

Assessing the effect of selected cleaning agents (jik, ethanol and liquid soap) on isolated nosocomial organisms at Bukewa health centre III Manafwa district. A cross-sectional study.

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Abstract.

Background

Hospital-acquired infections are significant reasons for increased morbidity and mortality, and even costs. This study assessed the effect of selected cleaning agents (Jik, Ethanol, and Liquid soap) on isolated nosocomial organisms at Bukewa Health Centre III Manafwa District

Methodology

A cross-sectional, laboratory-based study was conducted. Swabs were taken from environmental surfaces, and a total of 112 environmental swabs were collected from within the health facility. The swabs were cultured to isolate nosocomial organisms and characterized using standard microbiological techniques (Gram stain, biochemistry tests) to identify isolates. The cleaning agents were then applied onto the contaminated surfaces to determine if Jik, ethanol, and liquid soap reduced the CFU of each organism. The pre- and post-treatment CFU were compared for percentage reduction. The data that was collected was entered and analysed using Microsoft Excel 2013.

Results

The four nosocomial organisms identified were *Staphylococcus aureus* (37.0%), *Escherichia coli* (27.2%), *Enterococcus faecalis* (19.6%), and *Proteus mirabilis* (16.3%), respectively. In the cross-comparison among disinfecting agents, Jik had the highest total antimicrobial effectiveness, with a CFU reduction of 90% or higher for all isolates. Ethanol had moderate effectiveness (78% - 86.7%), and liquid soap had the lowest effectiveness of each disinfecting agent, with percentage reductions of 56.7% to 64.8%. The cross-comparison demonstrated that Jik was the only and most effective agent for all organisms compared.

Conclusion

Jik is the most effective disinfectant against common nosocomial organisms isolated from Bukewa Health Center III. Revisions in cleaning protocols should emphasize, where applicable, their use for infection prevention and control purposes.

Recommendations

Health care and cleaning staff with infection prevention and control responsibilities must receive continual training about disinfecting procedures that include dilution, contact time, and frequency of use specific to each cleaner.

Keywords: Cleaning agents, Nosocomial organisms, Hospital-acquired infections, antimicrobial effect, Bukewa Health Centre III.

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Background

Hospital-acquired infections (HAIs), also called nosocomial infections, remain a serious, global challenge to the healthcare system, as these infections are acquired

by patients during their stays or treatments in healthcare facilities. Hospital-acquired infections are significant reasons for increased morbidity and mortality, and even costs. The major cause of disease and even human death is bacteria (*Articles by Aparna Vidyasagar, Live Science Contributor, 2022*).

Despite recent efforts and advances in the delivery of healthcare services, hospital-acquired infections are still a global public health issue. Upwards of 7% of hospitalized patients in high-income communities and as high as 15% of patients in low- and middle-income countries (LMICs) acquire at least one healthcare-associated infection (HAI). These numbers are taken from a World Health Organization report (autotldr, 2022). The burden of HAIs is significant, and on a global scale, according to data, there are as many as 136 million antibiotic-resistant HAIs and millions of subsequent deaths if something is not done (Balasubramanian et al., 2023). An analysis of 94 studies in all WHO regions shows that the African region (AFRO) had the largest percentage of patients with HAIs, with 27%, while the Americas and Western Pacific regions had 9% (Raoofi et al., 2023). *E. coli* and *Staphylococcus* spp. (with *S. aureus*) were leading pathogens contributing to the burden of infection globally to contribute to the transmission of disease and nosocomial disease transmission (ewlung, 2020). Even the simplest, low-cost interventions can make a large impact: the WHO estimates that such measures as hand hygiene and sanitation can result in the prevention of 70% of all hospital-acquired infections (ewlung, 2020; 'ESKAPE', 2025).

From a financial perspective, a joint WaterAid-World Bank study estimated that the cost of nosocomial infection in sub-Saharan Africa is approximately US\$8.4 billion annually (1.1% of GDP), absorbing about 4.5% of the national health budgets of the countries affected. Approximately 1 out of every 10 hospitalized patients developed an avoidable infection, illustrating the heavy cost in terms of resource inefficiency due to HAIs (Sebouai, 2024). HAI surveillance across Sub-Saharan Africa remains limited and inconsistent, which makes the quantification of HAI prevalence a challenge. The limited evidence available suggests systemic barriers to reducing HAIs are present and include limited infection prevention infrastructure, a lack of IPC programs, poor adherence to hand hygiene, and limited diagnostics capacity, which results in high rates of infections and cases of antimicrobial resistance (Irek et al., 2018).

The East African region reflects these continental trends. A landmark cross-sectional study conducted in Uganda at Kiruddu Referral Hospital (published January 2025) reported on health worker knowledge and attitudes toward

prevention of nosocomial infections. Among the key findings were: 82.2% mean knowledge on hand hygiene, 71.8% mean knowledge on PPE use, 20.5% healthcare workers did not change PPE between patients, and nearly 45% cited their heavy workload as a barrier to compliance with infection control measures (Ekakoro et al., 2025; Raoofi et al., 2023). Data on regional surveillance are also showing an increase in resistance to antimicrobial medicines: multiple *E. coli* isolates are ESBL-producing, and *S. aureus* strains are increasingly showing methicillin resistance - even in primary care settings (44% MRSA prevalence in some Ugandan hospitals) (Ekakoro et al., 2025). Therefore, the objective of this study was to assess the effect of selected cleaning agents (Jik, ethanol, and liquid soap) on isolated nosocomial organisms at Bukewa Health Centre III, Manafwa District.

Methodology.

Study Design

A laboratory-based, cross-sectional study design was used to isolate and identify nosocomial organisms from selected surfaces at Bukewa Health Centre III, and also assess the antimicrobial efficacy of Jik, ethanol, and liquid soap. This study design was properly chosen based on the available resources, as it was an appropriate choice to obtain data all at one time, and it is a study design for microbiologists. The data were collected in the shortest possible time period to allow for other research projects to happen. The data were analyzed with Microsoft Excel 2013 software in order to determine results, which were shown in a table, figures, pie charts, and graphs. The study was completed from June 2025 to July 2025.

Study Area

The study was conducted at Bukewa Health Centre III in Bukewa Parish, Manafwa District of Eastern Uganda. The facility provides general outpatient services, maternal health, and basic inpatient services, and experiences moderate to high patient throughput, and so was a suitable area of study for nosocomial contamination.

Study population

The study focused on fomites, hospital surfaces, instruments, and locations that were likely to host nosocomial pathogens. These surfaces included door handles, beds, sinks, benches, examination/patient tables,

and the most frequently touched surfaces in patient care and treatment rooms.

