Assessing Drug Susceptibility Patterns of some bacteria isolated from the palms of Pharmacy Technicians

ABSTRACT

Background: In Ghana, pharmacy technicians play a crucial role in medication dispensing and healthcare product provision under pharmacist supervision. However, concerns exist regarding potential transmission of bacteria by pharmacy technicians, posing infection risks. Hand cleansing is vital to prevent spread, yet insufficient surveillance hinders collecting reliable global data.

Objective: This study investigated the prevalence and antimicrobial susceptibility pattern of targeted bacterial species isolated from the palms of pharmacy technicians in Ghana's Upper West Region.

Methods: Palm swabs were collected from pharmacy technicians from January-to-April 2019. Samples were inoculated onto culture media to identify target organisms including *Staphylococcus species, Escherichia coli, Klebsiella species,* and *Salmonella species.* Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method.

Results:*Staphylococcus species*, along with *Bacillus species* and *Enterobacter species*were identified. *Bacillus species* were most prevalent and showed susceptibility to most antibiotics tested. *Staphylococcus species* isolates displayed multidrug resistance.

Conclusion: Improper hand hygiene likely contributed to microbial contamination. *Staphylococcus species* showed alarming antimicrobial resistance. Proper handwashing practices for pharmacy staff are imperative. Ongoing monitoring of susceptibility patterns should inform infection control efforts.

KEYWORDS: Antimicrobial, Susceptibility, Bacteria, medicine dispensers, pharmacy technicians, Nosocomial infections.

1.0 INTRODUCTION

In the Upper west regional capital of Ghana, Pharmacy technicians, initially described as non-professionally trained personnel employed to assist doctors and pharmacists in their daily duties, have evolved from mere assistants into influential members of the pharmaceutical world[1]. With the focus of pharmacist training in Ghana centered around the provisions of Great Britain, the role of trained Pharmacy technicians has continued to be crucial in dispensing medications and providing healthcare products under supervision [2].

The significant transformation of Pharmacy technicians reflects the evolution of the pharmacy industry as a whole, encompassing medications, therapies, patients, and insurance [3]. In the past, these individuals were primarily seen as pharmacy assistants, but their position has grown in scope and responsibility over the years [4]. The initial reluctance to hire additional staff for assistance has given way to recognizing the invaluable contributions of Pharmacy technicians, especially as the complexities of the pharmacy landscape have multiplied. Factors such as increased patient numbers, technological advancements, electronic processes, insurance billing, and a wider array of medications have necessitated the professional growth of Pharmacy technicians[4,5].

As the training of Pharmacy technicians in Ghana expands to meet the growing population and the rising number of disease conditions requiring proficient dispensing skills, their role has extended beyond traditional community and hospital pharmacy settings. Referred to as dispensing technicians, they play a vital part in the pharmacy team, actively involved in the preparation and supply of medicines and healthcare products, while also providing additional advice and guidelines [1]. In addition to medication supply through prescriptions, their responsibilities may involve the production and provision of aseptically prepared medicines, extemporaneous compounding, and the supply of medicines for clinical trials [6].

However, the practice of Pharmacy technicians has recently garnered attention from health scientists due to the potential transmission of disease-causing bacteria. Bacterial multiplication and spread can occur through the hands of Pharmacy technicians, affecting prepared and

supplied medicines as well as potentially transmitting pathogens directly to patients through air contamination. This places healthcare providers, including doctors, and nurses, at a higher risk of nosocomial infections caused mainly by *Staphylococcus aureus* and *Enterococcus spp*. [7].

To prevent infections, hand cleansing with antiseptic agents is crucial. Moistening and sanitizing hands with disinfectants, such as liquid chloride solutions, have been identified as one of the most significant measures in reducing pathogen transmission in healthcare facilities[8, 9] However, the lack of surveillance systems for healthcare-associated infections in most countries, along with the absence of standardized diagnostic criteria, hampers the collection of reliable global information. Nonetheless, studies suggest that hundreds of millions of patients worldwide are affected by healthcare-associated infections each year, with developing countries experiencing a higher frequency compared to developed nations [10, 11].

