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Research Article

# MICROORGANISMS VARIANTS FOR HEALTHCARE-ASSOCIATED INFECTIONS IN A SELECTED TERTIARY CARE HOSPITAL

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**ABSTRACT**

**Objective:** Microorganisms are minute and can be only in microscope and these are not visible to naked eyes. Various types of microbe include bacteria, virus, fungi, and protozoa. These microorganisms are subclassified and these are disease causing leading to mortality and morbidity. Healthcare-associated infections (HAIs) arise from different variants of microbes and knowing the category of microbes for treating the diseases with specific antibiotics is important for better patient outcome.

**Methods:** Using secondary data, all the patients who had HAI for 3 years were taken into consideration by considering the different variants of microorganisms.

**Results:** Retrospective data collected for the period of 3 years the inpatients who got admitted for more than 48 h of duration, the data collected included the parameters for various microorganisms such as *Bacilli*, cocci, *Klebsiella*, *Acinetobacter*, and Aures, other micro-organisms such as *Escherichia coli*, *Citrobacter*, and *Pseudomonas* microorganisms. *Bacilli* group of microorganisms was more common for urinary tract infection, blood stream infection, and ventilator-associated pneumonia. Aures was more common among surgical site infection infections.

**Conclusions**: Most of the patients who had an HAI had two or more different kind of microorganisms which are responsible for spreading infection. There is a need to control microbial flora in the hospital set up as the rate of HAI increases with microbial flora.

**Keywords:** *Acinetobacter*, Aures, *Bacilli, Citrobacter,* Cocci, *Escherichia coli*, Microorganisms, *Pseudomonas*.

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## INTRODUCTION

Microorganisms such as bacteria, virus, fungus, protozoans, and many more microorganisms cause healthcare-associated infections (HAIs). Various microorganisms such as *Acinetobacter*, "*Methicillin-resistant Staphylococcus aureus* (MARSA)", "*Staphylococcus aureus*", "Vancomycin-resistant Enterococci", Gram-negative bacteria, Influenza, and "*Clostridium difficile*" MARSA are the most common microorganism that causes HAI [1]. The costs of treating HAIs are very high and it increases as the number of infections that are caused by "multiple drug-resistant organisms increases [2]. Approximately 70% of microorganisms that causes HAIs are resistant to at least one type of antibiotic drug are used treating HAIs [3].

During the delivery of healthcare, patients can be exposed to a variety of exogenous microorganisms (bacteria, viruses, fungi, and protozoa) from other patients, health-care personnel, or visitors. Other reservoirs include the patient's endogenous flora (e.g., residual bacteria residing on the patient's skin, mucous membranes, gastrointestinal tract, or respiratory tract) which may be difficult to suppress and inanimate environmental surfaces or objects that have become contaminated (e.g., patient room touch surfaces, equipment, and medications). The most common sources of infectious agents causing HAI, described in a scientific review of 1022 outbreak investigations [4] are (listed in decreasing frequency) the individual patient, medical equipment or devices, the hospital environment, the health-care personnel, contaminated drugs, contaminated food, and contaminated patient care equipment.

HAIs are caused by various microorganisms as bacteria, virus, fungi, and protozoans. The outcome of HAI is unpredictable and it is based on the type of microorganism causing the particular infection, location, and the site of origin of infection [5].

## METHODS

Study was conducted in M.S. Ramaiah hospital, a tertiary care teaching hospital with 12–general specialty and 13–super specialty departments with 800 bed strength. The hospital offers clinical services such as outpatient services, in-patient services, multidisciplinary intensive care, pediatric intensive care unit (ICU), neonatal ICU services, accident and emergency services -24/7, and 13 major operation theatres. Non-clinical/supportive services include National Accreditation Board for Testing and Calibration Laboratories accredited laboratory radiology, maintenance department, biomedical engineering department, medical records department, laundry, Board Certification as a Specialist in Sports Dietetics dietary services, rehab and physical medicine, and mortuary.

This study is based on the retrospective data for HAI surveillance data subjected to various types of microorganisms which are causing HAI. Most common type of microorganisms were taken into consideration.

### Statistical analysis

Retrospective data were collected using descriptive analysis, calculated based on micro- organisms isolated from HAI infections such as urinary tract infection (UTI), blood stream infection (BSI), ventilator-associated pneumonia (VAP), and surgical site infection (SSI). Data were collected entered into the Microsoft Excel Spread Sheet and summarized using Excel spread sheet presented in the form of tables.