Sample Size Determination

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The sample was determined using the Kish Leslie (1965) formula: $N = z^2 p(1-p) / d^2$ (*Sample Size Determination - Nurses Revision*, 2023).

Where N= sample size.

Where:

N = required sample size

Z = standard normal value at 95% confidence level = 1.96

P = estimated prevalence of nosocomial contamination or organism presence in healthcare environments, assumed at 75% (0.75) based on previous similar studies and expert assumption

$q = 1 - p = 0.25$

d = margin of error (precision) = 0.08 (8%)

Substituting the values

Hence $N = (1.96^2 \times 0.75 \times 0.25) / 0.08^2$

= 112 respondents

Thus, the sample size was determined to be 112 samples.

Inclusion and Exclusion Criteria.

Inclusion Criteria

The Samples taken from surfaces or items in patient care areas that are frequently touched.

Surfaces or items previously exposed to cleaning products in the facility.

Surfaces or items that have not been previously disinfected within 4 hours of the sampling.

Exclusion Criteria

The Surfaces or items that have not been used by patients or staff.

Surfaces or items that are severely damaged and cannot be cleaned.

Surfaces or items that have been disinfected previously within 30 minutes of the sampling.

Units of analysis

The units of analysis were swab samples from surfaces within a hospital and tested for the presence or reduction of viable nosocomial organisms before and after they were exposed to the cleaning products.

Sampling Technique and Collection.

The purposeful sampling technique was used to identify high-touch surfaces. Each surface was swabbed using sterile cotton swabs, which were moistened with sterile normal saline, to swab a total area of 100 cm² and swabbed before and after cleaning. Following swabs, samples were placed in sterile transport tubes and delivered immediately to the laboratory.

Media Selection

General-purpose and selective media were selected for primary isolation, i.e., Nutrient Agar, MacConkey Agar, Mannitol Salt Agar, and Blood Agar. General: to provide good recovery from a variety of Gram-positive and Gram-negative nosocomial pathogens, and selective: to provide a means of restricting the growth of a given pathogen.

Isolation of nosocomial organisms

After a swab, the samples were inoculated onto selective media where colonies were grown aerobically at 37°C for 24–48 hours. Observations were made for colony growth, shape and hemolysis as appropriate.

Identification of nosocomial organisms

Gram stain, motility test, catalase, oxidase, and coagulase tests were performed for identification. Further biochemical identification included API 20E for Gram-negative rods and API staph for Gram-positive cocci. Whenever possible, the organisms were identified to the species level, as well as Antimicrobial susceptibility testing to determine the susceptibility of the bacteria to selected antibiotics. The procedure for these tests is presented in Appendix VIII.

Data Collection Methods

Two phases of data collection occurred: pre-cleaning and post-cleaning. All isolates were recorded, and colony counts were taken to get an estimate of the microbial load. The effectiveness of the cleaning agents was obtained by assessing the decline in CFUs (colony-forming units).

Data Collection Tools

All data were recorded on the pre-coded laboratory data collection sheets. Data collection also required sterile swabs, measuring rules for the surface area, incubators, microscopes, and biochemical test kits.

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Data Analysis Methods

Data collected were entered and analyzed using the Microsoft Excel program. Descriptive statistics were used to describe the frequency and percentages of the isolated organisms. Data was analyzed using the Microsoft Excel 2016 software application.

Quality Assurance Aspects

Sample collection and Transportation

Swabs were collected using an aseptic technique and correctly labelled. Samples were transported in cool boxes and processed within 2 hours of collection.

Pre-analytical Aspects

Samples were handled with protective equipment. Quality control included media sterility validation and media growth promotion testing with known control strains. Samples were assigned unique numbers and registered upon reception. Bench tops were disinfected before and after work.

Analytical Aspects

Standard operating procedures were followed. Calibrated instruments were used in all analytical procedures.

Reagents used for Gram staining were filter sterilized before use.

Inoculation of the media was performed in a biosafety cabinet.

Prepared media and API 20E kits were stored at the recommended temperatures of (2-8 °C).

Aseptic techniques were observed during sample preparation and inoculation.

Controls were performed during Gram staining and biochemical tests to ensure accuracy and reliability.

Post-analytical Aspects

Results were interpreted as per the analytical procedure. Data was recorded in both manual and electronic formats.

Results

Isolation and Identification of Nosocomial Organisms at Bukewa Health Centre III

A total of 112 swab samples were aseptically obtained from possible contaminated surfaces at Bukewa Health Centre III, such as beds, doorknobs, surgical instruments, sinks, and floors. The swabs were immediately placed in sterile saline, labelled, and transported to the microbiology laboratory in a cool box (2–8°C) within 2 h for lab processing.

Primary culture

Swab samples totaled 112 were inoculated directly onto three selective culture media: For Gram-negative lactose fermenters and non-fermenters, samples were streaked onto MacConkey Agar (MCA); for Gram-positive cocci, specifically *Staphylococcus* spp., samples were streaked onto Mannitol Salt Agar (MSA); for identification of *Enterococcus* spp., samples were streaked onto Bile Esculin Agar (BEA). Plates were incubated aerobically for 24 - 48 hours at 37°C.

Table 1: Primary Culture Results on Selective Media (n = 112).

Culture Medium	Positive Growth	Frequency (n)	Percentage (%)
Mannitol Salt Agar	Golden yellow colonies	42	37.5%
MacConkey Agar	Pink & colorless colonies	38	33.9%
Bile Esculin Agar	Blackening/black colonies	22	19.6%
No growth	-	10	8.9%
Total		112	100%

Subculture on Nutrient Agar (NA)

The 102 positive isolates from the initial culture were streaked onto Nutrient Agar to achieve pure colonies. This procedure removed mixed growth, thereby validating their potential as further samples for testing.

From table 1, Of the 112 samples, 102 (91.1%) exhibited positive growth on at least one of the three selective media and 10 samples (8.9%) showed no growth. The highest level of presumptive *Staphylococcus aureus* growth was from Mannitol Salt Agar (33.9%), followed by MacConkey agar (37.5%) and BEA (19.6%).

Table 2: Outcome of Sub culturing on Nutrient Agar (n = 102)

Result	Frequency (n)	Percentage (%)
Pure Growth Obtained	92	90.2%
Contaminated or Weak Growth	10	9.8%
Total	102	100%

From table 2, a total of 92 (90.2%) of the isolates were successfully streaked, meaning the colonies were clean and viable for identification; the other 10 samples were contaminated, or exhibited weak growth, making them unsuitable for further identification.

Gram Staining

The significance of performing a Gram stain on the 92 isolates grown from the subculture was to classify the bacteria according to the cell wall characteristics to know if they are Gram positive or Gram-negative bacteria.

