Post Caesarean Wound sepsis and associated factors among patients attending a rural regional referral hospital in Western Uganda: A cross-sectional study

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Abstract

Background : Post-caesarean wound sepsis is among the most common problem for patients who undergo caesarean section. It remains a common and widespread problem contributing to morbidity and mortality; this could be due to an increase in antimicrobial resistance. Determining the burden of wound sepsis and common bacterial pathogens can provide solution to prevent incidence and establish microbiological mapping.

Aim: To determine prevalence, identify factors, common bacterial pathogens from post-caesarean wounds and antibacterial susceptibility pattern at Hoima Regional Referral Hospital.

Methods : A cross-sectional study was conducted among post-caesarean mothers attending Hoima Regional Referral Hospital. Consecutive enrolment of 303 participants who consented to participate was done. Structured questionnaires were used to collect data on associated factors and wound swabs were done prior to bacterial culture. Antibacterial susceptibility pattern of isolated bacterial pathogens was determined by Kirby Bauer disc diffusion method. Data was analyzed using Stata 14.2.

Results : The wound sepsis rate was 16.8%. Being educated, multiple vaginal examination, hygiene, previous caesarean sections and HIV seropositivity were all significantly and positively associated with post-caesarean wound sepsis (p<0.05). The most implicated bacteria was Staphylococcus aureus and was most susceptible to ciprofloxacin. Resistance was most exhibited against ciprofloxacin, gentamycin, ceftriaxone and cotrimoxazole especially by coliforms.

Conclusions. The rate of caesarean wound sepsis is high at Hoima Regional Referral Hospital . Being educated, multiple vaginal examination, hygiene, previous caesarean sections and HIV seropositivity are possible risk factors for the condition. Staphylococcus aureus is the commonest organism isolated from exudates of septic wounds after caesarean section. Awareness amongst health workers and patients about these major factors is necessary so that management can be directed. Rational use of antibiotics by health workers is paramount to combat resistance in this setting.

Background

Post-cesarean wound sepsis is common among women following cesarean section and this can easily progress into septic shock if poorly managed [1, 2]. Early diagnosis of post-cesarean wound sepsis using sepsis biomarkers such as pro-calcitonin (PCT) is an important medical practice [3]. These biomarkers are hardly available in several health care units in developing countries and this has led to the development of a global campaign on development of appropriate guidelines for successful management of sepsis [4, 5]. Successful management is crucial to ensure that unnecessary prolonged activation of the immune response is inhibited [6–8]. Though cesarean sections are done under aseptic conditions, the risk of post-cesarean wound sepsis always exists which puts post-cesarean wound sepsis among the most common nosocomial infections [9]. Globally, the rate of cesarean section is increasing rapidly [10] and the most common complication after cesarean section is wound sepsis, with an

incidence of 3–15% [11]. Post-cesarean wound sepsis is also associated with maternal mortality rate of up to 3% especially in health units that have no facilities to carryout safe cesarean sections or treat post-cesarean complications [12].

In sub-Saharan Africa, post-cesarean wound sepsis has been shown to be in the range of 1.7% to 10.4% showing that the condition is significant in the continent [13, 14]. This has been attributed to poor accessibility to health care services which is below 3% and thus resulting in poor postnatal follow up and wound care [15]. In addition, post-cesarean wound sepsis in sub Saharan Africa has been associated with poverty, environmental pollution, poor preoperative care, malnutrition, anemia, wound contamination, poor antibiotic selection and poor immunity [16]. In East Africa, the rate of cesarean sections is below 40%, which is a higher rate [17] compared to the recommended rate of cesarean section as per the WHO which considers that the best cesarean section rate is between 10–15% [18]. This increases the risk of post-cesarean wound sepsis.

In Uganda, a study conducted in Jinja showed that the major pathogenic bacteria associated with post-operative sepsis are; *Staphylococcus aureus,* coliforms*, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Enterobacter* spp [19]. In addition, the study showed that these pathogens were highly resistant to ampicillin, amoxicillin and chloramphenicol. A study conducted at Mulago National Referral Hospital in Uganda showed that majority of these septic wounds have pathogens that are methicillin resistant thus posing a major healthcare challenge due to the limited class of drugs available in several healthcare centers in Uganda [20].

At Hoima Regional Referral Hospital (HRRH) there was a high turnover of patients with eight to ten cesarean sections done in a day (maternity theatre register). It was also noted that theatres were being shared by other surgical teams and that the patients with post-cesarean wound sepsis were not isolated from the rest of the patients in ward, according to the findings during an onsite visit to the Hospital.

Several associated factors including patient related factors, hospital factors and obstetric factors have made management of post-cesarean wound sepsis challenging, leading to an increase in hospital stays [21]. Hence, thorough identification of the bacterial pathogens and the associated factors of post-cesarean wound sepsis is important for developing proper protocols to reduce its burden and complications.

Methods

Study design

We performed a descriptive and analytical cross-sectional study and we involved laboratory investigations to isolate the bacterial pathogens and antibacterial susceptibility pattern. The outcome variables were post-cesarean sepsis. We also assed predictors such as socio-demographic and clinical factors for the study participants.

Study site and setting

The study was conducted in the postnatal ward at Hoima Regional Referral Hospital (HRRH) between the months of July to September 2018. HRRH is a public hospital located in Hoima District with in coordinates; 01 24N, 31 18E and is approximately 230 km by road from Kampala (Capital city of Uganda). The major tribe is Banyoro and the main occupation is animal husbandry and crop farming.

Hoima Regional Referral Hospital is a well-established hospital and it offers both in-patient and out-patient services with a range of departments and clinics, including General Surgery, Orthopedics, Obstetrics and Gynecology and Internal Medicine. The hospital is well equipped with a bed capacity of 400. The Obstetrics and Gynecology Department of Hoima Regional Referral Hospital has four specialists, one Resident doctor, five intern doctors and 13 midwives. The obstetrics and gynecology department has 110 beds. The post-natal ward for post-cesarean mothers is located in the new block. The new block has about 60 beds which are always fully occupied with some patients lying on the floor.

According to the hospital records (Maternity Theatre register), Hoima Regional Referral Hospital performs approximately 8-10 cesarean sections per day. These are done in two theatres that are shared by other surgical teams. The hospital had a range of 10-20 vaginal deliveries per day and also offers antenatal and postnatal services. The main laboratory of Hoima Regional Referral Hospital consists of the following sections: hematology and blood bank, chemistry, parasitology and microbiology. It was composed of 20 staff members and these include three specialists, two laboratory technologists, eight laboratory technicians, six laboratory assistants, and one laboratory attendant. The microbiology laboratory was operated by one laboratory technologist, one laboratory technician, one laboratory assistant and one laboratory attendant. It was well equipped to carry out culture and sensitivity and other microbiological tests. Some of the equipment found in this laboratory were; autoclave, incubator, microscope, hot air oven, refrigerator, safety cabinet and gas cylinder.

Study population

The study population were mothers who have delivered by cesarean section at Hoima Regional Referral Hospital during the period of the study.

Selection criteria

Inclusion Criteria

All adult and emancipated mothers (on ward or re-admitted) who delivered by cesarean section at Hoima Regional Referral Hospital during the study period.

Exclusion Criteria

Cesarean section mothers from other health units that were referred to Hoima regional referral hospital were excluded due to limited access to their medical records. Mothers who would have had a re-

exploration due to cesarean section complications other than suspected sepsis, as well as those who were in their early puerperium and those who reported after six weeks, were also excluded.

