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APPRAISAL OF THE METHODS OF STORAGE AND HYGIENICITY OF TOOTHBRUSHES USED BY CHILDREN IN INSTITUTIONALIZED SETTINGS

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ABSTRACT

Introduction: Tooth brushing plays an important role in for personal oral hygiene and effective plaque removal. Appropriate toothbrush care and maintenance are also important considerations for sound oral hygiene. Keeping in view the risk of transmission of microorganisms due to improper storage and its possible repercussions this research was carried out to assess the methods of storage and conditions of toothbrushes after use by children living under institutionalized conditions in Jammu and Kashmir State of India.

Material and Methods: The present study was done in five (5) orphanages in vicinity of Srinagar city of Jammu and Kashmir State of India. Tooth brushes of 683 children ranging from of 3 to 16 years of age were assessed. The storage method of the tooth brushes, moisture in them and residues left on the toothbrushes or toothbrush bristles was recorded.

Statistical analysis used: Frequencies and percentages were taken out for categorical variables. Associations between different variables were assessed through application of χ^2 test. The data was analyzed using SPSS Statistics 20.0

Results: Highest number of toothbrushes was stored in bathrooms which comprised of 344 belonging to males and 154 to females. 417 children of either gender stored their toothbrushes in open containers in bathrooms. 89 children were storing their toothbrushes outside the bathroom area. Total of 341 tooth brushes were having moisture. 279 toothbrushes including 184 from boys and 95 from girls had some residue in them.

Conclusion: Present study concluded that the toothbrushes of institutionalized orphan children which were examined for storage practices were not placed either in a hygienic and recommended manner or there were remnants of either toothpaste or food particles present in them.

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INTRODUCTION

Mechanical means like tooth brushing is the most commonly used procedure that is undertaken in the present times for the control of plaque and reducing the growth of bacterial in oral cavity. It has been reported that among many other means, toothbrush is the only instrument that the great majority of the population uses to control the dental biofilm.^[1] Tooth brushing plays an important role in for personal oral hygiene and effective plaque removal. Not only the tooth brushing procedure but appropriate toothbrush care and maintenance are

also similarly important considerations for sound oral hygiene. Tooth brushing plays an important role by helping us to remove food and plaque, a sticky film of bacteria that can irritate the gums and lead to periodontal diseases and dental caries.

Although millions of toothbrushes are sold each year, there are a small number of people who are aware that their toothbrushes may be contaminated by micro-organisms due to usage and improper storage practices. These microorganisms are some of the millions of microbes that can be present in the oral cavity. The mouth serves as an attractive habitat for

microbial growth and a diverse range of Gram-positive and Gram-negative bacterial species can be isolated from the healthy oral cavity. In addition, yeasts, mycoplasmas and protozoa can be recovered occasionally.^[2] In recent years, scientists have reported that toothbrushes may harbor microorganisms that could cause oral and systemic infection.^[3,4] We know that the oral cavity is home to hundreds of different types of microorganisms.^[5] Therefore, it is not surprising that some of these microorganisms are transferred to a toothbrush during use. It may also be possible for microorganisms that are present in the environment where the toothbrush is stored colonies themselves on the toothbrush. It has been reported earlier that new toothbrushes may have bacteria on them right out of the box since they are not required to be sold in a sterile package.^[6] Many of these microbes may have a pathogenic potential, being able to grow on tiny particles of food and dentifrices that may be trapped between the bristles of the tooth brush after use.^[7,8] It is common to see that most of the families place their toothbrushes in a common container after use with moisture present on them. Additionally the moisture in the bathroom can facilitate growth and cause cross-contamination. Many people buy less than one toothbrush per year and despite recommendations made by dental surgeons they don't practice proper toothbrush replacement. They are reluctant to replace the brushes more frequently.^[7] While most of the people might not remember the day of purchase of their tooth brush.^[9] In a previous study, where tooth brushes of 20 patients with periodontitis were evaluated for four weeks, the results showed that immediately after brushing when the brushes were inoculated and incubated for 24, 48 hours and 7 days, microbial growth was seen in almost 100% of samples at different exposure times.^[9] The microorganisms remained viable even after 7 days in the environment. Therefore, it is suggested that periodonto-pathogenic microorganisms may be transmitted indirectly by use of contaminated toothbrushes.^[9] There is correlation between dental brushes contamination and the occurrence of infections in the oral cavity. Brushing teeth often with a contaminated brush makes a potential entry door for the microorganisms present in these brushes.^[10,11] Caudry et al. has verified that the brushes in their routine use are excessively contaminated by microorganisms.^[7] It has been stressed that there is possibility of contaminated bristles capable of transmitting and inoculation of microorganisms by means of gingival abrasion or through an existing lesions. Studies on brush contamination by microorganisms indicate that changing of toothbrushes at least once a month is the best protocol to be followed.^[11,12]