The number of Pharmacy technicians has been steadily increasing in the region since the introduction of dispensing technology at the Dr. Hilla Limann Technical University (formerly Wa Polytechnic) in 2013. This advancement has led to improved pharmaceutical service delivery, prompting pharmaceutical shops to replace medicine counter assistants and non-pharmacy staff with Pharmacy technicians to promote better pharmaceutical practices in the region [12]. However, concerns arise regarding their practice methods, as their service delivery could potentially contribute to disease transmission through the spread of bacteria [12].

This research aims to address the pressing issues surrounding pathogen transmission by pharmacy technicians in the Upper westregional capital and to explore the antimicrobial susceptibility pattern of some selected pathogens isolated from the palms of Pharmacy technicians. This study provides valuable insights for healthcare providers and health policymakers. The results will inform the control and management of nosocomial infections in hospitals and other healthcare-providing facilities outside the Upper West Region of Ghana.

2.0 METHODOLOGY

2.1 Study setting

The Upper West regional capital is undergoing rapid development in the pharmaceutical industry with an increasing number of pharmacies and pharmacy technicians. There has been an increasing demand for pharmaceutical services outside health facilities which lead to the increasing development of the pharmaceutical industry within the regional capital. The training of pharmacy technicians in the area has brought about the existence of Pharmacy technicians in various pharmacies in the region.

2.2 Study Design

The study followed a cross-sectional pattern involving the collection of palm swabs from pharmacy technicians from January to April 2019. The researchers included pharmacy technicians operating within the Upper West regional capital during the study period. There was no age restriction, and the participation of the individuals was voluntary as informed consent was obtained from each of them.

2.3 Inclusion Criteria and Exclusion Criteria

Authorized pharmacy technicians previously called dispensers operating within the regional capital were included in this study. Pharmacy technicians who were not part of the dispensing process as well as those who did not give their consent were excluded from this study.

2.4 Sample Collection and Inoculation

The sample for this study was collected using a stratified random sampling method in which swabs were taken from technicians according to their operation unit category. Samples were classified into those operating in hospitals pharmacies, community pharmacies, and over the counter (OTC) medicines seller's shops. The sample size was determined by taking a record of all technicians within the regional capital taking into consideration all the above-mentioned categories. Samples were collected by taking hand swabs of pharmacy technicians in the various units using a sterile cotton swab stick that was moistened with sterile normal saline. The sample was immediately transported to the Microbiology laboratory of Dr. Hilla Limann Technical University and inoculated onto brain heart infusion broth, MacConkey broth and Selenite cystine F broth and incubated overnight at 37^0C. The number of samples taken from each category was determined by the availability of technicians and the willingness to partake in the study.

2.5 Bacteria Identification and Isolation

The presence of bacteria was determined by inspection for bacteria growth and morphology on the agar plates. Separate colonies of bacteria were aseptically isolated onto differential media and biochemical reagents for identification and further examination. Mannitol salt agar was used to detect the presence of *Staphylococcus aureus* from Brain heart infusion broth while MacConkey agar was used for lactose fermenting bacteria such as *Escherichia coli, and Klebsiella species* growing in MacConkey broth.Salmonella Shigella agar was used for selective isolation of *Salmonella species* from Selenite cystine F broth. A series of biochemical tests such as the Indole test, Citrate test, Urease test, and Triple Sugar Iron (TSI) test were conducted on the cultures to identify and confirm the gram-negative bacterial isolates while gram stain, catalase and coagulase test were performed on gram-positive isolates. Control stains were confirmed along with all the tests done.

2.6 Antibiotics susceptibility testing

Antibiotic sensitivity was tested using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar according to CLSI antibiotic disk susceptibility testing guidelines [13].

