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Bacterial Contamination of Computer Keyboards As A Source of Infection

KEYWORDS

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ABSTRACT *Computers are increasingly present in operating rooms, dental examination rooms, Intensive care unit and wards for bedside documentation. Recently they have been suspected as possible reservoirs for microorganisms and provide opportunities for the transfer of pathogens to patients and ultimately leading to cause nosocomial infections. A number of studies indicate that healthcare workers may contaminate their hands by touching contaminated environmental surfaces and that contaminated hands participate to transmit the pathogen to patients. Pathogens may also be transferred directly from contaminated environmental surfaces to susceptible host in health care setting.*

The purpose of this study was to examine the microbial contamination of computer keyboards with potentially pathogenic microorganisms in clinical area and to postulate that computer keyboards are significant reservoirs of nosocomial pathogen.

Sterile swab samples were received from 20 computer keyboards randomly from fifth year medical and fourth year dental students at AlJabal AlGharbi University and Gharian teaching hospital during a period of one month. These computer keyboards were used in clinical areas (in hospital sitting or dental practice unit). Microbes obtained from the specimens were identified to the species level on the basis of colony morphology, gram stain, biochemical test and API. Organisms isolated from the keyboards included Micrococci, Bacillus spp, Coagulase-negative staphylococci and less common isolates were Staph. aureus, Bacteroides, Flavobacterium spp, Listeria grayi, and Pseudomonas spp. Some keyboards were also contaminated with anaerobic environmental organisms.

The findings of this study add evidence to support the hypothesis that these particular surfaces may serve as reservoirs of nosocomial pathogens and vector for cross transmission of infection in universities and hospital setting.

Introduction:

Nosocomial infections play an important role for morbidity and mortality in modern critical clinical practice. Staphylococcus aureus is responsible for approximately 25% of hospital acquired blood stream infection. Staphylococci have a remarkable capacity to develop antimicrobial resistance. There has been a marked increase in the number of blood stream infection caused by methicilin resistant staph aureus (MRSA) and now more than 40% of Staph. aureus blood stream infections are caused by MRSA. Pseudomonas aeruginosa and Acinetobacter are also innately resistant to many antimicrobial agents and therefore have become a major cause of hospital acquired infection. The coliform bacterium primarily responsible for infections in hospital is Escherichia coli. Acquired vancomycin resistance in enterococci has been reported in many hospitals

There is lack of evidence that the hospital environment serves as a reservoir of nosocomial pathogens. In addition the role of hospital environment as reservoir of pathogen is controversial (Bures et al, 2000). Jennie Wilson has drawn attention to the fact that the healthcare environment provides opportunities for microorganisms to transfer between patients and for antimicrobial resistant strains to emerge and spread (Wilson, 2006).

Nowadays computer technology has become an essential part in the hospital, in the examination room and at patient's bedside for information management (Neely and Sittig, 2002). Computer physician order entry (CPOE) allows physicians to enter orders directly into a computer rather than hand writing. For this reason computer has become as an important part of healthcare environment and increasingly present in patient's rooms (Rutala et al, 2006). As a result of increase computer use in hospital, computer may act as a reservoir for microorganisms and contribute to the transfer of pathogen to patients. But sufficient attention has not paid to the risk of infection to the patient that these devices might bring. Transfer of microorganisms from other inanimate environmental objects to patients reveals that the presence of computer keyboards in the clinical area needs to be examined for this microbial transfer potential (Neely and Sittig,2002).

In an excellent study in 2 hospitals, Devine et al cultured 25 computer terminals for MRSA. In hospital A 42% of computers were positive for MRSA and 8% were positive in hospital B. Hospital A had a significantly higher MRSA transfer rate for its patients than hospital B. Research by Devine et al suggest that keyboards playing an important role in the transmission of the bacteria (Devine et al, 2001).