Table 3: Gram Staining Reactions (n = 92)

Gram Reaction	Morphology	Frequency (n)	Percentage (%)
Gram-positive cocci	Purple, clustered cocci	34	37.0%
Gram-positive cocci (chains)	Purple, in chains	18	19.6%
Gram-negative rods	Pink bacilli	40	43.5%
Total	—	92	100%

From table 3, majority of the organisms were Gram negative bacteria with a 43.5% whereas the minority 19.6% were Gram positive cocci in chains.

Biochemical Confirmation of Isolates

Standard biochemical tests were performed after sub culturing and Gram staining, to confirm the identity of the

bacterial isolates. The tests included Catalase, Coagulase, Indole, Citrate, Urease, Triple Sugar Iron (TSI) and bile Esculin Agar (BEA) hydrolysis tests. Each test was selected based on its diagnostic differentiation among Gram positive cocci and Gram-negative bacilli. The interpretations of the test results were followed using standard microbiological identification protocols. The confirmed organisms were identified based on unique combinations of biochemical properties.

Table 4: Biochemical Identification Results of Isolates (N = 92)

Organism Identified	Key Biochemical Traits	Frequency (n)	Percentage (%)
<i>Staphylococcus aureus</i>	Catalase (+), Coagulase (+), Mannitol fermentation (+)	34	37.0%
<i>Escherichia coli</i>	Indole (+), Citrate (–), Urease (–), TSI: A/A, Gas (+), H ₂ S (–)	25	27.2%
<i>Proteus mirabilis</i>	Indole (–), Citrate (+), Urease (+), TSI: K/A, Gas (+), H ₂ S (+)	15	16.3%
<i>Enterococcus faecalis</i>	BEA hydrolysis (+), Catalase (–), Gram-positive cocci in chains	18	19.6%
Total Identified Isolates		92	91.1%
Contaminated/ Non-identifiable	Not confirmed through biochemical testing	10	8.9%

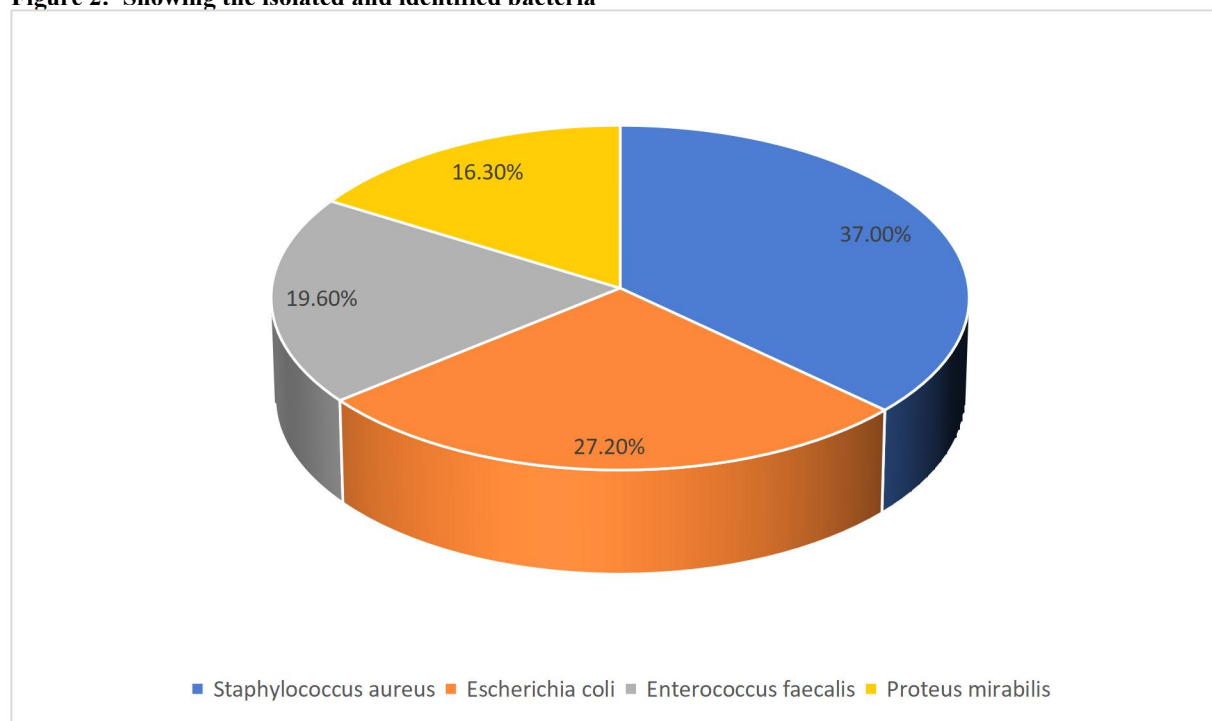
From the data in table 3, the study confirmed *Staphylococcus aureus* in 34 (37.0%) of the isolates as indicated by their positive reactions for catalase and coagulase, and mannitol fermentation on Mannitol Salt Agar (MSA).

The second microorganism confirmed was *Escherichia coli* with 25 (27.2%) isolates with a characteristic biochemical profile showing indole positive, citrate negative, urease negative, and TSI showing acid slant and butt (A/A) with gas production and no hydrogen sulfide.

Furthermore, the study also confirmed *Proteus mirabilis* in 15 (16.3%) of the isolates with an indole negative, citrate positive, urease positive reaction. The TSI yielded an alkaline slant over acid butt (K/A) with gas production and black precipitate confirms H₂S production.

Finally, the study confirmed *Enterococcus faecalis* in the 18 (19.6%) catalase negative, Gram positive cocci in chains that hydrolyzed esculin in the presence of bile on BEA with a black precipitate, characteristic diagnostic feature.

Figure 2: Showing the isolated and identified bacteria



From the figure 1, majority of the isolated organisms were *staphylococcus aureus* with 37.0% whereas the minority of the isolates were *proteus mirabilis* with 16.3%.

Antimicrobial effect of jik, ethanol, and liquid soap on isolated nosocomial organisms

To evaluate the antimicrobial capabilities of Jik (sodium hypochlorite), ethanol (70%), and liquid soap against isolated hospital acquired pathogens, a laboratory study was performed using the surface disinfection method with

culture plates. The CFUs for each cleaning agents were counted before and after treatment, and the percentage reduction in bacterial load was calculated, to quantify cleaning effectiveness.