Sample size

The sample size for this study was 303 and was computed using modified Kish Leslie formula (Daniel, 1999).

Sampling technique

Consecutive enrollment of participants who consent to participate in the study. This was carried out on a daily basis until required sample size.

Data collection instruments

Structured investigator-administered pre-tested questionnaire was used for each participant to collect information on socio-demographic and known factors that may be related to the development of post-cesarean wound sepsis in each patient including obstetric factors, hospital factors and health factors.

A detailed history was elicited (English), translated where necessary for women who did not understand English; and physical examination was performed. Presence or absence of post-cesarean wound discharge (exudate) was noted. Swabs for mothers with discharge were taken and cultured in the laboratory according to standard clinical laboratory guidelines. Susceptibility testing was carried out according to Kirby Baur diffusion methods.

Sample collection and transportation

Patients with post-cesarean wound sepsis who met the inclusion criteria of the study and were, educated, counseled about the study and then consented to participate. They were requested to allow history taking and physical examination and when a patient had post-cesarean wound discharge (Exudate), a sample was taken for microbiological analysis. Using sterile swab sticks, two samples from each participant were collected by gently rubbing the sterile swab sticks in the infected site (wound depth) using aseptic technique and immediately replaced inside the swab sticks case. The sterile swab stick was labeled with each participant's study number and transported to Microbiology laboratory immediately for processing, and in case of any delay, the sample was stored aerobically in the refrigerator at 4-8□C.

Sample processing and Laboratory analysis

Isolation

The collected samples were inoculated on blood agar, chocolate agar, MacConkey agar and mannitol salt agar. They were then incubated both aerobically and anaerobically at 37□C for 24-48hrs. Colony morphology was observed according to shape, size, elevation and margin and surface characteristics.

Direct Gram Microscopy

A direct smear was made for Gram stain; a drop of sterile normal saline was added at the center of a clean dried glass slide and the swab containing the sample rolled in the drop of normal saline spreading it on the glass slide in a circular motion to make a thin smear of the size of a fifty shilling coin. The smear was allowed to air-dry and then heat-fixed by passing it at least three times over a Bunsen flame. The slide was placed on the staining rack and flooded with crystal violet solution for 60 seconds, washed with clean water and covered with Lugol's Iodine (a mordant) and then allowed to act for a minute.

The slide was again washed in clean water and then decolorized with 50% acetone- alcohol under slow running tap water until a faint pink color was observed or no more color tend to flow from the smear. The process of decolorizing did not exceed 30 seconds. After decolorizing, the slide was washed in clean water and counterstained with neutral red solution. The slide was then washed in clean water; air-dried and observed under the microscope with x100 objective lens (oil immersion lens). Gram-positive bacteria was observed as blue or purple color and Gram-negative as red or pink color. Also, the morphology and shape of the bacteria was used to identify whether they are cocci, diplococcic, cocci in chains, clusters, and whether they are rods in appearance. Pus cells were also observed in the direct Gram-stained slide.

Identification of bacterial isolates

Cultural characteristics

The colony morphological characteristics of the bacterial isolates was observed as follows; color, margin, mucoid, texture, and hemolysis on blood agar medium, among others. This helped in determining the characteristics of the colonies of the bacteria on culture media such as Lactose or non-lactose fermenters on MacConkey agar and type of hemolysis (alpha, beta, and gamma hemolysis) on blood agar.

Biochemical tests

The isolates were identified using the conventional biochemical tests such as API (Analytical Profile Index) which depends on the Gram's stain reaction of the isolates (Gram-positive or Gram-negative bacteria). Other biochemical tests included catalase, optochin, bacitracin, coagulase, indole, citrate utilization, urea utilization, triple sugar iron agar fermentation, MR-VP test and oxidase as described below:

Catalase test

The Catalase Test was carried out to differentiate between *Streptococcus* and *Staphylococcus* species and this was done according to standard methods [22] . A drop of 3% hydrogen peroxide was added to a loop full of the test organisms. Presence of bubbles indicated catalase activity. *Streptococcus* species was catalase positive while Staphylococcus species was catalase negative.

Indole test

The Indole Test was carried out according to the method described by Cheesbrough [22] to determine the ability of the isolate to degrade amino acid tryptophan and produce tryptophanase enzyme. A 1% tryptophan broth in a test tube was inoculated with 7 days isolate and incubated at 37°C for 48 hours. After 48 hours, 1 ml of chloroform was added to the broth. The test tube was shaken gently, and 2.1 ml of Kovac's reagent was added and again shaken gently. This was allowed to stand for 20 minutes. The formation of red coloration at the top layer, indicated a positive test, while a yellow coloration indicated negative result. *Escherichia coli* and *Proteus* are indole-positive.

Urease test

The Urease test was carried out according to the method described by Cheesebrough [22] to determine the ability of the bacteria to hydrolyse urea and produce ammonia and carbon dioxide. The test organism were inoculated into urease broth and incubated at 30°C for 72 hours. Purplish pink coloration of the medium indicated a positive reaction for *Proteus* and negative for other enterobacteria like *Klebsiella* and *E. coli*.

Citrate utilization

This was carried out by inoculating the test organism in test tube containing Simon's citrate medium and incubated for 24 to 72 hours. The development of deep-blue color after incubation was indicate a positive result. *Klebsiella* species are citrate- positive.

Triple sugar- iron test

Triple sugar iron test was carried out according to the method described by Cheesbrough [22]; the test determined the ability of the organism to ferment the three sugar component of the medium: glucose, lactose and sucrose. The medium contains a pH indicator (phenol red) and a detection system (thiosulphate and ferrous sulphate) for hydrogen sulphide (H_2S). The medium was prepared as an agar slant. The test organism was inoculated by stabbing the medium using sterilized straight wire loop and the surface of the slope was also streaked with the test organism. The test was incubated at 37°C for 3 days. After incubation, gas production was determined by observing the cracking of the medium, and production of H_2S was observed by the blackening of the butt (bottom) of the medium. The triple-sugar iron-agar aided in identification of *Escherichia coli* which ferments all three sugars and produce acid, turning the media into yellow color. *Proteus* species produces H_2S which is indicated by black coloration of the media and fermentation at the butt of the tube.

Methyl red – Voges – Proskauer test (MR-VP)

Methyl red – Voges – Proskauer test (MR-VP) was carried out according to the method described by Cheesbrough [22]. It was used to determine the ability of the organisms to ferment glucose with production of acid. Five milliliters (5 ml) of MR-VP broth were inoculated with the test organism and incubated for 48 to 72 hours at 37°C. After incubation, 2 to 3 drops of methyl red test were added to 1ml

of the broth. A red color signified a positive methyl red test, while yellow color signified a negative test. To what remained, five drops of 4% potassium hydroxide (KOH) were added followed by fifteen drops of 5% α −naphthol in ethanol. The development of red color within 1 hour indicates VP positive test while no color change indicated VP negative test. *Escherichia coli* is methyl red positive and voges-proskauer negative.

Coagulase test

It was used to identify *Staphylococcus aureus* which produces the enzyme coagulase. The rapid slide test was done by placing a drop of distilled water on each end of slide. Then a colony of the test organism (previously checked by Gram-staining) was emulsified in each of the drops to make two thick suspensions. A loopful of plasma was added to one of the suspensions (no plasma was added to the second suspension), and mixed gently. Formation of clumps of the organisms within 10 seconds was indicative of a positive test while absence of these clumps was indicative of negative results.

