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Original Research Article

Hospital-Acquired Infection and its Associated Risk Factors among Patients Admitted to a Tertiary Care Hospital at District Mahasamund, Chhattisgarh: A Longitudinal Study

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Conflict of interest: Nil

Abstract:

Background: The rates of hospital-acquired infections are rapidly increasing across the globe, especially, in developing nations including India. In the Indian scenario, the data on hospital-acquired infections is scarce in the literature.

Aim: The present study aimed to assess hospital-acquired infection and its associated risk factors among patients admitted to a tertiary care hospital in the district of Mahasamund, Chhattisgarh.

Methods: In 508 admitted subject's risk factors, prevalence, and incidence were assessed throughout their stay in the hospital. In suspected subjects of hospital-acquired infection, biological specimens were taken and subjected to microbiological analysis. Laboratory and clinical data were statistically analysed.

Results: The overall prevalence and incidence of hospital-acquired infection were 20% and 29% per 1000 patient days respectively. The highest and lowest incidence was seen in ICU and ophthalmology departments respectively with 208.53 and 0.96 per 1000 patient days. In surgical subjects, high risk was seen with previous hospitalization history, and in non-surgical subjects with underlying disease, mechanical ventilation, and chest tube. Hospital-acquired infection led to increased hospital mortality and prolonged stay in study subjects (6.1 more days).

Conclusion: The present study concluded a high burden and poor outcomes of discharge in subjects at tertiary care hospitals in district Mahasamund. The risk factors differ between subjects who underwent surgery and did not undergo surgery. Efforts should be made to control the high burden of hospital-acquired infection to get better outcomes.

Keywords: Hospital-acquired infection, hospital-associated infections, nosocomial infection, risk factor.

Introduction

Hospital-acquired infections represent a systemic or local condition arising from the adverse reaction from an infectious agent or its toxins acquired from the hospital in subjects that were asymptomatic when admitted to that hospital. Hospital-acquired infections contribute to large damage from the healthcare setups in both developing and developed countries. However, higher incidence and prevalence is reported in developing and low-income nations. Hospital-acquired infections are becoming major healthcare concerns putting a threat to the wellbeing and safety of the patients as well as healthcare personnel. [1] Increased mortality and morbidity rates have been associated with hospital-acquired infections. It has been associated with various adverse reactions including the emergence of pathogens that are multidrug-resistant in the healthcare sector along with the dissemination of the re-emerging and emerging pathogens and infections in the community and healthcare personnel. [2] In general wards, hospital-acquired infection affects nearly 8% of the subjects and nearly 50% of the subjects admitted to ICU (intensive care units) in developing nations. In developing countries and low-income nations, the concern for hospital-acquired infection is underestimated and unknown owing lack of proper guidelines, incomplete or absence of surveillance, and the complex process of

diagnosis. Previous literature data suggest the occurrence of hospital-acquired infection in 15 subjects of every 100 hospitalized subjects which is contradictory and higher than reports from North America and Europe. However, the majority of the existing literature data concerns the prevalence of hospital-acquired infection and data is very scarce concerning the incidence of hospital-acquired infection. [3]

In India, limited literature data exists on hospital-acquired infections. The majority of the data focused on the subjects that were managed surgically and the reported prevalence rate was 10% to 40%. The most common presentations of these infections are blood infections, urinary tract infections, and surgical site infections. The most common associated factors are ward type, underlying systemic diseases, and surgery type. [4] Nearly half of the reported hospital-acquired infections can be managed well with the existing literature-based interventions. Still, these infections pose a high threat to the healthcare system in low-income nations and at the global level. Inadequate infection control practices mainly result from a limited number of personnel and overcrowding of the health care centers in developing nations. [5] With the scarce literature data on hospital-acquired infections in the Indian scenario, the present study aimed to assess hospital-acquired infection and its associated risk factors among patients admitted to a tertiary care hospital in district Mahasamund, Chhattisgarh.

Materials and Methods

The present longitudinal study aimed to assess hospital-acquired infection and its associated risk factors among patients admitted to the various departments of Government Medical College and Hospital, Mahasamund, Chhattisgarh. The study assessed subjects admitted to the institute. A verbal and written informed consent was taken from all the subjects before study participation.