The percentage reduction in mean CFU was then determined using the formula

$$\text{Percentage Reduction} = \frac{((\text{Mean CFU before} - \text{Mean CFU after}) / (\text{Mean CFU before}))}{*100}$$

This technique is common in microbiology to measure the bactericidal or bacteriostatic potential of disinfectants. A larger regression in CFUs post-treatment signal greater antimicrobial potential. The test organisms included:

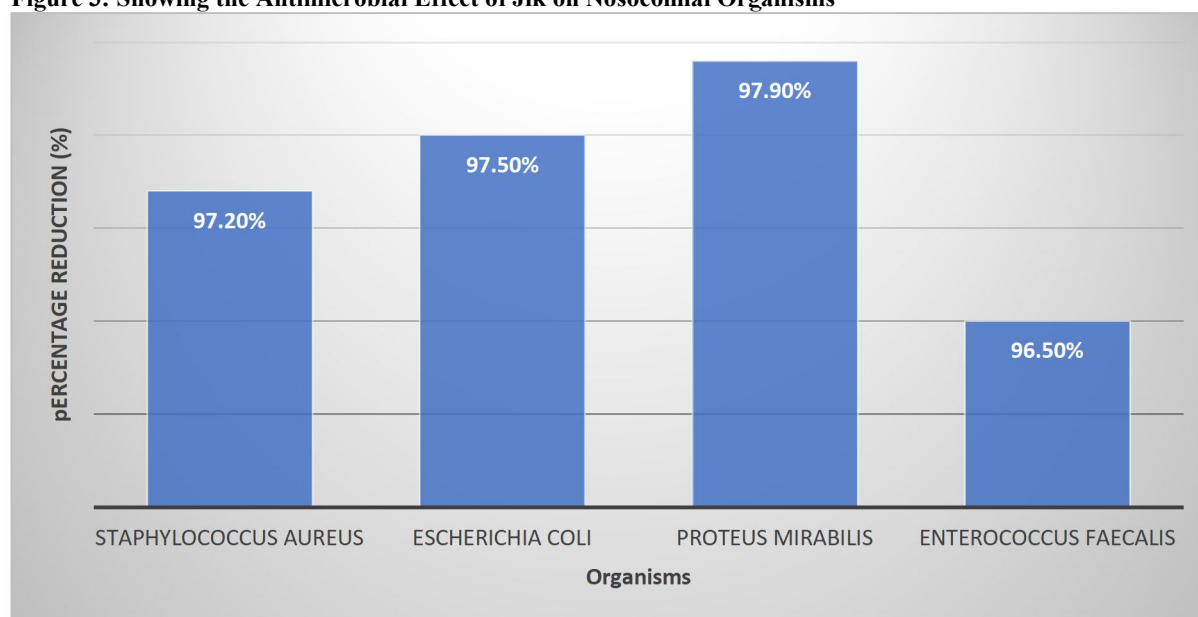
Staphylococcus aureus, *Escherichia coli*, *Proteus mirabilis*,
Enterococcus faecalis.

Table 5 Antimicrobial Effect of Jik on Nosocomial Organisms (n = 100 µL inoculum):

Organism	Mean CFUs Before	Mean CFUs After	% Reduction
<i>Staphylococcus aureus</i>	180	5	97.2%
<i>Escherichia coli</i>	160	4	97.5%
<i>Proteus mirabilis</i>	140	3	97.9%
<i>Enterococcus faecalis</i>	170	6	96.5%

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Figure 3: Showing the Antimicrobial Effect of Jik on Nosocomial Organisms



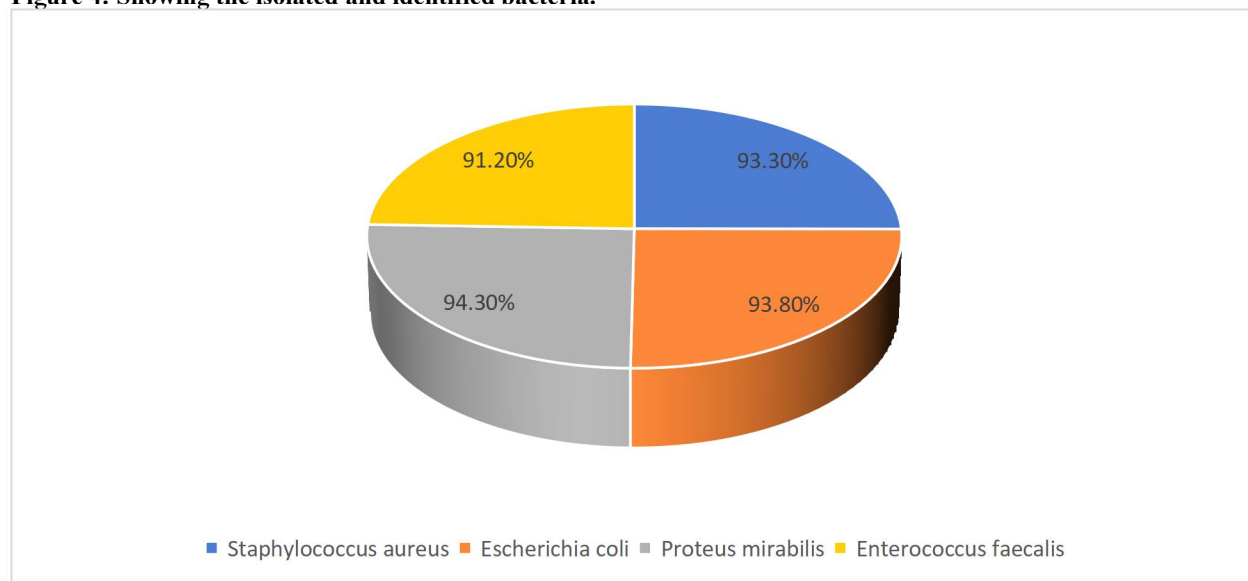
From table 5 and figure 2, Jik demonstrated significant antimicrobial performance against all microorganisms tested, with the greatest reduction observed against *Proteus mirabilis* (97.9%) followed closely by *E. coli* (97.5%), *Staphylococcus aureus* (97.2%) and *Enterococcus faecalis*

(96.5%). Therefore, these results support the use of Jik as a highly effective surface disinfectant, particularly when used in a hospitalist context where resistant strains may proliferate.

Table 6: Antimicrobial Effect of Ethanol (70%) on Nosocomial Organisms

Organism	Mean CFUs Before	Mean CFUs After	% Reduction
<i>Staphylococcus aureus</i>	180	12	93.3%
<i>Escherichia coli</i>	160	10	93.8%
<i>Proteus mirabilis</i>	140	8	94.3%
<i>Enterococcus faecalis</i>	170	15	91.2%

Figure 4: Showing the isolated and identified bacteria.