In 2004 Hartmann et al cultured 118 samples from frequently touched environmental objects in 14 surgical ICU rooms and 222 from keyboards and mice. This study shows that keyboard and mice were significantly more often contaminated than other inanimate object in hospital (Hartmann et al, 2004).). At least 16% of patients are colonized with MRSA in UK ICUs. The computer keyboards represent a high contact area for all staff in hospital area. A unique experiment conducted by Wilson et al demonstrated that MRSA was detected in 21% samples and the phage type of MRSA from keyboards near MRSA positive patients was

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similar to patient's isolates. Fifty one samples were collected from 17 keyboards by Wilson et al and CNS were found in all samples, Bacillus spp were found in 47 samples and coliforms were found in 30 samples. MSSA was detected in 3 samples from three keyboards (Wilson et al, 2005).

Computer is a new and essential event in the patient care area (Quinzio et al, 2005). However on the basis of the results mentioned above it is clear that the keyboards of computer can act as a reservoirs of pathogen like other inanimate objects and contributing to the transfer of pathogens to patients.

Healthcare associated pathogen for instance MRSA, VRE and Cl. difficile can survive day to weeks on environmental surface in hospital setting. When surfaces are touched by healthcare workers (HCWs) or patients are often contaminated their hands by such pathogens. In this way contaminated surfaces act as an important source of hand contamination among HCWs and contribute to transmission of pathogens to susceptible patient (Boyce, 2007).

Methods and Materials:
The purpose of the study was to determine which bacteria or yeasts are present on keyboards in routine use on wards and in other clinical areas.

The study was conducted at Gharian Teaching Hospital and Dental College AlJabal–AlGharbi University in April 2015 where computers are in use in clinical areas where patients are examined and treated.

Samples were obtained randomly from different students' computers keyboards. Keyboard sampling was carried out using sterile transport swab moistened with nutrient broth that was rotated over the enter key. Swabs were placed in transport media and transported to the microbiology laboratory. The swab was then inoculated immediately onto a labelled blood agar and anaerobic agar plate and incubated in air and anaerobically at 37°C. The samples were referred to numerically sample 1, sample 2 etc reflecting their chronological order. Swabs were placed in peptone water and incubated overnight at 37°C. Plates were examined at 24 and 48 hours. Broth cultures were inspected for visible growth after overnight incubation only if there was no growth of organisms on plates.

Identification and Biochemical Testing:
Where there was bacterial growth on a screening plate, a representative colony of all distinct isolates was gram-stained and appropriate additional biochemical tests performed as follows. Growth was found on all aerobic plates.

Gram positive cocci in clusters were tested for the presence of catalase enzyme using a standard hydrogen peroxide catalase test. Catalase positive isolates were subject to a commercial blue latex coagulase test (Staph Latex Kit Pro-Lab Diagnostics). Coagulase positive isolates were identified as Staphylococcus aureus. All isolates identified as Staphylococci were tested for DNAse activity. All isolates identified as Staphylococcus aureus and coagulase negative staphylococci were tested for susceptibility to methicillin on Iso-Nacl incubated for 48 hours at 30°C using the BSAC disc diffusion method. Coagulase negative isolates were presumptively differentiated into coagulase negative Staphylococci and Micrococcus spp. on the basis of the white/big colonial appearance of the former and the usual yellow or creamy, pigmented colonial appearance and gram stain (big gram positive cocci) of the latter. All anaerobic isolates on anaerobic plates were subcultured on blood agar plates to incubate aerobically and Metronidazole-5 disc susceptibility test was performed to identify strict anaerobic microbes. Formal identification of coagulase negative staphylococci to species level using API Staph strips (Biomerieux, France) was then conducted from purity plates.

All gram-positive bacilli were tested for presence of catalase enzyme. Gram positive bacilli with a gram stain demonstrating characteristic large square ended bacilli and dry colonies were presumptively identified as probable Bacillus spp. API Coryne (Biomerieux, France) was performed for aerobic Gram positive rods. All gram positive bacilli found in anaerobic plates were subcultured on blood agar plates to incubate aerobically and Metronidazole-5 disc susceptibility test was performed.