## RESULTS

### Microorganisms isolated from UTI infections

Microorganisms were isolated from UTI infections, microorganisms were confirmed with the available laboratory reports (hospital information system) of all the patients, analysis showed that below mentioned percentage of various microorganisms

- *Bacilli* 2013 (88.7%), 2014 (83.8%), and 2015 (82.7%), respectively
- Cocci 2013 (7.75%), 2014 (11.7%), and 2015 (13.7%), respectively
- Other Microorganisms 2013 (3.4%), 2014 (4.4%), and 2015 (3.4%) were found in the UTI infection.

*Bacilli* contributing the highest responsible microorganism and the other organism contributing being on the lower side causing infection. This is explained in Table 1 and graphical representation is explained in the Figure 1.

**Microorganisms isolated from BSI infections**

Microorganisms were isolated from BSI infections, microorganisms were confirmed with the available laboratory reports (hospital information system) of all the patients, analysis showed that below mentioned percentage of various microorganisms such as

- *Klebsiella* 2013 (10.4%), 2014 (6.8%), and 2015 (10.3%)
- *Acinetobacter* 2013 (14.5%), 2014 (6.8%), and 2015 (17.2%)
- *Bacilli* 2013 (25%), 2014 (27.2%), and 2015 (17.2%)
- Other Microorganisms 2013 (22.9%), 2014 (20.4%), and 2015 (31%)
- Cocci 2013 (25 %%), 2014 (38.6%), and 2015 (24.1%)
- Aures 2013 (3.4%), 2014 (0.0%), and 2015(0.0%).

Other microorganisms such as *Escherichia coli*, *Citrobacter*, and *Pseudomonas* microorganisms contributed to the highest No. of microorganisms. This is explained in Tables 2 and 3. Graphical representation is explained in the Figure 2.

*Bacilli* and cocci contributing the highest responsible microorganism and the aures contributing being on the lower side causing infection.

**Microorganisms isolated from VAP infections**

Various microorganisms were found in the VAP of infections, microorganisms such as

- *Bacilli* 2013 (71.4%), 2014 (71.4%), and 2015 (27.2%)
- Other Microorganisms 2013 (14.2%), 2014 (14.2%), and 2015 (27.2%)
- Cocci 2013 (14.2%), 2014 (14.2%), and 2015 (45.4%).

Other microorganisms included budding cells, Aures, *Acinetobacter*, and *Klebsiella* were not found in the VAP infection for all the 3 years, *Bacilli* contributing the highest responsible microorganism and the other organism contributing being on the lower side causing infection. This is explained in Table 4. Graphical representation is explained in the Figure 3.

**Microorganisms isolated from SSI infections**

Various microorganisms were found in the VAP of infections, microorganisms such as

- *Bacilli* 2013 (50%), 2014 (11.1%), and 2015 (11.1%)
- Other Microorganisms 2013 (12.5%) and 2015(22.2%)
- Cocci 2013 (14.2%), 2014 (44.4%), and 2015 (55.5%)
- Aures 2013 (37.5%), 2014 (22.2%), and 2015 (45.4%)
- *Klebsiella* 2014 (11.1%)
- *Acinetobacter* 2014 (11.1%), and 2015(11.1%).

This is explained in Table 5. and graphical representation is done in the Figure 4.

Cocci contributing the highest responsible microorganism and the other organism contributing being on the lower side causing infection.

**DISCUSSION**

Microorganisms are responsible for causing HAIs. Common health are associated that conditions were taken for most commonly occurring HAIs such as UTI, BSI, VAP, and SSI were taken for the study purpose. A study conducted by Bassetti *et al*. [6] bacteremia was responsible for the spread of HAI and most of the times this bacteremia leads to mortality leading to the poor outcome of the patient.

