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PREVALENCE AND IDENTIFICATION OF NOSOCOMIAL PATHOGENS AMONGST IN-PATIENTS ATTENDING SOBI SPECIALIST HOSPITAL, ILORIN, NIGERIA

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ABSTRACT

Nosocomial infections have consistently been a serious public health concern across the globe, and a major concern in developing countries. A cross-sectional, hospital-based study was carried out to assess the incidence and prevalence of nosocomial pathogens among in-patients. A total of 300 blood samples were collected from consenting in-patients within ages 0 to 26years over a period of 4 months from December 2020 and March 2021. Standardized close-ended questionnaires were administered to obtain socio-demographic data of participants. Of the 300 samples collected, 93 (31%) were positive for the presence of nosocomial pathogens. The most prevalent was *Bacillus cereus,* 53 (57%) while *Escherichia coli,* 3 (3.2%) had the least. Prevalence of infection was highest among age-group ≥26yrs (65.6%) while no infection was detected in patients <18yrs. Females (67%) had higher record of participation in this study and consequently had higher positivity (80.6%) than their male counterparts (33% and 19.4% respectively) ($p<0.05$). Gender ($p=0.003$), exposure to invasive techniques/procedures ($p=0.00$), duration of hospitalization ($p=0.039$), nature of illness (0.001) and prolonged use of antibiotics (0.00) were significant risk factors for nosocomial infection identified in this study. It is therefore pertinent to setup surveillance system for the monitoring of antimicrobial resistance that could result from continuous localized transmission of infections in healthcare facilities. Early detection of disease onset is pertinent for appropriate empirical therapy in the case of any identified blood stream infection. Likewise, adequate health awareness on the mode of transmission, impact and control of nosocomial infections is needed, to propel a conscious, self-motivated precautionary behaviour in individuals.

KEYWORDS: **Nosocomial infections; In-patients; *Bacillus cereus;* Hospitalization.**

INTRODUCTION

Nosocomial Infections (NI) are also known as Healthcare-Associated Infections (HAI) and are infections acquired by patients or persons visiting healthcare facilities, which had not been present at the time of visit. These infections have significant impact on the medical and public health wellbeing of individuals as well as the community at large. They are often responsible for significant morbidity and mortality among patients while also causing prolonged hospital admissions, increased treatment cost, promoting antimicrobial resistance as well as affecting the overall disability-adjusted life year (DALY) of patients [1,2]. Consequently, they have

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been considered as quality control index for healthcare facilities [3, 4].

Nosocomial Infections are caused by certain pathogens (referred to as nosocomial pathogens), which are contracted from hospital or healthcare environments within few days of admission [5]. Various viruses, fungi and parasites have been recognized as sources of nosocomial infections, but bacterial pathogens remain the most commonly recognized [6]. These pathogens vary, depending on patient populations, medical facilities, environment, and transmissibility. According to the US Centre for Disease Control and prevention (CDC) [7], *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus* species are the most abundant nosocomial pathogens [8].

The risk factors for nosocomial infection among hospitalized patients may include; decreased immunity among patients, increasing variety of medical procedures and invasive techniques, transmission of drug-resistant bacteria among crowded hospital populations, cross-contamination of patients via contaminated hands of healthcare givers, among others [9].

The most common types of NIs are urinary tract infections (usually catheter associated), surgical site infections (SSIs), primary bloodstream infections (BSIs) (usually associated with the use of an intravascular device), and pneumonia (usually ventilator associated) [10,11]. The major bacteria associated with NIs are *Staphylococcus aureus*, coagulase-negative *staphylococci* (CoNS), *Streptococcus pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Haemophilus influenzae*, *Klebsiella pneumoniae*, *Acinetobacter baumannii* and Enterococci [12,13].

Nosocomial infections, recognized by the World Health Organization (WHO), has public health concern, occur worldwide and affect both developed and developing countries. These infections have contributed to increase in mortality and financial burden in most healthcare facilities across the globe, however, paucity of reliable data and surveillance systems have hampered the knowledge of an accurate global burden of nosocomial infections. Epidemiological studies from Europe and the United States have been reported, showing varying prevalence of nosocomial infections in healthcare facilities. About 8.9 million episodes of nosocomial infections are reported to occur yearly in various health care facilities in Europe [14]. In the United States, about 1.7 million cases was reported in the early 2000s, while a reduced prevalence of about 687,000 was reported in 2015 [15, 16]. In Nigeria, nosocomial infection reports across various health facilities have observed infection rates of 2.7% in Ile-Ife, 3.8% in Lagos and 4.2% in Ilorin amongst others [17-20].