Although certain studies^[7,13] have reported that there is insufficient clinical evidence to support that bacterial growth on toothbrushes will lead to specific adverse oral or systemic health effects but a vast literature exists that has shown that various microorganisms can grow on toothbrushes after use and can cause cross infection in individuals.^[11,12]

Previous studies on caries prevalence in Institutionalized children of Kashmir reported a caries prevalence of 51.9% in deciduous dentition while it was rose upto 67.65% in permanent dentition of same population. These findings suggest that proper oral hygiene measures might not be in practice in such population.^[14] Keeping in view the risk of transmission of microorganisms due to improper storage of dental brushes and its possible repercussions this research was carried out to assess the methods of storage and conditions of

the these toothbrushes after use by children living under institutionalized conditions in Jammu and Kashmir State of India.

MATERIAL AND METHODS

The present study was done in five (5) orphanages in vicinity of Srinagar city of Jammu and Kashmir State of India from September 2016 to November 2016. The orphanages had a total children inmate population of 683 ranging from age of 3 to 16 years. Prior to the start of the study permission was taken from the directors or care takers of these institutions. The ethical clearance for the study was given by the ethical board of Government Dental College, Srinagar. All the tooth brushes that were present in these orphanages and were in use were assessed.

The storage method of the tooth brushes and other credentials were recorded by one examiner. The recording was made on the basis of storage of tooth brushes, either in bathroom or outside bathroom area. The placement of tooth brush either in an open area or a closed container was also recorded. The examiners also recorded the wetness of the toothbrushes by wiping the toothbrush bristles on a dry paper tissue. These examinations were done in between 3 pm to 5 pm for one institution. The residues left on the toothbrushes or toothbrush bristles was also recorded. A hand magnifying glass (Pricise 10X magnifier) with 10X magnifying power lens was used for checking the residues. The examination of the brushes was done under one uniform white light (REMAX light emitting diode (LED) folding eye lamp (RL-E180 White). The residues were checked and recorded as present or absent.

The number of the toothbrushes recorded in each institute was entered in a proforma and its storage method was entered. The moisture or wetness of the toothbrush was also recorded in the proforma in either yes or no, examiners also recorded these variables in regard to the gender.

Statistical method used

The data was entered manually on Microsoft excel (MS Office Excel 2000; Microsoft Corporation, Redmond, WA, USA) and checked for possible data entry errors. Frequencies and percentages were taken out for categorical variables. Associations between different variables were assessed through application of 2 test. The data was analyzed using SPSS Statistics 20.0 (IBM Corp. Released 2011 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). The significance level was set at 0.05.

RESULTS

Information regarding the toothbrushes was acquired from five accessible orphanages having a total population of 683 children which included 435 male and 248 female children. One of the five orphanages was exclusively harboring female, one male children while rest three sites were having mixed population of both male and females. The highest number of toothbrushes which were examined from a single site was 289 followed by 178, of males and females respectively. The total toothbrushes assessed were 587 which was less than the actual number of children enrolled in these institutions (table 1).

The assessment variables about the toothbrushes are presented in table 2. The assessment was done in regard to the place of storage, which was either bathroom or any other room other than bathroom. Table 2, shows that highest number (498) of

toothbrushes was stored in bathrooms which comprised of 344 belonging to males and 154 belonging to females. The results further show that maximum number (417) of the children of either gender stored their toothbrushes in open containers in bathrooms while total of 81 children were storing their toothbrushes in closed containers, either boxes or had brush head boxes but they kept them in bathrooms only. There was a statistically significant difference ($P = 0.0045$) in between the number of tooth brushes kept in open containers and closed containers inside the bathroom area. The results in table 2 further show that there were only 89 children who were storing their toothbrushes outside the bathroom area which comprised of 36 tooth brushes belonging to boys and 16 tooth brushes belonging to girls, however these were kept in open spaces while 12 boys and 25 females kept them in closed containers outside bathroom area. There was no significant difference ($P = 0.068$) in between the number of tooth brushes kept in open containers and closed containers outside the bathroom area. The results in table 2 also showed that there was a statistically significant difference ($P = 0.034$) in between the number of tooth brushes kept in bathroom area as compared to toothbrushes kept outside the bathroom area.

Table 1 Distribution of study population and total number tooth brushes examined per site.

Site No	Male	Female	Total Tooth brushes Examined
1	355	0	289
2	24	18	36
3	0	211	178
4	44	0	41
5	12	19	25
Total	435	248	587
Grand Total	683		

Table 2 Distribution of tooth brushes as per storage practices in regard to gender.