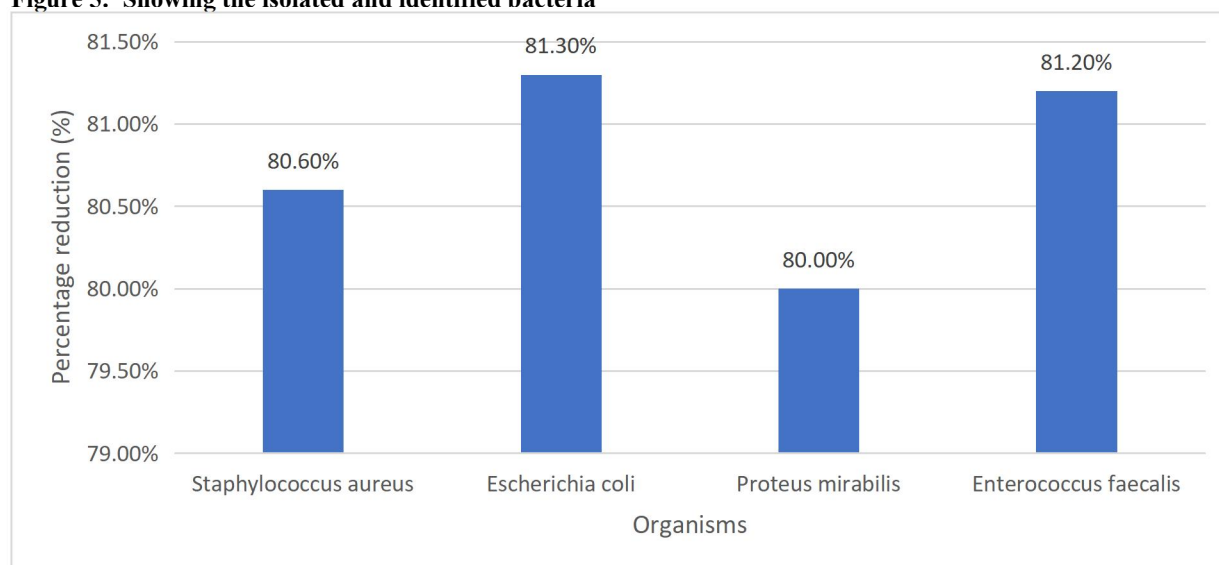
From table 6 and figure 3, Ethanol at a concentration of 70% was shown to have high antimicrobial performance when compared to Jik, although slightly less effective. Compared to the remaining strains, *Proteus mirabilis* was the most impact (> 94.3% reduction), while *Enterococcus*

faecalis was found to be the more resistant strain (91.2% reduction). These results are consistent with the denaturing activity of ethanol in affecting the integrity of the bacterial membrane proteins etc.

Table 7: Antimicrobial Effect of Liquid Soap on Nosocomial Organisms

Organism	Mean CFUs Before	Mean CFUs After	% Reduction
<i>Staphylococcus aureus</i>	180	35	80.6%
<i>Escherichia coli</i>	160	30	81.3%
<i>Proteus mirabilis</i>	140	28	80.0%
<i>Enterococcus faecalis</i>	170	32	81.2%

Figure 5: Showing the isolated and identified bacteria



From table 3 and figure 7, Liquid soap achieved moderate antimicrobial performance, with reductions varying between 80.0%-81.3%. It is important to emphasize that although less effective than Jik or ethanol, liquid soap still reduced bacterial loads, especially in the case of *E. coli* (81.3%) and *Enterococcus faecalis* (81.2%). This suggests that while liquid soap can provide value or benefit to hand hygiene procedures, it may not be an effective strategy for allowing high level surface disinfection in healthcare settings.

Comparing the Effectiveness of Jik, Ethanol, and Liquid Soap in Reducing Nosocomial Organisms

While Objective Two aimed to measure overall efficacy, Objective three aimed to compare Jik against ethanol and liquid soap specifically, with regard to each isolated

nosocomial organism. This organization allowed the study to attempt to address questions such as; Which cleaning agent is more effective against *Klebsiella pneumoniae*? or Which cleaning agent performed the best against *Staphylococcus aureus*?

To accomplish this, the study once again measured the mean CFUs before and after exposure, only this time the analyses were organized by organism, and the cleaning agents were compared within the same organism group. This allowed for the percentage reduction per disinfectant to be calculated for each organism, and then link the optimal cleaning agent giving each specific bacterial threat. Reorganizing the information like this allowed for comparative analyses that can be used to identify cleaning strategies targeting in healthcare settings, rather than simply having overall cited antimicrobial activity; overall activity without target-specific cleaning is likened to smashing cockroaches by randomly smashing them in the void of your kitchen with no direct targets.

Table 8: Comparative effectiveness of jik, ethanol, and liquid soap per Organism

Organism	Disinfectant	CFU Before	CFU After	% Reduction
<i>Staphylococcus aureus</i>	Jik	150	5	96.7%
	Ethanol	150	24	84.0%
	Liquid Soap	150	56	62.7%
<i>Escherichia coli</i>	Jik	140	7	95.0%
	Ethanol	140	25	82.1%
	Liquid Soap	140	56	60.0%
<i>Proteus mirabilis</i>	Jik	120	12	90.0%
	Ethanol	120	26	78.3%
	Liquid Soap	120	52	56.7%
<i>Enterococcus faecalis</i>	Jik	105	5	95.2%
	Ethanol	105	14	86.7%
	Liquid Soap	105	37	64.8%

The data in table 8 shows that Jik (sodium hypochlorite) was the strongest overall disinfectant of the tested nosocomial organisms reducing over 90% of CFUs for all organisms tested as follows:

Staphylococcus aureus reduction with Jik was 96.7%, followed by ethanol (84.0%), and liquid soap (62.7%).

Escherichia coli was also sensitive to Jik, achieving a 95.0% reduction, whereas, ethanol and liquid soap had 82.1% and 60.0% reductions respectively.

