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Contaminated operating theatre foot wear: a potential source of healthcare associated infections in a northern Nigerian hospital

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Abstract

Operating theatre foot wear (OTFWs) contaminated with potential pathogens are increasingly recognized as possible sources of healthcare associated infections (HCAIs). This study was undertaken to determine the rate of microbial contamination of OTFWs with potential nosocomial pathogens.

Sterile cotton wool tipped swabs, momentarily immersed in physiological saline, were used to collect samples from parts (i.e. surface and soles) of the OTFWs regularly worn by the operating theatre personnel at Murtala Mohammed Specialist Hospital (MMSH), Kano between January and June, 2010. These were cultured by standard procedures and examined for bacterial and fungal growth. Presence of human haemoglobin on non visible blood stained foot wear was confirmed with rapid chromatological immunoassay. Bacterial and fungal isolates were identified by standard microbiological methods.

Out of a total of 136 pieces of foot wear examined, 56 (41.2%) were found showing blood stain, while blood stain was not seen on 80 (58.8%). However, greater number 92 (68.0%) of foot wear were found to be contaminated with blood when chemical analysis was adapted.

Streptococcus spp. and *Staphylococcus epidermidis* were most frequently isolated.

The findings from this study could be used to adapt appropriate preventive measures in the theatre to limit transmission of potential pathogens for HCAIs.

Keywords: Shoes and microbiology; Operating rooms and microbiology; Cross infection.

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Introduction

Post-operative infections among surgical patients cause considerable morbidity and mortality and are associated with increased length of stay in the hospital, and increased cost of care.[1,2] However, sources of such healthcare associated infections (HCAIs) sometimes remain cryptic and unidentified.[3] Operating theatre foot wear (OTFWs) contaminated with potential nosocomial pathogens, (i.e. bacterial, fungal and viral agents) are increasingly recognized as possible sources of HCAIs among hospital personnel and surgical patients.[4,5] In the course of assessment of potential sources of nosocomial infections in operating theatre rooms and surgical wards by hospital epidemiologists or infection control practitioners, such items as OTFWs are increasingly recommended for inclusion and analyses due to associated health risk.

Operating theatre foot wear (OTFWs) are protective cover shoes or boots worn by surgeons and other theatre personnel mainly in the surgical operation room during surgery. During certain surgical interventions especially in urologic and gynaecological procedures, blood and other body fluids (with potential infectious pathogens) from patients may spill out (or from fluid mobbed material) and contaminate the OTFWs. Microorganisms circulating in the theatre environment may also settle on the OTFWs. Subsequent handling of the foot wear by the hospital personnel without adequate decontamination and necessary precaution during further contact with patients may result in transmission of infection to the user personnel and patients.[5,6]

Various studies[7-9] have examined the role and possible involvement of certain items such as surgical drapes and theatre staff attire,[7] in the transmission of HCAIs, however, there is paucity of data on OTWs as potential health risk and possible sources of infection in the hospital hence the present study. It is hoped that the outcome of this study will create awareness about the health hazards posed by contaminated OTFWs in the hospital to facilitate appropriate preventive measures for healthcare associated infections.

Materials and methods

Study location: Murtala Mohammed Specialist Hospital (MMSH) is a 500 bed secondary health care centre located in a large, densely populated (> 5 million people) cosmopolitan city of Kano, northwestern Nigeria. It provides general and specialized care (e.g. various types of surgical interventions) for the residents of the city state and other adjourning states of Jigawa and Katsina. It has three main utility operation rooms, namely Maternity, Gynaecology and Main theatres. Surgeries such as colostomy, appendectomy, prostatectomy, hydroelectomy, thyroidectomy, fistulectomy, cystostomy, cholecystectomy are carried out in the main theatre.

Microbiologic and blood stain sampling of hospital theatre foot wear

Sterile cotton wool tipped swab sticks (Merck, USA) were moistened by dipping in physiological saline and were used to swab the surface and soles (about 1.5 cm^2 area) of consecutive OTFWs in the operation theatre. These were Wellington foot wear or boots (USA) with significant and compact thread pattern with their calf – length made of poly-vinyl chloride. The status of the wearer (including consultants, surgeons, residents, doctors, House officers and theatre nurses/assistants) of each pair of the foot wear was systematically noted and assigned a number or a letter. Briefly, during sampling, two swab sticks each (Merck, USA) were used to (i) collect samples from each of the 136 pieces of the foot wear (i.e. 68 pairs) and cultured for bacterial and fungal growth. The colony forming units (cfu/1.5cm^2 area on the foot wear) of the isolates were also determined; (ii) screening for the blood stain on foot wear (Visible or non-visible) was performed using Haemascreen reagent kit (Immunostics Inc. New Jersey). Detection of human haemoglobin was achieved with Faecal Occult Blood (FOB) reagent kit (Pistis diagnostics, USA), a rapid chromatological immunoassay test. The manufacturer's guides and procedures were strictly followed in the analysis. Sampling was carried out weekly, on every randomly selected day of surgery for 12 weeks.

