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Qualitative evaluation of the antimicrobial efficacy of UV sterilization chambers employed by barbershops in Benin City, Nigeria

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Abstract:

Background: Barbershops where men and boys' hair are cut or shaved, have been implicated in the transmission of pathogens. With this growing concern, barbers are now acquiring and employing UV sterilization chambers to re-assure customers of the safety of their instrument. This study investigated the qualitative efficacy of the UV sterilization chambers employed by selected barbers in Benin City, Nigeria.
Methods: Swab samples of instruments (clippers, combs and brushes) were collected from 30 barbershops randomly selected from 6 Local Government Areas (LGAs) of Benin City before and after exposure to UV sterilization chambers employed by each barbershop. Standard microbiology techniques were employed to culture and identify the microbial (bacteria and fungi) isolates.
Results: A total of 15 genera of microorganisms (8 bacteria and 7 fungi) were identified. Three bacterial genera (*Staphylococcus* sp., *Bacillus* sp. and *Pseudomonas* sp.) and 5 fungi genera (*Aspergillus* sp., *Mucor* sp., *Rhizopus* sp., *Trichophyton* sp. and *Penicillium* sp) were isolated from sampled instruments at the barbershops in all 6 LGAs. Evaluation of efficacy of the UV sterilization chambers showed that all microbial isolates survived exposure time of 1 min. Antimicrobial efficacy of the UV chamber increases with longer duration (time) of exposure and decreases with the age of UV chambers, with chamber of 5-6 years old being least efficacious.
Conclusion: This study confirms the presence of myriads of microorganisms including pathogenic strains on instruments used in barbershops within Benin City. It is recommended that exposure of 60 mins is the ideal duration for UV sterilization chambers used in barbershops and barbers in Benin City should endeavor to replace their UV chambers after continual use for a period of 3 years.

Keywords: microbes, antimicrobial efficacy, UV sterilization, barbershop, Benin City,

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Évaluation qualitative de l'efficacité antimicrobienne des chambres de stérilisation UV utilisées par les salons de coiffure à Benin City, Nigéria

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Abstrait:

Contexte: les salons de coiffure où les cheveux des hommes et des garçons sont coupés ou rasés ont été impliqués dans la transmission d'agents pathogènes. Avec cette préoccupation croissante, les barbiers acquièrent et utilisent maintenant des chambres de stérilisation UV pour rassurer les clients sur la sécurité de leur instrument. Cette étude a examiné l'efficacité qualitative des chambres de stérilisation UV utilisées par des barbiers sélectionnés à Benin City,

au Nigeria.
Méthodes: Des échantillons d'écouvillons d'instruments (tondeuses, peignes et brosses) ont été collectés dans 30 salons de coiffure sélectionnés au hasard dans 6 zones de gouvernement local (LGA) de Benin City avant et après exposition aux chambres de stérilisation UV utilisées par chaque salon de coiffure. Des techniques de microbiologie standard ont été utilisées pour cultiver et identifier les isolats microbiens (bactéries et champignons).
Résultats: Au total, 15 genres de micro-organismes (8 bactéries et 7 champignons) ont été identifiés. Trois genres bactériens (*Staphylococcus* sp., *Bacillus* sp. et *Pseudomonas* sp.) et 5 genres fongiques (*Aspergillus* sp., *Mucor* sp., *Rhizopus* sp., *Trichophyton* sp. et *Penicillium* sp) ont été isolés à partir d'instruments échantillonnés dans les salons de coiffure dans tous les 6 LGA. L'évaluation de l'efficacité des chambres de stérilisation UV a montré que tous les isolats microbiens ont survécu à un temps d'exposition de 1 min. L'efficacité antimicrobienne de la chambre UV augmente avec une durée (temps) d'exposition plus longue et diminue avec l'âge des chambres UV, la chambre de 5-6 ans étant la moins efficace.
Conclusion: Cette étude confirme la présence de myriades de micro-organismes, y compris des souches pathogènes sur les instruments utilisés dans les salons de coiffure à Benin City. Il est recommandé que l'exposition de 60 minutes soit la durée idéale pour les chambres de stérilisation UV utilisées dans les salons de coiffure et les barbiers de Benin City devraient s'efforcer de remplacer leurs chambres UV après une utilisation continue pendant une période de 3 ans.

