria in the Gram-positive group, and most of the Gram-negative pathogens were the exogenous pathogens of humans — only 1 *Enterobacteriaceae*, *Enterobacter cloacae*, was found on the contaminated charts.

In the surgical ICU, *Klebsiella pneumoniae* isolated from 2 of 3 charts was also isolated from the corresponding patients, and one pair of isolates shared the same antibiogram of antibiotic susceptibility. Similarly, *A. baumannii* isolated from 4 of 9 contaminated charts was also isolated from the corresponding patients, although only 1 patient had the same antibiogram as the contaminated charts. Both of the *Stenotrophomonas*

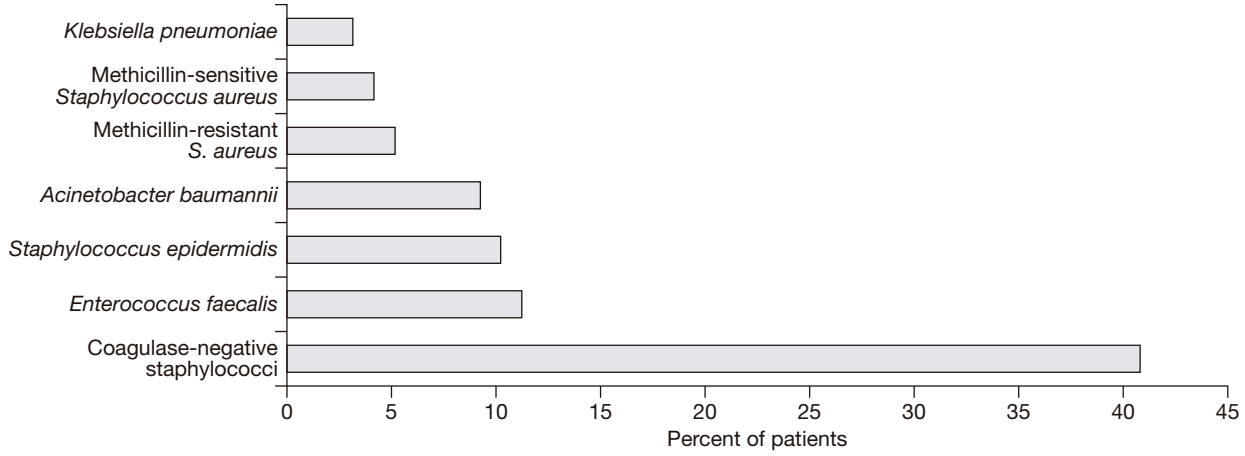

Fig. 1. Percent of bacterial isolates from patients' charts in the surgical intensive care unit (n = 98).

Table 2. Bacteria isolated from patients' charts in the surgical intensive care unit and the surgical ward.

Bacterial isolates	Surgical intensive care unit No. (%)	Surgical ward No. (%)
Gram-negative bacteria		
Acinetobacter baumannii	9 (9.2)	1 (1.4)
Klebsiella pneumoniae	3 (3.1)	0 (0)
Klebsiella oxytoca	2 (2.0)	0 (0)
Stenotrophomonas maltophilia	2 (2.0)	0 (0)
Pantoea agglomerans (formerly *Enterobacter agglomerans*)	2 (2.0)	0 (0)
Citrobacter freundii	1 (1.0)	0 (0)
Burkholderia cepacia	1 (1.0)	2 (2.8)
Flavimonas oryzihabitans (formerly *Pseudomonas oryzihabitans*)	0 (0)	2 (2.8)
Enterobacter cloacae	0 (0)	1 (1.4)
Pseudomonas stutzeri	0 (0)	1 (1.4)
Pseudomonas putida	0 (0)	1 (1.4)
Other glucose non-fermenters	0 (0)	5 (6.9)
Gram-positive bacteria		
Coagulase-negative staphylococci	40 (40.8)	48 (66.7)
Enterococcus faecalis	11 (11.2)	4 (5.6)
Staphylococcus epidermidis	10 (10.2)	4 (5.6)
Methicillin-resistant *Staphylococcus aureus*	5 (5.1)	0 (0)
Methicillin-sensitive *S. aureus*	4 (4.1)	0 (0)
Viridans streptococci	3 (3.1)	3 (4.2)
Enterococcus faecium	2 (2.0)	0 (0)
Group D *Streptococcus* (non-*enterococcus*)	2 (2.0)	0 (0)
Other streptococci	1 (1.0)	0 (0)
Total	98	72