The lack of uniform data and standardized procedure have hampered the availability of epidemiological data to ascertain the extent of nosocomial infections in the country, which has also impacted the effective implementation of control and preventive measures. Hence, this study was conducted to determine the occurrence and risk factors associated with nosocomial pathogens in a healthcare facility in Ilorin.

METHODS

Study Design

A cross-sectional hospital-based study was carried out among in-patients aged 0-26 years, attending the Sobi Specialist Hospital, Alagbado, Ilorin. Specimen and patient's data were collected over 1 month. All available and consenting patients within the age-group, irrespective of gender, were recruited for this study.

Study Area

Ilorin is the Capital of Kwara State in North-Central Nigeria, and the largest city in the State. It is located on Latitude 8° 29' 47.90" N and Longitude 4° 32' 31.70" E (Figure 1). With an area of 765km^2 and population of above 960,000 (2016 National Population Census), the city is inhabited majorly by the Muslim Yorubas, however, the Christian faithful are well represented. Food and cash crops such as yams, sorghum, peanuts, cassava, peppers, millet, rice, etc. are grown within and around Ilorin. Residents are majorly business men and women, with a good representation of Academia, Health Professionals, Civil Servants, Artisans, and other occupations in the city.

Study Population

This study was carried out among hospitalized patients (children, adults and aged) with the following inclusion criteria: Patients who had been hospitalized for 24 hours and above; Patient with Fever, headache and rashes; Patients who had undergone surgery; Redness, warmth, swelling, and pain from a surgical incision; Oozing of fluid (blood and/or pus) from a surgical wound; Patients with invasive devices such as catheter and Patient with severe cough, shortness of breath, and nausea and vomiting. While patients with less than 24 hours hospital stay were excluded irrespective of other stated inclusion criteria.

Ethical Consideration

Ethical approval for this study was obtained from the University of Ilorin Ethical Review Committee and the Kwara State Ministry of Health Ethical Review Committee (MOH/KS/EU/777/341). Consent was obtained from patients or the guardian/parents of respective participants.

Sample and Data Collection

Standardized and pre-tested questionnaires were administered to all subjects recruited for this study to obtain socio-demographic data of age, gender, education, occupation, etc. Other information such as patients' medical history, use of antibiotics and exposures to the risk factors associated with nosocomial infection were also collected.

About 5ml of blood samples were obtained using a sterile needle and syringe and dispensed directly into sterile blood culture bottles containing thioglycolate broth. This was placed in ice packs and transported to the laboratory for analysis. Samples were labeled with the same identification codes as written on the questionnaires filled by the patients.

Procedure for Isolation and Identification of Isolates

The samples in the thioglycolate broth were incubated for 5 days at 37ºC and later sub-cultured by streaking a loopful of the culture suspension on solidified MacConkey and Blood agar plates. This was incubated at 37ºC for 24 – 48 hours. Colonial morphology, Gram staining as well as biochemical identification (through the use of Hi25™ Enterobacteriaceae identification kit) was conducted.

Statistical Analysis

Data obtained were analysed using the Statistical Package for Social Science (SPSS) version 26. The statistical significance was at $p < 0.05$. Risk factors associated with nosocomial pathogens among in-patients were analysed using multivariate analysis. Values < 0.05 were considered statistically significant.

RESULTS

Demographic Characteristics and Risk Factor Assessment

The age distribution of participants is highlighted in Figure 2, where 4% were <18 years, 8.3% were within 18-19 years and the most represented group were age-group of 26 years and above (65%). Of the 300 patients recruited, 201 (67%) were females while males were 99 (33%) (Figure 3). The socio-demographic characteristics of subjects are outlined in Table 1.

The medical history and predisposing factors associated with bacterial pathogens causing nosocomial infections are outlined in Table 2. About 99.3% of the subjects have been hospitalized within 3 weeks, while 0.7% were hospitalized for more than 3 weeks. Over 80% of the participants had no recent surgical procedures, however, most of the participants reported antibiotics therapy of 1-3 weeks (82.3%), 3 weeks to 3 months (12%) and >3 months (5.7%) respectively. About 7% of the participants were exposed to invasive devices during hospitalization. (Table 2).

