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Effectiveness of UV Sterilisation Chambers in Barbering Shops and Salons

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ABSTRACT

The use of ultraviolet (UV) sterilisation chambers gained popularity in salons, spa and other beauty establishments as the popular method for sterilising barbering equipment. This is as a result of increasing awareness of infection transfer from the use of barbering implements. Due to the cost of these sterilisation chambers, most barbering shops resort to buying "Home used" UV sterilisation chambers. In this study, the effectiveness of these sterilisation chambers against microbes that cause skin infections was assessed. A random sample of 50 barbering shops using these boxes were analysed for microbial colonies or counts, type of UV lamps used, ages of sterilisation chambers and general condition of the sterilisation chambers in the North Kaneshie Municipality, a suburb of Accra, Ghana. In all, 70 sterilisation chambers were analysed. They had a wavelength in the range: 254-365 nm wavelength, Wattage 10 W, Intensity ranging between 760/720 $\mu W/cm^2$ at 3.0 in (76.2 mm), Voltage 240 V, 50 Hz and Dimensions of 7.5 in x 2.6 in x 2.0 in. The plate counts of swaps from shaving clippers, combs and brushes were performed for microbial colonies before and after UV sterilisation. In this research, Age of the effective sterilisation chamber correlated with UV lamp intensity ($r = -0.32$), with a coefficient of determination of 0.10. That is, in 10 % of chambers, Age had no effect on the intensity of the lamps, hence the effectiveness of the chamber. A correlation of $r = 0.65$ was obtained between Age of chamber with percentage change in colony count, and coefficient of determination of 0.42. This implies that, of the twenty chambers that inhibited microbial growth about 42 % of the chambers had significant effects while the remaining had minimal effects. More than 90 % of these effective chambers showed increased lamp wattage with increased intensity. It was observed that 50 of the chambers were defective, out of which 74 % were without lamps while 26 % of the defective chambers were not fitted with prescribed lamps or had lamps that needed to be replaced. Spraying alcoholic formulation on the clippers and combs before UV sterilisation and washing of combs with soap and warm water were observed. Sterilisation carried out after using the implements for a number of customers was documented. Sterilisation practices in the barbering salons and shops sampled were not satisfactory owing to the observation where 50 of the sampled sterilizers did not inhibit microbial growth. Cleaning is sometimes carried out simply by wiping the teeth of the clippers with dry foam material. A general lack of practical knowledge about decontamination procedures were observed. Also, there is lack of stick control measures and monitoring by relevant bodies.

KEYWORDS: Intensity, Plate count, Sterilisation, Wavelength.

1.0 INTRODUCTION

Radiation Effects Research Foundation (RERF), defined ultraviolet (UV) light as electromagnetic radiation with a short wavelength and energy that can break bonds between atoms and molecules thereby altering the chemistry of materials exposed to it (RERF, 2007). UV light can also cause some substances to emit visible light, a phenomenon known as fluorescence. The form of UV light present in sunlight can be beneficial to health, as it stimulates the production of vitamin D. Ultraviolet radiation has a number of uses. It is used in therapy to treat a number of skin conditions (Khafagy et al, 2013). However over exposure to UV radiation adversely affects the body, leading to many skin conditions. Ultraviolet germicidal irradiation is a disinfection method that uses UV light to kill microorganisms. It has a variety of applications in food, water and recently air purifications (Koutchma, 2008; Kowalski, 2009). It is effective in destroying the nucleic acids in microorganisms, disrupting their DNA and leaving them unable to perform vital cellular functions. Wavelength of ultraviolet light range between 10 nm and 400 nm and are classified as UV-A, UV-B or UV-C, in order of decreasing wavelength. At a wavelength of 254 nm, UV light will break the molecular bonds of DNA in a microorganism thereby destroying it and rendering the microorganism harmless or prohibiting growth and reproduction.

