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Original Research

Quantification of Dental Health Care Waste Generated among Private Dental Practices in Bengaluru City

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Abstract:

Background: Bengaluru, in India has more than 1148 practicing dentists for a population of 8.42 million. The amount and type of dental health care waste (DHCW) generated by the dental practitioners has to be assessed prior to chalking out and implementation of an effective DCHW management plan. Currently, there is no evidence available regarding the quantity, type, and method of disposal adopted by these practitioners. Hence, this study was conducted with the objective of estimating the quantity of DHCW by the private dental practitioners in Bengaluru city.

Materials and Methods: The sample size was estimated to be 110. The sampling frame was constituted from the registered dental practitioners in Bengaluru with the Department of Health and Family Welfare, Govt. of Karnataka. Sampling strategy employed included a probability proportional sampling strategy for the four zones in Bengaluru followed by a simple random sampling of clinics from each zone. Standardized weight method was followed to estimate the quantity of different category of waste. Three data collectors who were trained and calibrated collected the information regarding the type and quantity of waste generated, the nature of practice and years of establishment.

Results: Total quantity of waste generated was 0.161 kg/clinic/day with 0.130 kg and 0.026 kg of infectious and recyclables, respectively. The projected data for the actual number of private practices in Bengaluru city showed alarming figures of 41,535 kg and 8307 kg of infectious and recyclable waste being generated every year. Data also showed poor management practices of lead foil and plaster of paris and alarming figures projected annual quantity.

Conclusion: The data demonstrated large quantities of hazardous waste generation and poor segregation practices of the practitioners. This warrants the immediate need for collective, voluntary measures to be initiated for appropriate and effective management of DHCW.

Key Words: Dental health care waste, private dental practitioners, quantification

Introduction

Health care waste (HCW) has been identified as one of the contributing factors to environmental pollution and also the reason for increased prevalence of blood borne infection. This can be attributed to improper and inadequate handling of the waste. Concerns were raised by public, communities, and NGO for the callous attitude of health care professionals toward HCW. This resulted in the mediation of action at global level, which also percolated to National and Regional level with legislations and policies, plans, and guidelines for the safe management of HCW. In this context WHO recommended all countries to develop their national plans for safe management of HCW preceded by a survey to obtain data on types and quantity of waste generation.[1] Most of the countries have developed national plans for sound management of HCW. Dental health care facilities also generate dental waste that includes hazardous waste, which can be termed as dental HCW (DHCW). However, the concern is about the hazardous nature of some of the components of DHCW with enough evidence regarding its impact on environment, community, patients and health care personnel.[2-4] India was the first country in South Asia to establish a legal framework for the management of HCW but without specific mention for DHCW.[5,6] No guidelines, manuals, protocols, schedules relevant to the dental scenario are available that dental health care personnel (DHCP) can follow.

Information about different categories and quantities of waste contributes in arriving at meaningful, sustainable interventions for safe management. There are few studies reported in the literature from across countries about components and quantification but comparison is debatable due to differing awareness levels, utilization rates of services, and resources for

providing care classification systems and management options.[1] With this background, the present research was undertaken as a primary step. The objective was to estimate the quantity of different categories of waste generated among private dental practices in Bengaluru to facilitate in formulation of meaningful strategies for its safe management.

Materials and Methods

The project proposal was submitted to Institutional Ethics Committee and clearance obtained. Independent dental health care establishments for general dental practice in Bengaluru city formed our study units. A list of 1148 dental clinics with the name of the practitioner, contact details and address was obtained from Department of District Health and Family Welfare (HFW), Bengaluru that had registered under Private Medical Practitioners Act. The sampling frame was prepared by allotting the clinics to respective zones, referring to zones list, wards list, and the maps obtained by BBMP website. Sample size was estimated based on a pilot study conducted on a sample of 30 dental clinics. Data were collected for 3 days which resulted in total weight of DHCW as 0.19 kg with SD of 50 g generated per clinic per day. Using Nmaster software with a relative precision of 5%, the sample size was estimated to be 106 which was rounded off to 110. Probability proportional to the size was employed to select the units from each zone using the simple random technique. (Source - Bruhat Bangalore Mahanagara Palike website accessed on 8.1.12 - Mahadevapura, Dasarahalli, Yelahanka, Bommanahalli, Rajarajeshwarinagar, South, West and East, and 198 wards).

For quantifying DHCW standardized weight method was followed. Consumables that are utilized for providing care, by-products of dental care and that would eventually end up as DHCW were enlisted and a template was prepared. Each of these consumables was weighed on three different weighing scales and standard weight for that particular item was determined by calculating the average weight (Table 1).