Isolation of Bacteria

Overall, 93 (31%) of the 300 samples yielded bacterial growth (Table 3). *Bacillus cereus* was the most predominant isolate, occurring in 53 (57%) of the total 93 positive plates. *Staphylococcus aureus* (31 (33.3%), *Klebsiella pneumoniae* (6 (6.5%)) and *Escherichia coli* (3 (3.2%)) were also isolated respectively (Table 4).

Age-group of 26 years and above had the highest occurrence of infection (65.6%), while 22-23 years had the least (3.2%). No infection was observed in age-group <18 years. In this study, females, 75 (80.6%), were more infected than their male counterparts, 18 (19.4%) (Table 4).

Risk Factors Association

Results from this study identified gender, exposure to invasive techniques, duration of hospitalization, nature of illness and prolonged use of antibiotics as the probable risk factors associated with nosocomial infection of bacterial pathogens (Table 5).

DISCUSSION

The overall prevalence of nosocomial infection among the in-patients examined in this study is 31%. This shows a high prevalence of nosocomial infection in the study area and agrees with the findings of Muhammad et al, [21] that reported a high prevalence of nosocomial infection amongst Academic and Non-Academic communities. Consistently high prevalence (23.1% and 26.6%) of nosocomial infection among in-patients have been reported over the past decade in Nigeria and Africa as a whole [22,23]. This is a wake-up call for the appropriate health agencies, policy makers and individuals on the continuous rise of nosocomial infections towards preventive or control strategies to stem the burden. Also, there is need for implementation of qualitative and sustainable

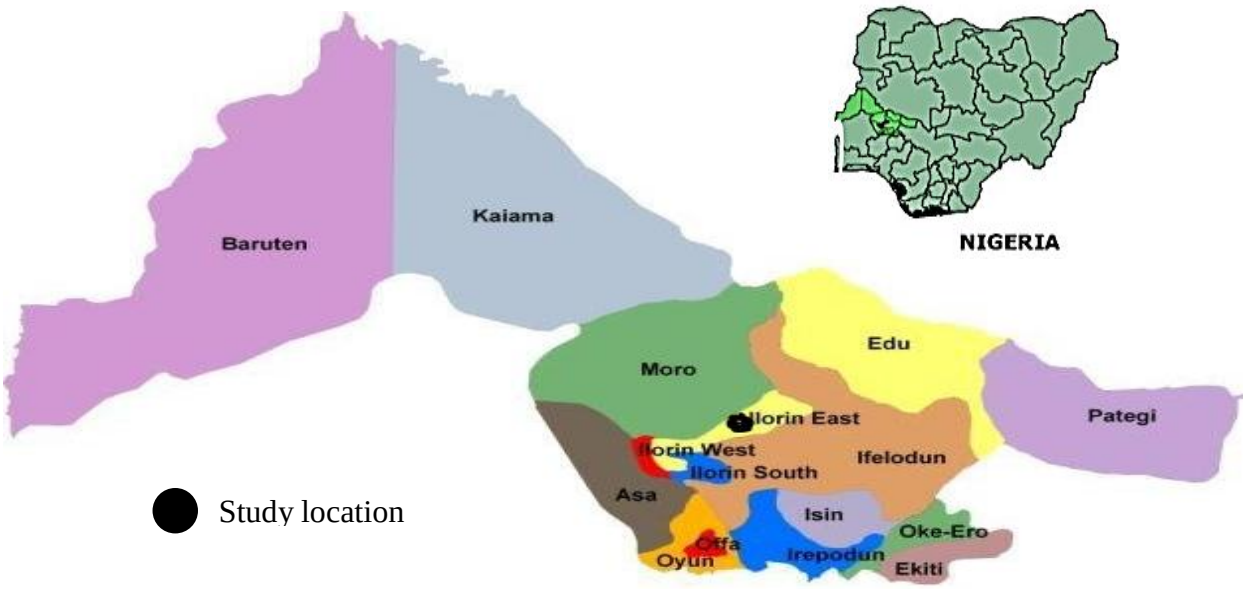

Figure 1: Map of Nigeria indicating Ilorin East, Kwara State.