maltophilia isolated from contaminated charts shared the same pathogens and antibiogram with the corresponding patients. All the patients with Gram-negative bacterial infection on their charts presented with pneumonia. In contrast, among the 5 patients with Gram-positive bacteria, only 3 patients associated with the corresponding 5 methicillin-resistant *S. aureus* (MRSA)–contaminated charts had MRSA infection, and 2 patients presented with pneumonia. Although CoNS was the most commonly isolated bacteria, CoNS infection was not clinically apparent. All of the patients associated with the contaminated charts were staying in the surgical ICU.

Discussion

HAIs, or health care–associated infections, are the most common complications affecting inpatients [2]. More

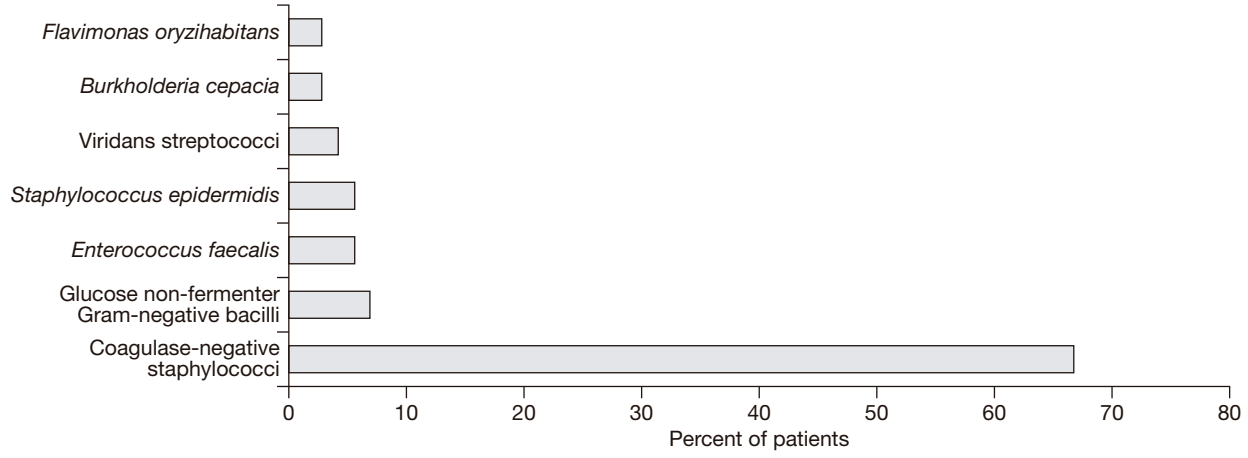

Fig. 2. Percent of bacterial isolates from patients' charts in the surgical ward (n = 72).

than 20% of HAIs are acquired in the ICU setting [3], and sepsis remains the leading cause of death in non-coronary ICUs in the United States [7]. Therefore, the surveillance of HAIs and the development of appropriate policies for infection control must have a high priority. Prevention of the transmission of infectious agents in a hospital setting can be divided into 2 parts: reducing person-to-person transmission and preventing transmission from the environment. Cross-infection of patients by the contaminated hands of HCP is a major source of infections. Hand hygiene is the single most important approach to reducing the transmission of infectious agents [8,9], but this behavioral change remains a formidable obstacle [2,6]. Most medical equipment can be cleaned and maintained according to the manufacturers' instructions, and this is part of the infection control policy of most hospitals. However, the contamination of many non-critical items, such as intravenous pumps, ventilators, computer keyboards, stethoscopes, blood pressure cuffs, electronic thermometers, and white coats of HCP, are ignored [8,10-12]. Patients' charts are commonly contaminated and can serve as a source of cross-infection [13-15].