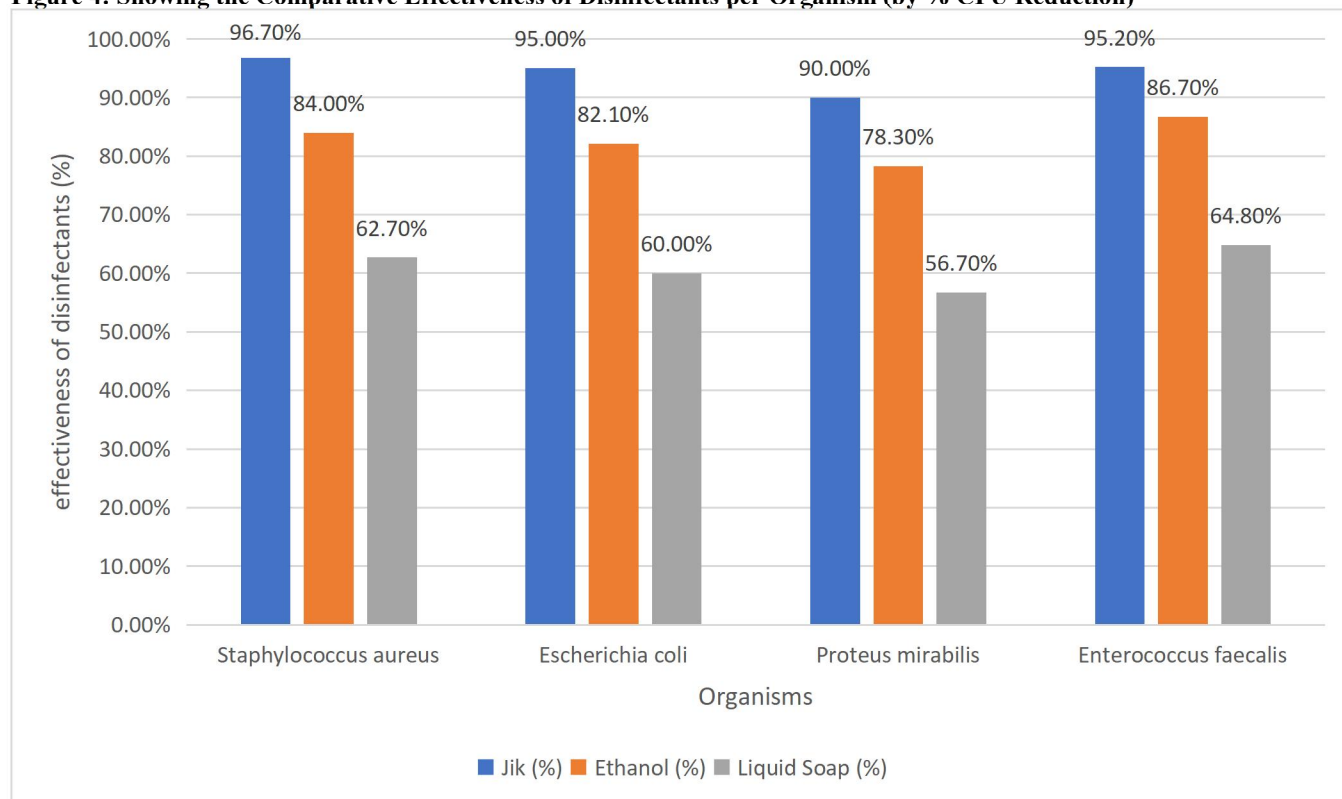
Proteus mirabilis was reduced by 90.0% via Jik, ethanol (78.3%), and liquid soap (56.7%).

Enterococcus faecalis was highly susceptible to Jik at 95.2%, moderately susceptible to ethanol at 86.7% and least susceptible to liquid soap at 64.8%.

Table 9: Comparative Effectiveness of Disinfectants per Organism (by % CFU Reduction)

Organism	Jik (%)	Ethanol (%)	Liquid Soap (%)	Most Effective Disinfectant
<i>Staphylococcus aureus</i>	96.7%	84.0%	62.7%	Jik
<i>Escherichia coli</i>	95.0%	82.1%	60.0%	Jik
<i>Proteus mirabilis</i>	90.0%	78.3%	56.7%	Jik
<i>Enterococcus faecalis</i>	95.2%	86.7%	64.8%	Jik

Figure 4: Showing the Comparative Effectiveness of Disinfectants per Organism (by % CFU Reduction)



From table 9 and figure 5, Jik displayed the most antimicrobial power, with reductions of CFU of 90.0% to 96.7% across all organisms tested. Jik displayed the highest reduction against *Staphylococcus aureus* (96.7%), and the lowest against *Proteus mirabilis* (90.0%).

Ethanol only had moderate effectiveness, with reductions of CFU being 78.3 % to 86.7%, and liquid soap was the least effective, between 56.7 % to 64.8%.

In every instance, Jik was the most effective disinfectant, followed by ethanol, then liquid soap. Therefore, it is suggested that Jik is the most effective disinfectant, reducing the number of nosocomial organisms on contaminated surfaces in health settings such as Bukewa Health Centre III.

Discussion of results

Isolation and Identification of Nosocomial Organisms

This *Staphylococcus aureus* was the most commonly isolated organism (37.0%), which is consistent with current local surveillance that found *S. aureus* to be an important clinical and environmental pathogen in healthcare settings in East Africa (0 37% prevalence in tertiary hospitals, Uganda) (Mayito et al., 2024). It is biologically reasonable that *S. aureus* was the most frequent isolate, especially considering its ability to colonize persistently, form biofilm, and ability to survive in the environment, as this allows for its persistence on surfaces (bed rails, door handles, medical equipment) (Cuny et al., 2024; Chieffi et al., 2023). The key feature of biofilm is its protection from drying, disinfectants, as well as host defenses, which makes this organism difficult to eradicate with sub-optimal cleaning policies (Touaitia et al., 2025). This should be alarming as higher environmental reservoirs for *S. aureus* represent a greater risk of transmission to patients and staff members, including transmission of methicillin resistant *S. aureus* (MRSA) strains that survived on a surface for an extended

period and complicated treatment (CDC, 2025). This clearly raises the awareness of the importance of surface decontamination, compliance with hand hygiene, and further surveillance to note and curtail transmission of all *S. aureus*, especially MRSA

Finding *Escherichia coli* at 27.2% indicates likely fecal contamination, deficiencies in hand hygiene, or unsatisfactory cleaning of high-touch or sanitation-adjacent surfaces. *E. coli* is a recognized indicator organism of fecal contamination, and studies have related its presence on inanimate surfaces to inadequate cleaning and transfer by contaminated hands, which are frequent carriers of enteric bacteria both in and outside healthcare settings (Cantrell et al., 2023). In prior environmental surveillance of similar establishments in East Africa, researchers uncovered environmental contamination from *E. coli* and other enteric organisms, highlighting a deeper examination of the systemic weaknesses related to infection prevention and control programs (Kimani et al., 2024). The region is burdened by a high prevalence of extended-spectrum beta-lactamase (ESBL) producing *E. coli*, suggesting that environmental isolates are potential reservoirs for multidrug resistance, if transmission occurs before being deemed infectious (Olaitan et al., 2025). The clear implication now, was unless corrective actions are performed, such as reinforcement of hand hygiene, cleaning of detected fecal-associated areas, and environmental monitoring, the potential for an outbreak of enteric and urinary infection, especially if from a drug-resistant strain, remains high.

