JOURNAL OF RADIOGRAPHY AND RADIATION SCIENCES

EVALUATION OF LEAD APRON AS A POTENTIAL SOURCE OF NOSOCOMIAL INFECTION IN OPERATING THEATER

[1]Abdulrahman Umaru, [2]Abdulrazaq Bamanga,[1] Mohammed Yusuf M, [3]Abduljabbar, Abubakar S, [1]Adam, Ali M, [1]Ibrahim Muhammed, [4]Hassan, Musa M, [5]Zayyad, Imam M, [1]Ahmad Lawal

[1]Ahmadu Bellow University, Zaria

[2]National Tuberculosis and Leprosy Training Centre Saye. Zaria

[3]Federal Polytechnic Mubi

[4] Esteem Diagnostic Medical Services Ltd Lagos

[5] Modibbo Adama University Teaching Hospital Yola.

Correspondence:abdulumaru08@gmail.com

https://doi.org/10.48153/jrrs/2023/URKE7051

Article info
First Submission
29th May 2023

Revised
26th July 2023

Accepted
17th August 2023

ABSTRACT

Background: For radiation protection, lead aprons are often carried into the operating theater from the radiology department, where there are few or no dedicated lead aprons for the operating theater and can be a potential source of nosocomial infection.

Objective: The main objective of this research is to evaluate the presence of microorganisms on the lead aprons and devising a simple method of cleaning to lower the risk of contamination in the operating room.

Methods: A total of 64 swabs were taken in two regions of the lead apron, the shoulders (inner and outer) and secondly, the front middle part of the apron (inner and outer). 40 samples were collected before cleaning, while 24 post-cleaning swabs was also taken from areas where growth were isolated using three different agents routinely used in our hospital: (cetrimide and chlorohexidine gluconate (savlon), isopropyl alcohol (methylated spirit) and sodium hydrochloride (Hypo/bleach). The samples collected were cultured on plates of Blood Agar, chocolate Agar, and MacConkey Agar and incubated at 37^{o}c for 48h. The data was analysed using SPSS version 16.0, using descriptive statistics such as frequency and percentage.

Result: Growth was observed on 72.5% (n = 29) of X-ray aprons, and Staphylococcus aureus 69% (n = 20) and Staphylococcus epidermidis 31% (n= 9), were the pathogens observed on the lead apron, mostly on the outer part of the lead apron at the level of the patients and bed, followed by the inner part at the same level. The least noticeable area of growth is the inner part of the shoulder. After cleaning, no growth was detected in the 24 samples collected.

Conclusion: Lead aprons can be a potential source of nosocomial infections in the operating theater and cleaning them with any of the available disinfectants in the hospital before taking them to the room will significantly reduce the bacteria load**.**

Keywords: Lead apron, nosocomial infection, operating theatre.

Introduction

Hospital environment contamination, especially in operating theatres (OT) and other units, has greatly contributed to multiple exposures to nosocomial infections [1]. Nosocomial infections, also known as hospital-acquired infections (HAI), are infections that are not present in the patient at the time of admission to the hospital but develop during the course of their stay there. [2,3]. Patient comes into contact with new infective agents, becomes contaminated, and subsequently develops an infection. One of the most life-threatening sources of nosocomial infection for patients is contamination of operating theatre (OT) [4]. A study [5] shows that about 14-17% of hospital acquired infections and 38% of nosocomial infections are surgical site infections.

Depending on the type of surgery, 1-10% of all surgical patients will develop a surgical site infection (SSI) [6]. A study has shown that In the United Kingdom, Hospital-acquired infection (HAI) constitutes a substantial financial burden of up to 1 Billion euro per year [7]. There is a prolong Patient stay in the hospital, delayed wound healing [8], higher personal costs [7], and a significant increase in morbidity and mortality [9].