Method of Storage	In bathrooms		Outside Bathrooms	
	Open containers	Closed containers	Open containers	Closed containers
Total				
Males	392	305	39	36
Females	195	112	42	16
Total	587	417	81	52
<i>P value</i>	$P = 0.0045^*$		$P = 0.068$	
	$P = 0.034^*$			

Table 3 Number of tooth brushes having some amount of wetness and residues in regard to gender.

Tooth Brushes	Wet		P value	Residues on Brush		P value
	N	%		N	%	
Males	392	226	57.65	184	46.93	0.346
Females	195	115	58.97	95	48.71	
Total	587	341	58.09	279	47.52	

*Significant using 2 test, P 0.005.

Table 3 presents the number of the toothbrushes which had some amount of wetness or moisture in them. The results show that a total of 341 tooth brushes were wet which included 226 from boys and 115 from girls. There was no significant difference ($P = 0.067$) in between the number of wet tooth in regard to gender. The table further shows that there were 279 toothbrushes which had some residue in them. These included 184 from boys and 95 from girls. There was no significant difference ($P = 0.067$) in between the number having some residue in regard to gender

DISCUSSION

Human mouth is not a homogeneous environment for microbial colonization. Distinct habitats exist, such as mucosal surfaces (lips, cheek, palate and tongue) and teeth which, because of their different biological and physical properties, support the growth of characteristic microbial communities. Teeth are unique sites in the human body for microbial colonization because they are non-shedding surfaces enabling extensive formation of complex biofilms (dental plaque), especially at protected and stagnant sites between teeth and around the gum margins. The human mouth shields hundreds of different types of microbes commonly called germ, out of which few are passed on to the tooth brush during its use and some come from the external environment where the toothbrushes are stored.^[15] There are many pathogenic microorganisms present in the oral cavity which can contaminate the brushes and possibly lead to cross infection.

In addition to the common known microbes even, more genera are found occasionally, especially in plaque samples from periodontal pockets, and include sulphate-reducing bacteria, methanogens, Bulleida, Cantonella, Cryptobacterium, Dialister, Filifactor, Mogibacterium, Olsenella, Pseudoramibacter, Shuttleworthia, Slackia and Solobacterium spp. Yeasts are also isolated regularly, especially from the tongue. Most belong to the genus, Candida, and C. albicans is the commonest species.^[2] Even infection-related pathogens respiratory, intestinal and other diseases Can be transferred.^[5] Hence, the toothbrush can have a number of microorganisms including bacteria, fungi and viruses which can also depend upon storage criteria.^[10] Therefore, toothbrush may act as a reservoir of many potential pathogens.^[10,15,16]

Although many studies have shown that various microorganisms can grow on toothbrushes after use, evidence is lacking that bacterial growth onto toothbrushes will lead to specific health problems however the risk can't be ruled out^[7,13,14] as ample literature exists that has shown that various microorganisms can grow on toothbrushes after use and can cause cross infection in individuals.^[11,12]

The proper storage of toothbrushes is of utmost importance to decrease the possible cross infection. In the present study it was found that most of the tooth brushes did not present identification although numerous tooth brushes were examined in a single centre and the children lived in common rooms and shared common bathrooms which could result in exposing the children to a high risk of infectious diseases. Such incidents have been reported earlier in literature where children didn't even remember their own tooth brushes.^[17] The present study also reports presence of dentifrice and residues in 279 (47.52%) toothbrushes. Similar results have been reported earlier in literature where good amount of residues were present at the base of the bristles.^[7,8] While many previous stuies have reported that upto 56% tooth brushes with predominance of dentifrice.^[15-17]

The results of the present study also show that 58.09% of the tooth brushes had some amount of moisture in them. Examination of toothbrushes was carried out in afternoon hours, which was approximately 6 hours after the previous tooth brushing or use of these brushes according to the institution authorities. The examination of the moisture on toothbrushes has been reported as a factor for retention and propagation of microbes, however there are no studies which

lay some light on the method of measuring or examining the retention of the water in toothbrushes or their bristles after use, thus a simple procedure of rubbing the toothbrush bristles on paper tissue was utilized. It has been reported that the toothbrush in the presence of moisture and Sorbitol or Mannitol which are used as sweeteners in many toothpaste, not only shelter but also propagate streptococcus mutans and the lactobacillus casei, due to the capacity of these microorganisms in metabolizing these types of Sugars.^[18] This might in turn increase the number of colonies of these microbes on the tooth brush and can be transferred to oral cavity during next tooth brushing. The presence of remnants of toothpastes or other particles have been reported earlier also, Many researchers have identified varying quantity of waste in toothbrush brush base.^[1,8] These findings show that users were not performing proper cleaning of their brushes and consequently were compromising its efficacy. It had been suggested that some measures could be performed in order to minimize the number of microorganisms on tooth brush after its use, which could be a vigorous washing in water after use or before storage.^[19]

