AMJ Australasian Medical Journal [AMJ 2016;9(1):1–7]

Microbiological burden in air culture at various units of a tertiary care government hospital in Nepal

Binaya Sapkota[1], Gopal Kumar Gupta[2], Saroj Kumar Shrestha[2], Ashish Pradhan[3], Prasant Karki[3], and Ajit Thapa[4]

1. Department of Pharmacy, Government of Nepal Civil Service Hospital, Minbhawan, Kathmandu, Nepal
2. Department of Biochemistry, Government of Nepal Civil Service Hospital, Minbhawan, Kathmandu, Nepal
3. Department of Microbiology, Government of Nepal Civil Service Hospital, Minbhawan, Kathmandu, Nepal
4. Department of Hematology, Government of Nepal Civil Service Hospital, Minbhawan, Kathmandu, Nepal

RESEARCH

Please cite this paper as: Sapkota B, Gupta GK, Shrestha SK, Pradhan A, Karki P, Thapa. A. Microbiological burden in air culture at various units of a tertiary care government hospital in Nepal. AMJ 2016;9(1): 1–7. http://dx.doi.org/10.4066/AMJ.2015.2558

Corresponding Author:
Binaya Sapkota
Minbhawan, Kathmandu, Nepal
Email: sapkota.binaya@gmail.com

ABSTRACT

Background

The environmental matrices (water, air, and surfaces) play a vital role as reservoirs of *Legionella spp*. and *Pseudomonas aeruginosa (Pseudomonas spp.)*. Hence, hospital environment control procedures are effective measures for reducing nosocomial infections.

Aims

This study was carried out to explore the profiles of microorganisms in air culture at various wards/units of a tertiary care hospital in Nepal.

Methods

A descriptive cross-sectional study was carried out at various wards/units of a tertiary care hospital in Nepal between January and September 2015 to explore the microbiological burden in inanimate objects. Each week one ward or unit was selected for the study. Bed, tap, the entire room, trolley, computer, phone, rack handles, table, chair, door, stethoscope, oxygen mask, gown, cupboard handles, and wash basins were selected for air culture testing. Ten different wards/units and 77 locations/pieces of equipment were selected for air culture by employing a simple random sampling technique. Information about the organisms was entered into the Statistical Package for the Social Sciences (SPSS) Version 22 (IBM: Armonk, NY) and descriptive analyses were carried out.

Results

Staphylococcus aureus (S. aureus), Micrococcus, coagulase negative staphylococcus (CONS), Bacillus, Pseudomonas aeruginosa, yeast, and *Acinetobacter* were the most commonly detected organisms. In the postoperative ward, *S. aureus* was the most frequently detected microorganism. *Micrococcus* was detected in four out of 10 locations. In the x-ray unit, *S. aureus* was detected in three out of four locations.

Conclusion

S. aureus, Micrococcus, CONS, Bacillus, Pseudomonas, yeast, and *Acinetobacter* were the most common organisms detected.

Key Words

Microorganism, Staphylococcus, Micrococcus, coagulase negative staphylococcus, Nepal

What this study adds:

1. What is known about this subject?

Various life-threatening, infectious microorganisms are present on the hospital's inanimate objects. These microorganisms can contribute to the morbidity and mortality of patients.

2. What new information is offered in this study?

To date, no study has published the profiles of microorganisms on inanimate objects in Nepalese hospitals.

This study's findings can be useful to prospective researchers as well as to administrators and government officials looking to make improvements.

3. What are the implications for research, policy, or practice?

This study can help Nepalese hospitals create and implement proper and effective infection control measures to improve patient safety.

Background

Staphylococcus aureus (S. aureus), Micrococcus spp., Pseudomonas spp., Proteus spp., Escherichia coli, Enterobacter, Bacillus cereus, fungi, and viruses are the main infectious microorganisms commonly found at healthcare facilities. They originate from other patients, healthcare providers, and environmental sources such as water, air, and surfaces. Aerosols generated from showers contain *Legionella* and gram-negative waterborne *Pseudomonas aeruginosa (P. aeruginosa)* and are spread via direct inhalation.[1] *P. aeruginosa* gets transmitted as a nosocomial infection because it is intrinsically resistant to most antimicrobial agents and can survive and multiply even at low temperatures and amidst disinfectants. *P. aeruginosa* colonises in the respiratory and urinary tracts, causes pneumonia and bacteraemia, and puts immunocompromised patients at the greatest risk of life-threatening infections.