Data collection

User manual with details of the clinics, data collection template, sufficient personal protective equipments (PPE) and weighing scale with precision of 1 g were given to three data collectors who were trained to use the scale. The data collectors obtained informed consent from the practitioners and visited the clinic for 3 consecutive days to record the quantity of waste from the randomly selected clinics from each ward. Data were collected on patient load, years of practice, number of dental units, DHCP and quantity of waste generated.

Data collectors would either visit during the closing time of the clinic or following morning. The cover containing DHCW was weighed on the weighing scale with a capacity of 1 g to obtain total waste (A). The waste bag was then sorted for collecting data on type and number of items. The weight for these items was calculated referring to standard weight (Table 1) to obtain (B). Weight for cotton and gauze was obtained by subtracting (A-B). It was ensured that people involved wore PPE sufficient for the exercise and also vaccinated against hepatitis B.

All the quantitative variables were expressed as mean and standard deviation or median with interquartile ranges. The relationship between total waste generated and other independent variables were estimated through Pearson correlation coefficient (R). Coefficient of determination was calculated as the square of correlation coefficient, which indicates the proportion of the variance, explained by the independent variable/s present in the total variation in the "dependent variable." $P \leq 0.05$ was considered for statistical significance.

The data was entered on an excel sheet and analyzed using SPSS 18.0 version.

Results

Data for the quantity of waste was collected from 110 dental clinics for 3 consecutive days by three data collectors. Clinics were established between 5 and 35 years. Total number of patients for 3 days among 110 clinics was 1176. On an average each clinic had 11 patients for 3 days and 4 patients/day. Based on the classification and definition given in biomedical waste (Management and Handling) rules of 1998, waste was grouped into infectious waste, recyclables, and waste sharps. To determine the potential for recycling and waste minimization measure, recyclables were split into plaster of Paris (POP), lead foil and syringes as these required special handling procedures.

Table 2 shows the total quantity of waste generated for 3 days from 110 clinics for 1176 patients was further calculated for per day/clinic and also projected to 1 month and 1 year with per clinic as constant. Relationships between total waste, total number of patients, years of establishment, number of dental units was assessed using Pearson correlation and found that all variables were significant with $P < 0.05$ except years of establishment. To find out independent factor predicting total waste generated, all the significant factors and non-significant factor up to $P = 0.2$ were included for forward step multiple regression analysis. The results showed total patients as the independent variable was contributing to only 10.3% toward variation in total waste generated (Table 3).

Median values were calculated wherever applicable and the same is depicted in Table 4. Mean lead waste generated per patient was 1.49 ± 0.638 kg. Table 5 shows the data projected to annual generation by the number of clinics in our sampling frame.

Discussion

Waste generation surveys provide an estimate of the quantity of waste generated and also the type of waste. Estimation of quantity of waste is an important activity to plan the safe

management of DHCW. The data so generated will facilitate procurement of required size covers, containers, bins, and planning waste minimization strategies. In addition it gives an idea about segregation practices, awareness and attitude of DHCP toward DHCW.[1] Therefore, this survey was conducted to estimate the quantity and type of dental waste generated among dental practitioners a very important group and largest contributing population to DHCW collectively in the city. Studies reported in the literature have discussed annual weight projected by weighing different categories of waste for 3, 22 days or 2 months in a year substantiating for seasonal variation. We adopted the system of standard weight per item to estimate the quantity of waste for 3 days. Weighing each category of waste was challenging as some of the clinics generated as less as 141 g, with one syringe and lead foil and rarely 2 numbers, considering the weight of one needle and lead foil, which is 0.91 and 0.72 g. The poor segregation practices resulted in two incidences of needle-stick injury while weighing. Hence for maintaining uniformity, practical and ethical reasons standard weight method was adopted and counseling and post exposure measures for HIV/AIDS and Hepatitis B was provided to the data collectors.

Table 1: Standard weight for sample of dental items.

Item	Scale no. 1	Scale no. 2	Scale no. 3
Syringe	3.408	3.41	3.41
Lead foil	0.726	0.72	0.72
POP casts	38.12	38.1	38.1
Glove	21.327	21.33	21.33
Needle	0.91	0.91	0.91

Scale no. 1: l010900737, Max-310 g/day, Scale no. 2: WD080016476, KERN 600 g, Scale no. 3: 1171573, Max 210 g. POP: Plaster of paris

Table 2: Quantity of waste, category wise among 110 clinics for 1176 patients.

Items N=110	Waste (kg) 3 days	Waste per clinic per day (kg)	*Waste per clinic per month (kg)	*Waste per clinic per year (kg)
Total waste	53	0.161	4.025	48.3
Infectious waste	43	0.130	3.25	39
Recyclable	8	0.026	0.65	7.8
Sharp	0.87	0.0026	0.065	0.78
POP	2.4	0.0072	0.18	2.16
Lead foil	0.56	0.0017	0.0425	0.51
Syringe	2.584	0.0078	0.195	2.34

*Projected figures for 1 month and 1 year (25 days in a month and 300 days for a year as per government working days). POP: Plaster of paris

Table 3: relationship between total waste (dependent variable) and other independent variables.