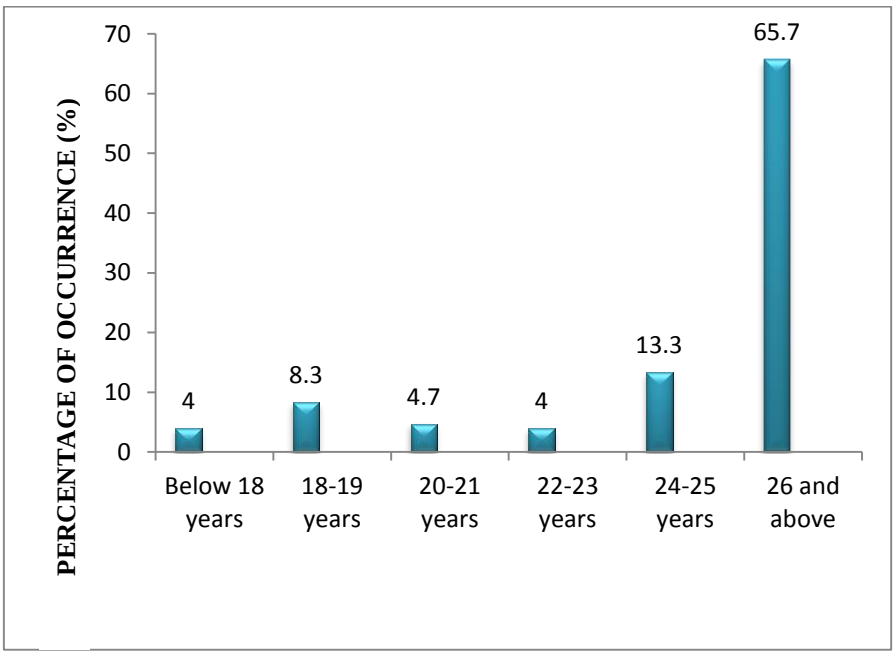

Figure 2: Age distribution among subjects.

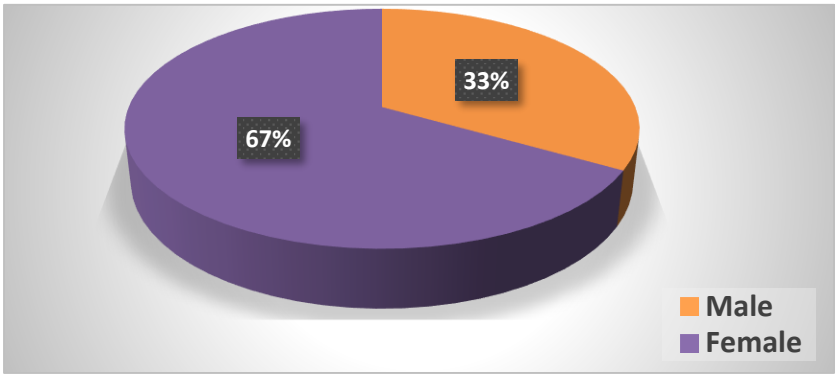

Figure 3: Gender distribution among subjects.

Table 1: Demographic Data of subjects

Parameters	Frequency (%)
EDUCATIONAL LEVEL	
No Education	34 (11.3)
Primary	74 (24.7)
Secondary	77 (25.7)
Tertiary	115 (38.3)
RELIGION	
Christian	67 (22.3)
Muslim	233 (77.7)
MARITAL STATUS	
Single	76 (25.3)
Married	204 (68.0)
Widow	20 (6.7)
Divorced	0 (0.00)
OCCUPATION	
Student	79 (26.3)
Civil Servant	54 (18.0)
Self Employed	167 (55.7)

Table 2: Medical history and predisposing risk factors

FEATURES	Frequency (%)
DURATION OF HOSPITALIZATION	
Within 3 weeks	298 (99.3)
More than 3 weeks	2 (7)
NATURE OF ILLNESS	
Infectious	261 (87)
Non-infectious	39 (13)
RECENT SURGICAL PROCEDURE	
Yes	38 (12.7)
No	262 (87.3)
DURATION OF ANTIBIOTICS USE	
1-3 weeks	247 (82.3)
3 weeks-3 months	36 (12)
3 months and above	17 (5.7)
QUALITY OF HOSPITAL HYGIENE	
Poor	0 (0)
Fair	73 (24.3)
Good	197 (65.7)
Very good	20 (6.7)
Excellent	10 (3.3)
PREVIOUS DIAGNOSIS OF DISEASE	
Yes	61 (20.3)
No	239 (79.7)
PREVIOUS ADMISSION	
Yes	64 (21.3)
No	236 (78.6)
DURATION OF PREVIOUS ADMISSION	
No previous history of hospital admission	234 (78.0)
Less than 3 weeks	50 (16.7)
Within 3 weeks	5 (1.7)
More than 3 weeks	11 (3.7)