Inhibition of growth of cells by UV light depends on a number of factors such as the length of time of exposure, power fluctuations of the UV source that impact the electromagnetic (EM) wavelength, the presence of particles that can protect the micro-organisms from the UV light and the ability of the microbe to withstand UV light

during its exposure (Damir, 2012). Mercury vapour lamps emit germicidal UV at 254 nm. Many germicidal UV bulbs use special ballasts to regulate electrical current flow to the bulbs. The lamps are either amalgam or medium pressure lamps. Each type has specific strengths and weaknesses. Microorganisms can be shielded from ultraviolet light in small cracks and other shaded areas. Therefore these lamps must be used only as a supplement to other sterilization techniques (Bolton, 2004).Communicable diseases such as ring worm and many other fungal infections can be transmitted via barbering services upon the reuse of the same barbering implements for several clients. In view of these, sterilisation methods such as alcohol disinfection, flame sterilization among others are applied in barbering services. UV sterilisation is currently the popular method used by many barbers due to its simple mode of operation. A random visit to some barbering shops and salons revealed that some sterilisers in these saloons have outlived their usefulness and could only pass for containers with a light and some have cracks in the glass cages. A good number of people visit barbering or hair salons for hairs cuts or for pedicure or manicure. Therefore, this study was carried out to determine whether UV sterilisers used in barbering shops inhibit growth of microbes. Specifically, the study conducted sought the nature of sterilisation chambers used in barbering shops and salons, and determine if the intensity of light and age of sterilizer chamber affects growth of microbes.

2.0 MATERIALS AND METHOD

This study was conducted in North Kaneshie Municipality, a suburb of Accra, where a total of 50 barbering shops and salons, were randomly sampled for 70 UV sterilisation chambers. Barbering implements such as brushes, combs and clippers were swabbed with sterile cotton swabs into saline before and after UV sterilization and analyzed for microbial colonies using the plate count technique. For each sample a 1:1000 dilution was plated on a plate count media at room temperature. Each UV chamber sampled was assessed based on the following: Bulb wattage, total chamber area, wavelength of the UV lamps used, dimension of the bulb, age of sterilisation chamber and visual inspection of the general condition. The UV lamps emission spectra were measured on Oriel InstaSpec I 1024 diode-array detector fitted with a 77101 MultiSpec Grating. The dimensions of the UV lamps were measured with a vernier calliper, and a meter rule for the measurement of the chamber area. A Molectron J25 pyroelectric calorimeter was used for absolute intensity determinations. Statistical analyses were performed using the Shapiro-Wilks test; analysis of correlation coefficient and determination coefficient were performed using Microsoft Excel.

3.0 RESULTS AND DISCUSSION

Only twenty out of the 70 sterilisers sampled showed inhibitory effect on microbial growth. In Table 1, wavelength of effective UV light was compared with intensity. Fifty-five percent of the lamps have a maximum at 255 nm and significant output at wavelengths of 250 nm which is germicidal thereby inhibiting growth. The wavelengths failed the correlation with the lamps intensity ($r = 0.019$), with a coefficient of determination of 0.00036 (Table 1). This implies that an increased in lamp intensity does not necessarily result in increase in the wavelength. The data are presented as the intensity (output power of the UV lamp integrated over the total area), Age of the chambers and wavelengths of the UV lamps (Table 1).

Table 1. Variation of Wavelength with Intensity

s/n	Chamber description	Age (yrs)	Wavelength (nm)	Intensity (µW/cm^2)
8	YM 9107	5	250	745.4
10	Doc Line	1	253	756.5
11	YM 9107	0.5	251	755.0
20	YM 9007	1	253	730.0
22	YM 9107	2	253	760.0
23	Doc Line	3.5	243	723.0
26	No label	2	246	726.5
28	YM 9107	1.5	275	725.0
33	YM 9107	1	254	758.0
34	CHR 208A	0.5	253	758.0

Table 1 cont'd. Variation of Wavelength with Intensity

s/n	Chamber description	Age (yrs)	Wavelength (nm)	Intensity (μW/cm^2)
39	YM 9007	2	254	740.5
43	CHR 208A	3.5	270	738.0
46	GM 209	4	271	740.0
48	CHR 208A	2	265	742.5
51	YM 9107	3	268	741.5
54	GM 209	2	253	750.5
57	CHR 208A	1	210	740.0
61	YM 9007	2	250	752.5
68	YM 9007	2	240	725.0
70	CHR 208A	1	252	750.0

When the age of the effective sterilisers was compared with change in the number of colonies counted after sterilisation, (Table 2) a correlation of r = 0.65 was obtained between the Age of chamber with percentage change in colony count, with a coefficient of determination of 0.42. That is, 42 % of the chambers had inhibitory effect on the microbial cells. According to Lyndsay *et al* (2014), the older the steriliser, the less its effectiveness. However, few of the old sterilizers apparently fitted with a new lamps, were effective, as observed where chambers with description, YM9107, though 5 and 3.5 years old, showed percentage changes in colony count of 70.6 % and 65.7 % respectively.