Microorganisms proliferate in various indoor areas when the microorganism-laden materials are carried by means of soil, water, dust, decaying organic matter, airflow, construction materials, equipment, and any other vehicle.[1] Bacteria enter into a wound during the intra-operative period and invasive procedures. Air quality in the operating room and other areas of the healthcare institution should be carefully monitored and controlled to prevent or at least minimise nosocomial infections.[2] Risk of contamination can be minimised by providing consistent, sufficient, quality airflow to the operating room. If airflow is interrupted, rapid air turbulence can stir the settled particles and thereby increase the risk of wound contamination. A laminar airflow mechanism (horizontal or vertical depending on the nature of procedures) in the operating room is another infection prevention measure.[3]

Organisms isolated from surgical wounds include *Pseudomonas, Proteus spp., coliforms, enterococci, serratia, corynebacterium, Micrococcus, propionibacterium, anaerobes, yeast, mycobacterium, listeria*, and *bacillus. S. aureus* is one of the most common organisms associated with orthopaedic surgical site infections (SSIs).[3,4] It causes skin and soft tissue infections, pneumonia, meningitis, endocarditis, and toxic shock syndrome.[5] *S. aureus* possesses a high degree of virulence because it produces toxins and develops resistance to antimicrobial agents.[3] *Coagulase negative staphylococcus (CONS)* is also associated with orthopaedic infections and readily develops antimicrobial resistance.

Shared toys cause transmission of *Pseudomonas* among paediatric patients.[4] *P. aeruginosa* may be introduced into bones or joints via direct inoculation during surgical procedures and haematogenous spread.[3] *P. aeruginosa* causes sepsis, soft tissue infections, folliculitis, and wound infections. *Acinetobacter spp.* are detected on dry environmental surfaces such as counters, sinks, cupboards, bedding, floors, telephones, and medical charts in the vicinity of infected patients. *Acinetobacter* causes sepsis, pneumonia, and urinary tract infections (UTIs) among immunocompromised patients in intensive care units (ICUs) and burn therapy units.[1] These organisms are difficult to treat due to their innate or acquired resistance to multiple antimicrobial agents.[4] Therefore, mortality rates with diseases caused by these organisms are 17–52 per cent.[1]

Microbial contamination can be evaluated via air sampling of the environments under undisturbed conditions.[2] When air is sampled during or after human activity (e.g., walking and vacuuming), a higher number of airborne microorganisms may be detected. However, microbiologic sampling of air, water, and inanimate surfaces (i.e., environmental sampling) is an expensive and time-consuming process.[1] Regular microbiological surveillance of different hospital units, patients' surveillance by the infection control unit, formulation of rational antimicrobial use policy, and implementation of findings help reduce nosocomial infections.[6] The present study was carried out to explore the profile of microorganisms in air culture at various units of a tertiary care hospital in Nepal.

Method

Study design

A descriptive cross-sectional study was carried out at various wards and units of the Government of Nepal Civil Service Hospital to explore the microbiological burden in inanimate objects.

Recruitment methods

The present study was conducted at postoperative, medicine, gynaecology/obstetrics, haematology,

orthopaedics, the surgical ward, high care unit (HCU), operation theatre, emergency unit, and x-ray unit at the Government of Nepal Civil Service Hospital from January to September 2015. In total, 10 different wards/units and 77 locations/pieces of equipment were selected, one ward or unit per week. Bed, tap, the entire room, trolley, computer, phone, rack handles, table, chair, door, stethoscope, oxygen mask, gown, cupboard handles, wash basins, etc., were selected for air culture.

Ethics statement

The study was ethically approved by the Government of Nepal Civil Service Hospital Ethical Review Committee.

Sample frame

Inclusion criteria

All inanimate objects at various wards/units were included for air culture sampling by employing a simple random sampling technique.

Exclusion criteria

Microorganisms present directly on animate objects and healthcare staff were excluded.

Data collection and analysis

All data related to microorganisms was entered into the Statistical Package for the Social Sciences (SPSS) Version 22 (IBM: Armonk, NY). Descriptive statistics such as frequency and percentage were applied.