A study conducted by Lamagni *et al*. [7] identified the longitudinal trends in the burden and characteristics of infections. *Streptococcus*

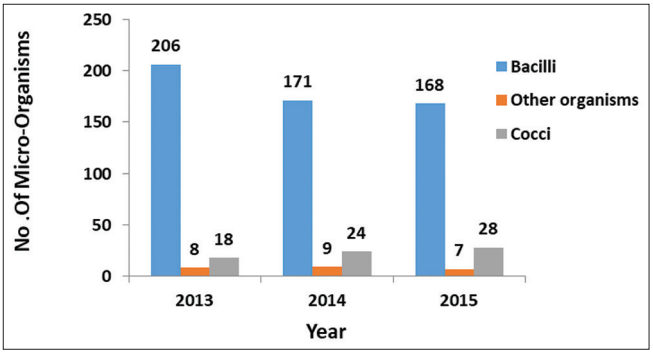


**Fig. 1: Microorganisms Isolated From Urinary Tract Infection Infections**

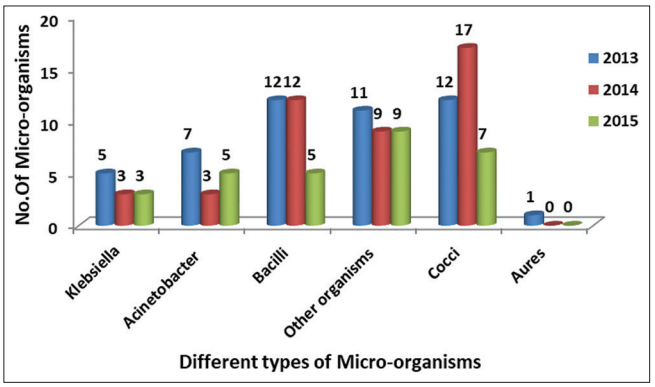


**Fig. 2: Microorganisms Isolated From Blood Stream Infection Infections**

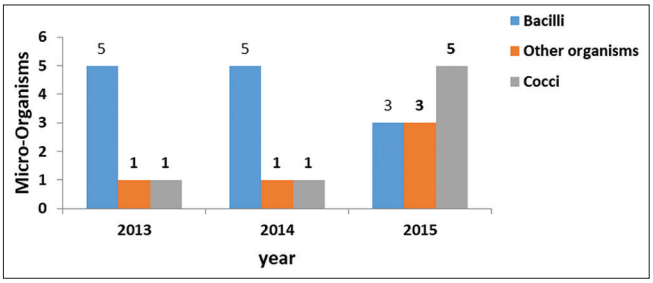


**Fig. 3: Microorganisms Isolated From Ventilator-Associated Pneumonia**

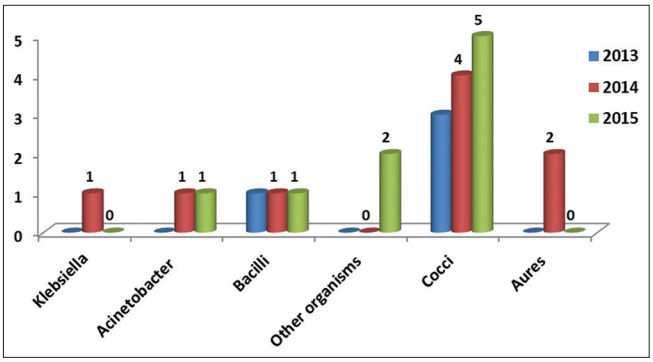


**Fig. 4: Microorganisms Isolated From Surgical Site Infection Infections**

**Table 1: Micro-organisms isolated from UTI infections represented in the numbers and the percentage of each HAI**

| Month | Bacilli n (%) | | | Other organism n (%) | | | Cocci n (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| January | 20 (42.55) | 15 (35.71) | 25 (38.46) | 0 (0) | 0 (0) | 2 (3.08) | 2 (4.26) | 1 (2.38) | 4 (6.15) |
| February | 17 (44.74) | 7 (33.33) | 18 (41.86) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (9.52) | 2 (4.65) |
| March | 30 (51.72) | 14 (35.9) | 14 (36.84) | 1 (1.72) | 0 (0) | 2 (5.26) | 1 (1.72) | 4 (10.26) | 0 (0) |
| April | 8 (30.77) | 12 (33.33) | 16 (33.33) | 0 (0) | 2 (5.56) | 1 (2.08) | 4 (15.38) | 2 (5.56) | 3 (6.25) |
| May | 17 (42.5) | 15 (39.47) | 14 (35.9) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 3 (7.89) | 4 (10.26) |
| June | 18 (40.91) | 16 (41.03) | 25 (39.06) | 0 (0) | 0 (0) | 0 (0) | 1 (2.27) | 1 (2.56) | 2 (3.13) |
| July | 21 (40.38) | 19 (34.55) | 18 (36) | 0 (0) | 1 (1.82) | 0 (0) | 0 (0) | 3 (5.45) | 7 (14) |
| August | 15 (40.54) | 16 (40) | 11 (30.56) | 0 (0) | 0 (0) | 0 (0) | 1 (2.7) | 2 (5) | 2 (5.56) |
| September | 13 (36.11) | 14 (32.56) | 8 (27.59) | 0 (0) | 1 (2.33) | 0 (0) | 1 (2.78) | 1 (2.33) | 3 (10.34) |
| October | 18 (32.73) | 10 (37.04) | 6 (27.27) | 3 (5.45) | 0 (0) | 0 (4.55) | 3 (5.45) | 1 (3.7) | 0 (0) |
| November | 13 (31.71) | 13 (35.14) | 6 (30) | 2 (4.88) | 1 (.2.7) | 0 (0) | 3 (7.32) | 3 (8.11) | 1 (5) |
| December | 16 (38.1) | 20 (32.79) | 7 (35) | 2 (4.76) | 4 (6.56) | 1 (5) | 2 (4.76) | 1 (1.64) | 0 (0) |

UTI: Urinary tract infection

**Table 2: Type of causative microorganisms isolated from BSI Infections**

| Month | *Klebsiella* | | | *Acinetobacter* | | | *Bacilli* | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| January | 1 (16.67) | 3 (33.33) | 0 (0.00) | 2 (33.33) | 0 (0.00) | 1 (12.50) | 0 (0.00) | 0 (0.00) | 2 (25.00) |
| February | 0 (0.00) | 0 (0.00) | 1 (9.09) | 1 (11.11) | 0 (0.00) | 1 (9.09) | 1 (11.11) | 0 (0.00) | 0 (0.00) |
