Prevalence and Antibacterial Susceptibility Pattern of Bacteria Contaminating the Wards and Operating Room of Mama Lucy Kibaki Hospital, Kenya

Johnstone Amulioto (jamulioto@gmail.com)
Kenyatta university school of medicine

Margaret Muturi
Kenyatta university school of medicine

Scholastica Mathenge
Kenyatta university school of medicine

Gideon M. Mutua
Mama Lucy kibaki hospital

Research Article

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Abstract

Background

Nosocomial infections are of public health concern globally. These infections are frequently caused by microbes residing in the healthcare environment, including contaminated medical equipment, wards, and operating theaters.

Objectives

To determine the prevalence and susceptibility pattern of bacteria that contaminated the wards and operating rooms of Mama Lucy Kibaki Hospital.

Methods

A cross-sectional descriptive study was done from October - November 2018. Surface swabs taken from predefined areas within the wards and operating room were assessed for bacterial contamination. The samples were processed through gram reaction, culture, and an array of biochemical tests. Antibiotics susceptibility tests were done for each swab by the Kirby Bauer disc diffusion technique. Statistical work was done through a statistical package for the social sciences version 20.

Results

The present work revealed an isolation rate of 64.7% (44/68) for culture-positive surface swabs while 35.3% (24/68) of the swabs failed to yield any organism. A total of 59 bacteria were isolated from the processed swabs. Of the isolates, gram-positive bacteria were more compared to gram-negative rods. Overall, Staphylococcus aureus 55.9% (n=33) was the prevalent bacteria followed by Bacillus species 30.5% (n=18), Citrobacter species 3.4% (n=2), Enterobacter species 3.4% (n=2), Pseudomonas aeruginosa 1.7% (n=1), Acinetobacter species 1.7% (n=1), Escherichia coli 1.7% (n=1) and Coagulase-negative staphylococcus 1.7% (n=1). Methicillin-resistant Staphylococcus aureus (MRSA) accounted for 61.8% of all staphylococci species. The bacteria were resistant to Ampicillin/Cloxacillin at 96.6% (n=57/59).

Conclusion

The infection of hospitalized patients by resident flora of the hospital environment may worsen the clinical condition of the patient. Therefore, it's paramount for all facilities to ensure that they assess periodically their healthcare environments to identify potential bacterial pathogens of nosocomial significance.

Introduction

Nosocomial infections are of public health concern globally. These infections are frequently caused by microbes residing in the healthcare environment, including contaminated medical equipment, wards, and operating theaters. Just like other micro-organisms, bacteria have a remarkable ability to survive and flourish on inanimate hospital surfaces such as bed bars, taps, and handles [1]. A pool of scientific literature has found that Proteus vulgaris, Acinetobacter species, Escherichia coli, Klebsiella species Pseudomonas aeruginosa, Staphylococcus aureus, Methicillin-resistant Staphylococcus aureus, and vancomycin-resistant enterococcus (VRE), can survive for days and even months on dry surfaces [2].

In a clinical setting, bacterial pathogens may spread either by indirect patient contact with contaminated surfaces or directly during interactions between patients and the healthcare providers [3, 4]. Studies also show that the housing of patients in hospital rooms previously occupied by patients colonized with vancomycin-resistant enterococcus increases the risk of acquiring VRE infection [5]. Also, medical care equipments are more likely to carry a considerable number of
pathogenic microorganisms [6]. However, in developing countries, there are few studies done to estimate the magnitude and extent of bacterial contamination in a hospital setting.

Prior to this study, there was no data published on bacterial prevalence and their susceptibility in Kenyan hospitals. It is common knowledge that most hospital environments have unique bacterial flora to which patients are at risk of acquiring infections during their stay. The bacterial flora present in these hospitals is most likely to exhibit unique patterns of antibiotic activity during a specific period. The current study determined the prevalence and susceptibility pattern of bacteria isolated from the wards and operating rooms of Mama Lucy Kibaki Hospital. The identification of the potentially pathogenic bacteria residing in hospitals may assist in mitigation strategies against nosocomial infections.