The study assessed all the subjects from both genders that were admitted to the general ward, ophthalmology, surgery, pediatrics, and gynecology and obstetrics ward of the Institute. The study included subjects who had no evidence of existing bacterial infection at the time of admission to the Institute.

The exclusion criteria were subjects that had previous bacterial infection and did not give consent for study participation. In pediatric subjects, the consent was taken from the guardians or parents. For unconscious subjects, consent was taken from their attendants. A preformed structured questionnaire was used to record the clinical data and sociodemographic characteristics of the study participants. All the included subjects were followed for 2 days, and subjects developing any infection in 2 days were excluded from the study. The remaining subjects formed the final sample size and were followed till discharge or death by an examiner. The presence of hospital-acquired infection was confirmed by examiners from their respective wards having expertise in their respective fields.

In subjects that were suspected to have the infection, biological specimens were collected following the strict sterile and aseptic protocol. All the collected specimens were assessed using microbiological tests for isolation of the bacteria followed by the blood culture following the guidelines by WHO (World Health Organization).

The study assessed the occurrence of infection after 48 hours of hospitalization in subjects who were asymptomatic when admitted or were in the incubation period. For specific hospital-acquired infections, definitions were adopted from Horan TC et al in 2008. [6] The bloodstream infection was considered in subjects with a minimum of one positive uncontaminated blood culture along with one of the pointing signs or symptoms including hypotension, rigors with chills, and/or fever. Hospital-associated pneumonia was considered with a minimum of two or more of the symptoms and signs seen during the hospital stay including the chest radiography correlating to the infection, purulent sputum, and/or cough. Infection at the surgical site was signified with spreading cellulitis, abscess, or purulent discharge at the site of surgery in the month following infection. For urinary tract infection, with a recent urinary catheterization history, with or without any sign or symptom, subjects with pyuria of clean catch urine with (>10 WBC/high power field), positive dipstick for leukocyte esterase, catheter urine with $>10^2$ CFU/ml and maximum two species of microorganisms, and/or midstream urine showing culture with $>10^5$ CFUs (colony forming units).

The gathered were reassessed and entered into MS Excel sheets. The data gathered were assessed statistically using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). The chi-square test was used for the assessment of the prevalence and incidence of nosocomial infections and the identification of risk factors associated with hospital-acquired infection. Adjusted risk ratio (ARR) and risk ratio were assessed using multivariate and bivariate logistic regression analysis to identify associated risk factors. The significance level was taken at $p<0.05$.

Results

The present study included 534 subjects where 26 subjects showed the symptoms of infections within the 48 hours of their admission and were excluded from the study. The remaining 508 subjects were assessed for occurrence of hospital-acquired infection till their death or till they were discharged from the hospital. Among these 58 subjects, 12

subjects were further excluded as complete data could not be gathered. Hence, the final sample size for the study was 496 subjects. The majority of the study subjects were from 18-30 years of age with 34.27% (n=170) subjects followed by 26.81% (n=133) subjects from 31-50 years of age, 23.58% (n=117) subjects from >50 years, and 14.91% (n=74) subjects were <18 years respectively. There were 44.75% (n=222) males and 55.24% (n=274) females in the present study.

The majority of participants were farmers with 37.5% (n=186) subjects followed by students and businessmen with 10.88% (n=186) and 10.28% (n=51) subjects respectively, and 8.46% (n=42) subjects were daily workers.45.16% (n=224) subjects were illiterate, whereas, 2.21% (n=11) subjects had education till the postgraduate level. The majority of the subjects were married with 70.56% (n=350) subjects, 18.14% (n=90) subjects were single, and 2.62% (n=13) subjects each were divorced and widowed. The subjects admitted to the general ward, ICU, Paediatrics, Ophthalmology, surgery, and obstetrics and gynaecology were 22.58% (n=112), 2/21% (n=11), 584% (n=29), 15.52% (n=77), 25.40% (n=126), and 28.42% (n=141) study subjects respectively as shown in Table 1. For chronic medical conditions, they have seen in 26.41% (n=131) study subjects where the most common condition was cardiovascular disease followed by hypertension, and diabetes mellitus was seen in 6.85% (n=34), 5.64% (n=28), and 3.835 (n=19) subjects respectively.