There are multiple reservoirs reported as being responsible for the contamination of the OT, including unfiltered air, ventilation systems [2], antiseptic solutions, drainage of the wounds, transportation of patients and collection bags [4], the surgical team, the theatre gown, footware, gloves, and hands [4], the use of inadequately sterilized equipment, a contaminated environment, white coats and ties [7], and grossly contaminated surfaces are potential reservoirs for infection [4, 10].

Ionizing radiation (X-rays) are used to visualize inside the body [11]. In the operating room, fluoroscopic imaging (X-ray based) examination is an indispensable aid for guidance and confirmation of the locations of instruments in the operating room [12]. However, it is associated with a high risk of radiation exposure [13, 14]. A lead apron is essential to minimize radiation exposure to the personnel in the operating room where there is obviously no other means of protection possible [15, 16]. For radiation protection, it is necessary for all the personnel in the operating theater to put on a lead apron [13]. The doctor participating directly in the surgery wears these lead X-ray aprons beneath their sterile surgical gowns, and no surgical gown is completely impenetrable to bacteria [17].

A dedicated lead apron for the operating theater is needed and should be cleaned regularly to avoid contamination in the room. However, a lead apron from the radiology department is often carried into the operating room whenever there is a need for radiological services. Since these aprons are worn during surgical procedures, they can also be a potential source of HAI. The main aim of this study is to evaluate the presence of microorganisms on the surface of lead aprons, identify the most common organisms on this source, and devise a simple method of cleaning to lower the risk of contamination.

Methods:

A total of ten (10) lead aprons from the radiology department of the University of Maiduguri teaching hospital in Borno State were used in the study. Disposable gloves, a sterile stick swab was used for sample collection, Blood Agar, Chocolate agar, and MacConkey Agar were used as culture mediums, and three different disinfectants routinely used in our hospital were used in cleaning the lead aprons: (cetrimide and chlorohexidine gluconate (Savlon), Isopropyl alcohol (methylated spirit), and Sodium hydrochloride (hypo/bleach). The samples were collected and incubated using Thermostat incubator machine with model number DNP-9022JH, for the period of one week from January 2nd to 7th2023. Permission was sought from the Head of the radiology department at the University of Maiduguri Teaching Hospital (UMTH).

A total of sixty-four (64) swabs were taken (both pre- and post- cleaning) in two regions of Based on observation and practice, these two areas were selected for the swab: the shoulders (inner and outer), as this area is always grasped when handling aprons, and the front middle part of the apron (inner and outer), as it is the area that comes into substantial contact with patients and beds. Using a sterile stick swab, 40 samples were collected before cleaning, while 24 post-cleaning swabs were also taken from areas where growth was isolated. Each sample was taken wearing new disposable gloves to minimize cross-contamination by a laboratory scientist and a microbiology technician.

After the initial culture result was done, 24 areas were selected where growth was recorded on the lead apron,

classified into three groups, and cleaned using the three different disinfectants listed above. The samples collected were cultured on plates of Blood Agar, Chocolate Agar and MacConkey Agar and incubated at 37^{o}c for 48 h. After an incubation period of 48 hours at 37^{0}c the plates were examined microscopically by a microbiologist and reviewed by the most senior lab scientist, and the data was analyzed using SPSS version 16.0, using descriptive statistics such as frequency and percentage. And the results were presented in a table and a chart. The data was uploaded on Mendeley, and the doi was obtained (doi: 10.17632/6t6s29z6vh.1).

Results:

Before cleaning the lead apron, forty (40) samples were collected and cultured. Growth was observed on 29 (72.5%) X-ray aprons. The pathogens include the most common organisms (skin flora), such as *Staphylococcus epidermidis* 9 (31%), and *Staphylococcus aureus* 20 (69%), on the aprons analyzed as seen in figure 1. Also, the outer part of the lead apron at the level of the patients and bed has the highest number of isolates: 9 (31%) followed by the inner part at same level and shoulder: 7 (24%). The least area where growth was noticed is the outer part of the shoulder 6 (21%) as shown in Table 1. Out of the 29 isolates where growth was detected, 24 samples were collected randomly, after cleaning with three different disinfectants (8 samples each), as stated earlier. No growth was detected on all the samples collected. (0/24).

