Medical waste management in a dental clinic

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Abstract

This study investigated how 14 dentists and five dental assistants dealt with the waste produced in a dental clinic of the public health service in the city of Rio de Janeiro. The method of direct observation associated with information obtained through a self-filling questionnaire and interviews with the participants were used. The findings pointed out the improper disposal of biological and sharps waste as well as those from dental amalgams. Only radiological waste received an appropriate treatment. Most health professionals ignored the law posing risks to the public health, environment and their own health. The lack of knowledge concerning the procedures recommended by health authorities is responsible for most of the negligent actions used in dentistry. Knowledge about the importance of the proper disposal of waste should begin in professional training courses.
Keywords: dentistry, environmental health, hazardous waste, management practices, occupational health, contamination.

1 Introduction

According to the World Health Organisation (WHO) [1], approximately 20% of the total waste produced by health services is dangerous, posing a potential risk to patients, health professionals, the general population and the environment. Those hazardous wastes are classified as infectious (any material with blood or other body fluids contaminated with human pathogenic microorganisms, cultures and stocks of infectious agents, waste from patients in isolation wards and infected animals from laboratories), pathological (identifiable parts of human bodies and carcasses of infected animals), sharps (any item having corners, edges, or projections capable of cutting or piercing the skin, chemical (from products for cleaning and disinfecting, clinical analysis, image processors), pharmaceutical (medicines unused/expired/contaminated vaccines and serums), geotaxis (substances with teratogenic, mutagenic or carcinogenic properties),

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radioactive (radioactive material or contaminated with radio nuclide used in nuclear medicine, clinical and radiotherapy laboratories) and residues of toxic metals (chromium, copper, lead, mercury, nickel, silver and zinc are the most common).

According to this classification, dental activity produces infections, sharps and chemical waste, besides the regular trash. Among those infections, the risk is related to the gauze, cotton rolls, gloves and other materials that have been used for patient care, but are not saturated or soaked with blood or saliva, and are discarded in regular waste. The sharps waste includes needles, syringes, scalpels, drills, blades [2], endodontic files and orthodontic wires [3]. Among the chemical waste, dental amalgam is the substance requiring the greatest care, since metallic mercury represents 50% of the composition of this restorative material and the relationship between the handling of amalgam and contamination by mercury has already been established in dentistry [4, 5] as well as the environmental contamination caused by amalgam residue [6, 7]. Radiological effluent (developer, fixer and washing water from radiographic films) is also relevant in view of the presence of organic and inorganic compounds, including silver [8, 9]. The extracted teeth are considered trash if they do not have amalgam fillings [10].

In order to minimise risks to public health and costs resulting from treatment and safe disposal of such waste, it is necessary that the generating institution has a waste management program including the separation and identification according to its classification as well as a proper storage inside the institution and forwarding to final disposal as per the waste classification [2]. The inappropriate disposal of such wastes, lack of information about the risk they pose, inadequate training in their management, and the lack of financial and human resources for this activity can lead to accidents and contamination, with harm to human health and the environment [11].

This study investigated the management of waste produced in a dental ambulatory in the city of Rio de Janeiro in order to contribute to the education and awareness on the care required by waste generated in the dental activity.

2 Method

The study took place in a dental ambulatory from a public health centre (PHC) in the city of Rio de Janeiro, whose staff was comprised of thirteen dentists and five dental assistants. The site chosen was a centre for dental specialties, considered as a reference in the organization of dental work and care to patients in the public health service. The way of managing the waste generated on site was investigated on the basis of the Brazilian sanitary legislation, which follows the recommendations established by the WHO [2]. Data were obtained through a structured questionnaire, interviews with participants and direct observation. Ethical permissions were obtained in the Ethics Committee in Research from the National School of Public Health/Oswaldo Cruz Foundation as well as the Bureau of Health and Civil Defence of Rio de Janeiro City. All participants have signed a free and informed consent form.

3 Results and discussion

3.1 Population of study

The study population consisted of eighteen individuals, including thirteen dentists and five dental assistants. Most participants were female (66.66%). The average time in the profession for dentists was nearly twice (97.78%) of that presented by the assistants. However, the assistants had a slightly higher mean age (11%) than the dentists. Seven dentists (53.8%) used amalgam regularly, while only two professionals (15.38%) used that material in restorative procedures of posterior teeth exclusively. The study population is described in Table 1.