For suspected *Staphylococcus aureus* isolates which turn negative for the rapid slide test, the test was done by emulsifying several isolated colonies of test organism in 1 ml of diluted rabbit plasma (1:5) dilution to give a milky suspension. The tubes were then incubated at 35°C in water bath for 4 hours. These were then examined at intervals of 1, 2 and 4 hours for clot formation by tilting the tube through 90°. If the test was still negative, the tube was left at room temperature overnight and examined again for *Staphylococcus aureus* that produced a delayed clot.

Oxidase test

The test was used in identification of organisms which produce the enzyme cytochrome oxidase. A filter paper soaked with the substrate tetramethyl-p-phenylenediamine dihydrochloride was moistened with sterile distilled water. Using a glass rod, a colony of the test organism was smeared on the filter paper. The development of a blue-purple color within a 10 seconds was indicative of positive test while absence or formation of a blue-purple color after 10 seconds was considered negative. *Pseudomonas* species and *Neisseria* species are oxidase positive.

Susceptibility Pattern Determination (Kirby-Bauer disc diffusion technique)

The susceptibility pattern of the identified pathogens was determined by agar disc diffusion technique by Kirby-Bauer using Muller Hinton agar. The Muller Hinton agar was prepared according to the manufacturer's instructions under sterile conditions to avoid any contamination that may result. About 4-5 colonies of the organism were diluted in sterile peptone water and mixed and incubated for 4-5 minutes and its turbidity compared to a McFarland standard 0.5%.

A prepared Muller Hinton agar was dried in an incubator for at least 15 minutes and using a sterile glass rod or swab stick, the surface were smeared with the diluted organism of the peptone water, and using sterile forceps, ten different antibiotic containing discs were placed on the dried surface of the Muller Hinton agar containing the organism and then placed in the incubator at 37⬚C for 24 hours.

The diameter of a clear zone surrounding the antibiotic disc was measured in millimeters and compared to a standard antibiotic chart for measuring zones of inhibition. Zones of inhibition measured were recorded as susceptible (S), Intermediate (I), and Resistant I according to the standard chart.

Statistical analysis

Data on questionnaires was entered in Microsoft Excel version 2010, and then data from Excel was exported to IBM SPSS statistics version 23 as well as STATA 14.1 (Statacorp, USA Texas). Socio-demographic and clinical factors were summarized as means and medians, standard deviations and interquartile range (for continuous variables). Proportions, percentages and frequencies were used for categorical variables using STATA 14.1.

Prevalence of post caesarian sepsis was summarized as frequencies and percentages. The factors associated with post-cesarean wound sepsis were assessed using binary logistic regression. For factors with odds ratio ≤ 0.2 at bivariate and those with biological plausibility were transferred for multivariate analysis. Bar charts were used to present susceptibility profile.

Quality control

The questionnaires was checked for completeness before collection to ensure valid data is obtained. Two independent microbiologists were involved in identification bacterial isolates. Additionally, standard operating procedures were adhered to.

Ethical considerations

Permission to conduct this study was obtained from the department of obstetrics and gynecology and post graduate directorate. Afterwards approval was obtained from Kampala International University Research Ethics Committee (KIU-REC).

Results

Socio-demographic characteristics of study participants attending Hoima Regional Referral Hospital

Table 1. The median age was 23 years for both referred and non-referred study participants, with 92.2%married among the non-referred participants. Majority of the non-referred study participants had no formal education (56%) compared to 24% among referred participants (p=0.001). Farming was the major occupation (79%) among the referred participants with 41% Anglicans were the majority among the non-referred participants while believers of Bishaka faith were the minority (<5%) in both groups.

Clinical characteristics of study participants attending Hoima Regional Referred Hospital

Table 2. The median BMI among non-referred participants is 27 compared to 26 in referred participants (p=0.02). The prevalence of diabetes Mellitus, Hypertension, HIV and Cancer was low, i.e. <1 %,< 7 %,< 3% and <1% respectively.

Hospital and obstetric factors of women attending Hoima Regional Referral Hospital

Table 3. In our study, intern doctors mainly handled caesarean sections for both referred and non-referred mothers attending Hoima Regional Referred Hospital. Emergency caesarean section were the majority in this setting with the most preferred type of incision being midline. Among 61% of non-referred patients, there were no antibiotics given before surgery compared to 42% among referred patients. Premature rupture of membranes was more among referred patients (13%) compared to Premature rupture of membranes among non-referred patients (p=0.03). Participants with more than one previous caesarean section were more in non-referred 29% compared to 25% in referred patient (p = 0.42)

Prevalence of post caesarean wound sepsis of women attending Hoima Regional Referral Hospital, western Uganda

Table 4. In the study comprising 303 participants, 16.8% were diagnosed with post-caesarean wound sepsis with non-referred and referred participants having the condition of 11.7% and 27.6% respectively

Bivariate and multivariate logistic regression analysis of post-caesarean wound sepsis on associated socio-demographic factors among non-referred patients attending Hoima Regional Referral Hospital

Table 5. In the study single mothers were four times more likely to develop post-caesarean wound sepsis compared to married mothers (cOR=4.2, 95% CI 1.0- 18.2). Mothers who completed primary education were six times more likely to develop post-caesarean wound sepsis compared to those who didn't attain formal education (cOR=6.2, 95%CI 1.8-21.4). Mothers who completed secondary level were ten times more likely to develop post-caesarean wound sepsis than those who didn't attain formal education (cOR=10.2, 95% CI 2.7-38.3). Mothers who completed tertiary education were ten times more likely to develop post-caesarean wound sepsis compared to those who didn't attain formal education (cOR= 10.1, 95% CI 2.2-46.1). Anglican mothers were 60% times less likely to develop post-caesarean wound sepsis than Catholics (cOR= 0.4, 95% CI 0.1-0.2).

On adjusted analysis: Non-referred mothers who completed primary education were 5.5 times more likely to develop post-caesarean wound sepsis compared to those who never attained formal education (aOR=5.5, 95%CI 1.5-20.2). Non-referred mothers who completed secondary level were 11.6 times more likely to develop post-caesarean wound sepsis compared to those who never attained formal education (aOR=11.6, 95%CI 2.6-51.5). Non-referred mothers who completed tertiary level were 8.7 times more likely to develop post-caesarean wound sepsis compared to those who never attained formal education (aOR=8.7, 95%CI 1.8-43.1).

Bivariate and Multivariate logistic regression analysis of post-caesarean wound sepsis on associated clinical, hospital and obstetric factors among non-referred patients attending Hoima Regional Referral Hospital

Table 6. Mothers who are HIV positive were 8.5 times more likely to develop post-caesarean wound sepsis than those who are HIV negative (cOR=8.5, 95%CI 1.6-44.7). Mothers who had prior caesarean section

were 2.9 time more likely to develop post-caesarean wound sepsis than those without prior caesarean section (cOR=2.9, 95% CI 1.2-6.8).