The mean onset of hospital-acquired infection in the study subjects was 4.62 with a 95% CI of 14.44, 8.84 per 100 patient days. The overall incidence was 28.13 per 100 patient days with a 95% CI (12.42, 32.32) and the overall prevalence was 19.43/100 patient days with a 95% CI of 16.95, 21.83. The highest incidence rate was seen in subjects admitted to ICU with 207.62 (133.42, 309.12) followed by subjects from paediatrics with 16.18 per 100 patient days and 95% CI of 45.32, 101.32, surgery subjects with 29.53 per 100 patient days and 95% CI of 23.3, 37.4, general ward subjects with 22.94 per 100 patient days with 95% CI of 16.66, 31.32 and was last in subjects from Department of Ophthalmology with 0.96 per 100 patient days and 95% CI of 0.07, 4.92 as depicted in Table 2. Concerning the infection type, the most common infection was UTI (urinary tract infection seen in 44.95% (n=223) subjects followed by surgical site infection in 12.90% (n=64) subjects, combined UTI and bloodstream infection in 10.08% (n=50) subjects, surgical site infection, and UTI in 9.87% (n=49) subjects, bloodstream infection in 7.05% (n=35) study subjects, bloodstream infection, and surgical site infection and intravenous site infection in 5.04% (n=25) study subject each, pneumonia in 3.02% (n=15) subjects, and UTI and pneumonia in 2.01% (n=10) study participants respectively (Table 3).

Biological samples were taken from 19.35% (n=96) subjects which were subjected to laboratory assessment for causative microorganism identification. The study identified 21 bacterial species from these specimens and a culture positivity rate of 61%. Among identified bacteria, 72% (n=15) were gram-negative and 28% (n=6) were gram-positive bacteria. The bacteria isolated most commonly were E. coli, Staph aureus, and Klebsiella species in 27%, 25%, and 18% of study subjects respectively.

Among 496 subjects in the present study, 11 subjects were admitted to the ICU. The subjects admitted to the ICU were of age <23 years with 54.54% (n=6) subjects. Among these subjects, 54.54% (n=6), 72.7% (n=8), 54.54% (n=6), and 54.54% (n=6) subjects were respectively with indwelling urinary catheter, peripheral I.V line, nasogastric tube, and mechanical ventilation. The subjects admitted to ICU and who underwent cataract surgery were excluded from the study as statistical tests were not applicable.

Hence, risk factor analysis was done on the remaining 460 study subjects. These 460 subjects were divided into surgery and nob-surgery groups including 225 and 235 subjects respectively. On comparison of the clinical demographic variables in the two groups at baseline, results are summarized in Table 4. In the surgery group, the risk-ratio analysis showed that subjects with previous hospitalization, clean-contaminated wounds, elective surgery, and male gender had a predisposition for developing hospital-acquired infection with an adjusted risk ratio of 1.63, 95% CI as 1.05, 2.52.

The mean age of study subjects in the surgery and non-surgery groups was 35.13±20.05 and 31.07±13.74 years respectively which had significant differences with p=0.01. It was seen that a lower risk for hospital-acquired infection was seen in subjects aged 18-30 years with an adjusted risk ratio of 0.52 and 95% CI of 0.34, 0.91. In the non-surgery group, the risk factors seen were underlying disease, mechanical ventilation, indwelling urinary catheter, and chest tube. In the non-surgery group, the mean age of study subjects was lower in subjects with hospital-acquired infection compared to subjects without it, and lower risk was seen in the ages 31-50 and >50 years of age p<0.05.

The mean duration of hospital stays in study subjects having hospital-acquired infection was 13.93±6.76 days, whereas, in subjects with no hospital-acquired infection, the stay duration was 7.61±4.38 days which was statistically significant with p=0.001. 44 deaths were reported in the present study with an overall rate of mortality of 4%, whereas, in subjects

with hospital-acquired infection, the mortality rate was 8%. Significantly increased risk for death was seen in subjects that had hospital-acquired infection compared to subjects without it with p=0.01.