Table 1: Description of the study population.

	Dentists (n=13)	Assistants (n=5)
Gender		
Male	5 (38%)	1 (20%)
Female	8 (62%)	4 (80%)
Mean age (years)	42.4	47.2
Mean working time (years)	16.2 (10 - 25)*	8.2 (2 - 20)*
Mean amalgam fillings per day	2.4	-

*(range)

Regarding the knowledge of sanitary legislation on waste from health-care activities, dentists and assistants were unanimous in saying they did not know all the rules about managing such wastes as well as not always complied with those which were of their knowledge. All dentists (100%) and auxiliaries (100%) had been vaccinated against hepatitis B.

Unlike the research on management of dental waste performed by Hashim *et al*. [12], in which men were the majority (61%), the greatest participation was female dentists in this study (62%). However, similarly, the dentists had over 10 years of professional practice in both studies. According to this research, the concern about the risk of contamination with hepatitis B was great, since all participants had been vaccinated. Despite the publications [13, 14] emphasising that hepatitis poses a risk to dental professionals, just 60% of participants were protected against that disease in the United Arab Emirates (UAB) [12] and only 10.75% in Palestine [15].

The Greek professionals investigated by Kizlary *et al*. [16] also used the amalgam in dental restorations like the dentists in our study and produced on average 1.6 gm of amalgam waste a day. As dentists work 5 days a week, one

could assume that only a single dentist would generate 32 gm of amalgam a week, 128 gm a month and 1536 gm (over 1.5 kg) a year. It is an impressive and worrying amount when thinking in thousands of dentists producing amalgam waste around the world. However, studies showed that dentists gave up using dental amalgam in their professional routine in recent decades, mainly due to either the unfavourable cosmetic aspect or concern for the toxicity of mercury present in the mixture [17, 18].

The ignorance and/or negligence of dentists and assistants in relation to the protocols for managing the waste generated in the offices have been noticed by several authors [19–22]. It should be emphasised that the lack of infrastructure to adequately perform such management still exists in many places.

3.2 Site of study

The site consisted of 10 rooms of 2.9 m × 2.8 m × 5.10 m (length × width × height) each with an internal corridor of 0.95 m width and 29 m in length along the dental offices. In each room, there was a rubbish bin lined with a black or blue plastic bag without any identification on the classification of the waste. At the end of the work shift (morning and afternoon), a cleaning worker collected and took those bags to the dump in the PHC on a wheeled cart.

As a result of the United Nations Conference on Environment and Development in 1992, a document called Diary 21 was elaborated containing recommendations for waste management. According to this document, any waste producer is responsible for the treatment and final disposal of its products. The waste segregation minimises the risks arising from handling such residues [2], but this practise did not apply to all dental waste as observed in the present study. Nevertheless, several studies have demonstrated that the lack of a plan for managing waste generated in dental offices is customary [9, 22, 23].

Each room of a primary healthcare centre should have rubbish bins appropriate to the type of waste generated. Bins and bags made of washable material and labelled with the symbol or colour of the risk both internationally standardised [10]. According to those recommendations, a dental office requires pedal bins, milky white bags for contaminated waste and blue bags for ordinary rubbish. The outpatient clinics did not follow the guidance since an ordinary rubbish bin was found in each dental office for any residue.

The PHC had a specialised service of collection for health waste. However, that service only included sharp and radiological materials. All other sorts of waste generated in the dental clinic were discarded as ordinary trash, including amalgam and biological wastes.

Such a situation poses a risk to the individuals involved in the following steps of waste management, as well as the general population and the environment, and is similar to those described by two research [9, 22] in which most of the sites investigated did not characterise their waste.

Unlike this study carried out in a unit of public health, most research on the topic has been developed in private offices [8, 15, 18, 22]. This situation may reflect the difficulty in obtaining permission to investigate public establishments

since authorities prefer not to expose the failures in services provided to the population in many places.

3.3 Sharps waste

A yellow cardboard box for the collection of sharps marked with the universal biohazard symbol was in all dental offices. After containers had completed 2/3rds of their capacity an employee from the cleaning staff closed them and sent them to the special dump in the PHC.