| March | 1 (8.33) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 5 (41.67) | 1 (20.00) | 1 (25.00) |
| April | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (25.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (7.69) | 1 (25.00) |
| May | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 | 0 (0.00) | 0 (0.00) | 1 (25.00) | 0 (0.00) |
| June | 0.0 | 0.0 | 0.0 | 1 (14.29) | 0.0 | 0.0 | 2 (28.57) | 0.0 | 0.0 |
| July | 0.0 | 0.0 | 1 (1.06.67) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| August | 1 (25.00) | 0.0 | 0.0 | 1 (25.00) | 0.0 | 0.0 | 0.0 | 2 (25.00) | 0.0 |
| September | 1 (16.67) | 0 (0.00) | 0 (0.00) | 1 (16.67) | 0 (0.00) | 1 (25.00) | 1 (16.67) | 1 (14.29) | 0 (0.00) |
| October | 1 (10.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 3 (30.00) | 1 (20.00) | 1 (25.00) |
| November | 0 (0.00) | 0 (0.00) | 1 (5.00) | 0 (0.00) | 2 | 1 (50.00) | 0 (0.00) | 3 (25.00) | 0 (0.00) |
| December | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (33.33) | 0 (0.00) | 2 (33.33) | 0 (0.00) |

BSI: Blood stream infection

**Table 3: Type of causative microorganisms isolated from BSI Infections Cont**

| Month | E-coli | | | Other organism | | | Cocci | | |
|---|---|---|---|---|---|---|---|---|---|
| January | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| February | 0 (0.00) | 1 (11.11) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 2 | 0 (0.00) | 2 (22.22) | 1 (12.50) |
| March | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (11.11) | 2 (33.33) | 0 (0.00) | 1 (11.11) | 2 (33.33) | 4 (36.36) |
| April | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (8.33) | 1 (20.00) | 0 (0.00) | 1 (8.33) | 3 (60.00) | 0 (0.00) |
| May | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (25.00) | 0 (0.00) | 0 (0.00) | 2 (50.00) | 3 (23.08) | 1 (25.00) |
| June | 1 (100.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (25.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) |
| July | 1 (14.29) | 0 (0.00) | 0 (0.00) | 1 (14.29) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (100.00) | 0 (0.00) |
| August | 3 (75.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 1 (16.67) |
| September | 0 (0.00) | 2 (25.00) | 0 (0.00) | 1 (25.00) | 0 (0.00) | 0 (0.00) | 1 (25.00) | 2 (25.00) | 0 (0.00) |
| October | 1 (16.67) | 0 (0.00) | 2 (50.00) | 0 (0.00) | 1 (14.29) | 1 (25.00) | 2 (33.33) | 1 (14.29) | 0 (0.00) |
| November | 0 (0.00) | 0 (0.00) | 2 (50.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 3 (30.00) | 0 (0.00) | 0 (0.00) |
| December | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 2 (66.67) | 3 (25.00) | 0 (0.00) |