Mots-clés: microbes, efficacité antimicrobienne, stérilisation aux UV, salon de coiffure, Benin City,

Introduction:

The hairs of men are usually uncovered and directly exposed to several environmental particles such as dusts. These particles serve as means of transportation for bioaerosols (1). The hairs also get in contact with various stationary fomites housing millions of pathogenic microbes (2). These pathogens are directly or indirectly transmitted from one person to another in barbershops (3). With this, a myriad of pathogens has been isolated from various barbershops. With the ever-increasing need for men to cut their hairs to size and style, barbershops have been implicated in the increasing cross-contamination and infection of persons using the barbershops services (4).

Exposure to pathogenic strains of fungi and bacteria can lead to common diseases on the hair, skin, and respiratory tracts such as rhinitis, asthma and pneumonia (5). The structure of the human hair makes it act like an air-filter. The spaces between the hair lines forms a perfect trap for all forms of microbes and the hair scrap provides a suitable landing and proliferation ground (6). Infection may occur during hair dressing, cutting and styling while employing clippers, scissors, razors, hairpins and combs through broken skin resulting from accidental injury (7).

With the current growing public awareness and concern for the potential microbial dangers in barbershops, barbers are now widely employing the use of both branded and unbranded UV sterilization chambers in disinfecting their equipment and tools with the hope of re-assuring customers safety and satisfaction (8). However, these barbers do not have basic knowledge on how to optimally use these chambers and lack the skills required to ascertain their potency or efficacy. This study therefore aimed to investigate the types of possible pathogens associated with their equipment, the qualitative efficacy of their UV sterilization chambers on the identified pathogens, and efficacy of their UV sterilization chambers based on the age of the chamber used.

Materials and method:

Study setting

This study was conducted in Benin City located in south-south geopolitical zone of Nigeria. Benin City is the capital of Edo State, with geographic coordinates of latitudes 06° 06' N, 06° 30' N and longitudes 005° 30' E, 005° 45' E. There are six Local Government Areas (LGAs) within the City; Oredo, Uhunmwonde, Ikpoba-Okha, Egor, Ovia South-West and Ovia North-East, and all the LGAs were involved in the study.

Selection of barbershops and sample collection

A total of thirty (30) barbershops were selected from the six LGAs with five shops randomly selected for sampling from each of the LGA. The barbers instrument (clippers, combs and brushes) were aseptically swabbed over 1 cm (length) by 1 cm (breadth) area using sterile swab sticks moistened with peptone water (9).

Swab samples were collected in pairs, with one pair for bacteria and the other for fungi before and after sterilization. Swab samples collected before exposure to UV sterilization chamber served as baseline. Swab samples were then collected after 1 min, 5 mins, 10 mins, 20 mins, 30 mins and 60 mins sterilization duration.

All swab samples were labelled appropriately and transported immediately to the Microbiology Departmental Laboratory, University of Benin, for culture isolation and identification of bacteria and fungi using standard microbiology procedures (10).

Culture and isolation of microorganisms

Swabs for bacterial isolation were inoculated on Nutrient agar containing 250 mg nystatin (to inhibit the growth of fungi) and incubated aerobically at 37^{o}C for 24 hours. Similarly, swabs for fungi isolation were inoculated on Notman agar containing 250 mg chloramphenicol (to inhibit the growth of bacteria) and incubated at laboratory room temperature for 5 - 7 days (10).

Identification of isolates

Colonial growths on primary isolation media were sub-cultured on Nutrient agar for bacteria and Potato Dextrose agar for fungi to obtain pure cultures. A variety of selective and differential microbial media such as CHROM-agar, Czapek agar and inhibitory mold agar (IMA) for fungi, and mannitol salt agar (MSA), MacConkey agar and Eosin methylene blue (EMB) for bacteria, were used to further purify the isolates before being stored on Nutrient agar slants and kept at 4^{o}C pending identification.

Bacteria isolates were identified to genus level using morphological, cultural and biochemical characteristics with the Bergey's Manual of Determinative Bacteriology (11). Fungi isolates were identified using the procedure described by De-hoop in Atlas of Clinical Fungi (12).

Information on UV sterilization practice

Information on the age of UV sterilization chambers (mean wavelength of sampled chambers was 254 nm with average wattage of 10W and intensity of 760 μW/cm^2) and the average time duration for sterilization of instrument was obtained by oral interview from each barber. The age range of the sterilization chambers were categorized as 1-2 years, 3-4 years and 5-6 years while the duration of sterilization was set at 1 min, 5 mins, 10 mins, 20 mins, 30 mins and 60 mins.

Data entry and statistical analysis

Data were presented in frequency distribution tables and analysed using GraphPad Instat package (GraphPad Software Inc., San Diego). Comparison of the frequency of isolation of microorganisms in the barbershops between the LGAs was done using Chi square test and $p < 0.05$ was considered significant.