3.0 RESULTS AND DISCUSSION

3.1 Results

This study set out to investigate the presence of *E. coli, Klebsiella species, Salmonella species* and *Staphylococcus species* amongst palms of pharmacy technicians in Wa municipality. Interestingly, only *Staphylococcus species* in conjunction with *Bacillus species* and *Enterobacter species* were identified during the study period. The samples were distributed among three

different pharmacy units (Figure 1). The majority of the organisms isolated belonged to the genus *Bacillus* and most were isolated from the 'over-the-counter shops' (Figure 2).

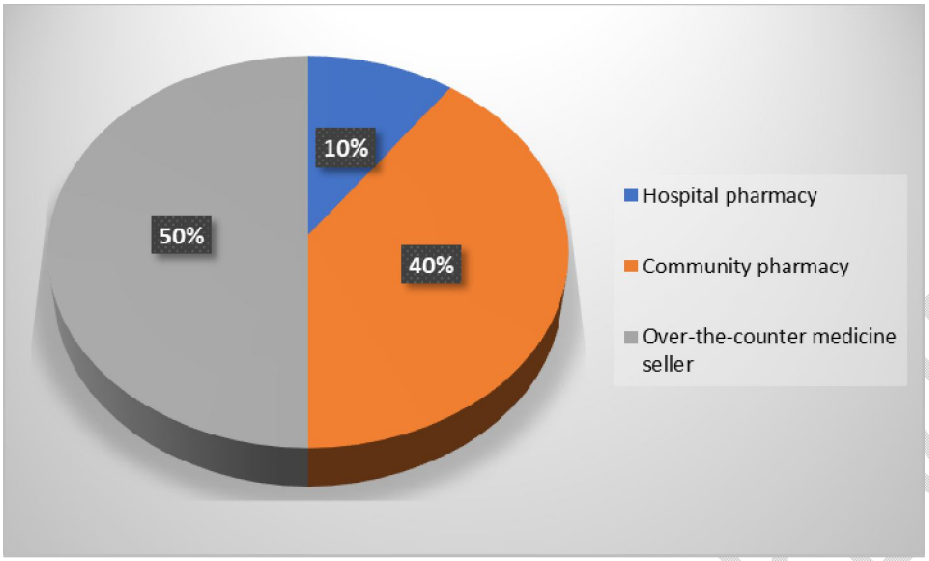