Table 1: Lead apron site or location on which microorganisms were isolated

Site \Isolate	Staphylococcus aureus	staphylococcus epidermidis	Total
Shoulder IN	2 (28.6%)	5 (71.4%)	7 (100%)
Shoulder OUT	3 (50.0%)	3 (50.0%)	6(100%)
Abdomen IN	6 (85.7%)	1 (14.3%)	7 (100%)
Abdomen OUT	9 (100%)	0 (0%)	9 (100%)
Total	20 (69.0%)	9 (31.0%)	29 (100%)

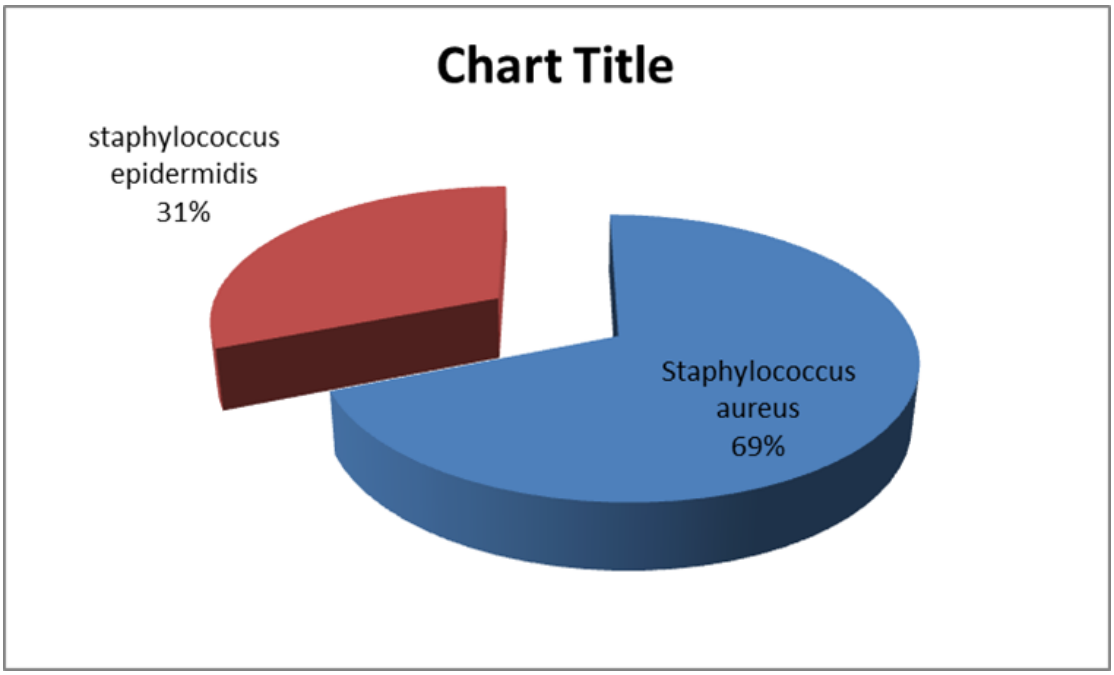

Fig 1: Percentage occurrence of the Isolates

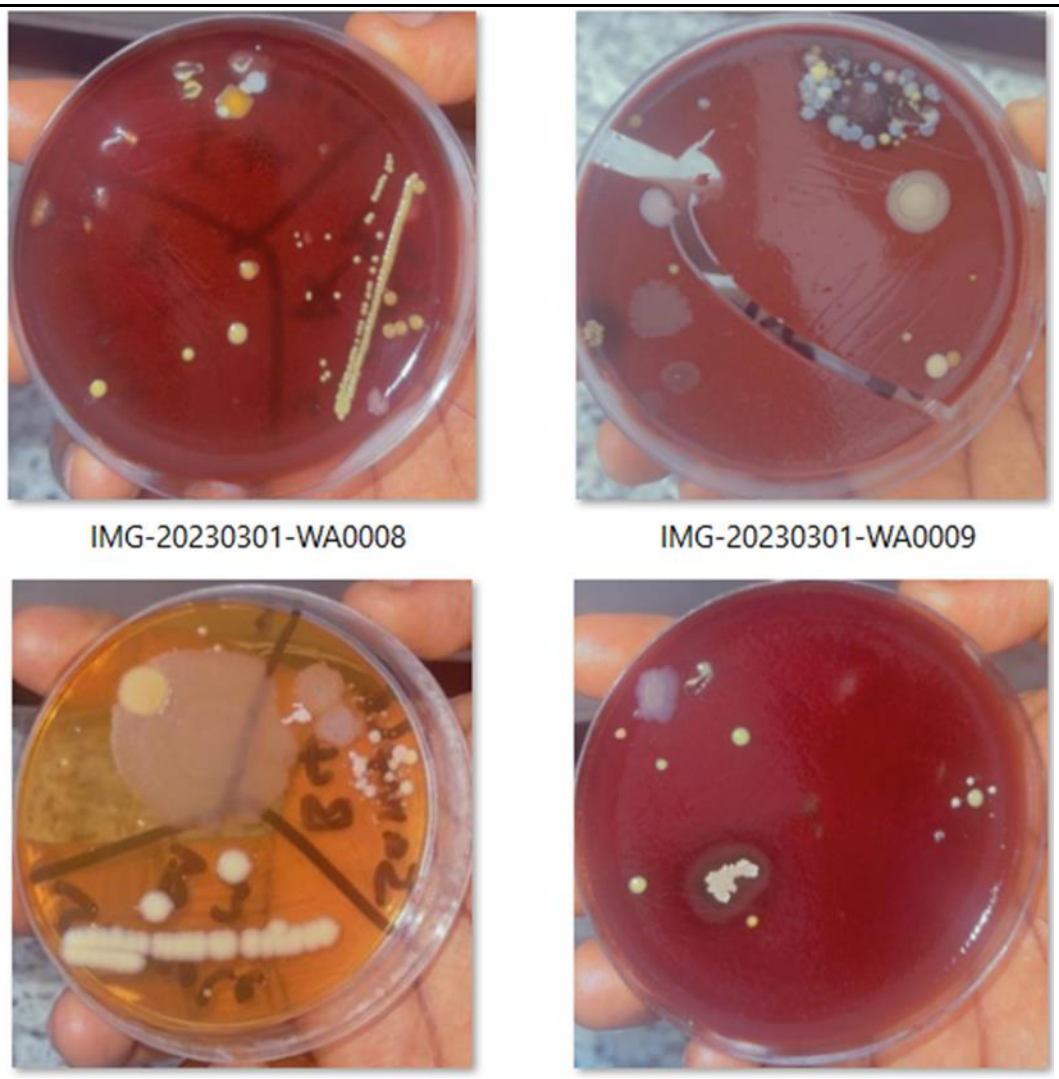

Fig 2: Some culture plates of the Isolates

Discussion:

There is increased use of fluoroscopy in the operating theatre (OT) which comes with the risk of radiation exposure [12]. As such, lead aprons are used to protect users from secondary radiation exposure [16]. The lead apron is also a potential source of infection and is worn under scrubs by surgeons and other members of the OT. Following the assessment of forty (40) samples from ten (10) lead aprons in the radiology department, the results show that 29 out of forty samples, or 71.5%, show growth of microorganisms. This high percentage can be because the lead aprons used in radiology are poorly kept and have a lot of contamination from body fluid and spillage during special examinations. This result is in tandem with the research conducted by Jain et al. [17] and Feierabend & Siegel [18], with 80% and 81%, respectively. Furthermore, the most common bacteria found in this study were *Staphylococcus aureus* (69%) and *Staphylococcus epidermidis* (31%); these organisms are frequently found on the skin and upper respiratory tract [21]. they are an opportunistic pathogen and a common cause of skin infection, abscess, and respiratory infection [22]. The result from this study is in agreement with what was reported by Muhammed et al. [19] and Genet et al. [20], which showed that *Staphylococcus aureus* is the most common isolate found in the hospital environment. There was no growth detected after cleaning the lead apron with all three types of disinfectants used in our study. These disinfectants were selected because they are readily available and are active against viruses and bacteria [23]. And this result is in agreement with the