On adjusted analysis: Non-referred mothers who were HIV positive were 6.4 times more likely to develop post-caesarean wound sepsis compared to those who were HIV negative (aOR=6.4, 95%CI 1.1-38.6). Non-referred mothers who experienced more than 4 vaginal examinations were four times more likely to develop post-caesarean wound sepsis compared to those done four times or less (aOR=4.0, 95% CI 1.1-14.3). Mothers with prior caesarean section were 3.5 time more likely to develop post-caesarean wound sepsis compared to those without (aOR=3.5, 95%CI 1.3-9.5)

Bivariate and multivariate logistic regression analysis of post-caesarean wound sepsis on associated socio-demographic factors among referred patients attending Hoima Regional Referral Hospital

Table 7. Mothers who bathed more than two time were seven times more likely to develop post-caesarean wound sepsis compared to those who bathed two time or less (aOR = 7.0 ,95% CI 1.6-30.2). Referred Bishaka faith mothers were 6.8 times more likely to develop post-caesarean sepsis compared to catholics though it was statistically not significant (cOR=0.6, 95%CI 0.6-71.7). Referred mothers who bathed more than two times were 3.3 times more likely to develop post-caesarean wound sepsis compared to those who bathed two times or less though it was statistically not significant (cOR=3.5, 95%CI 0.9-11.2). Referred mothers who were underweight were 1.3 times more likely to develop post-caesarean wound sepsis compared to those with normal BMI though it was statistically not significant (cOR=1.3, 95% CI 0.5-3.4)

Bivariate and Multivariate logistic regression analysis of post-caesarean wound sepsis on associated clinical, hospital and obstetric factors among referred patients attending Hoima Regional Referral Hospital

Table 8. Mothers who experienced more than four vaginal examinations were 3.8 times more likely to develop post-caesarean wound sepsis compared to those in whom four and less vaginal examinations were done (cOR=3.8, 95% CI 1.5-9.8). Referred mothers who were HIV positive were 2.7 times more likely to develop post-caesarean wound sepsis compared to those who are HIV negative although there was no statistical significance (cOR=2.7, 95%CI 0.2-44.5). Referred mothers who were hypertensive were 2.1 times more likely to develop post-caesarean wound sepsis compared to those without hypertension though there was no statistical significance (cOR=2.1, 95% CI 0.4-10.0). Referred mothers who were given antibiotics before surgery were 2.1 times more likely to develop post-caesarean wound sepsis compared to those who never received antibiotic though there was no statistical significance (cOR=2.1, 95%CI 0.8-5.3).

On adjusted analysis: Referred mothers who experienced more than four vaginal examinations were 6 times more likely to develop post-caesarean wound sepsis compared to those in whom four and less vaginal examinations were done (aOR = 6.0 95%CI 1.9-18.9).

Common bacterial pathogens that were isolated among study participants attending Hoima Regional Referral Hospital

Table 9. The most common bacterial isolates were *Staphylococcus aureus* 28.8%, followed by E. *coli*, 21%. The least was *Proteus mirabilis.*

Drug susceptibility pattern of bacterial isolates from septic wounds of mothers in Hoima Regional Referral Hospital, Uganda

Figure 1: Ciprofloxacin, gentamicin, ceftriaxone,penicillin and cotrimoxazole were the most resisted drugs by *Staphylococcus aureus*, *E. coli* and *Klebsiella Pneumoniae.*

Drug susceptibility pattern of bacterial isolates from septic wounds of mothers in Hoima Regional Referral Hospital, Uganda.

Figure 2: Imipenem was the most active drug on all organisms especially on E. coli, klebsiella pneumonae and Pseudomonas auruginosa.

Coliforms showed high susceptibility to imipenem followed by *Staphylocccocus aureus* to ciprofloxacin.

Discussion

Prevalence of post caesarean wound sepsis among mothers attending post-natal ward at Hoima Regional Referral Hospital, Western Uganda

In our study the overall prevalence of post-caesarean wound sepsis was 16.8%. This was much higher than the reported Sub-Saharan Africa prevalence of 7.3% [23]. The discrepancy could be due to small area of coverage within the population by the researcher as he only considered Burundi, DRC and Sierra Leone and generalized it to all Sub-Saharan Africa. Though Chu *et al.* [23] had a bigger sample size compared to this study, this study considered only one referral hospital. In addition, the current prevalence is also lower than that of 22.2% done in Kenyatta National Hospital [24]. This may be due to fact that KNH is the biggest national referral Hospital in East Africa handling more cases than HRRH.

Our study findings show that post-caesarean wound sepsis was higher among referred patients than non-referred patients. This result could be due to complications such as obstructed labour that was higher among the referred patients (48%, 47/98) and this may be attributed to the multiple vaginal examinations before caesarean section and delayed ambulation after surgery. Our findings agree with those by Sai *et al* where 70% of the cases in Government Hospital, Tirupati, Chitoor district, India were due to obstructed labor [25].

Risk factors of post caesarean wound sepsis among mothers attending Hoima Regional Referral Hospital, Western Uganda

High level of education (primary and post primary) was a significant predictor of post- caesarean wound sepsis among non-referred patients. This is contrary to the findings by Apanga *et al* from Northern Ghana where mothers with higher level education were less likely to experience post caesarean sepsis compared to those with primary and lower education [26]. Our findings could be explained by non-compliance of educated mothers towards health education offered by health workers; in our setting there is the "we know it all" among the educated mothers (especially secondary school education) as compared to mothers with no formal education. Also it may be due to increased maternal requests for caesarean sections which is a risk factor for post-caesarean wound sepsis among educated mothers [27]. However, our findings are consistent with those obtained by Rajab *et al* in South Western Iran where mothers that had attained high school education were 1.4 times likely to have post-caesarean wound sepsis than those with lower school education [28].

Behaviourally, mothers (non-referred) who reported having over 2 baths per day were more likely to experience post-caesarean wound sepsis compared to their counterparts who reported to have two or less number baths per day. This is against biological plausibility and it is possible that baths taken may be unhygienic as our participants were culturally oriented who incorporate herbs in their baths and this increases chances of microbial contamination of the wound post-caesarean section [3]. Additionally, the study participants were from low income background and possibility of having no recommended bathing soap is likely. There is need to sensitise such mothers against use of herbal concoctions in their baths.

Mothers who experienced more than four vaginal examinations had increased risk of post caesarean sepsis compared to mothers who experienced less than 4 vaginal examinations. Our findings are consistent with findings by Hassan *et al* obtained among mothers attending Port Harcourt Teaching Hospital, Southern Nigeria [24, 29]. The similarity is the highest delivery rate between the two hospitals; Hoima Regional referral Hospital and Port Harcourt teaching Hospital. Frequent vaginal examinations are likely to introduce microbial pathogens during examination into uterus through the vagina.

In our study, mothers who were HIV positive were more likely to develop post-caesarean wound sepsis compared to HIV sero-negative mothers. Our findings are similar to those obtained by Marsel in Tygerberg Hospital, South Africa where HIV ART naïve patients were about 6 times more likely to experience post-caesarean sepsis [30]. This can be explained by immunosuppression associated with HIV positivity that facilitate bacterial infection in such mothers.

In our study, mothers who had a prior caesarean section were more likely to have post-caesarean wound sepsis compared to those with no prior caesarean section[31]. The explanation could be explained by several reasons: There are high chances of prolonged caesarean section for mothers with prior Caesarean section due to fibrosis and adhesion. Also, prolonged CS is likely to result into severe bleeding leading to anemia, delayed or no ambulation that have a significant role on risk of Post-caesarean wound sepsis [32].