Figure 1: Distribution of samples across the various units

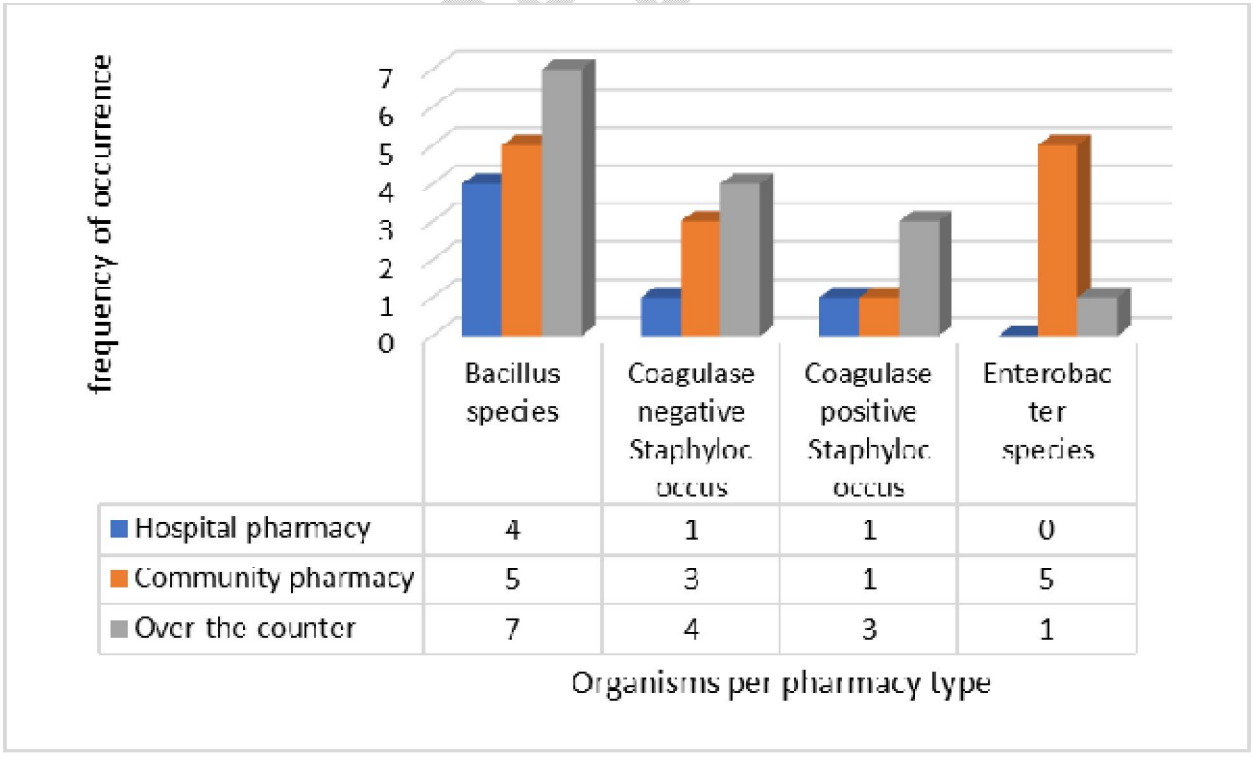

Figure 2: Organisms Isolated Per The Location Of Sampling

The genus *Bacillus* was sensitive to most of the antibiotics used in the test except ciprofloxacin (CL/5), Penicillin G (P/10), Erythromycin (EM/30) and Piperacillin (PT/100) (Figure 3). On the other hand, both coagulase negative and coagulase positive *Staphylococcus* isolates showed resistance to the antibiotics used (Figure 3). The *Enterobacter spp.* was sensitive to half of the antibiotics tested and resistant to the other half (Figure 4)