Table 3: Summary of isolates obtained from subjects

ISOLATES DISTRIBUTION					
Isolates	***Bacillus cereus***	***Staphylococcus aureus***	***Klebsiella pneumoniae***	***Escherichia coli***	**Total (%)**
No. (%)	53 (57)	31 (33.3)	6 (6.5)	3 (3.2)	93 (100)

Table 4: Gender and Age Distribution among positive isolates

Characteristics	*Bacillus cereus*	*Staphylococcus aureus*	*Klebsiella pneumoniae*	*Escherichia coli*	TOTAL (%)
AGE					
Below 18	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18-19	8 (15.1)	5 (16.1)	0 (0)	0 (0)	13 (14)
20-21	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22-23	3 (5.7)	0 (0)	0 (0)	0 (0)	3 (3.2)
24-25	8 (15.1)	2 (6.5)	6 (100)	0 (0)	16 (17.2)
26 and above	34 (64.2)	24 (77.4)	0 (0)	3 (100)	61 (65.6)
TOTAL	53 (100)	31 (100)	6 (100)	3 (100)	93 (100)
GENDER					
Male	10 (18.9)	6 (19.4)	0 (0)	2 (66.7)	18 (19.4)
Female	43 (81.1)	25 (81)	6 (100)	1 (33.3)	75 (80.6)
TOTAL	53 (100)	31 (100)	6 (100)	3 (100)	93 (100)

Table 5: Multivariate analysis of the risk factors in association with nosocomial pathogens
P <0.05 - Statistically significant

S/N	Variables		No. Positive (%)	No. Negative (%)	Total (%)	Mean square (x^2)	P-value
1	**Age**	Below 18	0 (0)	12 (5.8)	12 (4.0)		
		18-19	13 (14)	12 (5.8)	25 (8.3)		
		20-21	0 (0)	14 (6.8)	14 (4.7)		
		22-23	3 (3.2)	9 (4.3)	12 (4.0)		
		24-25	16 (17.2)	24 (11.6)	40 (13.3)		
		26 and above	61 (65.6)	136 (65.7)	197 (65.7)	0.98	0.79
2	**Gender**	Male	18 (19.4)	82 (39.6)	100 (33.3)		
		Female	75 (80.6)	125 (60.4)	200 (66.7)	0.90	0.003
3	**Duration of Hospitalization**	Within 3 weeks	93 (100)	205 (99.0)	298 (99.3)		
		More than 3 weeks	0 (0)	2 (1.0)	2 (0.7)	0.00	0.039
4	**Nature of Illness**	Infectious	73 (78.5)	188 (90.8)	261 (87.0)		
		Non infectious	20 (21.5)	19 (9.3)	39 (13.0)	0.61	0.001
5	**Recent Surgical Procedure**	Yes	13 (14.0)	25 (12.1)	38 (12.7)		
		No	80 (86.0)	182 (87.9)	262 (87.3)	0.12	0.40
6	**Duration of Antibiotics Use**	1-3 weeks	68 (73.1)	179 (86.5)	247 (82.3)		
		3 weeks - 3 months	18 (19.4)	18 (8.7)	36 (12.0)		
		3 months and above	7 (7.5)	10 (4.8)	17 (5.7)	1.50	0.00
7	**Exposure to Invasive Device**	Yes	11 (11.8)	10 (4.8)	21 (7.0)		
		No	82 (88.2)	197 (95.2)	279 (93.0)	0.31	0.00
8	**Previous Hospitalization**	Yes	21 (22.6)	42 (20.8)	64 (21.3)		
		No	72 (77.4)	164 (79.2)	236 (78.7)	0.40	0.10
9	**Duration of Previous Hospitalization**	Less than 3 weeks	17 (18.3)	33 (15.9)	50 (16.7)		
		Within 3 weeks	3 (3.3)	2 (1.0)	5 (1.7)		
		More than 3 weeks	1 (1.1)	10 (3.3)	11 (3.7)	0.48	0.40

monitoring protocols in healthcare facilities to ensure that there is proper adherence to standards of practice, as well as provision and usage of the required amenities and equipment in healthcare facilities.

The highest prevalence of nosocomial infection was observed among age-group 26 years and above in this study, while 22-23 years had the least infection rate (3.2%). This correlates with the findings from other research [24-27] which also reported a higher prevalence of infection amongst older age-group of 20 years and above. This indicates notable relationship between age and acquisition of nosocomial infection. Findings from Chen et al. [28] research provides evidence that suggests a considerable increased risk of infection among older patients, particularly above 60-65 years. According to the concept of immunoscience which explains the change in immune responses as a result of aging, individuals belonging to older age groups are more susceptible to infectious diseases, cancer development and auto immune responses [29,30].