Results

The present study showed that *S. aureus, Micrococcus, coagulase negative staphylococcus (CONS), Bacillus, Pseudomonas, yeast,* and *Acinetobacter* were the most commonly detected organisms. *S. aureus* was the most frequently detected microorganism at the postoperative ward (six out of seven areas), the high care unit (HCU) (four out of six locations), the medicine ward (three out of five locations), the haematology ward (five locations out of eight locations), the orthopaedics ward (five out of 15 locations), the surgical ward (five out of 10 locations), and the x-ray unit (three out of four locations). At the emergency unit, *CONS* was detected at 10 out of 19 locations (Table 1).

In this study, *S. aureus* was detected in six out of seven areas (85.7 per cent) of the postoperative ward. *Micrococcus* was detected more at the gynaecology/obstetrics ward (one out of two areas). *Bacillus* was observed more at the high care unit (two out of six areas). *Pseudomonas* was observed at two areas out of eight areas of the haematology ward. *Yeast* was observed in two out of 15 areas of the orthopaedics ward. *Acinetobacter* was detected in one out of four areas of the x-ray unit (Table 2).

The present study showed that the postoperative ward was laden with 57.1 per cent *S. aureus*, 26 per cent *Micrococcus*, 29.9 per cent *CONS,* and 14.3 per cent *Bacillus*. Haematology ward was filled with 2.6 per cent *Pseudomonas*. Yeast was detected at 3.9 per cent of areas of the orthopaedics ward (Table 3).

Discussion

Each medical and/or surgical procedure at healthcare institutions involves contact between the medical devices or surgical instruments and the patients' sterile tissue or mucous membranes, and may thereby introduce infectious microorganisms. This study showed that *S. aureus, Micrococcus, CONS, Bacillus, Pseudomonas, yeast,* and *Acinetobacter* were the most common organisms detected. Javed et al. observed that *S. aureus* was predominantly isolated from urology (40.9 per cent) and neurosurgery (40 per cent), whereas *CONS* (53.7 per cent) was detected from the surgical operation theatre instruments.[7] Abdollahi et al. also found that *Micrococcus* and *Staph. epidermidis* were the most common bacteria in all wards.[8]

Bacillus, spore-forming organisms that can survive for long periods causing serious medical problems,[6] were observed more at the high care unit (33.3 per cent). *CONS* were observed more at the gynaecology/obstetrics ward (two out of two areas). This may be due to the ability of these organisms to form biofilms and may cause infections with the use of intravenous catheters.[5]

Pseudomonas was observed at two out of eight areas of the haematology ward. Nwankwo also found that the suction tube was infected with *P. aeruginosa, Proteus mirabilis,* and *Aspergillus spp.*, and isolated *P. aeruginosa* and *Streptococcus spp.* from the sink and suction tip, respectively.[9] *Pseudomonas* is ubiquitous in healthcare settings and is common among immunocompromised and critically ill patients.[5] It has minimal nutritional requirements, can grow even in distilled water, and tolerate a variety of physical conditions. Hand hygiene, glove use, and elimination of contaminated reservoirs are essential to prevent spread of *Pseudomonas*.[1]

Acinetobacter was detected in one out of four areas of the x-ray unit. Abdollahi et al. also detected that *Enterococcus* and *Acinetobacter* were the predominant pathogens in ICU and operating rooms, respectively.[8] *Acinetobacters* can live

for long periods on equipment and surfaces, are frequent patient colonisers, and pose increasing antibiotic resistance.[5] Strict adherence to hand hygiene prevents the spread of both *Acinetobacter spp.* and *Enterobacter spp.*[1]

Sterilisation is vital to ensure that medical procedures and surgical instruments do not transmit infectious microorganisms. Since sterilisation of all patient care items is not essential, healthcare policies must identify the need to clean or sterilise based on the intended use of the items. Failure to properly disinfect or sterilise equipment poses risk to the host barriers and causes person-to-person transmission (e.g., *P. aeruginosa, hepatitis B virus*). *S. aureus* and *Streptococcus pyogenes* are killed by 60–95 per cent ethyl alcohol in 10 seconds. Similarly, more than two per cent aqueous solutions of glutaraldehyde (buffered to pH 7.5–8.5 with sodium bicarbonate), effectively kill *M. tuberculosis*, fungi, and viruses within 10 minutes; and spores of *Bacillus* and *Clostridium* species in three hours.[10] In 2002, the United States Centers for Disease Control and Prevention (CDC) recommended that healthcare personnel in contact with high-risk patients in the ICU and the operating room not wear artificial fingernails and extenders due to the probability of outbreaks of *Bacillus* and candidal infections.[4]