Variables	*R*	*P* value	Regression
Dental health care personnel	0.262	0.006	NS
Total patients	0.209	0.028	R=0.321 R^2=0.103 Significant F Change=0.001
Years of establishment	0.039	0.736	NS
Dental unit	0.172	0.021	NS

Pearson correlation significant two-tailed, N=110, *P*=<0.05%

Table 6 shows quantification data from different countries.[7-12] However, comparing data across studies is not recommended owing to differences in services provided, organizational complexity, availability of resources and the number of staff available, waste management systems and the proportion of single-use disposable items.[1] Moreover, this is compounded by the fact that as studies were conducted at different periods of time adopting different methodologies. There are evidences in literature with recommendations and waste minimization plans preceded by waste quantification. One such was a recommendation by researcher in Australian study to allow Australian dentists to dispose their waste generated along with municipal waste owing to minimum quantity of waste[7] though not a practical recommendation and another one best utilized the data for developing waste minimization plans through setting up of recycling programs.[1] The projected data for annual waste generation rate for the sampling frame or for whole population demonstrates an alarming situation with 51,439 kg of total waste which is unsegregated adding to increased quantity of incinerable waste contributing to increased cost and also environmental pollution. Quantity of POP, lead foil, and syringes which is 2300, 543, and 2492 kg, respectively also indicates the benefits in terms of revenue and health of the community if segregated and scientifically managed as these need specific type of management (Table 5). The quantity appears insignificant when the individual clinic is considered, but collectively the figures indicate the need for serious thought towards chalking out measures. The data can be considered as indicative values only warranting actions to be initiated by dental professionals before the issue is considered seriously by other interest groups, NGO and regulatory bodies. Though it was not our objective we got an insight into the

Table 4: Average quantity of different categories of dental health care waste generated.

Waste category	Median	IQR	*n*
Total waste	335.38	141.5-760.27	110
Infectious waste	290.80	119.10-553.80	110
Recyclables	43.00	12.90-164.10	85
Waste sharps	7.73	2.73-10.46	85
POP	228.00	228.00-237.50	10
Syringes	12.900	4.30-38.70	85
Lead foil	12.60	2.16-21.60	18

IQR: Interquartile range, POP: Plaster of paris

Table 5: Projected data for the actual number of clinics as obtained by Department of Health and Family Welfare.

Items	Waste per clinic per year (kg)	Waste from total number of clinics (1065 clinics)
Total waste	48.3	51439.5
Infectious waste	39	41,535
Recyclable	7.8	8307
Sharp	0.78	830
POP	2.16	2300.4
Lead foil	0.51	543.15
Syringe	2.34	2492.1

POP: Plaster of paris

Table 6: Comparative table showing quantification of waste in different countries.			
Country	**Study units/days of data collection**	**Total waste kg/day/clinic**	**Infectious waste**
India (Bangalore) 2014	110 clinics/3 days	0.161 (0.040/patient/day)	0.130
India (Davangere) 2005	28 clinics	0.007/patient/day	-
USA (Florida), 1990	64 clinics	0.130	0.17
Iran (Bandar Abbas) - 2012	30 clinics/4 samples	0.498	-
Australia	10 clinics/1 week	0.19	-
Greece (Xanthi) - 2008	22 clinics/22 days	0.513	0.486
Brazil - 2009	5 clinics, 3 samples	0.241	-
Iran (Hamadan) - 2012	28 clinics, 3 samples	41,947.43	-

poor segregation practices followed by practitioners which was evident during sorting and weighing, large percentage of practices unregistered with Department of HFW. It also demonstrates negligence or ignorance by waste generators and managers toward lead foil and POP the two wastes that should neither be incinerated nor treated as general waste owing to their hazardous nature. The most significant observation was the zero use of mercury in the dental establishments studied.

Recommendations

1. Create awareness/(sensitize) among practitioners regarding safe management of DHCW
2. Measures to segregate the waste to contribute in cost reduction and revenue generation
3. Initiate discussion with Karnataka State Pollution Control Board, common waste treatment facility and professional bodies to help in identifying certified buyers and possibilities for networking for POP, lead foil, fixer solution, etc.

Conclusion

The study was able to quantify the waste generated in private dental practices following standard weight method. The projected figures indicate the need to initiate the process to address this issue through voluntary measure without waiting for specific regulatory measures and contribute in waste minimization methods that is safe, sustainable, and revenue generating.

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