The disposal of the material was suitable in this site of study. The collection boxes were replaced before being overfilled. However, the closing of those containers were not in agreement with health regulations since trained personnel should be responsible for this task and not the cleaning staff [24].

Sharps waste were properly packed in 73.3% of the sites investigated in New Zealand [25] and in 60% of dental offices studied in Brazil [22], while only 13.5% of the 37 dental clinics investigated in Palestine adopted this practise [15].

The majority of reports on sharps injuries involve needles, especially during the procedures for recapping needles and collecting waste as demonstrated by Pournaras *et al*. [26] and Sharma *et al*. [27]. At a Taiwanese hospital, most accidents occurred with support personnel [28]. However, in the UK, the number of needle stick injuries was reduced to zero after the association between adoption of safer syringes and intensive training of the exposed personnel [29].

According to the WHO [30], sharps waste poses a great risk of contamination with hepatitis B and C virus, as well as HIV/AIDS for healthcare professionals. Such accidents are unexpected and can generate confusion regarding curative measures. Thus, the periodic training of workers exposed is necessary to prevent their occurrence.

3.4 Chemical waste

In the outpatient clinics, the dentists regularly used the encapsulated amalgam. However, pots of metallic mercury and silver amalgam were kept in stock and used in volumetric amalgamators when some capsule amalgamator broke.

In each clinic, the amalgam residues resulting from the portion prepared and not used were stored in a plastic container with a lid and full of water. Later, the residue was simply discarded in the ordinary waste of the PHC.

Empty amalgam capsules were discarded in the waste container located on top of the support tray. After reaching its limit, the content was disposed in a waste bin found in each clinic. Likewise the amalgam waste and all other waste generated in the dental office, the empty capsules were taken to the general dump in the PHC.

Among the dentists, one professional reported the habit of opening capsules to remove the fillings and using them to strengthen the glass ionomer cement, associating the resistance of one with the adhesiveness to the dental structure of the other. Thus, she practised a technique considered advantageous which combines good qualities of two products to produce a ‘bonded amalgam’ [31]. According to this dentist, after removing the fillings, the mercury and capsule

were discarded in a small waste container located on the instrument tray and kept in this receptacle until its storage capacity was exhausted. The content of the waste container was then placed in a common trash bin as found in each clinic. In addition, leftovers from procedures of insertion and sculpturing of fillings, accumulated on the floor of the mouth cavity were discharged on the spit bowl by patients, going straight to sewers. Similarly, the residue from removal of old amalgam fillings was equally discharged into the sewage system through the spit bowl.

The use of dental amalgam is a matter of great controversy since mercury is a component of that restorative material and toxic to living beings and the environment. According to the report of the WHO [32] on evaluation of restorative materials alternative to amalgam, the possible adverse effects of these alternative materials require further research and monitoring. Hence, a total ban on amalgam would not be realistic, practical or achievable, despite recognising the harmful effects of mercury on human health and the environment. In view of that statement, it can be presumed that the amalgam will still be long used by dental professionals.

However, the dental amalgam waste is a source of mercury and requires special care as already mentioned. The practise of storing such waste in lidded pots containing water inside observed in this study is considered an adequate procedure according to researchers, who also pointed out the importance of the care to be taken with the amalgam residue in dental offices and advised their placement in unbreakable containers, air-tight sealed and with water or fixing solution inside [33]. Some studies have shown that no solution completely prevents the passage of the mercury vapour to the environment. For this reason it is recommended the sending, in as short a time as possible, of the amalgam residue to a recycling laboratory [33].

Although all dental amalgam residues should be sent to recycling facilities, given that its common final destination can produce environmental contamination [34], this recommendation was not followed at the site evaluated as all amalgam waste were discarded in the regular trash, even those which had previously been stored immersed in water. This situation is similar to that found by another Brazilian study, in which the majority of the dentists interviewed (63.7%) stored the amalgam waste in pots with water, and then sent those residues to the regular trash [22]. Although awareness on the need to properly store the amalgam waste is growing among dentists, several reports about inadequate disposal of such waste can be found in the literature [12, 15, 16].

Regarding the mercury used only in emergency situations, the storage was considered correct. However, since 1984, the American Dental Association (ADA) condemns the use of metallic mercury, recommending the use of precapsulated amalgam alloy [34].