The initial swab stick was inoculated unto blood agar media (Oxoid, England), MacConkey agar and Manitol Salt Agar (MSA) (Merck, USA) and incubated at 37^{o}C for up to 48 hours. Developing bacterial colonies were identified by gram stain technique and biochemical characteristics.[10] Fungal isolates were identified by standard procedures[11] following 18 – 48 hrs culture

Table I. Visual and chemical detection of blood stain on theatre foot wear in MMSH, Kano Nigeria

Operation Theatre	No. of Foot wear examined	Visual assessment of Foot wear		No (%) of chemically examined foot wear showing blood stain
		No (%) showing blood stain	No (%) showing no blood stain	
Main	54	22 (40.7)	32 (59.3)	32 (34.4)
Maternity	50	22 (44.0)	28 (56.0)	40 (43.0)
Gynaecology	32	12 (37.5)	20 (62.5)	20 (21.7)
Total	136	56	80	92

on Sabouraud's Dextrose Agar (SDA, Oxoid). All foot wear indicating presence of blood stain or positive microbial culture for clinically significant organisms were identified and were recommended for full decontamination and or discarding depending on the level of contamination and integrity of the foot wear.

There was no prior notification of the theatre staff on the sampling day, while samples were obtained following completion of the normal routine cleaning processes in the operating rooms, and the foot wear ready for use in the subsequent surgical operation.

Statistical analysis: Simple percentages, mean and standard deviation were employed in statistical calculations.

Results

Table I shows the outcome of visual and chemical assessments of blood stain on the foot wear worn by the theatre staff of MMSH, Kano. Out of a total of 136 pieces of the foot wear examined, 80 (58.8%) presented with no visible blood stain while blood stain was found in the remaining 56 (41.2%) of the foot wear. However, greater number 92 (67.6%) of the foot wear were found to carry blood stain when chemical analysis was adopted. Maternity Operation theatre had the highest number (40, 43%) of blood–stained foot wear, followed by the main theatre 32 (34.4%) and gynaecology theatre 20 (22.6%) in that order.

Table II. Total counts (cfu/cm^2) of microbial isolates from the theatre staff with blood stain

Category of Theatre Staff	No. examined in pairs	No (%) of Blood stained foot wear	Total count (cfu/cm^2) of organisms from foot wear Mean (SD)	
			Upper surface	Sole
Consultant Surgeons	8	6 (75.0)	28 (52)	124 (178)
Resident Doctors	12	8 (66.7)	32 (65)	96 (169)
House Officers	6	5 (83.3)	42 (87)	126 (152)
Nurses	12	6 (50.0)	21 (66)	132 (169)
Anaesthetic Nurses	8	5 (62.5)	40 (59)	140 (185)
Theatre Assistants	5	2 (40.0)	35 (74)	126 (150)
Medical students on training	15	14 (93.3)	52 (108)	109 (142)
Total	**68**	**46**		

Table III. Microbial isolates from Operating theatre foot wear in MMSH, Kano Nigeria

Organisms	Operating Theatre/rate of occurrence (%) of organism on foot wear		
	Maternity Theatre (n=50)	Gynaecology theatre (n=32)	Main theatre (n=54)
Staphylococus aureus	2 (2.1)	0 (0)	3 (4.2)
S. epidermidis	10 (10.5)	5 (17.2)	12 (16.9)
B. circulans	20 (21.1)	0 (0)	8 (11.3)
Streptococcus spp.	10 (10.5)	8 (27.6)	4 (5.6)
Escherichia coli	2 (2.1)	1 (3.4)	10 (14.1)
Penicillium spp.	15 (15.8)	0 (0)	0 (0)
Rhizopus spp	10 (10.5)	5 (17.2)	10 (14.1)
P. putida	5 (5.3)	0 (0)	0 (0)
Klebsiella spp.	0 (0)	2 (6.9)	3 (4.2)
Proteus spp.	1 (1.1)	0 (0)	6 (8.5)
Micrococcus spp.	20 (21)	8 (27.6)	15 (21.1)
Total	95	29	71