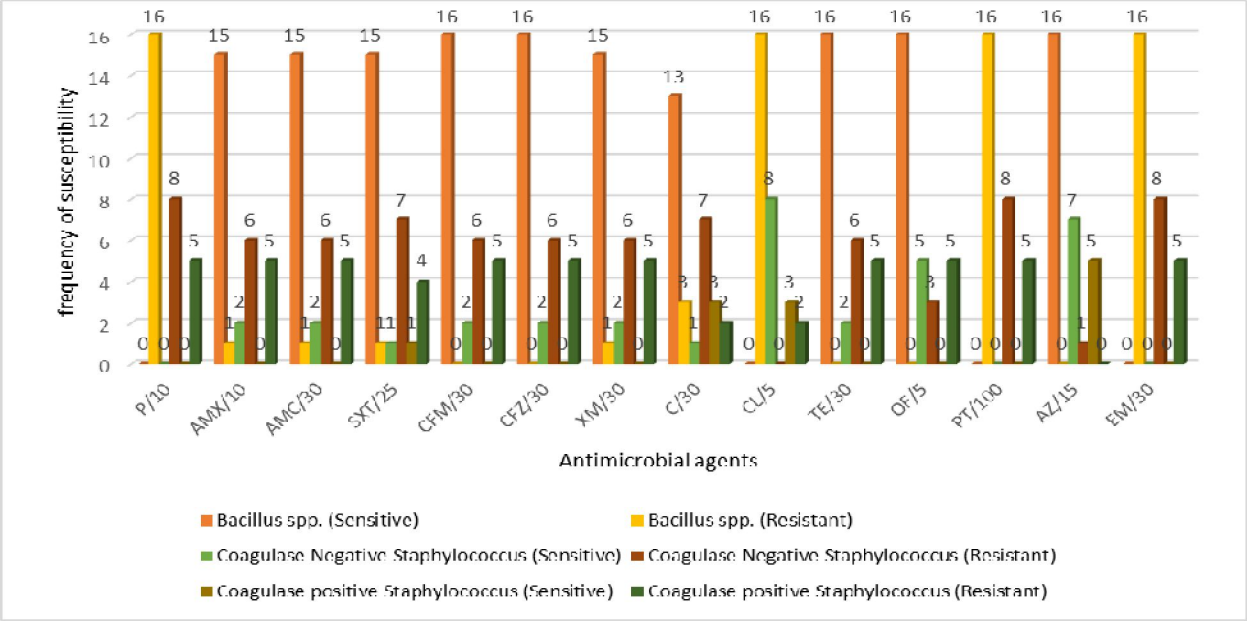

Figure 3: Distribution of antimicrobial susceptibility pattern displayed by Gram-positive organisms isolated

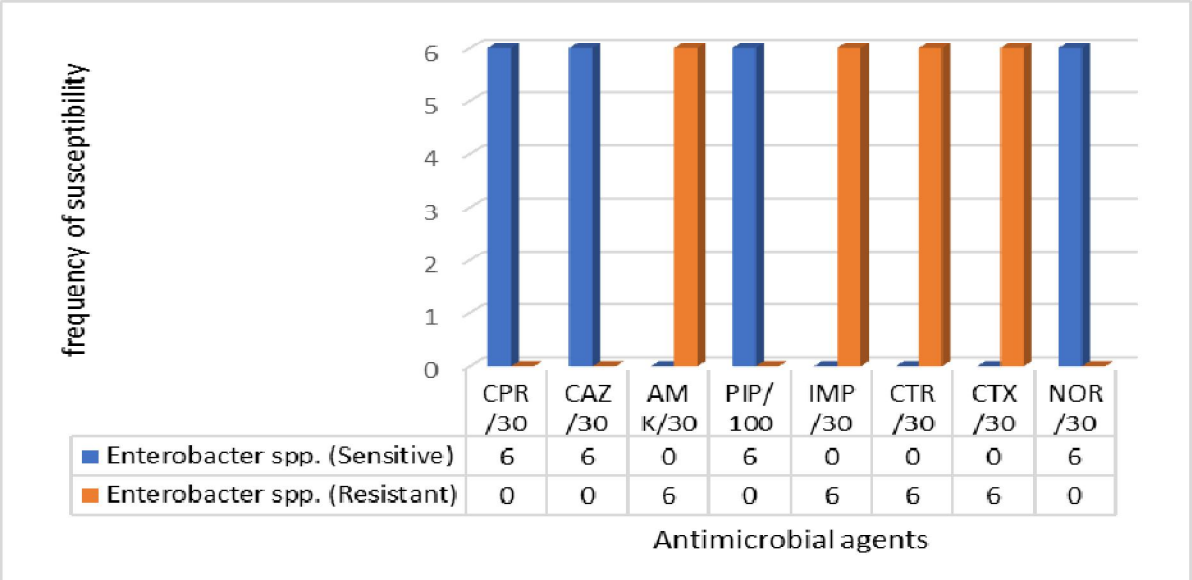

Figure 4: Showing antimicrobial susceptibility pattern of *Enterobacter species*

3.2 Discussion

Thirty (30) samples were taken from all three (3) operation categories (community pharmacy, hospital pharmacy and over-the-counter medicine sellers' shops) for this study. The study intended to have taken an equal number of samples from each operation category; however, due to the bureaucracy involved in the acquisition of permission to take samples from the public-owned hospital, it could not go as planned. As such, samples were randomly taken based on the availability and the willingness to partake in the study, with three (3) of the samples taken from hospital pharmacies, twelve (12) of them from community pharmacies and the remaining fifteen (15) taken from over-the-counter medicine sellers. As a result of unequal sampling, it is difficult to determine which category has the highest contamination rate. However, the presence of microbes across all sampling units indicates potential risk of transmission of microbes to the health workers as well as to the clients who use the facility.