Conclusion

The present study showed that *S. aureus, Micrococcus, CONS, Bacillus, Pseudomonas, yeast,* and *Acinetobacter* were the most common organisms detected on inanimate objects in various wards/units of a tertiary care hospital in Nepal. Hospital administrators may direct interventions to minimise microbial burdens to make hospital environment safe.

References

1. Centers for Disease Control and Prevention. Guidelines for Environmental Infection Control in Health-Care Facilities. Centers for Disease Control and Prevention. US Department of Health and Human Services, USA, 2003. [Accessed 2015 Jan 7]. Available from: http://www.cdc.gov/hicpac/pdf/guidelines/eic_in_HCF_03.pdf.
2. Napoli C, Marcotrigiano V, Montagna MT. Air sampling procedures to evaluate microbial contamination: a comparison between active and passive methods in operating theatres. BMC Public Health. 2012 Aug 2;12:594. doi: 10.1186/1471-2458-12-594.
3. Greene LR, Mills R, Moss R, et al. Guide to the Elimination of Orthopedic Surgical Site Infections: An APIC Guide 2010:1–79. [Accessed 2015 Jan 7]. Available from: http://www.apic.org/EliminationGuides.
4. Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. [Accessed on 2015 Jan 22]. Available from: http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf.
5. Sydnor ERM, Perl TM. Hospital Epidemiology and Infection Control in Acute-Care Settings. Clin Microbiol Rev. 2011 Jan;24(1):141-73. doi: 10.1128/CMR.00027-10.
6. Awosika SA, Olajubu FA, Amusa NA. Microbiological assessment of indoor air of a teaching hospital in Nigeria. Asian Pac J Trop Biomed. 2012 Jun;2(6):465-8. doi: 10.1016/S2221-1691(12)60077-X.
7. Javed I, Hafeez R, Zubair M, et al. Microbiological surveillance of operation theatres and ICUs of a tertiary care hospital, Lahore. Biomedica. 2008;24:99–102.
8. Abdollahi A, Mahmoudzadeh S. Microbial Profile of Air Contamination in Hospital Wards. Iranian Journal of Pathology. 2012;7(3):177–82.
9. Nwankwo E. Isolation of pathogenic bacteria from fomites in the operating rooms of a specialist hospital in Kano, Northwestern Nigeria. Pan Afr Med J. 2012;12:90. Epub 2012 Jul 28.
10. Rutala WA, Weber DJ, Healthcare Infection Control Practices Advisory Committee (HICPAC). Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008:1–158.

ACKNOWLEDGEMENTS

The authors are thankful to all members of the Health Care Waste Management Committee (HCWMC) and the Department of Microbiology at the Government of Nepal Civil Service Hospital for their valuable contribution throughout our research. We thank Vincenzo Bollettino, Program Director on Resilient Communities and Research Associate from the Harvard University School of Public Health who provided medical writing services on behalf of the investigators listed in this project.

PEER REVIEW

Not commissioned. Externally peer reviewed.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

FUNDING

This research did not receive any grant from any public or commercial funding agency, or not-for-profit sectors.

ETHICS COMMITTEE APPROVAL

The study received ethics approval by the Government of Nepal Civil Service Hospital Ethical Review Committee.