Results:

In this study, a total of 15 microbial genera were isolated from instruments of 30 selected barbershops in the 6 LGAs sampled in Benin City. Among the microbes were 8 bacteria and 7 fungi genera (Table 1). The distribution pattern of the isolates from each LGA before sterilization is shown in Table 2. Among the bacteria isolates; *Staphylococcus* sp., *Bacillus* sp. and *Pseudomonas* sp. were recovered from instruments swabbed at the barbershops in all the LGAs (100%).

Similarly, *Aspergillus* sp., *Mucor* sp., *Rhizopus* sp., *Trichophyton* sp. and *Penicillium* sp. were recovered from barbershops in all the LGAs (100%). Barbershops in Egor LGA had the highest frequency of microbial isolates of 86.7% (13 of 15 genera isolated) while barbershops in Ovia-Southwest LGA had the least frequency of microbial isolates of 60% (9 of 15 genera isolated) from their instruments (X^2= 3.6000; p=0.6083).

Table 1: Identified microbial genera from instruments of selected barbershops in Benin City, Nigeria

Isolates ID	Bacteria genera	Isolate ID	Fungi genera
BtA	*Staphylococcus* sp.	FgA	*Aspergillus* sp.
BtB	*Streptococcus* sp.	FgB	*Mucor* sp.
BtC	*Micrococcus* sp.	FgC	*Rhizopus* sp.
BtD	*Corynebacterium* sp.	FgD	*Trichophyton* sp.
BtE	*Bacillus* sp.	FgE	*Penicillium* sp.
BtF	*Enterococcus* sp.	FgF	*Cladosporium* sp.
BtG	*Pseudomonas* sp.	FgG	*Candida* sp.
BtH	*Proteus* sp.		

ID = Identification

Table 2: Distribution of microbial isolates from barbershops in six LGAs of Benin City, Nigeria

Isolates	Local Government Area						Frequency of isolates (%)
	Oredo	Uhunmwonde	Ikpoba-Okha	Egor	Ovia South-West	Ovia North-East	
Bacteria							
Staphylococcus sp.	+	+	+	+	+	+	100
Streptococcus sp.	+	+	-	+	-	-	50
Micrococcus sp.	-	+	+	-	+	-	50
Corynebacterium sp.	+	-	+	-	-	-	33.3
Bacillus sp.	+	+	+	+	+	+	100
Enterococcus sp.	-	+	-	+	-	-	33.3
Pseudomonas sp.	+	-	+	+	+	+	100
Proteus sp.	-	+	-	+	-	-	33.3
Fungi							
Aspergillus sp.	+	+	+	+	+	+	100
Mucor sp.	+	+	+	+	+	+	100
Rhizopus sp.	+	+	+	+	+	+	100
Trichophyton sp.	+	+	+	+	+	+	100
Penicillium sp.	+	+	+	+	+	+	100
Cladosporium sp.	-	-	+	+	-	+	50
Candida sp.	-	+	-	+	-	+	50
Frequency per LGA (%)	66.7	80	73.3	86.7	60	66.7	X^2=3.6000 p=0.6083^{ns}

X^2= Chi square; ns = not significant; LGA=Local Government Area

Table 3: Survival rate of microbial isolates from exposure to UV Chamber of 1-2 years of age

	Before exposure to UV	After exposure to UV					
Isolates		1min	5mins	10mins	20mins	30mins	60mins
Bacteria							
Staphylococcus sp.	+	+	-	-	-	-	-
Streptococcus sp.	+	+	-	-	-	-	-
Micrococcus sp.	+	+	-	-	-	-	-
Corynebacterium sp.	+	+	-	-	-	-	-
Bacillus sp.	+	+	+	-	-	-	-
Enterococcus sp.	+	+	-	-	-	-	-
Pseudomonas sp.	+	+	-	-	-	-	-
Proteus sp.	+	+	-	-	-	-	-
Bacterial Survival rate (%)		100	12.5	0	0	0	0
Fungi							
Aspergillus sp.	+	+	+	-	-	-	-
Mucor sp.	+	+	+	-	-	-	-
Rhizopus sp.	+	+	-	-	-	-	-
Trichophyton sp.	+	+	-	-	-	-	-
Penicillium sp.	+	+	+	-	-	-	-
Cladosporium sp.	+	+	+	-	-	-	-
Candida sp.	+	+	-	-	-	-	-
Fungi Survival rate (%)		100	57.1	0	0	0	0
Total Isolates Survival rate (%)		100	33.3	0	0	0	0