In order to prevent any chances of cross infection or contamination of toothbrushes they must be stored or transported in a correct way with bristles properly protected.^[20] Other than this the toothbrushes shall be dried by vigorous shaking so that excess water is removed, care can also be taken if the toothbrush is placed in place near direct sunlight. The results of the present study show that highest number (498) of toothbrushes were stored in open spaces and maximum number of the children of either gender stored their toothbrushes in open containers in bathrooms. Such reports have been published earlier which reported that 53.4% children stored their toothbrushes in open places. The same study also reported that numerous toothbrushes were being stored in collective containers.^[21] These findings are in line with the findings of the present study were most of the tooth brushes were seen in common containers as steel glasses or plastic containers. It has been repeatedly pressed that toothbrushes shall not be stored in bathroom areas as it can attract certain fecal coliforms.^[1] In the present study the highest number of toothbrushes were found to be stored in bathrooms and were kept without covers. It has been previously reported that upto 70% of the toothbrushes exposed directly to the environment of the bathroom present various types of bacterial growth.^[1,15] These included important genres of Fecal coliforms, Enterobacter sp. and Citrobacter Sp. while contrary to this observation, the brushes which are stored in a cabinet, exposed to the same environment, did not present such bacterial growth. In the same study it was also established that group using acrylic boxes for storage of tooth brushes presented least growth of entero-bacteria and coliforms.^[1]

In the present study children who were storing their toothbrushes outside the bathroom areas were either using plastic boxes, cloth, wood or cardboard containers. Similar methods of storage of tooth brushes have been reported elsewhere.^[17] The main disadvantage of storage in the closed containers may be the propagation of microbes can be accelerated as compared to the open space storage.^[22] In a previous study it was concluded that the number of bacteria on the brushes stored in closed containers after use increased in a shorter period of time than toothbrushes stored in open containers.^[22] For this reason it is recommended that storage of toothbrushes shall be carried out in containers which have

means of air circulation and such storage devices shall not provide contact with the surface of the brush head or bristle areas which will avoid contamination.^[7]

American Dental Association (ADA) and the Council on Scientific Affairs has provided certain methods for storage of tooth brushes after use. It has been recommended that, we shall thoroughly rinse toothbrushes with tap water after brushing to remove any remaining toothpaste and debris. The toothbrushes shall be stored in an upright position if possible and allow the toothbrush to air-dry until they are used again. If more than one brush is stored in the same holder or area the brushes shall be kept separated to prevent cross-contamination. ADA further suggests that toothbrushes should not be routinely covered or stored in closed containers as moist environment in closed container is more conducive to the growth of microorganisms as compared to open air.^[23]

To prevent the loss of efficacy and any chances of cross infection it is recommended to replace toothbrushes every 3–4 months. The bristles become frayed and worn with use and cleaning effectiveness decreases.^[12] Timely changing of toothbrushes shall also help to prevent any cross infection. We recommended that the care takers and the officials at such institutions harboring large number of children shall be educated about the possibilities of cross infection due to contamination of the tooth brushes. A proper storage system shall be taught to the children that shall reduce the possibility of bacterial growth and in turn shall reduce the burden of diseases on such underprivileged population. The present descriptive study was undertaken in order to gather information on the storage methods and cleanness or hygiene of tooth brushes. However certain limitations exist, the study could have shed more light on the conditions of the tooth brushes if microbiological examination of the brushes could have been undertaken. Furthermore, the information of these toothbrushes was collected from orphanages, which can prevent the generalization of the results on the other privileged section of the population, as living conditions can be different. Other than these there are no standard procedures are defined to check for the moisture or wetness of the tooth brushes, which needs to be addressed. In spite of the limitations, this study shall invoke the health workers to induce positive attitude regarding storage and cleanliness of the tooth brushes in all subsets of the society.

The present study concluded that the toothbrushes of institutionalized orphan children which were examined for storage practices were not placed either in a hygienic and recommended manner or there were remnants of either toothpaste or food particles present in them. Furthermore, more than half of the examined toothbrushes were stored wet or contained some amount of moisture. These findings show that these toothbrushes may act as reservoirs and carriers of infection in these children, increasing their burden. We recommend that ADA recommendations on storage of toothbrushes shall be practiced and education of storage procedures shall be provided to children. Care takers shall be targeted to make sure necessary arrangements are made for avoidance of such improper habits and they shall provide best way of storing and maintaining the tooth brushes.

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