Table 1: Demographic and disease characteristics of the study subjects

S. No	Characteristics	Number (n=496)	Percentage (%)
1.	**Age range**		
a)	<18	74	14.91
b)	18-30	170	34.27
c)	31-50	133	26.81
d)	>50	117	23.58
2.	**Gender**		
a)	Males	222	44.75
b)	Females	274	55.24
3.	**Occupation**		
a)	Students	54	10.88
b)	Farmers	186	37.5
c)	Employed	74	14.91
d)	Daily workers	42	8.46
e)	Businessmen	51	10.28
f)	Others	89	17.94
4.	**Education status**		
a)	Illiterate	224	45.16
b)	Primary schooling	63	12.70
c)	High school	76	15.32
d)	Intermediate	46	9.27
e)	Diploma	41	8.26
f)	Undergraduate	35	7.05
g)	Postgraduate	11	2.21
5.	**Marital status**		
a)	Single	90	18.14
b)	Married	350	70.56
c)	Divorced	13	2.62
d)	Widowed	13	2.62
6.	**Admission ward**		
a)	General	112	22.58
b)	ICU	11	2.21
c)	Pediatrics	29	5.84
d)	Ophthalmology	77	15.52
e)	Surgery	126	25.40
f)	Obstetrics and Gynecology	141	28.42

Table 2: Incidence rates of hospital-acquired infections in the study subjects

S. No	Parameter	Rate/100 patient days (%)	95% CI
1.	**Mean onset**	4.62	8.84, 14.44
2.	**Overall incidence**	28.13	32.32, 124.42
3.	**Overall prevalence**	19.43	16.95, 21.83
4.	**Wards**		
a)	General	22.94	16.66, 31.32
b)	ICU	207.62	133.42. 309.12
c)	Pediatrics	69.18	45.32, 101.32
d)	Ophthalmology	0.96	0.07, 4.92
e)	Surgery	29.53	23.3, 37.4
f)	Obstetrics and Gynecology	28.99	22.1, 36.6

Table 3: Type of infection in the study participants

S. No	Infection type	Number (n=496)	Percentage (%)
1.	Surgical site infection and UTI	49	9.87
2.	Bloodstream infection and Surgical site infection	25	5.04
3.	Intravenous site infection	25	5.04
4.	Surgical site infection	64	12.90
5.	UTI	223	44.95
6.	UTI and pneumonia	10	2.01
7.	UTI and Bloodstream infection	50	10.08
8.	Pneumonia	15	3.02
9.	Bloodstream infection	35	7.05

Table 4: Risk of hospital-acquired infection based on age, gender, and underlying diseases in study subjects

Variable	Surgical cases (n=225)					Non-surgical cases (n=235)				
	hospital-acquired infection (n)	%	Total	Risk ratio	Adjusted risk ratio	hospital-acquired infection (n)	%	Total	Risk ratio	Adjusted risk ratio
Gender										
Males	26	30.95	84	1.83 (1.34, 3.64)	1.42 (0.95, 2.12)	16	13.79	116	0.82 (0.54, 1.24)	0.95 (0.62, 1.47)
Females	24	17.02	141			20	16.80	119		
Age (years)										
<18	10	33.33	30			10	27.7	36		
18-30	14	13.59	103	0.43 (0.23, 0.65)	0.52 (0.34, 0.91)	10	16.12	62	0.54 (0.34, 0.96)	0.63 (0.32, 1.05)
31-50	12	21.81	55	0.67 (0.44, 1.11)	0.92 (0.54, 1.53)	13	17.56	74	0.65 (0.42, 1.12)	0.52 (0.33, 0.91)
>50	13	35.13	37	1.03 (0.64, 1.67)	1.05 (0.64, 1.44)	4	30.76	13	0.22 (0.07, 0.44)	0.24 (0.12, 0.46)
Wound type										
Clean	28	17.61	159	1.96 (1.33, 2.87)	1.26 (0.83, 1.92)		-			
Clean contaminated	14	35.89	39	1.32 (0.75, 2.24)	0.83 (0.45, 1.44)		-			
Contaminated/ dirty	6	21.4	28				-			
Surgery type										
Emergency	20	17.54	114	1.56 (1.12, 2.24)	0.96 (0.63, 1.44)		-			
Elective	30	27.02	111				-			
Previous hospitalization										
Yes	10	43.47	23	2.26 (1.54, 3.32)	1.63 (1.05, 2.52)	3	23.07	13	1.51 (0.71, 3.17)	
No	40	19.70	203			33	14.86	222		
Chest tube										
Yes	1	16.66	6	0.73 (0.23, 2.72)		2	100	2	5.03 (2.73, 9.24)	4.12 (2.32, 7.44)
No	48	22.42	214			34	14.65	232		
IV line										
Yes	40	29.19	137	0.85 (0.54, 1.32)		15	20.27	74	1.52 (0.96, 2.27)	
No	10	26.31	38			22	13.66	161		