In this study, 146 of the 180 patients' charts (81.1%) in a surgical ICU and a surgical ward were contaminated by infectious agents, and 30 charts (16.67%) were contaminated by environmental organisms. Research into the contamination of patients' charts in a large district general hospital in the United Kingdom found a 99.6% contamination rate, but most of the isolates were environmental organisms, with *S. aureus* only isolated from 3.9% of charts and no Gram-negative bacteria isolated [13]. Two studies in Saudi Arabia found that 57% to 100% of patients' charts were contaminated by pathogenic or potentially pathogenic bacteria [14,15]. The contamination rate varies in different hospitals and different parts of the world, which may be related to the infection control policies in different hospitals.

Different contamination rates have also been found within hospital departments in different areas. In this study, 90.0% of the charts in the surgical ICU and 72.2% of those in the surgical ward were found to be contaminated by pathogenic or potentially pathogenic bacteria. This difference was more significant in Panhotra et al's study, in which 85.2% of files in the ICU and 24.7% in the surgical wards were contaminated [14]. The ICU is a sealed and crowded unit to which most critically ill patients are admitted. Infected patients may serve as a source of cross-infection, and most virulent infectious agents or drug-resistant bacteria accumulate in the ICU. Debilitated patients in the ICU are at increased risk for HAIs compared with those in other areas of the hospital because of the higher number of contacts with the contaminated hands of HCP and the more frequent need for invasive procedures performed by HCP. Cross-infection due to poor compliance with hand washing may result from an increased workload in an overcrowded ICU. Many studies have demonstrated that overcrowding and understaffing appear to play an important role in outbreaks of HAIs and should be avoided [16-18]. Appropriate bedside design and furnishings enabling HCP to provide high-quality efficient care may promote infection control [19].

CoNS, including *S. epidermidis,* were the most commonly isolated bacteria in both the surgical ICU (52.0%) and the surgical ward (72.2%). At the Wan Fang Hospital, most patients are admitted to the surgical ICU for neurosurgical conditions, including traumatic or non-traumatic intracranial hemorrhage, elective or emergency neurosurgery, or ventriculoperitoneal shunting or extraventricular drainage. Most of the patients admitted to the surgical ward have orthopedic conditions, usually prosthetic joint replacement. Traumatic and post-surgical wound handling is a frequent practice in the surgical ICU and the surgical ward. CoNS are one of the most common flora colonized on the skin, and are considered relatively avirulent. However, these potentially pathogenic bacteria have become increasingly recognized as infectious agents, especially in high-risk immunocompromised patients with prosthetic devices, intravascular catheters, or other implanted devices. CoNS has become one of the most common nosocomial pathogens in the hospital setting, and most of them are multidrug resistant [20]. However, even though CoNS were the most common contaminating bacteria of the charts in this study, no corresponding patients with CoNS infection were noted.

It is interesting that the second most common bacteria isolated from the charts in the surgical ICU was *E. faecalis* (11/98, 11.2%). However, no *E. faecalis*, including vancomycin-resistant enterococci, was isolated from a corresponding patient. Three of 5 patients with MRSA contaminated charts had MRSA infection, but the antibiogram did not demonstrate a relationship between the contaminated chart and the infected patient. The Gram-negative bacteria, including *A. baumannii*, *K. pneumoniae*, and *S. maltophilia*, had undergone cross-infection between the patient and

their corresponding chart. Multidrug-resistant *A. baumannii* (1/9), *S. maltophilia* (2/2), and *K. pneumoniae* (1/3) isolated from the patients' charts had the same antibiogram as the corresponding bacteria isolated from the patients. Cross-infection of patients by HCP with contaminated hands has an impact on nosocomial infections.

There were limitations to this study. As the colonized bacteria were isolated from the outer surface of reused file folders, the causality between the infected patients and the contaminated files is questionable.

Patients' charts in the surgical ICU were mostly contaminated with pathogenic and potentially pathogenic bacteria. Contaminated files can serve as a source of cross-infection. Cleaning and disinfecting many non-critical items is difficult, especially patients' charts. Therefore, hand washing remains the cornerstone of infection control in the ICU [9], so HCP should wash their hands before and after contact with the charts to reduce the incidence of nosocomial infection.

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