Table 2: Variation of Age of chamber with % change in Colony Count

s/n	Chamber description	Age (yrs)	Colony count before UV sterilization (CFU/ml)	Colony count after UV sterilization (CFU/ml)	% change in colony count
8	YM 9107	5	34	10	70.6
10	Doc Line	1	73	2	97.3
11	YM 9107	0.5	45	5	88.9
20	YM 9007	1	05	0	100
22	YM 9107	2	78	7	91
23	Doc Line	3.5	56	50	10.7
26	No label	2	85	50	41.2
28	YM 9107	1.5	82	76	7.3
33	YM 9107	1	55	3	94.5
34	CHR 208A	0.5	68	10	85.3
39	YM 9007	2	12	1	91.7
43	CHR 208A	3.5	64	53	17.2
46	GM 209	4	71	60	15.5
48	CHR 208A	2	54	40	25.9

51	YM 9107	3	35	12	65.7
54	GM 209	2	12	00	100
57	CHR 208A	1	83	56	32.5
61	YM 9007	2	76	12	84.2
68	YM 9007	2	32	12	62.5
70	CHR 208A	1	20	00	100

Table 3 compares the intensity of the effective sterilizers with the percentage change in the number of colonies counted after sterilisation. A correlation of r = 0.65 was obtained between the intensity of chamber with percentage change in colony count, with a coefficient of determination of 0.42. This shows that 42 % of the chambers had effect on the microbial cells. Usually intensity of bulbs decreases with increasing age of the chamber (Mackey et al, 2001). However, it was observed in Table 4 that, some old (aged) UV sterilisation chamber inhibited microbial growth. This probably may be due to new lamps fitted in the old chambers.

Table 3: Variation of UV lamp Intensity with % change in Colony Count

s/n	Chamber description	Intensity ($\mu W/cm^2$)	Colony count before UV sterilization (CFU/ml)	Colony count after UV sterilization (CFU/ml)	% change in colony count
8	YM 9107	745.4	34	10	70.6
10	Doc Line	756.5	73	2	97.3
11	YM 9107	755.0	45	5	88.9
20	YM 9007	730.0	05	00	100
22	YM 9107	760.0	78	7	91
23	Doc Line	723.0	56	50	10.7
26	No label	726.5	85	50	41.2
28	YM 9107	725.0	82	76	7.3
33	YM 9107	758.0	55	3	94.5
34	CHR 208A	758.0	68	10	85.3

Table 3 cont'd. Variation of UV lamp Intensity with % change in Colony Count

s/n	Chamber description	Intensity ($\mu W/cm^2$)	Colony count before UV sterilization (CFU/ml)	Colony count after UV sterilization (CFU/ml)	% change in colony count
39	YM 9007	740.5	12	1	91.7
43	CHR 208A	738.0	64	53	17.2
46	GM 209	740.0	71	60	15.5
48	CHR 208A	742.5	54	40	25.9
51	YM 9107	741.5	35	12	65.7
54	GM 209	750.5	12	00	100
57	CHR 208A	740.0	83	56	32.5
61	YM 9007	752.5	76	12	84.2
68	YM 9007	725.0	32	12	62.5
70	CHR 208A	750.0	20	00	100

From Tables 4, it was noted that, Ages of the effective chambers correlated with UV lamp intensities (r = - 0.32) in the evaluation of the sterilisation chambers, with a coefficient of determination of 0.10. This shows that only 10 % of the chambers sampled had ages that did not affect sterilisation effectiveness. According to Damir (2012), the actual lifetime of a lamp depends on many factors including operating voltage, manufacturing defects, exposure to voltage spikes, mechanical shock, frequency of cycling on and off, lamp orientation and ambient

operating temperature, among other factors. This may account for the observation in Table 2, where two chambers though old showed effectiveness against microbial growth.