This study identified female in-patients to be more infected than males, similar to previous findings [31-33]. However, Aleksa et al. [34] reported higher infections among males. The relationship between gender and infection in this study was significant, indicating that there is a higher chance for females to contract nosocomial infection than males. The need for longer healthcare and attention among female patients, involvement in activities that promotes physical contact with other patients, formites or healthcare workers in the hospital premises are likely factors that may be responsible for the higher prevalence of nosocomial infection observed in this study. Nevertheless, a wider study group is needed to ascertain the significance of gender on nosocomial infection.

Gender, exposure to invasive techniques, duration of hospitalization, nature of illness and prolonged use of antibiotics were identified as the major risk factors for nosocomial infection in this study ($p<0.05$). Factors such as age, duration of antibiotics use, recent surgical procedure, previous hospitalization and duration are confounding risk factors for nosocomial infections, however, in this study, they were not significantly associated with nosocomial infections. We observed a high prevalence of nosocomial infection among patients with recent surgical procedures, which also corroborate multiple reports from other studies [35-37], where surgical wards are consistent hot-spots for nosocomial infections. This could be as a result of substandard surgical procedure, unethical conduct of healthcare professionals during procedure and/or contamination due to improper dressing or exposure after a surgical procedure. This, therefore, calls for implementation and monitoring of standard surgical procedures, particularly in developing countries.

Of the 93 bacterial isolates identified in this study, *Bacillus cereus* (57%) had the highest occurrence while *E. coli* (3.2%) had the least. The high occurrence of *B. cereus* may be due to food poisoning, blood stream infections and respiratory tract infections, as highlighted by Arnesen et al. [38]. Majority of the isolates (81%) were recovered from blood samples of female patients.

There is need for a larger sample size to be examined, as well as inclusion of different geopolitical zones, in order to ascertain the significance of the risk factors, the severity and the extent of the burden of nosocomial infections amongst the populace.

CONCLUSION

This study recorded a high prevalence of nosocomial infection among in-patients receiving treatment at Sobi Specialist Hospital in Ilorin, with *Bacillus cereus* being the most abundant isolate. The associated risk factors identified in this study also clarifies that it is imperative to adopt a rapid, effective and consistent intervention measure towards early detection, analysis and prevention of outbreak that could result from hospital-acquired infections. Appropriate empirical therapy should commence immediately after blood stream infection is identified. Rapid detection methods could also be appropriated in hospitals and other healthcare facilities to facilitate detection of pathogens alongside proper dissemination of information to necessary health management bodies for the purpose of epidemiological survey and awareness.

Finally, there is need for adequate health education on the mode of contact, transmission, impact and control of nosocomial infections for patients and healthcare workers, in order to propel a conscious, self-motivated precautionary behaviour in individuals.