Methods

Study setting

The study was done at Mama Lucy Kibaki Hospital. The hospital is a public health facility located in the populous Eastlands area of Nairobi city in Kenya. The facility is among the largest county referral hospital in Nairobi. The maternity, surgical and pediatric wards as well as the theatre were of significance for the current work. All these characteristics influenced our choice of this facility as a research area.

Study design

This was a cross-sectional descriptive study. The data was collected from October - November 2018.

Sampling technique

The study assessed three wards that is maternity, surgical and pediatric ward as well as an operating room for bacterial contamination. The predefined areas were selected based on the risk that they posed to in-patients. Prior studies of similar areas also informed our decision in selecting these areas. The areas included the floor, sinks, tap handles, drip (iv) stands, bed handles, ward bedside tables, ward screens, suction machine, operating table, surgical pack, surgical lamp, and anesthetic machine.

Sample collection

Swabbing was done in areas where patients and healthcare providers had frequent direct body contact with surfaces. Sterile swabs moistened with the sterile saline solution were used to swab the surfaces of the sampled areas. The swabbing was carried out according to the guidelines by the International Organization for Standardization [7]. The collection was done by stroking the moistened swab in close parallel sweeps over the defined sampling area while rotating it slowly. All collections were done on clean surfaces. The floor of the hospital wards is covered by square tiles. Therefore to ensure that every part of the ward floor was represented, adequate spacing was taken into consideration during the collection of floor swabs. After collection, the swabs were labeled and without delay taken to the laboratory of the department of Medical Lab Science Kenyatta University for analysis.

Bacterial culture and identification
Inoculation of samples was done on blood agar and MacConkey agar. Afterward, the plates were incubated aerobically at 35°-37° C for 24 hrs. After incubation, preliminary identification of individual colonies was through gram reaction and colony characteristics for example pigmentation, hemolysis, and swarming growth. Additionally, pure colonies were analyzed further using an array of biochemical tests.

**Antibiotic susceptibility testing**

Antibiotic susceptibility tests were performed by Kirby Bauer antibiotic testing method according to the Clinical and Laboratory Standards Institute's (CLSI) guidelines [8]. A saline suspension of 3-5 well-known colonies was prepared and its turbidity adjusted to match that of 0.5 McFarland standard. Using a sterile cotton swab fairly devoid of excess fluid after dipping the swab in a test tube with the test organism suspension, the inoculum was evenly applied on the agar surface of Mueller Hinton medium. After a brief period, the antibiotics discs were uniformly placed on the inoculated surface agar. The clearly labeled plates were incubated at 35° C for 24 hrs. Following incubation, diameters of zones of inhibitions around the discs were measured and interpreted as either sensitive, intermediate, or resistant using breakpoints provided by the Clinical and Laboratory Standards Institute [9] The study also included *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923 as quality controls to guarantee the reproducibility of the tests.

The following antibiotics were tested; Cefepime (30ug), Ceftriaxone (30ug), Chloramphenicol (50ug), Vancomycin (30ug), Doxycycline (30ug), Ciprofloxacin (30ug), Oxacillin (1ug), Azithromycin (15ug), and Ampicillin (10ug).

**Data analysis**

Data were entered in Microsoft excel, cleaned, and the information exported to IBM statistical package for the social sciences version 20. Afterward, descriptive statistics for example count and percentages were determined. The association between the bacterial groups and the sections of the hospital was determined using the Pearson Chi-square test. The P-value of < 0.05 was used to indicate the statistical difference. The presentation of the final data was in form of tables.

**Results**

The present study revealed an isolation rate of 64.7% (44/68) for culture-positive surface swabs while 35.3% (24/68) of the swabs failed to yield any organism. A total of 59 bacteria were isolated from the processed swabs. Of the isolates, *Staphylococcus aureus* 55.9% (n=33) was the prevalent bacteria followed by *Bacillus* species 30.5% (n=18), *Citrobacter* species 3.4% (n=2), *Enterobacter* species 3.4% (n=2), *Pseudomonas aeruginosa* 1.7% (n=1), *Acinetobacter* species 1.7% (n=1), *E.coli* 1.7% (n=1) and *Coagulase-negative staphylococcus* 1.7% (n=1). The majority of the isolates were gram-positive bacteria (88.1%) (Table 1). Whereas gram-negative bacteria accounted for (11.9%) of all isolates. The maternity wards had the highest (49.2%) number of potentially pathogenic bacteria and the least isolation for potentially pathogenic bacteria (10.2%) was recorded from the operating rooms. Among the areas swabbed, the sinks had the highest variety (7) of bacteria. However, no association was seen between the bacterial groups and the hospital sections P< 0.438.