BSI: Blood stream infection

**Table 4: Type of causative microorganisms isolated from VAP**

| Month | *Bacilli* | | | Other organism | | | Cocci | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| January | 1 (50) | 0 | 1 (25) | 0 | 0 | 1 (25) | 0.0 | 0.0 | 0.0 |
| February | 0 (0) | 0 | 0 | 1 (25) | 0 | 1 (33.33) | 1 (25) | 0.0 | 0.0 |
| March | 3 (33.33) | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| April | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 1 (50) |
| May | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 3 (50) |
| June | 0 | 0 | 1 (20) | 0 | 0 | 0 | 0.0 | 0.0 | 1 (20) |
| July | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| August | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| September | 0 | 2 (25) | 0 | 0 | 0 | 1 (50) | 0.0 | 1 (12.5) | 0.0 |
| October | 0 | 1 (50) | 1 (25) | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| November | 1 (33.33) | 1 (50) | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| December | 0 (0) | 1 (33.33) | 0 | 0 | 1 (33.33) | 0 | 0.0 | 0.0 | 0.0 |

VAP: Ventilator-associated pneumonia

**Table 5: Type of causative micro-organisms isolated from SSI Infections**

| Month | *Klebsiella* | | | *Acinetobacter* | | | *Bacilli* | | | Cocci | | | Aures | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 | 2013 | 2014 | 2015 |
| January | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | – |
| February | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (25) | 1 (100) | 0 (0.0) | 1 (25) | – |
| March | – | 0 (0.0) | 0 (0.0) | 0.(0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | – |
| April | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | – |
| May | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (50) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (100) | 1 (50) | 0 (0.0) | 0 (0.0) | – |
| June | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (100) | 1 (100) | 0 (0.0) | 0 (0.0) | – |
| July | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (50) | 1 (100) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | – |
| August | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (50) | 0 (0.0) | 0 (0.0) | 1 (50) | – |
| September | – | 1 (50) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (100) | 0 (0.0) | 0 (0.0) | – |
| October | – | – | – | 0 (0.0) | 1 (100) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (50) | 0 (0.0) | 0 (0.0) | – | – | – |
| November | – | – | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (33) | 0 | 0 (0.0) | 1 (33) | 0 (0.0) | 1 (50) | – | – | – |
| December | – | – | – | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (50) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | – | – | – |

SSI: Surgical site infection

galactic, cocci group are currently the most frequent cause of sepsis and infectious death in neonates in England.

A study conducted by CDC [8] analyzed that *Acinetobacter* infections typically occur in ICUs and health-care settings housing very ill patients. *Acinetobacter baumannii* accounts for about 80% of reported infections. *Acinetobacter* infections rarely occur outside of healthcare settings. Similar analysis was reported our study. A study conducted by Khan *et al*. [9] reported that agents that are usually involved in hospital-acquired infections include *Streptococcus* spp., *Acinetobacter* spp., enterococci, *Pseudomonas aeruginosa* (*P. aeruginosa*), coagulase-negative staphylococci, *S. aureus*, *Bacillus cereus* (*B. cereus*), *Legionella,* and *Enterobacteriaceae* family members including *Proteus mirablis*, *Klebsiella pneumoniae* (*K. pneumoniae*), *E. coli*, and *Serratia marcescens*. This was a similar finding from our study.

The Gram-negative bacilli vary in the frequencies that they cause the four most frequent types of hospital-acquired infection: Pneumonia, SSI, UTI, and BSI Weinstein [10].

## CONCLUSIONS

The control of microorganisms is responsible to reduce the HAIs. Variants of microorganisms strains help to identify antimicrobial resistance and help in treating the patients with HAI. The transmission of these infections in the hospital settings through healthcare workers can be avoided by the use of infection control practices. There is also a great need that the best practice should be shared among hospitals to stop the spread of nosocomial infections by healthcare workers.

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## CONFLICT OF INTEREST

None declared.

## ETHICAL APPROVAL

Not required.

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