An oxidase test was performed on all gram negative bacilli and gram negative cocci. Identification of Gram negative bacilli to species level using API 20NE was performed from purity plates. Strict anaerobes were identified by comparing the aerobic subculture plates with anaerobic plates for metronidazole sensitive.

Result:
A total of twenty samples were obtained from twenty different keyboards at Gharian Teaching Hospital and Dental College AlJabal–AlGharbi University during a period of one month. Bacterial growth was found in all screening plates and there was no sterile keyboard. Isolate identified as Staph. aureus was tested for susceptibility to methicillin and it was sensitive to methicillin. Coagulase negative staphylococci (CNS) were tested for methicillin sensitivity. All CNS were methicillin sensitive except Staph. hominis found in isolate-15. The highest rate of contamination was found on keyboards with Micrococci spp. (N=16), Coagulase negative staphylococci (N=7) and Bacillus spp (N=5) .Bacteroides spp was found only in sample -14. Flavobacterium spp was isolated in sample 9 and 19. Listeria grayi was found in sample-15 and Pseudomonas luteola was identified in sample-13. Strict anaerobic environmental organisms were found in sample 4, 7,8,11,14,16,19 and 20. Gram negative cocci was found in sample-3 and sample-19. The number of colonies and identification of microbes found in each sample on blood agar plates and anaerobic agar plates after overnight and 48 hours incubation respectively at 37°C are illustrated in Table 1.

Table 1: Colonies count/plate and isolated organisms on blood agar and anaerobic plates after overnight and 48 hours incubation respectively at 37°C.

Sample	Total aerobic count/ plate	Isolated organisms	Total anaerobic count/ plate	Isolated organisms
1	14	13 (Staph.xylosus) 1 Micrococci spp., 1 GNR		
2	2	2 (Staph.aureus)		
3	15	15 GNC		
4	13	13 (Staph. simulans)	224	GPR (Environmental organism)

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5	3	3 (Bacillus spp.)		
6	65	64 (Micrococci spp.),1 (Bacillus spp)		
7	5	4 (Micrococci spp.) 1 (Staph.epidermidis)	1	GPR (Environmental organism)
8	75	75 (Micrococci spp.)	48	GPR (Environmental organism)
9	16	10 (Staph. hominis) 2 (Staph.aureus) 2 (Micrococci spp.) 1 (Bacillus spp.) 1 (Flavobacterium spp.)		
10	66	65 (Micrococci spp.), 1 GNR		
11	26	17 (Micrococci spp.) 9 (Staph.epidermidis)	7	GPR (Environmental organism)
12	8	8 (Micrococci spp.)		
13	23	13 (Pseudomonas luteola) 9 (Micrococci spp.), 1 (Bacillus spp.)		
14	7	7 (Micrococci spp.)	25	9 (GPR- Environmental organism) 16 (Bacteroid spp.)
15	49	24 (Staph. hominis) 18 (Micrococci spp) 7 (Listeria grayi)		
16	89	69 (Micrococci spp.) 20 (Staph. warneri)	155	GPR (Environmental organism)
17	206	128 (Micrococci spp.) 78 (Bacillus spp.)		
18	64	64 (Micrococci spp.)		
19	202	189 (Flavobacterium spp) 9 (Micrococci spp.), 4 (GNC)	16	GPR (Environmental organism)
20	13	13 (Micrococci spp.)	11	GPR (Environmental organism)

Discussion:

Computers are ubiquitous in the healthcare facilities. There has been increase recognition of the value of this technology in quality medical care. There are a variety of computer devices from PCs to various portable units. The availability of software packages for medical records programs to diagnostic aids increased the presence of computer in all patient care area including admission, clinical area and ICU. Recently only few studies investigate that these computer devices can serve as fomites for the harbouring and transfer of microorganisms (Neely and Sittig, 2002).