Discussion

Among the 496 subjects assessed in the present study, the majority of the study subjects were from 18-30 years of age with 34.27% (n=170) subjects followed by 26.81% (n=133) subjects from 31-50 years of age, 23.58% (n=117) subjects from >50 years, and 14.91% (n=74) subjects were <18 years respectively. There were 44.75% (n=222) males and 55.24% (n=274) females in the present study. The majority of participants were farmers with 37.5% (n=186) subjects followed by students and businessmen with 10.88% (n=186) and 10.28% (n=51) subjects respectively, and 8.46% (n=42) subjects were daily workers.45.16% (n=224) subjects were illiterate, whereas, 2.21% (n=11) subjects had education till the postgraduate level. The majority of the subjects were married with 70.56% (n=350) subjects, 18.14% (n=90) subjects were single, and 2.62% (n=13) subjects each were divorced and widowed. The subjects admitted to the general ward, ICU, Paediatrics, Ophthalmology, surgery, and obstetrics and gynaecology were 22.58% (n=112), 2/21% (n=11), 584% (n=29), 15.52% (n=77), 25.40% (n=126), and 28.42$ (n=141) study subjects respectively. For chronic medical conditions, they have seen in 26.41% (n=131) study subjects where the most common condition was cardiovascular disease followed by hypertension and diabetes mellitus was seen in 6.85% (n=34), 5.64% (n=28), and 3.835 (n=19) subjects respectively. These data were similar to the studies of Petersen MH et al [7] in 2010 and Gandhi NR et al [8] in 2013 where authors assessed subjects with demographic data comparable to the present study.

It was seen that the mean onset of hospital-acquired infection in the study subjects was 4.62 with a 95% CI of 14.44, 8.84 per 100 patient days. The overall incidence was 28.13 per 100 patient days with a 95% CI (12.42, 32.32) and the overall prevalence was 19.43/100 patient days with a 95% CI of 16.95, 21.83. The highest incidence rate was seen in subjects admitted to ICU with 207.62 (133.42, 309.12) followed by subjects from paediatrics with 16.18 per 100 patient days and 95% CI of 45.32, 101.32, surgery subjects with 29.53 per 100 patient days and 95% CI of 23.3, 37.4, general ward subjects with 22.94 per 100 patient days with 95% CI of 16.66, 31.32 and was last in subjects from Department of Ophthalmology with 0.96 per 100 patient days and 95% CI of 0.07, 4.92. These data correlated with Razine R et al [9] in 2011 and Gosling R et al [10] in 2003 where authors reported a similar prevalence of hospital-acquired infection that was comparable to the present study.

The study results showed that for the infection type, the most common infection was UTI (urinary tract infection seen in 44.95% (n=223) subjects followed by surgical site infection in 12.90% (n=64) subjects, combined UTI and bloodstream infection in 10.08% (n=50) subjects, surgical site infection, and UTI in 9.87% (n=49) subjects, bloodstream infection in 7.05% (n=35) study subjects, bloodstream infection, and surgical site infection and intravenous site infection in 5.04% (n=25) study subject each, pneumonia in 3.02% (n=15) subjects, and UTI and pneumonia in 2.01% (n=10) study participants respectively. These results were consistent with the previous studies of Beyene G et al [11] in 2011 and Melaku S et al [12] in 2012 where authors reported UTI to be the most common hospital-acquired infection in their study population.