A total of 59 bacterial isolates were tested against seven different selected antibiotic discs. Only 3.4% (n=2/59) of bacteria isolates were sensitive to Ampicillin/Cloxacillin. Majority of the bacteria had sensitivity to Chloramphenicol 93.2% (n=55/59), Vancomycin 100% (n=52/52), Ciprofloxacin 86.4% (n=51/59) and Doxycycline 88.1% (n=52/59). Methicillin-resistant *Staphylococcus aureus* (MRSA) was seen in 61.8% of all *staphylococci* species (Table 2).
Table 1: Prevalence of bacteria isolated from sections of Mama Lucy Kibaki hospital from October-November 2018.

| Hospital section     | Gram-positive bacteria n (%) | Gram-negative bacteria n (%) | Total isolates n (%) |
|----------------------|------------------------------|-----------------------------|---------------------|
| Operating room       | 6(11.5)                      | 0(0.0)                      | 6(10.2)             |
| Surgical wards       | 15(28.8)                     | 1(14.3)                     | 16(27.1)            |
| Pediatric ward       | 6(11.5)                      | 2(28.6)                     | 8(13.6)             |
| Maternity wards      | 25(48.1)                     | 4(57.1)                     | 29(49.2)            |

Areas swabbed | Types and proportion of bacteria isolated | Total n (%) |
|--------------|-------------------------------------------|-------------|
| Sinks        | *Staphylococcus aureus* (1), *Citrobacter* species (2), *Bacillus* species (2), *E.coli* (1), *Acinetobacter* species (1), *Enterobacter* species (1), *Pseudomonas aeruginosa* (1) | 9(15.3)     |
| Floors       | *Staphylococcus aureus* (7), *Bacillus* species (6) | 13(22)      |
| Ward bedside tables | *Staphylococcus aureus* (5), *Bacillus* species (1) | 6(10.2)     |
| Operating table | *Staphylococcus aureus* (1) | 1(1.7)      |
| Suction machine | *Staphylococcus aureus* (1) | 1(1.7)      |
| IV stands     | *Staphylococcus aureus* (5), *Bacillus* species (1) | 6(10.2)     |
| Ward screens  | *Staphylococcus aureus* (1), *Bacillus* species (2) | 3(5.1)      |
| Bed handles   | *Staphylococcus aureus* (8), *Bacillus* species (3) | 11(18.6)    |
| Tap handles   | *Staphylococcus aureus* (2), *Bacillus* species (3), *Enterobacter* species (1), *Coagulase negative staphylococcus* (1) | 7(11.9)     |
| Anesthetic machine | *Staphylococcus aureus* (2) | 2(3.4)      |
| Surgical lamp  | negative                           | 0(0.0)      |
| Surgical Pack  | negative                           | 0(0.0)      |
| Total isolates |                                     | 59(100)     |

Table 2: Antibiotic sensitivity pattern of bacteria isolated from wards and operating room of Mama Lucy Kibaki hospital from October-November 2018.