Table 4. Variation of Age of chamber with UV lamp Intensity

s/n	Chamber description	Age (yrs)	Intensity ($\mu W/cm^2$)	% change in colony count
8	YM 9107	5.0	745.4	70.6
10	Doc Line	1.0	756.5	97.3
11	YM 9107	0.5	755.0	88.9
20	YM 9007	1.0	730.0	100
22	YM 9107	2.0	760.0	91
23	Doc Line	3.5	723.0	10.7
26	No label	2.0	726.5	41.2
28	YM 9107	1.5	725.0	7.3
33	YM 9107	1.0	758.0	94.5
34	CHR 208A	0.5	758.0	85.3
39	YM 9007	2.0	740.5	91.7
43	CHR 208A	3.5	738.0	17.2
46	GM 209	4.0	740.0	15.5
48	CHR 208A	2.0	742.5	25.9
51	YM 9107	3.0	741.5	65.7
54	GM 209	2.0	750.5	100
57	CHR 208A	1.0	740.0	32.5
61	YM 9007	2.0	752.5	84.2
68	YM 9007	2.0	725.0	62.5
70	CHR 208A	1.0	750.0	100

According to Mackey et al (2001), when lamps are installed their power output can fluctuate significantly until they are "burn-in" when their UV emission stabilizes. This burn-in period is typically about 100 hours. At this point they are at their maximum intensity. As lamps age, their output diminishes over time. Lamp replacement is typically not at lamp failure but when the lamp has reached on the order of 50 to 80 % of initial output. This determination is made by either a drop in UV intensity sensor output or lamp hours (Mackey et al, 2001). This explains the observation in Table 4.

Table 5 contains descriptions of defective sterilizer chambers without lamps. During the sampling, 37 sterilizer chambers were found to have no lamps at all. Hence, the wavelengths and intensities could not be determined. This represented 52 .8 % of the total chambers sampled. Some of the sterilisers had no label, therefore their ages were not known.

Table 5. Defective sterilizers without lamps

s/n	Chamber description	Age (yrs)	Wavelength (nm)	Intensity ($\mu W/cm^2$)	Colony count before UV sterilization (CFU/ml)	Colony count after UV sterilization(CFU/ml)
1	GM 209	N/A	N/A	N/A	54	N/D
3	YM 9107	N/A	N/A	N/A	63	N/D
4	YM9007	5	N/A	N/A	69	N/D
6	YM9007	4	N/A	N/A	78	N/D
9	No label	N/A	N/A	N/A	82	N/D
13	GM 209	3	N/A	N/A	62	N/D
14	No label	N/A	N/A	N/A	100	N/D
15	No label	N/A	N/A	N/A	67	N/D
17	YM 9107	6	N/A	N/A	46	N/D
18	GM 209	4	N/A	N/A	13	N/D

Table 5 cont'd. Defective sterilizers without lamps

s/n	Chamber description	Age (yrs)	Wavelength (nm)	Intensity ($\mu W/cm^2$)	Colony count before UV sterilization (CFU/ml)	Colony count after UV sterilization(CFU/ml)
19	No label	N/A	N/A	N/A	52	N/D
21	Germix	2	N/A	N/A	60	N/D
24	YM 9107	4.5	N/A	N/A	98	N/D
25	YM 9107	3	N/A	N/A	51	N/D
27	No label	N/A	N/A	N/A	54	N/D
29	No label	N/A	N/A	N/A	43	N/D
31	YM 9107	3	N/A	N/A	96	N/D
32	No label	N/A	N/A	N/A	78	N/D
36	GM 209	4	N/A	N/A	75	N/D
37	YM 9007	4	N/A	N/A	46	N/D
38	No label	-	N/A	N/A	32	N/D
40	YM 9107	4	N/A	N/A	4	N/D
41	No label	-	N/A	N/A	79	N/D
42	GM 209	6	N/A	N/A	57	N/D
44	No label	-	N/A	N/A	61	N/D
47	GM 209	-	N/A	N/A	67	N/D
49	YM 9107	-	N/A	N/A	87	N/D
50	No label	-	N/A	N/A	50	N/D
52	YM 9107	-	N/A	N/A	56	N/D
56	No label	-	N/A	N/A	66	N/D