In the study subjects, biological samples were taken from 19.35% (n=96) of subjects which were subjected to laboratory assessment for causative microorganism identification. The study identified 21 bacterial species from these specimens and a culture positivity rate of 61%. Among identified bacteria, 72% (n=15) were gram-negative and 28% (n=6) were gram-positive bacteria. The bacteria isolated most commonly were E. coli, Staph aureus, and Klebsiella species in 27%, 25%, and 18% of study subjects respectively. These results were in agreement with the findings of Vandepitte J et al [13] in 2003 and Durando P et al [14] in 2015 where the most commonly isolated microorganisms from hospital-acquired infection were E. coli.

The study results showed that subjects admitted to the ICU were of age <23 years with 54.54% (n=6) subjects. Among these subjects, 54.54% (n=6), 72.7% (n=8), 54.54% (n=6), and 54.54% (n=6) subjects were respectively with indwelling urinary catheter, peripheral I.V line, nasogastric tube, and mechanical ventilation. The subjects admitted to ICU and who underwent cataract surgery was excluded from the study as statistical tests were not applicable. Hence, risk factor analysis was done on the remaining 460 study subjects. These 460 subjects were divided into surgery and nob-surgery groups including 225 and 235 subjects respectively. In the surgery group, the risk-ratio analysis showed that subjects with previous hospitalization, clean-contaminated wounds, elective surgery, and male gender had a predisposition for developing hospital-acquired infection with an adjusted risk ratio of 1.63, 95% CI as 1.05, 2.52. These results were comparable to the studies of Kibret M et al [15] in 2015 and Balkhy HH et al [16] in 2006 where authors reported similar risk factors for hospital-acquired infection as seen in the present study.

It was seen that the mean age of study subjects in the surgery and non-surgery groups was 35.13±20.05 and 31.07±13.74 years respectively which had a significant difference with p=0.01. It was seen that a lower risk for hospital-acquired infection was seen in subjects aged 18-30 years with an adjusted risk ratio of 0.52 and 95% CI of 0.34, 0.91. In the non-surgery group, the risk factors seen were underlying

disease, mechanical ventilation, indwelling urinary catheter, and chest tube. In the non-surgery group, the mean age of study subjects was lower in subjects with hospital-acquired infection compared to subjects without it, and lower risk was seen in the ages 31-50 and >50 years of age $p<0.05$. These findings correlated with the studies of Tesfahunegn Z et al [17] in 2009 and Ige OK et al [18] in 2011 where authors suggested similar low-risk and high-risk factors for hospital-acquired infection in their study cohorts.

The study results showed that the mean duration of hospital stays in study subjects having hospital-acquired infection was 13.93±6.76 days, whereas, in subjects with no hospital-acquired infection, the stay duration was 7.61±4.38 days which was statistically significant with $p=0.001$. 44 deaths were reported in the present study with an overall rate of mortality of 4%, whereas, in subjects with hospital-acquired infection, the mortality rate was 8%. Significantly increased risk for death was seen in subjects that had hospital-acquired infection compared to subjects without it with $p=0.01$. These findings were in line with the findings of Forster AJ et al [19] in 2012 and of Yallew WW et al [20] in 2016 where similar mortality rates, death risks, and hospital stay duration were reported by study subjects as seen in the present study.

Conclusion

Considering its limitations, the present study reported a high burden and poor outcomes if discharged in subjects at tertiary care hospitals in district Mahasamund. The risk factors differ between subjects who underwent surgery and did not undergo surgery. Efforts should be made to control the high burden of hospital-acquired infection to get better outcomes.