Table 1: Microbiological profile at various wards/units

Department	Location	Microorganism detected
Postoperative ward (Total: 7)	Bed	*Staph. aureus, CONS, Micrococcus*
	Tap	*Staph. aureus, Micrococcus, CONS*
	Corners	*Bacillus, Staph. aureus, CONS*
	Room door handle	*Staph. aureus*
High Care Unit (HCU) (Total: 6)	Trolley	*Staph. aureus*
	Phone and computer	*Staph. aureus*
	Beds	*Bacillus, Staph. aureus*
	Oxygen mask (used)	*Bacillus*
Medicine ward (Total: 5)	Room	*Staph. aureus*
	Handles rack, door and cupboard	*Bacillus, Staph. aureus, Micrococcus*
Gynaecology/Obstetrics ward (Total: 2)	Rooms and Bed	*Staph. aureus, CONS, Micrococcus*
Operating theatre (Total: 1)		*Not detected*
Haematology ward (Total: 8)	Rooms, tables, chair and beds	*Bacillus, Staph. aureus, Micrococcus*
	Wash basins at room	*Pseudomonas*
Emergency Unit (Total: 19)	Rooms, beds, tap, door, door handle	*Staph. aureus, CONS, Micrococcus*
	Trolley	*Bacillus*
	Stethoscope	*Bacillus, Staph. aureus*
	Gown	*Staph. aureus*
	Recovery bed	*Staph. aureus*
	Hand wash	*Staph. aureus*
Orthopaedics ward (Total: 15)	Tables at rooms	*Bacillus spp., Staph. aureus, Micrococcus*
	Room tap and doors	*Yeast, CONS*
	Beds	*Staph. aureus, Micrococcus*
	Swabs at beds	*Staph. aureus*
	Trolley	*Micrococcus, Staph. aureus*
Surgical ward (Total: 10)	Rooms	*Bacillus, Staph. aureus, CONS, Micrococcus*
	Observation bed and table	*Staph. aureus, CONS, Micrococcus*
	Trolley	*Staph. aureus, Micrococcus*
	Beds	*Micrococcus, CONS*
	Staff room tap handle	*Yeast*
X-Ray unit (Total: 4)	X-Ray bench	*Staph. aureus, CONS*
	CT scan injector	*Acinetobacter*
	CT scan Main	*Staph. aureus*
	Trolley	*Staph. aureus, CONS*

Staph. aureus = Staphylococcus aureus; CONS = Coagulase negative Staphylococcus; *spp.* = species

Table 2: Location-wise distribution of microorganisms at various wards/units

Microorganism	Location	Percentage of locations
Staph. aureus	Postoperative ward	85.71% (6/7)
	High Care Unit (HCU)	66.66% (4/6)
	Medicine ward	80% (4/5)
	Gynaecology/Obstetrics ward	50% (1/2)
	Haematology ward	62.5% (5/8)
	Emergency unit	42.1% (8/19)
	Orthopaedics ward	53.33% (8/15)
	Surgical ward	60% (6/10)
	X-ray unit	75% (3/4)
Micrococcus	Postoperative ward	28.57% (2/7)
	Medicine ward	40% (2/5)
	Gynaecology/Obstetrics ward	50% (1/2)
	Haematology ward	12.5% (1/8)
	Emergency unit	42.1% (8/19)
	Orthopaedics ward	20% (3/15)
	Surgical ward	40% (4/10)
CONS	Post-operative ward	71.42% (5/7)
	Gynaecology/Obstetrics ward	100% (2/2)
	Emergency unit	52.63% (10/19)
	Orthopaedics ward	6.66% (1/15)
	Surgical ward	30% (3/10)
	X-ray unit	50% (2/4)
Bacillus	Post-operative ward	28.57% (2/7)
	High Care Unit (HCU)	33.33% (2/6)
	Medicine ward	20% (1/5)
	Haematology ward	12.5% (1/8)
	Emergency unit	10.52% (2/19)
	Orthopaedics ward	13.33% (2/15)
	Surgical ward	10% (1/10)
Pseudomonas	Haematology ward	25% (2/8)
Yeast	Orthopaedics ward	13.33% (2/15)
	Surgical ward	10% (1/10)
Acinetobacter	X-ray unit	25% (1/4)

Table 3: Overall distribution of microorganisms at various wards/units

Microorganism	Location	Percentage of locations
Staph. aureus	Postoperative ward	57.14% (44/77)
Micrococcus	Postoperative ward	25.97% (20/77)
CONS	Postoperative ward	29.87% (23/77)
Bacillus	Postoperative ward	14.28% (11/77)
Pseudomonas	Haematology ward	2.59% (2/77)
Yeast	Orthopaedics ward	3.89% (3/77)
Acinetobacter	X-ray unit	1.29% (1/77)