We found out that antiseptic use (Savlon) was protective against post-caesarean wound sepsis among referred mothers and this is so because most of these mothers are from refugee camps (Kyangwali

refugee resettlement) where they are supported with supplies like antiseptics. Our findings are consistent with those found by Kawakita and Landy in their review paper where use of Chlorhexidine (similar ingredient for savlon) as antiseptic was protective against post-caesarean wound sepsis [33].

We found that single mothers were more likely to have post-caesarean wound sepsis compared to the married mothers. This is possible because such mothers have got reduced care and support as compared to married ones. A similar study by Nansikombi has been observed among mothers in Mulago hospital, Kampala [34].

Mothers of Anglican Faith were 64% less likely to have post-caesarean wound sepsis compared to Catholics. In Anglican settings, there are formed groups such as Mother's Union which hold regular discussions concerning guidance about maternal health and hygiene among other activities. This has a bearing on reducing post-caesarean sepsis. Conversely catholic faith is liberal about alcohol consumption and this may have an implication on the risk of post- caesarean wound sepsis among the catholic mothers [35].

Common bacterial isolates

We found common bacteria being *Staphylococcus aureus* followed by *E. coli*. These findings are in agreement with findings in central Uganda in which *Staphylococcus aureus* and coliforms have been shown to be common pathogens in post-caesarean wound sepsis [19] . In addition, in Zanzibar, *Staphylococcus aureus* and *E. coli* were found to be common pathogens in sepsis [36], showing similarities in the common pathogens of Tanzania and Uganda, this may be attributed to the fact that *Staphylococcus* is a normal skin flora, and may have contaminated the wound during caesarean section since most of the work was handled by intern doctors who possibly had poor surgical techniques .In addition, a study done by Matinyi *et al* revealed that *Staphylococcus* was the most common organism isolated in hospital environment especially the door handles(100%) of Mbale Regional Referral Hospital, Eastern Uganda [37]. However findings are different from the study done in Muhimbili teaching Hospital [38], where the commonest organism isolated was *Pseudomonas aeruginosa*, this may be due to the difference in the standard of Hygiene (poor aseptic technique) as evidenced in this Hospital, since one nurse was responsible for cleaning and dressing 15 post-operative wounds hence putting patients at risk of cross infection.

Drug susceptibility pattern of bacterial isolates

In our study, coliforms showed high susceptibility to Imipenem followed by *Staphylococcus aureus* to Ciprofloxacin and this is comparable to a study done in Mbale Regional Referral Hospital, Eastern Uganda [37]. Furthermore, the study also showed that *Staphylococcus aureus* and other coliforms were resistant to Ciprofloxacin, Ceftriaxone, Gentamycin and Cotrimoxazole. This may be attributed to the fact that these drugs were the most erroneously prescribed medications among the study population in Hoima Regional Referral Hospital. These findings are similar to those found in Greece [39].

The study also showed that *Staphylococcus aureus* was also resistant to Tetracycline and Penicillin which was in agreement with a study conducted by Bebell et al in a Ugandan referral hospital [40] where over 80% antibacterial resistance to Penicillins among in postpartum mothers was reported. In addition, a study done in Mulago National Referral Hospital revealed a development of *Staphylococcus aureus* methicillin resistance in post-caesarean wound sepsis [20].

Strengths and Weakness of the study

It is the first documented study done at HRRH to report post-caesarean wound sepsis and associated bacterial organisms. Additionally, people who were re-admitted upon exudate were swabbed, so we minimized loss of follow-up and under reporting of Post-caesarean wound sepsis.

In our study, we did not swab the theater surfaces and aerial space to correlate environmental contamination and post-caesarean wound. We were unable to characterize the bacterial isolates at molecular level due to limited budget.

Conclusions

The prevalence of post-caesarean wound sepsis at Hoima Regional Referral Hospital is 16.8%. The major significant risk factors of post-caesarean wound sepsis were: higher level of education, history of previous caesarean section, hygiene, obstructed labor, HIV seropositivity and multiple vaginal examinations prior to surgery. The most common bacterial pathogens were *Staphylococcus aureus* and the least was *Proteus mirabilis.* Resistance was highest for coliforms and *Staphylococcus aureus* against, ciprofloxacin, gentamycin, penicillin, ceftriaxone and cotrimoxazole.

Recommendations

The local hospital management should alert the health workers about the high prevalence of post caesarean sepsis at this hospital to devise means of controlling it.

Enhanced awareness to the health workers and the patients on the major risk factors of sepsis and attending to them during management.

Health workers should enhance hygiene amongst mothers before, during and after caesarean section. Community based engagements of Health workers on rational use of antibiotics is extremely necessary.

Additionally, further studies should be carried out to involve swabbing theater and aerial space to correlate environmental contamination and post-caesarean wound sepsis.

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Abbreviations

aOR	adjusted Odds Ratio
APH	Antepartum Hemorrhage
BMI	Body Mass Index
CI	Confidence Interval
cOR	crude Odds Ratio
CS	Caesarean Section
E. *coli*	*Escherichia coli*
HRRH	Hoima Regional Referral Hospital
IQR	Interquartile Range
KIU-REC	Kampala International University Research Ethics Committee
KIU-WC	Kampala International University- Western Campus
KNH	Kenyatta National Hospital
LTCS	Lower Transverse Caesarean Section
MRSA	Methicillin-Resistant *Staphylococcus aureus*
PCT	Pro-calcitonin

PET	Pre-eclamptic Toxemia (Preeclampsia)
RCOG	Royal College of Obstetrics and Gynecology
Sd	Standard Deviation

Declarations

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Availability of Data and Materials

Tables and figures have been provided as supplementary material.

The raw data are available upon reasonable request from the corresponding author.

Contributions

IM: Conceptualized the research idea, designed research and participated in drafting the manuscript. AZL, BT, AAA, FMK, JT & VOT were helpful in providing technical assistance and proof reading the draft manuscript. EN, UA, IBF & VK participated in proof reading the manuscript. CA & RS were helpful in data analysis and drafting a manuscript.

Ethics approval and consent to participate

Study participants provided written informed consent. Approval to conduct this research was sought from Kampala International University Research & Ethics committee and Hoima Regional Referral Hospital Research Ethics Committee. The reference number: UG-REC-023.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Tables

Table 1: Socio-demographic characteristics of study participants attending Hoima Regional Referral Hospital

Variable	Patient type		p-value
	Non-referred (n=205)	Referred (n=98)	
Median age in years (IQR)	23(20-28)	23(19-28)	0.95
Marital status n (%)			
Married	189(92.2)	87(88.8)	0.56
Single	9(4.4)	8(8.2)	0.51
Divorced	5(2.4)	2(2.0)	0.95
Cohabiting	2(1.0)	1(1.0)	1.00
Education n (%)			
None	115(56.1)	23(23.5)	**0.001**
Primary	49(23.9)	52(53.1)	**0.004**
Secondary	26(12.7)	19(19.4)	0.51
Tertiary	15(7.3)	4(4.1)	0.075
Employment n (%)			
Farmer	119(58.1)	77(78.6)	0.25
Health worker	2(1.0)	2(2.0)	0.95
Saloon	28(13.7)	7(7.1)	0.51
Teacher	9(4.4)	3(3.1)	0.94
Others	47(22.9)	9(9.2)	0.44
Religion n (%)			
Catholic	68(33.2)	39(39.80)	0.75
Anglican	84(41.0)	32(32.7)	0.69
Muslim	15(7.32)	4(4.1)	0.88
SDA	12(5.9)	4(4.1)	0.93
Bishaka	7(3.4)	4(4.1)	0.97
Others	19(9.3)	15(15.3)	0.78
Median no. of times bathe a day (sd)	1.94(0.64)	1.12(1.20	**<0.001**