Table 3 shows the survival rate of microbial isolates after exposure to UV Chamber of 1-2 years of age. All the microbial isolates survived exposure after 1 minute and grew to produce colonies on the agar plate. However, only *Bacillus* sp. survived 5 mins exposure time (12.5%) among all the bacteria isolates. Moreover, *Aspergillus* sp., *Mucor* sp., *Penicillium* sp. and *Cladosporium* sp. survived (57.1%) the 5 mins exposure time for fungi. The total isolate survival rate at 5 mins exposure was 33.3%, and 0% at 10, 20, 30, and 60 mins exposure time.

Table 4 shows the survival rate of isolates after exposure to UV Chamber of 3-4 years of age. All the isolates survived 1 min exposure time. However, 75% of the *Staphylococcus* sp., *Streptococcus* sp., *Micrococcus* sp., *Bacillus* sp., *Pseudomonas* sp. and *Proteus* sp. survived 5 mins exposure time among all the bacteria isolates while 57.1% of *Aspergillus* sp., *Mucor* sp., *Penicillium* sp., *Trichophyton* sp., *Clado- sporium* sp. and *Candida* sp. survived 5 mins exposure time among the fungi. Similarly, 62.5%% of *Staphylococcus* sp., *Streptococcus* sp., *Bacillus* sp., *Pseudomonas* sp. and *Proteus* sp. survived 10 mins exposure time among all the bacteria isolates while 71.4% of *Aspergillus* sp., *Mucor* sp., *Penicillium* sp. and *Candida* sp. survived 10 mins exposure among the fungi. The total microbial isolates survival rate at 5 mins exposure was 33.3%, 10 mins 66.7% and 0% at 20 mins, 30 mins and 60 mins exposure time.

Table 4: Survival rate of microbial isolates from exposure to UV Chamber of 3-4 years of age

	Before exposure to UV	After exposure to UV					
Isolates		1min	5mins	10mins	20mins	30mins	60mins
Bacteria							
Staphylococcus sp.	+	+	+	+	-	-	-
Streptococcus sp.	+	+	+	+	-	-	-
Micrococcus sp.	+	+	+	-	-	-	-
Corynebacterium sp.	+	+	-	-	-	-	-
Bacillus sp.	+	+	+	+	-	-	-
Enterococcus sp.	+	+	-	-	-	-	-
Pseudomonas sp.	+	+	+	+	-	-	-
Proteus sp.	+	+	+	+	-	-	-
Bacterial Survival rate (%)		100	75.0	62.5	0	0	0
Fungi							
Aspergillus sp.	+	+	+	+	-	-	-
Mucor sp.	+	+	+	+	-	-	-
Rhizopus sp.	+	+	-	+	-	-	-
Trichophyton sp.	+	+	+	-	-	-	-
Penicillium sp.	+	+	+	+	-	-	-
Cladosporium sp.	+	+	+	-	-	-	-
Candida sp.	+	+	+	+	-	-	-
Fungi Survival rate (%)		100	85.7	71.4	0	0	0
Total Isolates Survival rate (%)		100	80.0	66.7	0	0	0

Table 5: Survival rate of microbial isolates from exposure to UV Chamber of 5-6 years of age

	Before exposure to UV	After exposure to UV					
Isolates		1min	5mins	10mins	20mins	30mins	60mins
Bacteria							
Staphylococcus sp.	+	+	+	+	+	-	-
Streptococcus sp.	+	+	+	+	-	-	-
Micrococcus sp.	+	+	+	-	-	-	-
Corynebacterium sp.	+	+	+	-	-	-	-
Bacillus sp.	+	+	+	+	+	+	-
Enterococcus sp.	+	+	-	-	-	-	-
Pseudomonas sp.	+	+	+	-	-	-	-
Proteus sp.	+	+	+	+	-	-	-
Bacterial Survival rate (%)		100	87.5	50	25	3.1	0
Fungi							
Aspergillus sp.	+	+	+	+	+	-	-
Mucor sp.	+	+	+	+	+	+	-
Rhizopus sp.	+	+	+	+	-	-	-
Trichophyton sp.	+	+	+	-	-	-	-
Penicillium sp.	+	+	+	+	+	+	-
Cladosporium sp.	+	+	+	+	-	-	-
Candida sp.	+	+	+	+	+	-	-
Fungi Survival rate (%)		100	100	85.7	57.1	28.3	0
Total Isolates Survival rate (%)		100	93	66.7	33.3	20.0	0