References

1. Allegranzi B, Storr J, Dziekan G, Leotsakos A, Donaldson L, Pittet D. The first global patient safety challenge “clean care is safer care”: from launch to current progress and achievements. J Hosp Infect. 2007; 65:115–23.
2. Rosenthal VD, Maki DG, Mehta Y, et al. International Nosocomial Infection Control Consortium (INICC) report, data summary of 43 countries for 2007-2012. Device-associated module. Am J Infect Control. 2014; 42:942–56.
3. Feinmann J. Unsafe surgery: make it zero. BMJ. 2011; 343:d7773.
4. Hauri AM, Armstrong GL, Hutin YJ. The global burden of disease is attributable to contaminated injections given in healthcare settings. Int J STD AIDS. 2004; 15:7–16.
5. Leape LL, Brennan TA, Laird N, et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. N Engl J Med. 1991; 324:377–84.
6. Leape LL, Brennan TA, Laird N, et al. The nature of adverse events in hospitalized patients. Results of the Harvard Medical Practice Study II. N Engl J Med. 1991; 324:377–84.
7. Petersen MH, Holm MO, Pedersen SS, Lassen AT, Pedersen C. Incidence and prevalence of hospital-acquired infections in a cohort of patients admitted to medical departments. Dan Med Bul. 2010; 57:4210.
8. Gandhi NR, Weissman D, Moodley P, et al. Nosocomial transmission of extensively drug-resistant tuberculosis in a rural hospital in South Africa. J Infect Dis. 2013; 207:9–17.
9. Razine R, Azzouzi A, Barkat A, et al. Prevalence of hospital-acquired infections in the University Medical Center of Rabat. Morocco Int Arch Med. 2012; 5:26.
10. Gosling R, Mbatia R, Savage A, Mulligan JA, Reyburn H. Prevalence of hospital-acquired infections in a tertiary referral hospital in northern Tanzania. Ann Trop Med Parasitol. 2003; 97:69–73.
11. Beyene G, Tsegaye W. Bacterial uropathogens in urinary tract infection and antibiotic susceptibility pattern in Jimma university specialized hospital, southwest Ethiopia. Ethiop J Health Sci. 2011; 21:141–6.
12. Melaku S, Gebre-Selassie S, Damtie M, Alamrew K. Hospital-acquired infections among surgical, gynecology, and obstetrics patients in Felege-Hiwot referral hospital, Bahir Dar, northwest Ethiopia. Ethiop Med J. 2012; 50:135–44.
13. Vandepitte J, Verhaegen J, Engbaek K, Rohner P, Piot P, Heuck CC. Basic laboratory procedures in clinical bacteriology. Second ed. Geneva, Switzerland: World Health Organization; 2003.
14. Durando P, Bassetti M, Orengo G, et al. Hospital-acquired infections and leading pathogens detected in a regional university adult acute-care hospital in Genoa, Liguria, Italy: results from a prevalence study. J Prev Med Hyg. 2010; 51:80–6.
15. Kibret M, Abera B. Prevalence and antibiogram of bacterial isolates from urinary tract infections at Dessie Health Research Laboratory, Ethiopia. Asian Pac J Trop Biomed. 2014; 4:164–8.
16. Balkhy HH, Cunningham G, Chew FK, et al. Hospital- and community-acquired infections: a point prevalence and risk factors survey in a tertiary care center in Saudi Arabia. Int J Infect Dis. 2006; 10:326–33.
17. Tesfahunegn Z, Asrat D, Woldeamanuel Y, Estifanos K. Bacteriology of the surgical site and catheter-related urinary tract infections among patients admitted in Mekelle hospital,

Mekelle, Tigray. Ethiopia Ethiop Med J. 2009; 47:117–27.
18. Ige OK, Adesanmi AA, Asuzu MC. Hospital-acquired infections in a Nigerian tertiary health facility: an audit of surveillance reports. Niger Med J. 2011; 52:239–43.
19. Forster AJ, Taljaard M, Oake N, Wilson K, Roth V, van Walraven C. The effect of hospital-acquired infection with Clostridium Difficile on length of stay in hospital. CMAJ. 2012; 184:37–42.
20. Yallew WW, Kumie A, Yehuala FM. Point prevalence of hospital-acquired infections in two teaching hospitals of Amhara region in Ethiopia. Drug Health Patient Saf. 2016; 8:71–6.