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REFERENCES

1. Rosenthal VD, Maki DG. Mehta Y, International Nosocomial Infection Control Consortium (INICC) report, data summary of 43 countries for 2007-2012. Device-associated module. Am J Infect Control, 2014, 42(19):42-56.
2. Cassini A, Plachouras D, Eckmanns T, Burden of six healthcare-associated infections on European population health: estimating incidence-based disability-adjusted life years through a population prevalence-based modelling study, PLoS Med, 2016, 13e1002150.
3. Watson CM, Al-Hasan MN, Bloodstream infections and central line-associated bloodstream infections. Surg. Clin. North Am., 2014, 94(6):1233-44.
4. Luangasanatip N, Hongsuwan M, Limmathurotsakul D, Lubell Y, Lee AS, Harbarth S, Comparative efficacy of interventions to promote hand hygiene in hospital: systematic review and network meta-analysis. BMJ, 2015, 351:h3728.
5. Medubi SA, Akande TM, Osagbemi GK, Awareness and pattern of needle stick injuries among health workers at University of Ilorin Teaching Hospital, Ilorin, Nigeria, Afr. J. Cln. Exper. Microbio, 2006, 7 (3): 183-187.
6. Dembri L, Zervos MJ, Heirholzer WJ, Nosocomial bacterial infections, 3rd ed. p.501-528. In E.A Brachman (ed.). Bacterial infection in humans, 1998, New York. N.Y. Plenum Publishing Corporation.
7. CDC, Outbreak of Multidrug-resistant Tuberculosis at a Hospital - New York City, 1993. MMWR;42:427–34.
8. Wren MWD, Rollins MSM, Jeanes A, Hall TJ, Coen PG, Gant VA, Removing bacteria from hospital surfaces: a laboratory comparison of ultramicrofibre and standard clothes, Journal of Hospital Infection, 2008, 70: 256-271.
9. Tabatabaei S, Behmanesh P, Osmani S, Pour F, Epidemiology of hospital-acquired infections and related antimicrobial resistance patterns in a tertiary-care teaching hospital in Zahedan, Southeast, Iran. Int. J. Infect, 2015, 2(4); 3–8.
10. Wenzel R, Health care–associated infections: major issues in the early years of the 21st century. Clin. Infect. Dis, 2007, 45(1); 85–88.
11. Shoaei S, Sali S, Yousefi H, Incidence and resistance patterns of nosocomial infections in Labbafi Nezhad hospital admitted patients during 2012-2014, Tehran, Iran. Infect. Epid. Micro, 2017, 3(3); 78–81.
12. Siddique T, Farzand S, Waheed S, Khan F, Frequency and etiology of nosocomial infections in medical unit-I, Nawaz Sharif Social Security teaching hospital, Lahore, Pak. J. Med. Sci, 2012, 6(2), 499-501.
13. Davoudi A, Najafi N, Shirazi M, Ahangarkani F, Frequency of bacterial agents isolated from patients with nosocomial infection in teaching hospitals of mazandaran University of medical sciences in Casp. J. Int. Med, 2012, 5(4), 227–231.
14. Suetens C, Latour K, Kärki T, Ricchizzi E, Kinross P, Moro ML, Jans B, Hopkins S, Hansen S, Lyytikäinen O, Reilly J, Deptula A, Zingg W, Plachouras D, Monnet DL, Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. Euro Surveill, 2018, 23:46.
15. Klevens RM, Edwards JR, Richards CL, Estimating health care-associated infections and deaths in U.S. hospitals. Public Health Rep. 2007, 122 (2):160- 166.
16. Magill SS, O'Leary E, Janelle SJ, Thompson DL, Dumyati G, Nadle J, Wilson LE, Kainer MA, Lynfield R, Greissman S, Ray SM, Beldavs Z, Gross C, Bamberg W, Sievers M, Concannon C, Buhr N, Warnke L, Maloney M, Ocampo V, Brooks J, Oyewumi T, Sharmin S, Richards K, Rainbow J, Samper M, Hancock EB, Leaptrot D, Scalise E, Badrun F, Phelps R, Edwards JR, Emerging Infections Program Hospital Prevalence Survey Team. Changes in Prevalence of Health Care-Associated Infections in U.S. Hospitals. N Engl J Med, 2018, 01;379(18):1732-1744.
17. Harris DD, Pacheco A, Lindner AS, Detecting potential pathogens on hospital surfaces: An Assessment of Carpet Tile Flooring In The Hospital Patient Environment. J. Ind. Bui. Envi. 2010, 19(2): 239-249.
18. Adejobi, A, Ojo O, Alaka O, Odetoyin B, Onipede A, Antibiotic resistance pattern of Pseudomonas spp. from patients in a tertiary hospital in South-West Nigeria. Germs, 2021, 11(2), 238–245.
19. Maitanmi OJ, Anise I, Knowledge and Preventive Practices of Nosocomial Infections among Health Workers in Two Selected Tertiary Hospitals in Ogun State. Int. J. Car. Sci. 2021, 14 (1); 174-184.
20. Stanley C, Ekada I, Prevalence, Distribution, and Antibiotic Susceptibilities of Nosocomial