Amongst all the four (4) organisms initially targeted by this study, only *Staphylococcus spp.* was found to be present on the hands of pharmacy technicians; *Escherichia coli*, *Klebsiella spp.* and *Salmonella* spp. were not found to contaminate the hands of Pharmacy technicians. This corroborates to the findings of Asim *et, al.* 2015 [12], which also showed greater contamination of the hands of healthcare givers in Eastern India by *Staphylococcus spp.* Other organisms worth

mentioning (*Bacillus spp.* and *Enterobacter spp*.) were also found to contaminate the palms of Pharmacy technicians. *Bacillus spp.* was the most abundant organism isolated in this study. *Bacillus spp., coagulase negative and coagulase positiveStaphylococcus* were distributed across all three (3) categories, while *Enterobacter spp*. was found mainly among the community pharmacy and the over-the-counter medicine sellers and this could be a result of less sampling from the hospital pharmacy. It can be argued that, the comparatively high number of *Staphylococcus spp.* isolates found on the palms of over-the-counter medicine dispensers compared to the other groups could be because of lack of training and supervision of pharmacy technicians as received in hospital and community pharmacy settings coupled with less strict regulations on hygiene in the areas of over-the-counter medicine sellers.Although it has been reported that most *Bacillus* spp. pose no significant health dangers and are rather opportunistic, a few *Bacillus sp* groups are pathogenic to humans and animals[14] causing deadly infections such as anthrax (in the case of *B. anthracis*)in humans and livestock [15] and food poisoning similar to staphylococcal food poisoning [16]. *Bacillus spp.* are also known to cause some systemic and local infections which include but are not limited to fulminant bacteremia, endophthalmitis, pneumonia, and gas gangrene-like cutaneous infections in immunocompromised persons such as neonates and patients sustaining traumatic or surgical wounds [16,17] who are also persons most likely to patronize the services of pharmacy units. Its infection can necessitate prolonged hospitalization involving expensive antimicrobial agents.

Staphylococcus spp. which is of greater concern in this study causes a wide range of infections, of which most are caused by *Staphylococcus aureus.* Although *Staphylococcus aureus* is a common member of the human microflora, it can produce disease through two different mechanisms. One is based on the ability of the organisms to multiply and spread widely in tissues, and the other is based on the ability of the organisms to produce extracellular enzymes and toxins. Infections based on the multiplication of organisms are a significant problem in hospitals and other healthcare facilities[18] . Multiplication in tissues can result in manifestations such as boils, skin sepsis, post-operative wound infections, enteric infections and septicaemia.

Majority of the *Bacillus spp.* isolated showed greater sensitivity to most of the antibiotics tested contrary to *Staphylococcus spp.* which resisted most of the antibiotics tested against them. This high level of antimicrobial resistance of *Staphylococcus spp.* is not strange because of the

continued spread of methicillin-resistant *S. aureus* (MRSA) over the past several decades in both human and animal species[19]. This is still very worrisome as it continues to compound the menace of multidrug resistant strains of *Staphylococcus species* from the pharmacy units.

4.0 CONCLUSION AND RECOMMENDATIONS

This study investigated the prevalence and antimicrobial susceptibility patterns of targeted bacterial species isolated from the palms of pharmacy technicians in Ghana's Upper West Region. The results revealed alarming levels of microbial contamination likely stemming from insufficient hand hygiene practices. Although the intended target organisms like *Escherichia coli, Klebsiella species,* and *Salmonella species* were not identified, the isolation of *Staphylococcus species, Bacillus species,* and *Enterobacter species* points to potential risks of pathogen transmission to healthcare workers and patients through improper hand cleansing.

The high prevalence of *Bacillus species* across all pharmacy categories sampled is worrying given the ability of some strains to cause dangerous infections, especially in vulnerable populations that commonly utilize pharmacies. However, most Bacillus isolates displayed susceptibility to the panel of antibiotics tested. In contrast, the isolated *Staphylococcus species* exhibited multidrug resistance, compounding the ongoing spread of treatment-resistant strains in healthcare settings.