| Sensitivity in (%) | VA 30ug | CIP 30ug | C 50ug | DO 30ug | AX 10ug | AZM 15ug | OX 1ug | CTR 30ug | CPM 30ug |
|--------------------|---------|----------|--------|---------|---------|----------|--------|----------|----------|
| *Staphylococcus aureus* | 100     | 87.9     | 90.9   | 87.9    | 6.1     | 42.4     | 33.3   | -        | -        |
| *Coagulase negative staphylococcus* | 100     | 100      | 100    | 100     | 0       | 100      | 0      | -        | -        |
| *Bacillus* species | 100     | 100      | 100    | 100     | 0       | 88.9     | -      | -        | -        |
| *Enterobacter* species | -      | 50       | 50     | 50      | 0       | -        | -      | 0        | 0        |
| *Citrobacter* species | -      | 0        | 100    | 100     | 0       | -        | -      | 0        | 0        |
| *Acinetobacter* species | -     | 100      | 100    | 0       | 0       | -        | -      | 0        | 100      |
| *Pseudomonas aeruginosa* | -     | 0        | 100    | 0       | 0       | -        | -      | 100      | 100      |
| *E.coli*          | -      | 100      | 100    | 100     | 0       | -        | -      | 100      | 100      |
cip-ciprofloxacin, ax-ampicillin/cloxacillin, azm-azithromycin, ox-oxacillin, c-chloramphenicol, va-vancomycin, do-doxycycline, cpm-cefepime, ctr-ceftriaxone.

**Discussion**

The analysis of hospital wards and operating room at the current setting saw the predominance of *Staphylococcus aureus* and bacillus species across the evaluated sites. This was in contrast to reports from a similar study in Morocco that found Enterobacteria 31.6% (62/196) as the primary contaminant of the healthcare environment [10]. The variation in the types of isolates reported could be ascribed to several factors, for example, sampling methodology, culturability of organisms, the level of shedding by patients, and the difficulty of cleaning a particular area [11].

The majority of the bacterial contaminants came from the hospital wards compared to the operating rooms, which saw the isolation of fewer bacteria. The floor (13/59) constituted a large share of the isolates, with the bed handles (11/59) and sinks (9/59) coming in second and third, respectively. The preponderant bacteria on the floors of the wards were *Staphylococcus aureus* (7/13). The same bacteria were seen in 42% of the bacteria that were isolated from the floors of the surgical wards of the University of Abuja teaching hospital in Nigeria [12]. Some of the contaminants from the present hospital surfaces like ward screens, drips stand, suction machine, and bed handles came as a result of frequent touching of these surfaces by staff. This meant that there was a failure or negligence by the hospital staff to observe regular cleaning and hand hygiene. But, the blame shouldn't be entirely on staff only, patients and visitors were also to blame for contamination of surfaces like bed handles.

The sensitivity of bacteria to vancomycin and ciprofloxacin in this study was comparable to data generated from a study in Uganda [13]. In contrast to the rate of Methicillin-resistant *Staphylococcus aureus* (61.8%) caused by this work. The rate was lower than that of an MRSA rate of 73.7% reported in Ethiopia [14]. This wide variation in susceptibility of MRSA between the settings could be attributed to the indiscriminate use of antibiotics that resulted in the selection of bacterial strains into resistant bacteria. The high prevalence of MRSA in the present setting also shows that are breaks in the cleaning and disinfection of the hospital surfaces. The infection of hospitalized patients by resident flora of the hospital environment may worsen the clinical condition of the patient. It's therefore paramount for all facilities to ensure that they assess periodically their healthcare environments to identify potential bacterial pathogens of nosocomial significance.

**Study Limitation**

The study did not factor in the amount of bacterial load in the hospital environment. However, the project managed to gather sufficient data that could assist the infection prevention team at the current setting in their decision-making process.

**Conclusions**

Except for the surgical pack and surgical lamp, the rest of the areas evaluated for bacterial contamination had at least one bacteria of nosocomial importance. Therefore periodic surveillance of medical equipment and hospital environments may assist in identifying potential bacterial pathogens, associated factors, and mitigate against nosocomial infections.

**Abbreviations**

KUERC: Kenyatta University Ethics Review Committee; MRSA: Methicillin-resistant *Staphylococcus aureus*; ATCC: American type culture collection; CLSI: Clinical and laboratory standards institute; VRE: vancomycin-resistant enterococcus; IBM: International Business Machines Corporation; IPC: Infection prevention and control.
Declarations

Ethical approval

The work commenced after getting clearance from the Kenyatta University Ethics Review Committee (KUERC).

Data availability

All the datasets supporting the conclusions of this article are included within the article.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Consent for publication

Not applicable

Funding statement

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