Infections at a Tertiary Hospital in Port Harcourt, Nigeria, Inf. Contr. Hosp. Epid. 2020, 41(S1), S359-S359. doi:10.1017/ice.2020.980.
21. Muhammad W, Mohamed A, Yong-Fang K, Juan AP, Robert W, Ashwani SK, Higher Frequency of Hospital-Acquired Infections but Similar In-Hospital Mortality Among Admissions with Alcoholic Hepatitis at Academic vs. Non-academic Centers, Front. Physiol. 2020, 11; 1497 DOI=10.3389/fphys.2020.594138 .
22. Gutema G, Håkonsen H, Engidawork E, Multiple challenges of antibiotic use in a large hospital in Ethiopia – a ward-specific study showing high rates of hospital-acquired infections and ineffective prophylaxis. BMC Health Serv Res, 2018, 18; 326.
23. Izadi N, Eshrati B, Etemad K, Mehrabi Y, Hashemi-Nazari S, Rate of the incidence of hospital-acquired infections in Iran based on the data of the national nosocomial infections surveillance. New Microbes New Infect. 2020, 38.
24. Mythri H, Kashinath KR, Nosocomial infections in patients admitted in intensive care unit of a tertiary health center, India. Ann. Med. Health Sci Res, 2014, 4(5), 738-741.
25. Sahu MK, Siddharth B, Choudhury A, Vishnubhatla S, Singh SP, Menon R, Kapoor PM, Talwar S, Choudhary S, Airan B, Incidence, microbiological profile of nosocomial infections, and their antibiotic resistance patterns in a high volume Cardiac Surgical Intensive Care Unit. Ann. Card. Anaesth 2016, 19 (2), 281–287.
26. Zhang J, Zhao C, Chen H, Li H, Wang Q, Wang Z, Zhang F, Wang H, A multicenter epidemiology study on the risk factors and clinical outcomes of nosocomial intra-abdominal infections in China: results from the Chinese Antimicrobial Resistance Surveillance of Nosocomial Infections (CARES) 2007-2016. Infect. Drug Res 2018, 11, 2311–2319.
27. Ebrahimzadeh A, Allahyari E, Nikoomanesh F, Zare-bidaki F, A Comparative Analysis of Nosocomial Infections between Internal and Surgical Intensive Care Units of a University Hospital in Birjand, Iran from 2015 to 2016: A Retrospective Study. 2020.
28. Chen S, Zhang Z, Yang J, Wang J, Zhai X, Bärnighausen T, Wang C, Fangcang shelter hospitals: a novel concept for responding to public health emergencies. Lancet. 2020, 395 (10232), 1305-1314.
29. Castelo-Branco C, Soveral I, The immune system and aging: A Review. Gynecol. Endocrinol, 2013, 30(1):16-22.
30. Simon A, Hollander G, McMichael A, Evolution of the immune system in humans from infancy to old age. Proc. Royal Soc. B, 2015, 282(1821):20143085.
31. Zheng YL, Wan YF, Zhou LY, Ye ML, Liu S, Xu CQ, Chen JH, Risk factors and mortality of patients with nosocomial carbapenem-resistant *Acinetobacter baumannii* pneumonia. Am. J. Infect. Control, 2013, 41(7), e59-e63.
32. Graves N, Tong E, Morton AP, Halton, K, Curtis M, Lairson D, Whitby M, Factors associated with health care-acquired urinary tract infection. Am. J. Infect. Control, 2007, 35(6), 387-392.
33. Mulu W, Kibru G, Beyene G, Damtie, H, Associated risk factors for postoperative nosocomial infections among patients admitted at Felege Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia. Clin Med Res. 2013, 2(6), 140-7.
34. Aleksa D, Branko M, Ivana M, Nikola M, Andja C, Snezana J, Goran S, Goran S, Hospital-acquired infections in the adult intensive care unit-Epidemiology, antimicrobial resistance patterns, and risk factors for acquisition and mortality. Am. J. Infect. Control, 2020, 48 (10), 1211-1215.
35. Peterson LR, Brossette SE, Hunting health care-associated infections from the clinical microbiology laboratory: passive, active and virtual surveillance. J. Clin. Microbiol. 2002, 40:1–4.
36. Samuel SO, Kayode OO, Musa OI, Nwigwe GC, Aboderin AO, Salami TAT, Taiwo SS, Nosocomial infections and the challenges of control in developing countries. Afr. J. Cln. Exper. Microbiol, 2010, 11(2): 102-110.
37. Mukagendaneza MJ, Munyaneza E, Muhawenayo E, Nyirasebura D, Abahuje E, Nyirigira J, Harelimana JD, Muvunyi TZ, Masaisa F, Byiringiro JC, Hategekimana T, Muvunyi CM, Incidence, root causes, and outcomes of surgical site infections in a tertiary care hospital in Rwanda: a prospective observational cohort study. Patient Saf. Surg. 2019, 13:10.
38. Arnesen SLP, Fagerlund A, Granum PE, From soil to gut: *Bacillus cereus* and its food poisoning toxins. FEMS Microbiol. Rev. 2008, 32: 579-606.