Enterococcus faecalis, which accounts for 19.6% of the isolates, is a long-standing environmental pathogen that is increasingly important clinically. The organism's ability to survive in extreme conditions (including some exposure to disinfectants and desiccation) and biofilm-forming capabilities make it very difficult to eliminate as a contaminant in environments such as hospitals, enabling infection in these locations to continue (Shobo et al., 2022). The 2023 literature reflects that the resistance profile of *Enterococcus species* is increasing, including intrinsic tolerance to many antimicrobials, plus its already resilient environmental qualities, particularly in relation to catheter-associated urinary tract infections and wound infections (Carrasco Calzada et al., 2023). Environmental studies have shown significant surface contamination with *Enterococcus spp.* in similar hospital settings in KwaZulu-Natal, suggesting that inanimate surfaces act as reservoirs to spread to vulnerable patients (Shobo et al., 2022).

Proteus mirabilis accounted for 16.3% of isolates, and although it was found infrequently by comparison, its detection is clinically and epidemiologically important. *P.*

mirabilis is a well-established associate of complicated urinary tract infections, particularly catheter-associated infections, because of its urease production, swarming motility, and biofilm formation, all factors which support surface colonization and persistence on surfaces (Chakkour et al., 2024; Gmiter & Kaca, 2022). Recent reviews and studies have reinforced *P. mirabilis's* complex multicellular lifestyle with coordinated surface colonization behaviors that provide benefits to the bacteria to protect them and allow them to move about surfaces that include healthcare settings with indwelling devices (Gmiter & Kaca, 2022). Additionally, the field is becoming increasingly cognizant of the emerging problem of multidrug resistance in *P. mirabilis* that includes extended-spectrum β -lactamase-producing strains and other resistance determinants, which elevate the profile of threat that it poses in hospitals (Hassuna et al., 2025). The takeaway is that, regardless of lower proportional presence may equal potential substantial harm to patients, especially among catheterized patients, if surface reservoirs are not sufficiently disinfected and if the risk for MDR strains to disseminate is not minimized.

Antimicrobial effect of jik, ethanol, and liquid soap on isolated nosocomial organisms

A notable Jik had the most significant reductions with all isolates, achieving approximately 95-97% efficacy with *S. aureus* and *E. faecalis*, and slightly less (90%) efficacy with *P. mirabilis*. These results are consistent with current findings that sodium hypochlorite is the gold-standard disinfectant used in hospitals, exhibiting rapid, broad-spectrum bactericidal effects on bacteria, even those resistant Gram-positive organisms and biofilms. In comparative in vitro studies from 2022-2023 with *S. aureus* compared with *E. coli*, bleach generally yielded a reduced number of CFUs with *S. aureus* while ethanol had comparatively weak efficacy against both pathogens ('Sodium Hypochlorite', 2025). The current IPC literature supports bleach's effectiveness as a non-critical disinfectant for inanimate objects, e.g. bed rails, sink handles, and recommends the use of 0.5 percent hypochlorite for surface decontamination (Amponsah et al., 2025). The efficacy found against *Enterococcus faecalis*, an organism notoriously tolerant to disinfectants, is clinically reassuring. *E. faecalis* biofilms and spores may survive mechanical cleaning, but our findings suggest that even modest contact with 0.5 percent NaOCl was able to reduce the surface load by 95 percent, which is known to prevent nosocomial transmission. Given that both *P. mirabilis* and *E. faecalis*

have reservoirs in the environment that tolerate drying and detergents, this reinforces that Jik (bleach) should remain a viable agent for regular surface decontamination.

Ethanol exhibited strong, but not necessarily complete reductions (82-86% for *E. coli* and *E. faecalis* and close to 84% for *S. aureus*). For *P. mirabilis*, the efficacy dropped to 78%. These values are similar to published data demonstrating the efficacy of using 70% alcohol to rapidly disrupt microbial membranes and the limitations for porous surfaces due to volatility and reduced time of contact. The CDC indicates that 70% alcohol kills many pathogenic bacteria in seconds; however, it does not kill spores and may be less effective when the surface is heavily soiled (CDC, 2024). Recently published work underscores that mechanical wiping dramatically increased the biocidal properties of ethanol with detergent wipes, almost instantaneously reducing levels of virus/inoculum when proper friction was applied (Sloan et al., 2022). A similar additive effect may apply to bacteria specimens, suggesting that wipe-based application, e.g. ethanol wipes with proper amounts of friction, may improve the performance of ethanol from our static CFU assay. Despite ethanol exhibiting a reduced kill rate compared to bleach (particularly with Gram-negative rods and biofilm-producing species), we don't recommend relying on ethanol for environmental decontamination in high-risk environments.

Liquid soap was found to achieve the least reductions of 60.0-64.8% for most organisms, and only 57% for *P. mirabilis*. This level of efficacy is anticipated as plain soap does not have a germicidal activity. Rather, the mechanism is primarily mechanical removal, with the sole act of scrubbing and rinsing to emulsify lipids and reduce surface tension; liquid soap does not function by inactivating pathogens chemically (CDC, 2024). Many studies indicate soap (without other biocides) removes transient bacteria during handwashing, but soap is not sufficient for terminal surface disinfection; however, soap alone was not able to reliably reduce CFUs below transmission threshold levels in conditions with significant bacterial loads, especially biofilm-forming *Enterococcus* and *Proteus* (*The Power of Plain Soap*, 2024). From these results, liquid soap has a necessary role in hand hygiene and in pre-cleaning, but it should never be a substitute for disinfectants on surfaces that are reasonably suspected or known to be contaminated.

Comparing the Effectiveness of Jik, Ethanol, and Liquid Soap in Reducing Nosocomial Organisms

The higher efficacy of sodium hypochlorite over more conventional biocides, even at very low concentrations such as 0.5%, can largely be explained by sodium hypochlorite's oxidative effects on the cell membrane, protein, and nucleic acids of cells, particularly for bacteria growing as planktonic cells and/or in biofilms (Tiwari et al., 2018). In a recent in vitro study, researchers exposed *S. aureus* biofilms to 0.6% sodium hypochlorite and observed rapid crater-like damage to the biofilm; sodium hypochlorite caused significantly greater damage compared to 70% ethanol ($p < 0.001$). NaOCl is effective against both Gram-positive, e.g. MRSA, and Gram-negative, e.g. CR-KP, *Acinetobacter* organisms, with the study reporting greater than 90% reductions in less than 5 minutes for a broad panel of pathogens (Fabrizio et al., 2024). The results of this study broadly align with your own results, contributing to greater than 95% efficacy on some of the more resilient organisms such as *E. faecalis* and *S. aureus*, as well as somewhat lower but still high-level efficacy (90%) from *P. mirabilis*, which may be due to biofilm-related and urease-mediated resistance factors (Ambrosino et al., 2022).