Table 2: Clinical characteristics of study participants attending Hoima Referral Hospital.

| | Patient type | | p-value |
	Non-referred (n=205)	Referred (n=98)	
Median BMI (IQR)	27(25.0-29.9)	25.5(23.56-28.57)	0.017
History of diabetes			
No	204(99.51)	98(100.0)	0.31
Yes	1(0.49)	0(0.0)	<0.001
History of hypertension			
No	202(98.5)	91(92.86)	0.04
Yes	3(1.46)	7(7.14)	0.04
HIV			
No	199(97.1)	96(98.0)	0.63
Yes	6(2.9)	2(2.0)	0.63
History of cancer			
No	204(99.5)	98(100.0)	0.31
Yes	1(0.49)	0(0.0)	-

Table 3: Hospital and obstetric factors of women attending Hoima regional referral Hospital

Variable	Patient type		
	Non-referred (n=205)	Referred (n=98)	p-value
Cadre that performed the surgery n (%)			
Intern	204(99.5)	96(98.0)	0.32
Medical officer	1(0.49)	2(2.0)	0.06
Antibiotics given prior surgery			
No	124(60.5)	41(41.8)	**0.02**
Yes	81(39.5)	57(58.2)	**0.02**
Median length of labor in hours (IQR)	9(6-13)	10(6-18)	0.07
Median parity (IQR)	2(1-3)	2(1-4)	0.30
Type of incision			
Transverse	86(42.0)	34(34.7)	0.16
Midline	119(58.1)	64(65.3)	0.23
Median no. of vaginal examination (IQR)	3(2-4)	2(1-5)	0.057
Type of c/section n (%)			
Emergency	190(92.7)	94(95.9)	0.24
Elective	15(7.3)	4(4.1)	0.24
Techniques of CS n (%)			
Classical	5(2.44)	6(6.12)	0.17
LTCS	200(97.56)	92(93.9)	0.17
Premature rapture of membrane			
No	193(95.1)	85(86.7)	**0.03**
Yes	10(4.9)	13(13.3)	**0.03**
Previous CS			
1	146(71.22)	74(75.5)	0.42
>1	59(28.8)	24(24.5)	0.42

Table 4: Prevalence of post-caesarean wound sepsis of women attending Hoima Regional Referred Hospital, western Uganda

Overall prevalence (n=303)		Patient type				p-value
		Non-referred (n=205)		Referred (n=98)		
Frequency	%(95%CI)	Frequency	%(95%CI)	Frequency	%(95%CI)	
51	16.8(13.0-21.5)	24	11.7(7.9-16.9)	27	27.6(19.4-37.4)	0.002[a]

[a]P-value between prevalence of post-caesarean wound sepsis among referred and non-referred patients

Table 5: Bivariate logistic regression analysis of post-caesarean wound sepsis on associated socio-demographic factors among non-referred patients attending Hoima Regional Referral Hospital

Variable n (%)	No sepsis (n=181)	Sepsis (n=24)	Crude analysis cOR(95%CI)	p-value	Adjusted analysis aOR (95%CI)	p-value
Age in years n (%)						
18-23	42(89.4)	5(10.6)	1.00			
24-28	43(86.0)	7(14.0)	1.37(0.40-4.65)	0.62		
>28	96(88.9)	12(11.1)	1.10(0.35-3.17)	0.93		
Marital status						
Married	169(89.4)	20(10.6)	1.00	-		
Single	6(66.7)	3(33.3)	4.23(1.00-18.22	0.05		
Divorced	4(80.0)	1(20.0)	2.11(0.22-19.8)	0.51		
Cohabiting	2(100.0)	0(0.0)	-			
Education						
None	111(96.5)	4(3.5)	1.00		1.00	
Primary	40(81.6)	9(18.4)	6.24(1.82-21.40)	0.004	5.50(1.50-20.17)	0.01
Secondary	19(73.1)	7(26.9)	10.22(2.73-38.32)	0.001	11.6(2.62-5.45)	0.001
Tertiary	11(73.3)	4(26.7)	10.09(2.21-46.05)	0.003	8.73(1.77-43.15)	0.008
Employment						
Farmer	107(89.9)	12(10.1)	1.00			
Health worker	2(100.0)	0(0.0)	-			
Saloon	25(89.3)	3(10.7)	1.07(0.28-4.08)	0.92		
Teacher	7(77.8)	2(22.2)	2.55(0.47-13.68)	0.28		
Others	40(85.1)	7(14.9)	1.56(0.57-4.24)	0.38		
Religion						
Catholic	56(82.3)	12(17.7)	1.0			
Anglican	78(92.9)	6(7.1)	0.36(0.13-1.0)	0.05		
Muslim	14(93.3)	1(6.7)	0.33(0.04-2.78)	0.31		
SDA	10(83.3)	2(16.7)	0.93(0.18-4.82)	0.93		
Bishaka	6(85.7)	1(14.3)	0.78(0.09-7.07)	0.82		
Other	17(89.5)	2(10.5)	0.55(0.11-2.70)	0.46		
Number of times bathed per day n (%)						

≤2	165(88.2)	22(11.8)	1.00	
>2	16(88.9)	2(11.1)	0.94(0.20-4.35)	0.69
BMI				
Normal (18.5-25)	46(90.2)	5(9.8)	1.00	
underweight<18.5	0(0.00)	1(100.0)	-	
Overweight >25	134(88.2)	18(11.8)	1.24(0.43-3.52)	0.69

Table 6: Bivariate and Multivariate logistic regression analysis of post-caesarean sepsis on associated clinical, hospital and obstetric factors among non-referred patients attending Hoima Regional Referred Hospital

	No sepsis (n=181)	Sepsis (n=24)	Crude analysis		Adjusted analysis	
Variable n (%)			cOR (95%CI)	p-value	aOR(95%CI)	p-value
History of hypertension						
No	179(88.6)	23(11.4)	1.00			
Yes	2(66.7)	1(33.3)	3.89(0.34-44.62)	0.28		
HIV						
Negative	178(89.4)	21(10.6)	1.00		1.00	
Positive	3(50.0)	3(50.0)	8.48(1.61-44.71)	0.012	6.35(1.05-38.62)	0.045
Antibiotics given prior surgery						
No	111(88.0)	14(11.2)	1.00			
Yes	70(87.5)	10(12.50)	1.13(0.48-2.69)	0.78		
Length of labor in hours						
<12	126(86.3)	20(13.70)	1.00			
>12	49(92.5)	4(7.6)	0.51(0.17-1.58)	0.25		
Parity						
Primi-para 1	62(87.3)	9(12.7)	1.00			
Multipara (2-4)	10(89.8)	12(10.2)	0.78(0.31-1.96)	0.60		
Grand Multipara >4	13(81.3)	3(18.8)	1.59(0.38-6.69)	0.53		
Type of incision						
Transverse	77(89.5)	9(10.5)	1.00			
Midline	104(87.4)	15(12.6)	2.60(0.51-2.97)	0.64		
Times vaginal examination						
≤ 4	158(89.3)	19(10.5)	1.00		1.00	
>4	16(76.2)	5(23.8)	2.60(0.86-7.90)	0.092	4.00(1.10-14.28)	0.035
Types of CS						
Emergency	168(88.4)	22(11.6)	1.00			
Elective	13(86.7)	2(13.3)	1.17(0.25-5.56)	0.84		
PROM						
No	170(88.1)	23(11.9)	1.00			
Yes	9(90.0)	1(10.0)	0.82(0.10-6.78)	0.86		
Prior CS						
No	134(91.8)	12(8.2)	1.00		1.00	
Yes	47(79.7)	12(20.3)	2.85(1.20-6.78)	0.018	3.46(1.26-9.46)	0.016
Use of antiseptic						
No	34(82.9)	7(17.1)	1.00		1.00	
Yes	147(89.6)	17(10.4)	0.56(0.22-1.46)	0.24	0.53(0.16-1.83)	0.32