Table 5 cont'd. Defective sterilizers without lamps

s/n	Chamber description	Age (yrs)	Wavelength (nm)	Intensity ($\mu W/cm^2$)	Colony count before UV sterilization (CFU/ml)	Colony count after UV sterilization(CFU/ml)
59	CHR 208A	-	N/A	N/A	47	N/D
60	YM 9107	-	N/A	N/A	96	N/D
63	No label	-	N/A	N/A	35	N/D
64	YM 9007	4.5	N/A	N/A	55	N/D
65	YM 9107	5	N/A	N/A	62	N/D
66	No label	-	N/A	N/A	48	N/D
67	YM 9107	2.5	N/A	N/A	49	N/D

Table 6. Colony count of defective sterilizers with lamps

s/n	Chamber description	Age (yrs)	Wavelength (nm)	Intensity ($\mu W/cm^2$)	Colony count before UV sterilization(CFU/ml)	Colony count after UV sterilization(CFU/ml)	% change in colony count
2	YM 9107	10	-	-	44	60	26.7
5	No label	-	-	-	20	32	37.5
7	No label	-	-	-	34	48	29.2
12	No label	-	-	-	59	59	0
16	No label	-	-	-	103	107	3.7
30	YM 9007	4	-	-	20	33	39.4
35	YM 9107	3	-	-	63	66	4.5
45	YM 9107	3	-	-	98	98	0
53	No label	-	-	-	60	65	7.7
55	No label	-	-	-	54	57	5.3
58	YM 9107	-	-	-	52	55	5.5
62	YM 9107	-	-	-	84	89	5.6
69	YM 9107	3	-	-	74	76	2.6

In Table 6, thirteen chambers contained lamps, however, did not inhibit growth of microbes. This could be due to the possibility that the chambers were not fitted with prescribe UV lamps or the lamps were old and needed replacement. This represented 18.5 % of the total sterilizers sampled. Table 7 shows the variation of the lamps wattage with intensity. A high wattage light sources were correlated (r = 0.95) with higher UV intensity (Lyndsay *et al,* 2014), with a coefficient of determination of 0.911. This implies that 91.1 % of the lamps wattages increased with increased UV intensity.

Table 7: Variation of UV lamps wattage with intensity

s/n	**Chamber description**	**Age (yrs)**	**Wattage (W)**	**Intensity ($\mu W/cm^2$)**
8	YM 9107	5	10	745.4
10	Doc Line	1	12	756.5
11	YM 9107	0.5	12	755.0
20	YM 9007	1	6	730.0
22	YM 9107	2	18	760.0
23	Doc Line	3.5	4	723.0
26	No label	2	6	726.5
28	YM 9107	1.5	4	725.0
33	YM 9107	1	13	758.0
34	CHR 208A	0.5	13	758.0
39	YM 9007	2	9	740.5
43	CHR 208A	3.5	7	738.0
46	GM 209	4	8	740.0
48	CHR 208A	2	10	742.5
51	YM 9107	3	9	741.5
54	GM 209	2	11	750.5
57	CHR 208A	1	8	740.0
61	YM 9007	2	12	752.5
68	YM 9007	2	4	725.0
70	CHR 208A	1	11	750.0

4.0 CONCLUSION

This study revealed that sterilisation practices in the barbering shops and salons sampled were not satisfactory owing to the observation where only 20 sterilisers were effective. About 42 % out of the twenty working sterilisers showed high effectiveness against microbial growth while the remaining 58 % had minimal effects on microbial cell growth. Fifty chambers sampled were defective out of which 74 % were without lamps. Some of the chambers investigated had no labels. Therefore information relating to year of manufacture could not be obtained. Apparently, some barbers and hair dressers knew that their sterilizers are not working but occasionally put their clippers, pedicure and manicure sets in them to deceive the public. Different types of disinfecting solutions are used, however not in strict accordance with manufacturer's directions. Clippers, including those with plastic attachments, should be dismantled after each use and thoroughly cleaned before it is used on another client. However cleaning is sometimes carried out simply by wiping the teeth of the clipper with dry foam material. General lack of practical knowledge about decontamination procedures were observed. Also, lack of strict control measures and monitoring by relevant bodies was observed.

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