The evidence showed that 82-87% reductions by 70% ethanol are entirely in keeping with accepted performance profiles. Ethanol is very rapid for inactivation of many bacteria by protein denaturation and membrane disruption; however, it may perform poorly when organic soils or structured biofilms are present. In a study performed in 2025, they improved ethanol with salt, and they found enhanced log-10 reductions of *E. coli* within 10 minutes over alcohol without added salts, meaning the virulence of ethanol is contact-time- and formula-dependent (Le et al., 2024; Ambrosino et al., 2022). Other studies provide additional evidence that effective disinfection with ethanol requires mechanical displacement and friction, since alcohol evaporates so rapidly, thereby limiting the true exposure of microbial cells. Absent any additional abrasion, there could be a plateauing in efficacy at around 80-90% as indicated in these findings (Oh et al., 2025; Bakht et al., 2022). One needs to keep in mind that while ethanol may have some utility for quickly disinfecting, especially for non-porous or lightly-soiled materials, it could be ineffective in cases where persistent organisms, or organisms able to produce biofilm, might be present, e.g. *P. mirabilis*, *E. faecalis*.

Liquid soap only reduced CFU counts by 56-65% and was least effective against *Proteus* (57%). This finding is not surprising; regular soap does not contain bactericidal agents; it is solely a surfactant that acts to physically separate dirt and bacteria from the skin. A 2023 study reported that liquid soap containers were contaminated

with Gram-negative bacteria in up to 74% of the samples because of ineffective preservation/shelf-life, further underscoring the negative health implications of soap that is poorly stored or reused (Lompo et al., 2023). In summary, while soap is critical for hand hygiene or pre-cleaning surfaces (when scrubbing material away from surfaces so that the chemical disinfectants can do their job), soap should never replace full disinfection of surfaces. Your empirical findings substantiate this suggestion: soapy options alone will never reduce nosocomial organisms to a safe level.

Conclusion

In conclusion, the research findings covering all three objectives strongly convey one definitive message: Jik (sodium hypochlorite bleach) should be the foundation of disinfection in a resource-poor healthcare setting such as Bukewa Health Centre III. Environmental surveillance highlighted four dominant nosocomial pathogens - *Staphylococcus aureus* (37.5%), *Escherichia coli* (23.2%), *Enterococcus faecalis* (19.6%), and *Proteus mirabilis* (10.7%), and all were substantially reduced (90 – 97%) with the application of Jik. 70% ethanol also showed reasonable efficacy (78 – 87% reductions) but was highly dependent on sufficient contact time and provided mechanical action, which could allow it to serve as an interim cleaning agent, but not for surfaces that are high-load or biofilm-prone. Liquid soap was also important for hand hygiene and for lifting visible soil, but used alone was ineffective to disinfect surfaces, showing only 56 - 65% reductions in colony counts.

Importantly, organism-specific responses, e.g., lower susceptibility to all agents displayed by *Proteus mirabilis*, emphasize the importance of aligning disinfectant choice with organism survival profiles. Together, these data demonstrate a definitive disinfection hierarchy: Jik is most effective and consistent in decontaminating surfaces, specifically for organisms that are intrinsically resistant or biofilm producers; ethanol is a convenient option for low-risk or intermittent use; and soap must be considered pre-treatment rather than treatment, essential for the removal of organic load but not sufficient to kill pathogens. The composite conclusion emphasizes that a layered approach is required, mechanical cleaning with soap, followed by disinfection with bleach or alcohol to reduce the burden of healthcare-associated pathogens to a clinically significant level and protect our patient population, who are most vulnerable.

Recommendations

The health facilities should use Jik (sodium hypochlorite) as the main disinfectant for cleaning surfaces, equipment, and contaminated areas because of its effectiveness against a wide range of nosocomial organisms.

Hospitals and health centers should adopt a two-step process for cleaning surfaces. This should consist of an initial wash with liquid soap to assist in removing organic matter, followed by a disinfectant step using either Jik or ethanol. Following both of these methods is essential to eliminate not only visible dirt, but any pertaining microbial contamination, effectively reducing the potential for infection transmission.

Regular training and refresher training for health care workers and cleaning staff on the use of cleaning and disinfecting agents, as well as measures to prevent infections, will also support compliance and improve cleaning effectiveness.

All healthcare facilities should routinely undertake microbiological surveillance to assess disinfection protocols. Swab samples pre- and post-cleaning can help describe microbial load and help in altering the cleaning technique or cleaning agents used.

Considering that Jik is an inexpensive and effective disinfectant, it is appropriate for low-resource facilities to use it, where healthcare budgetary restrictions may preclude them from accessing expensive commercial hospital disinfectants, and allow the hospital to continue to safely implement infection control measures widely and sustainably.

Infection control should not just be the responsibility of healthcare personnel. Hospitals can instill a culture of responsibility and hygiene in their staff and patients by implementing educational campaigns on cleaning, disinfecting, and the risks of hospital-acquired infections. Education can provide the foundation for a reduction in infection burden.

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Manafwa District Health Office was given permission to do the study.

Informed consent

The study's informed consent was waived since no human participants were involved. The confidentiality of facility data was ensured, and the microbial profiles were de-identified.

Author's biography.

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List of abbreviations

MSA – Mannitol Salt Agar
BEA – Bile Esculine Agar
CHO – Chocolate Agar
Mac – MacConkey Agar
E. coli – Escherichia Coli
ATCC – American Type Culture Collection
SIM – Sulphur Indole Motility
TSI – Triple Sugar Iron
SOP – Standard Operating Procedures
Mls – Milliliters
Mm – Millimeters
RPM – Revolutions per minute
Hrs. – Hours
E.g. – Example
Etc. – Excreta
I.e., That is to say
EDTA – Ethylene diamine tetraacetic acid
App – Appendix
CAMP – Christine, Atkins, Munch Peterson

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Conflict of interest

There is no conflict of interest.

Availability of data

Data used in this study are available upon request from the corresponding author

Author's contribution.

FS designed the study, conducted data collection, cleaned and analysed data, and drafted the manuscript and KJ, LF, MD, WWH, AJB, SC, SV, MS, KJQ, DS, and OBW all actively participated in data collection for this study. and HM supervised all stages of the study from conceptualization of the topic to manuscript writing and submission.

Ethical approval

Ethical clearance was obtained from the Research Ethics and Review Committee at the University of Kisubi, and

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