These findings underscore the critical need for reinforced handwashing protocols and hygiene monitoring among pharmacy staff. Additionally, regular surveillance of antimicrobial susceptibility patterns will be vital to guide interventions for infection control and prevention. More stringent regulations may be warranted, especially for over-the-counter medicine shops. Overall, this study provides valuable insights into mitigating risks from nosocomial pathogens in community and hospital pharmacies to protect wider public health. Enhanced training and supervision of pharmacy technicians will be key to improving pharmaceutical hygiene practices in this region and beyond.

REFERENCES

[1] A. Koduah, I. Kretchy, R. Sekyi-Brown, M. Asiedu-Danso, T. Ohene-Agyei, and M. Duwiejua, "Education of pharmacists in Ghana: evolving curriculum, context and practice in the journey from dispensing certificate to doctor of pharmacy certificate," *BMC Med Educ*, vol. 20, no. 1, Dec. 2020, doi: 10.1186/s12909-020-02393-x.

[2] E. Jordan, "Suitable and remunerative employment: the feminization of hospital dispensing in late nineteenth-century England," *Soc Hist Med*, vol. 15, no. 3, pp. 429–456, 2002, doi: 10.1093/SHM/15.3.429.

[3] P. Sodnomtseren*et al.*, "Pharmacy technician training in Mongolia: Past, present, and future," *Pharmacy Education*, vol. 22, no. 1, pp. 904–912, Oct. 2022, doi: 10.46542/PE.2022.221.904912.

[4] M. Boughen and T. Fenn, "Practice, Skill Mix, and Education: The Evolving Role of Pharmacy Technicians in Great Britain," *Pharmacy: Journal of Pharmacy Education and Practice*, vol. 8, no. 2, p. 50, Mar. 2020, doi: 10.3390/PHARMACY8020050.

[5] D. Andalo, "Regulator says curriculum for pharmacy technicians should focus on patient care," *Pharm J*, Dec. 2015, doi: 10.1211/PJ.2015.20200233.

[6] M. Boughen, J. Sutton, T. Fenn, and D. Wright, "Defining the Role of the Pharmacy Technician and Identifying Their Future Role in Medicines Optimisation," *Pharmacy: Journal of Pharmacy Education and Practice*, vol. 5, no. 3, p. 40, Jul. 2017, doi: 10.3390/PHARMACY5030040.

[7] A. K. Labi *et al.*, "Multi-centre point-prevalence survey of hospital-acquired infections in Ghana," *J Hosp Infect*, vol. 101, no. 1, pp. 60–68, Jan. 2019, doi: 10.1016/J.JHIN.2018.04.019.

[8] P. A. Bannor *et al.*, "Infection Prevention and Control in Healthcare Facilities During the Covid-19 Pandemic in Ghana," *International Journal of Infection Prevention*, vol. 1, no. 2, pp. 29–47, Sep. 2021, doi: 10.14302/ISSN.2690-4837.IJIP-20-3944.

[9] R. M. Klevens*et al.*, "Estimating Health Care-Associated Infections and Deaths in U.S. Hospitals, 2002," *Public Health Reports*, vol. 122, no. 2, p. 160, 2007, doi: 10.1177/003335490712200205.

[10] B. Allegranzi, J. Storr, G. Dziekan, A. Leotsakos, L. Donaldson, and D. Pittet, "The First Global Patient Safety Challenge 'Clean Care is Safer Care': from launch to current progress and achievements1 1 On behalf of the World Health Organization (WHO) Global

Patient Safety Challenge (Lead, Professor D Pittet), World Alliance for Patient Safety, WHO Headquarters, Geneva, Switzerland.," *Journal of Hospital Infection*, vol. 65, no. SUPPL. 2, pp. 115–123, Jun. 2007, doi: 10.1016/S0195-6701(07)60027-9.

[11] D. Pittet, B. Allegranzi, J. Storr, and L. Donaldson, "'Clean Care is Safer Care': the Global Patient Safety Challenge 2005-2006," *Int J Infect Dis*, vol. 10, no. 6, pp. 419–424, Nov. 2006, doi: 10.1016/J.IJID.2006.06.001.