Table 7: Bivariate and multivariate logistic regression analysis of post-caesarean wound sepsis on associated socio-demographic factors among referred patients attending Hoima Regional Referral Hospital

Variable n (%)	No sepsis (n=71)	Sepsis (n=27)	Crude analysis		Adjusted analysis	
			cOR(95%CI)	p-value	aOR (95%CI)	p-value
Age in years						
18-23	16(76.2)	5(23.8)	1.00			
24-28	20(80.0)	5(20.0)	0.8(0.20-3.25)	0.76		
>29	35(67.3)	17(32.7)	1.55(0.49-4.95)	0.46		
Marital status						
Married	62(71.3)	25(28.7)	1.00			
Single	6(75.0)	2(25.0)	0.83(0.20-3.25)	0.76		
Divorced	2(100.0)	0(0.00)	-			
Cohabiting	1(100.0)	0(0.0)	-			
Education						
None	18(78.3)	5(21.7)	1.00			
Primary	38(73.1)	14(26.9)	1.33(0.41-4.25)	0.64		
Secondary	12(63.2)	7(36.8)	2.1(0.54-8.19)	0.29		
Tertiary	3(75.0)	1(25.0)	1.1(0.10-14.19)	0.89		
Employment						
Farmer	54(70.1)	23(29.9)	1.00			
Health worker	2(100.0)	0(0.0)	-			
Saloon	6(85.7)	1(14.3)	0.39(0.04-3.44)	0.40		
Teacher	2(66.7)	1(33.3)	1.17(0.10-13.60)	0.90		
Others	7(77.8)	2(22.2)	0.68(0.13-3.48)	0.63		
Religion						
Catholic	27(69.2)	12(30.8)	1.00			
Anglican	25(78.1)	7(21.9)	0.63(0.21-1.85)	0.40		
Muslim	3(75)	1(25)	0.75(0.07-7.79)	0.81		
SDA	3(75)	1(25)	0.75(0.07-7.97)	0.81		
Bishaka	1(25)	3(75)	6.75(0.64-71.71)	0.11		
Others	12(80.0)	3(20)	0.56(0.13-2.37)	0.43		
Number of time bathed per day						
≤2	65(76.5)	20(23.5)	1.00		1.00	
>2	6(50.0)	6(50.0)	3.25(0.94-11.20)	0.062	6.95(1.60-30.18)	**0.01**
BMI						
Normal	29(76.3)	9(23.7)	1.00	-	-	
<18.5	1(100.0)	0(0.0)	1.34	0.52-	0.54	

			3.42
>25	41(70.7)	17(29.3)	

Table 8:Crude and adjusted logistic regression analysis of post-caesarean sepsis on clinical, hospital and obstetric factors among referred patients attending Hoima Regional Referral Hospital

Variable n (%)	No sepsis (n=71)	Sepsis (n=27)	cOR (95%CI)	p-value	aOR(95%CI)	p-value
History of hypertension						
No	67(73.6)	24(27.1)	1.00			
Yes	3(57.1)	3(42.9)	2.09(0.44-10.04)	0.49		
HIV						
Negative	70(72.9)	26(27.1)	1.00		1.00	
Positive	1(50.0)	1(50.0)	2.69(0.16-44.64)	0.49	0.54(0.02-22.68)	0.69
Antibiotics given before surgery						
No	33(80.5)	8(19.5)	1.00			
Yes	38(66.7)	19(33.3)	2.06(0.80-5.33)	0.14		
Length of labor in hours						
≤12	44(75.9)	14(24.1)	1.00	-		
>12	27(67.5)	13(32.5)	1.51(0.62-3.70)	0.36		
Parity						
Primi-para	23(63.9)	13(36.1)	1.00	-		
Multipara	32(74.4)	11(25.6)	0.61(0.23-1.60)	0.31		
Grad Multipara	16(84.2)	3(15.8)	0.33(0.08-1.36)	0.13		
Type of incision						
Transverse	26(76.5)	8(23.5)	1.00			
Midline	45(70.3)	19(29.7)	1.37(0.51-3.57)	0.52		
No. of vaginal examination made						
≤4	57(80.3)	14(19.7)	1.00		1.00	
>4	14(51.9)	13(48.1)	3.78(1.46-9.82)	0.006	6.04(1.93-18.96)	0.002
Type of CS						
Emergency	68(72.3)	26(27.7)	1.00			
Elective	3(75.0)	1(25.0)	0.87(0.09-8.76)	0.91		
PROM						
No	62(72.9)	23(27.1)	1.00			
Yes	9(69.2)	4(30.8)	1.20(0.34-4.27)	0.78		
Prior CS						
No	50(67.6)	24(32.4)	1.00		1.00	
Yes	21(87.50)	3(12.50)	0.30(0.08-1.10)	0.07	0.26(0.06-1.09)	0.07
Use of antiseptic						
No	12(46.2)	14(53.8)	1.00		1.00	

Yes	59(81.9)	13(18.1)	0.19(0.07-0.50)	**0.001**	0.20(0.05-0.70)	**0.012**

Table 9: Common bacterial isolates from post-caesarean septic wounds from Mothers in Hoima Regional Referral Hospital, Uganda.