The study of Hartmann, B. et al (2004) found a large amount of colonization of potentially pathogenic microorganisms for computer keyboards and mouse than for other user interfaces in patient's room and central ward. In their study the contamination rate of keyboard and mouse was 6% when compared with other interfaces showing a rate of only 3%. The highest rate of contamination of potentially pathogenic microorganisms was found on keyboards with 5.4% Enterococcus spp. Staph. aureus was found from 3 of 222 samples (1.4%). Gram negative rods were isolated in only two samples (0.9%) taken from keyboards. The most common cultured potentially non-pathogenic organisms from keyboards were Staph. epidermidis (85%); spore forming organisms (63.5%); micrococcus spp. (57.7%); other staphylococcus spp. (33.3%) and mould (2.3%).There was no keyboard contaminated with Candida albicans (Hartmann et al, 2004).

The importance of the keyboards in hospital environment as a source of infection is the subject of this paper. In this study the selection of keyboards for sampling was random. A total of twenty environmental samples were obtained from twenty different keyboards. The most common cultured organisms from keyboards were with 80% Micrococci spp. (N=16); 35% CNS (N=7) and 25% Bacillus spp. (N=5). Staph. aureus was found only in sample-2 and 9 (10%), it was sensitive to methicillin disc according to BSAC guideline. Bacteroides spp was found only in one sample (5%). Flavobacterium spp was isolated in two samples (10%). Listeria grayi was found in sample-15 (5%) and Pseudomonas luteola was identified in sample-13 (5%). Strict anaerobic environmental organisms were found in total eight samples. No contamination with Candida albicans and MRSA occurred. This confirms the findings of Hartmann et al who detected similar rates of contamination of computer keyboards.

In this study there was no keyboard contaminated with MRSA. On the other hand the study of Wilson P et al (2006) noticed that over one third of the keyboards tested in their study were contaminated with MRSA. The organisms found in their study include CNS (100%), Bacillus spp. (92%), Coliforms (59%) and MSSA (5.8%) (Wilson et al, 2005).The reduced colonization rate compared to the findings of Hartmann et al (2004) and Wilson et al (2005) may be due to better compliance with the institution's hand washing and surface decontamination policy.

Isolated Staph. aureus on computer keyboards may act as a source of infection. Among non-pathogenic microorganisms analysis showed a contamination with anaerobic GPR being part of the environmental organisms. The contamination rate of keyboards with Micrococci spp. was comparatively high. It may be presumed that computer keyboards come into contact with provider's hands more frequently and the organism is normally present in skin microflora. The result of this study may suggest that contamination of computer keyboard may act as a possible source of cross transmission of pathogen in hospital setting.

Patient become at high risk when direct contact occur between nurses and physicians with both the patient and computer terminal at the bedside. Frequently touched computer keyboards have been implicated in nosocomial colonization and infections in various patient populations (Neely et al, 1999). Staph aureus can cause a wide range of infections from boils, impetigo to toxic shock syndrome, pneumonia, endocarditis, osteomyelitis, brain abscess. Staph aureus and Staph epidermidis have a wide range of virulence and antibiotic resistance genes which has ability

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to spread strains. In unfavourable condition Bacillus spp. can forms tough and durable spores which can vegetate when environmental condition becomes favourable. The Bacillus genus consists of numerous species but only a few are capable of causing disease in humans. These include Bacillus anthracis is the causative agent of anthrax and Bacillus cereus responsible for food poisoning. Bacteroids may cause wound infections, abscesses and peritonitis but often in mixed infections with coliforms (Irving, 2005).

It was informed by personal communication with the students that there was no specific cleaning policy for computer keyboards after using the computer in clinical area. Detergents are used to clean and decontaminate the computer keyboards. Appropriate control measures can reduce the risk of transfer of microorganisms to susceptible patients. Control measures can include the use of keyboard covers, cleaning and disinfection of appropriate computer hardware surfaces and hand washing with or without gloving of pertinent personnel (Neely and Sittig, 2002). Hand hygiene is a simple and paramount measure to prevent nosocomial infection. The object of hand washing is to decrease hand colonization with transient flora and to reduce the risk of transmission of potentially dangerous pathogens. Hand washing can be performed with soap and water or by using an alcohol based hand rub. The use of hand rub is more effective and it is faster in action (Barbe and Pittet, 2001).

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