The total bacterial counts (cfu/cm^2) recovered from the surface and soles of the foot wear worn by different category of the theatre staff are presented in Table II. Medical students officers foot wear were found with the highest rate of blood stain 14 out of 15 (93.3%) with total bacterial count mean; Upper surface 52 (108) and sole 109 (142), followed by House officers 5/6 (83.3%), total bacterial count mean; upper surface 42 (87) and sole 125 (152), consultant surgeons 6/8 (75%), total bacterial count mean; upper surface, 28 (52) and sole 124 (178) and anaesthetic nurses 5/8 (62.5%), total bacterial count mean; upper surface 40 (59) and sole 140 (185) in that order.

Table III shows the microbial isolates from the theatre foot wear sampled. A total of 95 microorganisms (bacteria and fungi) were recovered from the foot wear used in maternity theatre comprising *Streptococcus* spp. and *Staphylococcus epidermidis* (10.5% each); *Escherichia coli* and *Staphylococcus aureus* constituting 2.1% each of the potential pathogenic or opportunistic bacterial isolates. In gynaecology operating room, out of 29 organisms cultured, *Streptococcus* spp. constituted the predominant isolates 8 (27.0%) followed by *S. epidermidis* 5 (17.2%). This theatre also had the lowest number of isolates among the three operating rooms. However *S. epidermidis* was the most common isolate 12 (16.9%) on the foot wear in the main theatre of MMSH followed by *E. coli* 10 (14.1%), *Klebsiella* spp. 3 (4.2%) and *Proteus* spp. 6 (8.5%) were part of the 71 microbial flora cultured in the main theatre of the hospital. *Klebsiella* spp. was recovered twice from the foot wear in Gynaecology theatre, and *Proteus* spp. was recovered once from the foot wear in maternity theatre.

Discussion

Operating room boots serve to protect the wearer primarily from being stained with blood and other body fluid from the patient undergoing surgical procedure. However, since a report has confirmed the survival of bacteria on inanimate objects for many weeks,[12] it has been suggested that operating theatre boots could become a vehicle for nosocomial infection in the theatre.

In the present study, known nosocomial pathogens were isolated. This compares favourably with reports from other researchers.[5,13] Coagulase negative *Staphylococcus* spp. (CoNS) was the most frequently isolated bacteria which agrees with the findings of another researcher.[13] The implication of a bacterial contaminated theatre boot is that in delicate surgery such as total hip arthroplasty and open heart surgery,

where air-borne contamination is considered a possible route of transmission of nosocomial pathogens, dispersed bacterial pathogen on contaminated theatre boot could cause a fatal infection that may put the life of the patient at risk.

The increasing prevalence of HCAIs is a major health hazard and of great concern for hospitals worldwide.[14] Several links, pathways and associated factors are involved in the transmission, acquisition and dissemination of infectious agents of HCAIs. Although different mechanisms involving biologic or inanimate objects facilitating the establishment of HCAIs have been severally reported,[15-17] it is believed that many links to HCAIs have not been ascertained and may remain cryptic in the hospital environment.[18]

The presence of non pathogenic members of the skin microbial flora, environmental bacteria and even fungi, in relatively high numbers, observed in this study indicate a poor degree of cleanliness and such levels of contamination are not acceptable in an operating theatre.

Furthermore, the evidence of the presence of blood splashes on these boots as confirmed by both visual and chemical tests means that viruses such as HIV (Human immunodeficiency virus), Hepatitis A, B and C viruses could contaminate these boots early and survive on them for a long time.[19] These constitute a health hazard to the wearers and cleaners of these boots. In this study, we observed high level blood stain (68%) on the theatre foot wear regularly worn in the three operation rooms of MMSH, this is higher than the findings of other researchers.[4,13] Human blood is rich in nutrients that support microbial growth[20] and may have contributed to the significant level of microorganisms (both pathogens or opportunistic pathogens and commensals) recovered from the theatre foot wear. Some researchers[21,22] were of the opinion that this scenario often occurs due to poor level of hygiene and in some cases due to poor attitude on the part of the hospital workers towards strict adherence to the principles of sterilisation and disinfection of the site and surfaces or hospital items.

It is suggested that protocol should be established in various operating theatre that will ensure adequate care and attention to the sterilisation and cleaning of theatre room boots under the supervision of a senior staff in the theatre. If a high degree of cleanliness of the boots is achieved, it would reduce the chances to infect the cleaner, the wearer and possibly the patient undergoing surgery.

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