studies conducted by Jain et al. [17], Feierabend & Siegel [18], and Genet et al. [20], who use hospital-grade disinfectant wipes, bleach-based disinfectant wipes, and low-alcohol concentration wipes, respectively. The limitations of these studies include the number of gowns used and the fact bacterial transmission through the surgical gown wasn't done.

Conclusion:

The study demonstrates that lead aprons can also be a potential source of nosocomial infections in the operating theatre, the most common isolate found on them is *Staphylococcus aureus,* followed by *Staphylococcus epidermidis.* However, cleaning them with any of the available disinfectants in the hospital before taking them to the room will significantly reduce or eliminate the bacterial load when compared to unclean gowns, and therefore recommends that all lead aprons be cleaned always before entering the OT.

Acknowledgment:

None.

Conflict of interest:

None.

References

1. Matinyi, S., Enoch, M., Akia, D., Byaruhanga, V., Masereka, E., Ekeu, I. Et al. Contamination of microbial pathogens and their antimicrobial pattern in operating theares of peri-urban eastern Uganda: a cross-sectional study. *BMC infection Disease,* 2018. *18:460.* https://doi.org/10.1186/s12879/-018-3374-4
2. Sikora, A., and Zahra, F. Nosocomial infection. *Startpearls publisher*. Treasure island. Treasure island (FL). 2021. Available at https://www.cbi.nlm.nih.gov/books/NBK559312/
3. Khan, H. A., Kanwal, F. B. And Mehboob, R. Nosocomial infection: Epidemiology, prevention, control and surveillance. *Asian Pac J of Tropical Biomedicine.* 2017. *7(5): 1 – 5.* Http://dx.doi.org/10.1016/j.apjtb.2017.01.019
4. Matthew, D., Dadah, A. J. And Mohammed, S. S. D. Bacterial Contamination of operating theatres: a case study of a hospital in northan Nigeria. *Science world journal.* 2020. *15(2):* 84 – 90. *ISSN 1597-6343.*
5. Spagnolo. A. M., Ottria, G. Amicizia, D., Perdelli, F. And Christina, M.L. Operating theatre quality and prevention of surgical site infection. *J. Prev Med Hyg.* 2013. *54: 131-137.*
6. Hold A. Infection control in theatre, Southern African Journal of Anaesthesia and Analgesia. 2011. 17(1): 56-64, DOI: 10.1080/22201173.2011.10872732) http://doi.org/10.1080/22201173.2011.10872732
7. Jaber, M. M., Qiao, E., Harvill M. L. And Nasser F. A. Contamination of interventional radiology lead apron by nosocomial pathogens. *Biomed J Sci & Tech Res.* 2017. *1(2). 391 -393. DOI: 10.26717/BJSTR.2017.01.000203*
8. Raksha, G. S. Operation Theatres: A source of nosocomial infection. *Era@s journal of Med. Res.* 2019. *6(1): 1 - 6* Doi: 10.24041/ejmr2019.103.
9. Doll, M. *Guide to infection control in the hospital: the new technologies in infection prevention. Chapter 56.* international society for infectious diseases. 2018 1- 13. Available at https://isid.org/2018/02/ISID_infectionguige_chapter22.pdf
10. Okon, K.O., Osundi, S. Dibal, J., Ngbale, T., Bello, M., Akuwhwa, R. T., et al. Bacterial contamination of operating theatre and other specialized care in a tertiary hospitals in northeastern Nigeria. *Afr. J. Microbiol. Res.* 2012. *6*(13): 3092 – 3096. Doi: 10.5897/AJMR11.834
11. Kumar, P. Radiation safety issues in fluoroscopy during percutaneous Nephrolithotomy. *Urol J. Winter.* 2008. *5*(1): 15 – 23. PMID 18454421 available at http://pubmed.ncbi.nlm.nih.gov/18454421/
12. Manhajan, A., Samuel, S., Saran, A. k. Mahajan, M. K. an Mam, M. K. Occupational radiation exposure from C arm Fluoroscopy During common Orthopaedic Surgical Procedures and it prevention. *J. clinical. Diagn. Res.* 2015. *9*(3): 1 – 4. Doi: 10.7860/JCDR/2015/10520.5672.
13. Narain, A. S., Hijji, F. Y., Yom, K. H., Kudaravalli, T., Haws, B. E. And Singh, K. Radiation exposure and reduction in the operating room: prospective and future directions in spine