[12] A. Sarfraz *et al.*, "Study of bacterial flora of hands of health care givers in a tertiary care hospital in eastern India," *J Evol Med Dent Sci*, vol. 4, no. 27, pp. 4644–4649, Apr. 2015, Accessed: Jul. 08, 2023. [Online]. Available: https://go.gale.com/ps/i.do?p=AONE&sw=w&issn=22784748&v=2.1&it=r&id=GALE%7CA471274870&sid=googleScholar&linkaccess=fulltext

[13] R. M. Humphries *et al.*, "CLSI methods development and standardization working group best practices for evaluation of antimicrobial susceptibility tests," *J Clin Microbiol*, vol. 56, no. 4, Apr. 2018, doi: 10.1128/JCM.01934-17/SUPPL_FILE/ZJM999095879S1.PDF.

[14] F. A. Drobniewski, "*Bacillus cereus* and related species," *Clin Microbiol Rev*, vol. 6, no. 4, pp. 324–338, 1993, doi: 10.1128/CMR.6.4.324.

[15] R. C. Spencer, "*Bacillus anthracis*," *J Clin Pathol*, vol. 56, no. 3, pp. 182–187, Mar. 2003, doi: 10.1136/JCP.56.3.182.

[16] J. Bartram, J. Cotruvo, M. Exner, C. Fricker, and A. Glasmacher, "Heterotrophic Plate Counts and Drinking-water Safety: The Significance of HPCs for Water Quality and Human Health," *Water Intelligence Online*, vol. 12, Sep. 2013, doi: 10.2166/9781780405940.

[17] E. J. Bottone, "Bacillus cereus, a Volatile Human Pathogen," *Clin Microbiol Rev*, vol. 23, no. 2, p. 382, Apr. 2010, doi: 10.1128/CMR.00073-09.

[18] J. P. Rasigade and F. Vandenesch, "*Staphylococcus aureus*: a pathogen with still unresolved issues," *Infect Genet Evol*, vol. 21, pp. 510–514, Jan. 2014, doi: 10.1016/J.MEEGID.2013.08.018.

[19] C. J. Heaton, G. R. Gerbig, L. D. Sensius, V. Patel, and T. C. Smith, "*Staphylococcus aureus* Epidemiology in Wildlife: A Systematic Review," *Antibiotics 2020, Vol. 9, Page 89*, vol. 9, no. 2, p. 89, Feb. 2020, doi: 10.3390/ANTIBIOTICS9020089.

LIST OF ANTIMICROBIAL AGENTS USED

Gram positive agents

1. P/10 = PENICILLIN –G 10 micrograms
2. AMX/10 = AMOXICILLIN 10 micrograms
3. AMC/30 = AMOXICILLIN + CLAUVOLANIC ACID 30 micrograms
4. SXT/25 = COTRIMOXAZOLE 25 micrograms
5. CFM/30 = CEPHALEXIN 30 micrograms
6. CFZ/30 = CEFAZOLIN 30 micrograms
7. XM/30 = CEFUROXIME 30 micrograms
8. C/30 = CHLORAMPHENICOL 30 micrograms
9. CL/5 = CIPROFLOXACIN 5 micrograms
10. TE/30 = TETRACYCLINE 30 micrograms
11. OF/5 = OFLOXACIN 5 micrograms
12. PT/100 = PIPERACILLIN 100 micrograms
13. AZ/15 = AZYTHROMYCIN 15 micrograms
14. EM/30 = ERYTHROMYCIN 30 micrograms

Gram negative agents

1. CPR/30 = CIPROFLOXACIN 30 micrograms
2. CAZ/30 = CEFTAZIDIME 30 micrograms
3. AMK/30 = AMIKACIN 30 micrograms
4. IMP/30 = IMIPENEM 30 micrograms
5. CTR/30 = CEFTRIAXONE 30 micrograms
6. CTX/30 = CEFOTAXIME 30 micrograms
7. NOR/30 = NORFLOXACIN 30 micrograms

8. PIP/100= PIPERACILLIN 100 micrograms