Table 5 shows the survival rate of isolates after exposure to UV Chamber of 5-6 years of age. All the isolates survived 1 min exposure time. However, 85.7% of the *Staphylococcus* sp., *Streptococcus* sp., *Micrococcus* sp., *Corynebacterium* sp., *Bacillus* sp., *Pseudomonas* sp. and *Proteus* sp. survived 5 mins exposure time among all the bacteria isolates, while all fungi isolates (100%) survived the 5 mins exposure time. Similarly, 50% of the *Staphylococcus* sp., *Streptococcus* sp., *Bacillus* sp. and *Proteus* sp. survived 10 mins exposure time among all the bacteria isolates while 85.7% of *Aspergillus* sp., *Mucor* sp., *Penicillium* sp., *Rhizopus* sp., *Candida* sp., *Penicillium* sp., *Cladosporium* sp. and *Candida* sp. survived 10 mins exposure time among the fungi. At 20 mins exposure time, only 25% of *Staphylococcus* sp. and *Bacillus* sp. among the bacteria isolates survived while 57.1% of *Aspergillus* sp., *Mucor* sp., *Penicillium* sp. and *Candida* sp. survived 20 mins exposure time among the fungi. At 30 mins exposure time, only 3.1% of *Bacillus* sp. among the bacteria isolates survived while 28.3% of *Mucor* sp. and *Penicillium* sp. survived 30 mins exposure time among the fungi. The total microbial isolates survival at 5 mins exposure was 93%, 10 mins 66.7%, 20 mins 33.3%, 30 mins 20.0% and 0% at 60 mins.

Discussion:

In this study, a total of 15 microbial genera (8 bacteria and 7 fungi) were isolated, some of which are of public health importance (7). The high level of microbial variability isolated from instruments used at the sampled barbershops to some extent may be due to open (uncovered) nature of male hair and direct exposure to dust particles, other environmental

elements, and life style. The spaces between the hair lines forms a perfect trap for all forms of microbes and the hair scrap provides a suitable landing and proliferation ground for microbes (6).

The bacterial (*Staphylococcus* sp*., Bacillus* sp*.* and *Pseudomonas* sp.) and fungi isolates (*Aspergillus* sp*., Mucor* sp*., Rhizopus* sp*., Trichophyton* sp*.* and *Penicillium* sp*.*) were isolated from barbering instruments across all LGAs (100%), implying that these isolates are indigenous microbes in Benin City (6,10,11,12). Egor LGA had the highest frequency of isolates recovery (86.7%), which could be attributed to the relatively poor state of hygiene practices observed at the barbershops within this locality.

Evaluation of the UV sterilization chambers revealed that all isolates survived exposure time of 1 minute as previously reported by Berrin (13) and Katara et al., (14). This is because the isolates were able to repair their altered nucleic acids resulting from the brief exposure to ultraviolet radiation (15,16). Our result therefore debunks the belief by some barbers in Benin City who presumes that brisk exposure of their clippers, combs and other items to UV light is enough to kill all microbial contaminants irrespective of the duration of exposure. Furthermore, our evaluation study shows that the older the UV chamber is, the less effective its antimicrobial efficacy, which is in consonance with the reports of Sowah and Ahiabor (8), and Mackey et al., (17). *Bacillus* sp*., Mucor* sp. and *Penicillium* sp. survived exposure duration of 30 mins in the UV chambers that were 5-6 years old, as previously reported (14,18). This study also shows that the longer the duration of exposure, the more effective the sterilization efficacy which agrees with findings of previous studies (8,14). At 60 mins, no visible microbial growth was observed, signifying highest level of disinfection/sterilization, which indicate that 60 mins is ideal time for UV sterilization of barbering instruments (19).

It was generally observed in this study that fungi were more adapted to the UV sterilization chambers than bacteria as previously established (13), with *Bacillus* sp., being the most formidable bacteria isolate (20), while *Mucor* sp. and *Penicillium* sp. were the most formidable fungi isolates (21,22). It was also observed that *Enterococcus* sp. and *Trichophyton* sp. were the most effectively eliminated bacteria and fungi isolates respectively.

Conclusion:

This study confirms the presence of myriads of microbial organisms including pathogenic strains on instruments used in barbershops within Benin City. It is recommended that exposure of 60 mins is the ideal duration for UV sterilization chambers used in barbershops, and barbers in Benin City should endeavor to replace their UV chambers after continual use for a period of 3 years.

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Conflict of interest:

No conflict of interest is declared.

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