sugery. *World J. Ofrthop.* 2017, *8*(7). 524 - 530 Doi: 10.5312/wjo.v8.i7.524

14. Kaplan, D.J., Patel, J.N., Liporace, F. A. And Yoon, R.S. Intraoperative radiation safety in orthopedics:a review of ALARA(as low as reasonable achievable) principle. *Patient saf surg.* 2016. *10(27): 1 – 7. Http://doi.org/10.1186/s13037-016-0115-8*

15. Boyle, H. and Strudwick, R. Do lead rubber aprons pose an infection risk? *J. Radiography* 2010. 16(4): 297-303. ISSN 1078-8174. available at http://www.radiographyonline.com/article/S1078-8174(10)00038-6/abstract

16. Bamanga, A., Umaru, A., Mohammed, Y. M., Musa, H. M., Mohammed, I. and Ibrahim, I. Z. Quality assurance of personal protective apparel at tertiary hospitals in Yola, Adamawa state. *Journal of radiography and radiation sciences.* 2022. *36*(1). https://doi.org/10.48153/jrrs/2022/ZJYW8662

17. Jain, S., Rajfer, R. A., Melton-Kreft, R., Nistico, L., Miller M. C., Stoodley, P., et al. Evaluation of bacterial presence on lead X-ray aprons utilised in the operating room via IBIS and standerd culture methods. *Journal of infection Prevention.* 2019, *20(4):*191-196 doi: 10.1177/1757177419833163

18. Feierabend, S. and Siegel G. Potential infection risk from thyroid radiation protection. *Journal of orthopaedic trauma.* 2015. *29*(1). Doi: 101097/BOT.0000000000000161.

19. Muhammad, U. K., Alhaji Isa, M. and Aliyu, M. Z. Distribution of potential nosocomial pathogens isolated from enviroments of four hospitals in Sokoto. North western Nigeria. *J. microbiol. biotech. Res.* 2013. *3*(1): 139 - 143. Available at http://www.researchgate.net/publication/296862219_distribution_of_potential_nosocomial_pathogens_isolated_from_enviroments_of_four_selected_hospital_in_sokoto_north_western_nigeria

20. Genet, C., Kibru, G. and Tsegaye, W. Indoor air bacterial load and antibiotic susceptibility pattern of isolate in operating room and surgical wards at jimmauniversity specialized hospital, southwest Ethiopia. *Ethiop j health sci.* 2011. *21*(1): 9 – 17. doi: 10.4314/ejhs.v21i1.69039.

21. Percival SL, Emanuel C, Cutting KF, Williams DW. Microbiology of the skin and the role of biofilms in infection. International wound journal. 2012 Feb;9(1):14-32.

22. Cogen AL, Nizet V, Gallo RL. Skin microbiota: a source of disease or defence?. British journal of dermatology. 2008 Mar 1;158(3):442-55.

23. Nagington J, Sutehall GM, Whipp P. Tonometer disinfection and viruses. British journal of ophthalmology. 1983 Oct 1;67(10):674-6.

.