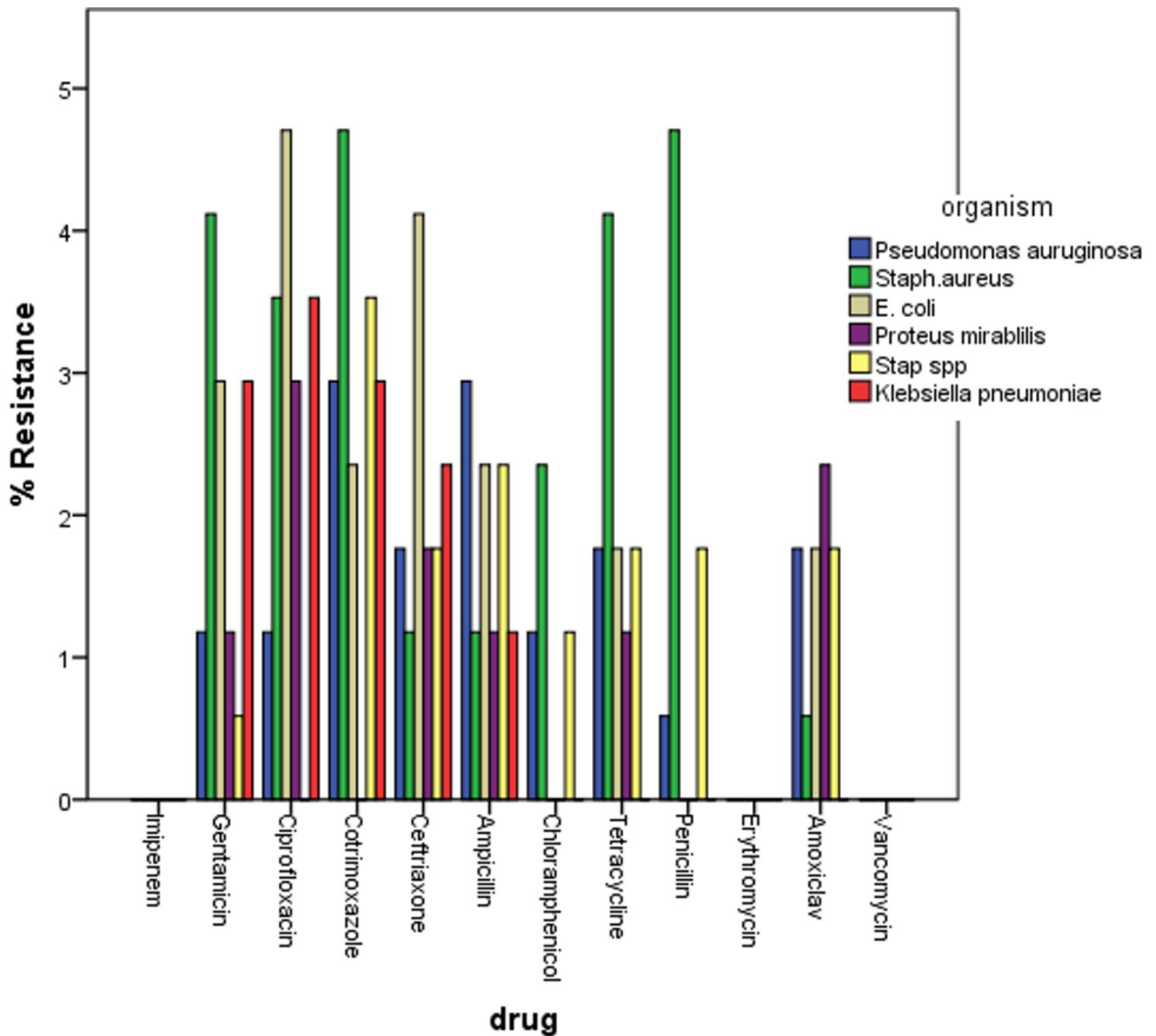| Pathogen	Frequency	Percent	95%CI
Pseudomonas aeruginosa	43	15.3	11.5-20.0
Staphylococcus aureus	81	28.8	23.8-34.4
E. *coli*†	59	21.0	16.6-26.2
Proteus mirabilis	24	8.5	5.8-12.5
Staphylococcus spp	35	12.5	9.1-16.9
Klebsiella pneumoniae†	39	13.9	10.3-18.5

†coliforms

Figures

Figure 1

Resistance pattern of bacterial isolates against major antibiotics among mothers attending post-natal ward Hoima Regional Referral Hospital, Western Uganda
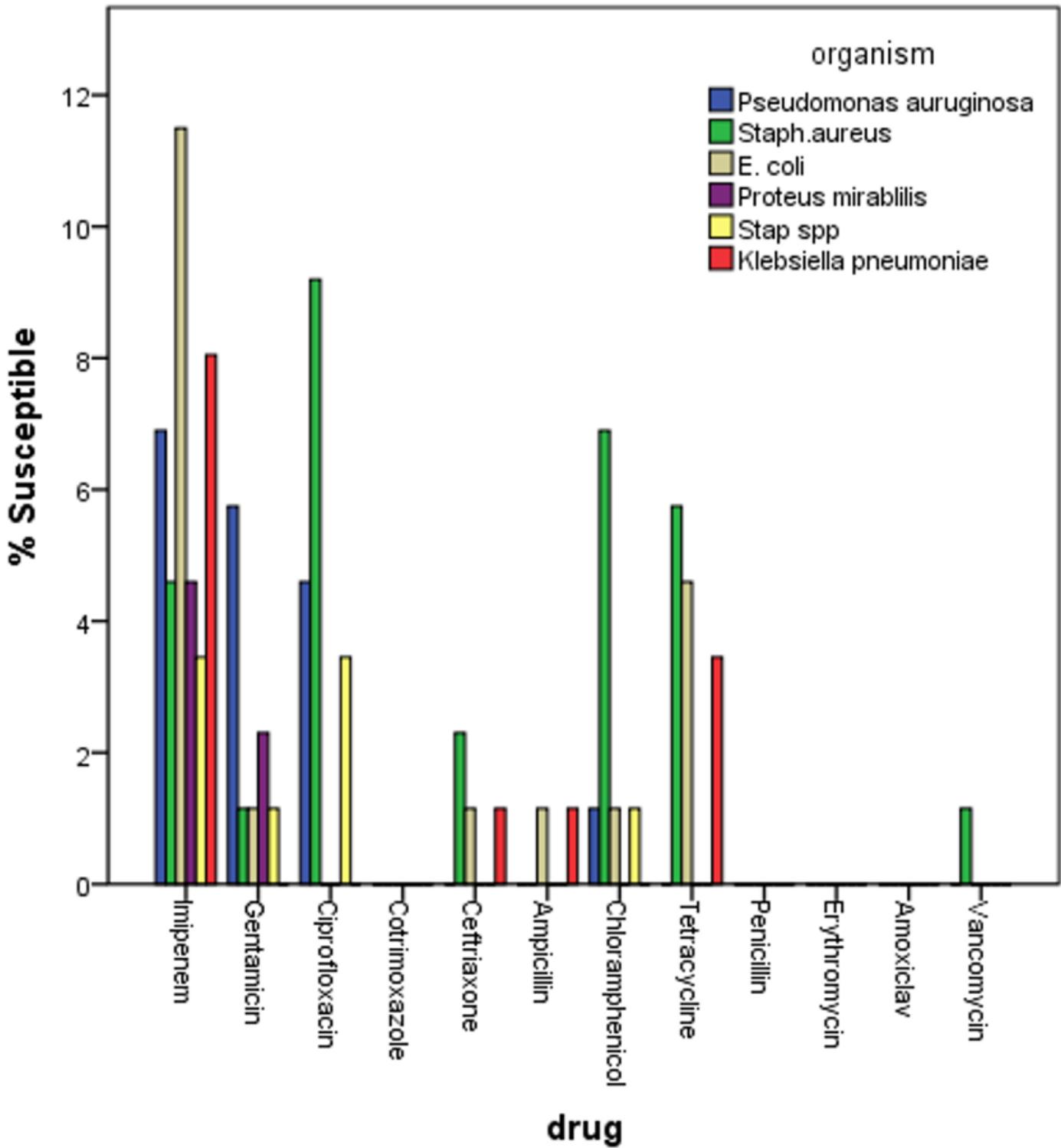
Figure 2

Susceptibility pattern of bacterial isolates against major antibiotics among mothers attending post-natal ward Hoima Regional Referral Hospital, Western Uganda