After use, the amalgam waste are retained within the capsules and hence the mercury. Therefore, the capsules should not be discarded in the trash, but sent for recycling [35]. However, this practise was not adopted by dentists in this study as well as most professionals investigated in research on the topic [22, 23]. Despite the apparent safety, there are reports of mercury leakages during the use

of amalgam capsules, which causes contamination not only of the amalgamators but also the entire working environment where they had been used [36, 37]. It is necessary to highlight that mercury leakage from capsules, unexpected as it is and usually imperceptible, delays the establishment of corrective actions and exposes the workers to vapours of the metal.

The absence of an amalgam separator, equipment placed in-line and designed to capture dental amalgam particles from a dental facility wastewater, is a common finding in research on the topic [9, 22, 38]. A study financed by the American Dental Association estimated that 50% of mercury found in the sewage systems in US cities came from dental offices [7]. Lima Neto *et al*. [22] emphasised that the amalgam waste discharged into the sewage system caused mercury contamination despite being an alloy, since mercury may be released via natural chemical reaction, heat, shaking and changes in pH that occur in the environment. According to the WHO [6], dental amalgam is the major anthropogenic and non-industrial source of Hg vapour to the environment. Therefore, in order to decrease the contribution of dentistry of environmental pollution by mercury, the use of filters and separators is essential to prevent the amalgam waste from entering the sewage system.

3.5 Radiological waste

Liquid waste (developer, fixer and wash water) generated in the processing of dental radiographic films was stored in plastic containers sealed with screw caps and identification as to the type of material. Each month, a private specialised company collected and sent the effluent for recycling. However, packaging of intraoral radiographic films was discarded directly into the trash.

The correct management of radiological effluents found in this study differs from most reports. Such behaviour is of great concern, since the fixer used for the X-ray film processing contains high concentrations of silver, and organic compounds [35]. Studies carried out by Grigoletto *et al*. [8], Mushtaq *et al*. [9], Hashim *et al*. [12] and Silva *et al*. [39] identified shortcomings in the storage and disposal of this waste at the sites investigated, showing negligence or ignorance regarding the protocols to be followed.

The developer can only be disposed into the sewage system or receiving body after being subjected to a process of neutralization for achieving a pH between 7 and 9 [40]. However, an investigation conducted by Staliskas *et al*. [41] identified a high load of contaminants in radiological effluents from the public sewage even after the neutralization process, showing that those residues posed a great risk to human health and the environment. On the other hand, the fixing solution and the water for film washing should be submitted to a process for treating and recovering silver [42]. Thus, it is possible to reuse the water and minimise the environmental impact generated by those effluents. The high market value of the metal must also be emphasised. The radiographic effluent treatment can be done in the health facility where the wastewater is generated or in a company specialising in this service. Several methods of treatment are available; however Igarashi-Mafra *et al*. [43] recommend photo-Fenton oxidation, since it does not require expensive equipment or special skills.

Therefore, it is suitable for places producing a small volume of effluent which does not require more sophisticated processes. Moreover, the photo-Fenton technology is considered less aggressive to the environment.

It should be emphasised that the improper disposal of dental radiological effluents is a global problem and has been identified by research in Pakistan [9], the UAE [12], Iran [44] and the USA [45]. Grigoletto *et al*. [8] highlighted the increasing adoption of digital equipment as a probable solution to the problem of radiological effluents. Other research also found packaging of intraoral X-ray films discarded into the trash [39, 46] corroborating the results of the present study. Packages of dental radiographic films impact the environment, mainly due to the presence of lead shields. Lead is a nonessential toxic element which accumulates in the organism. It is considered toxic to human beings and animals and has no physiologically known function in the organism. Lead toxic effects can affect almost all organs and systems in the body, especially blood, nervous system and kidneys, among others. In the environment, lead does not degrade, remaining available for methylation during decades in the soil and at the bottom of water bodies [47]. Although shields of lead in dental films are small, their accumulation can cause considerable environmental damage. Besides lead, packages are made of plastic material which takes 20–30 years to degrade in the environment [48]. Recycling is one of the most important strategies currently available to reduce the environmental impact generated by those materials. It also represents a reduction in the use of raw materials in production processes and in carbon dioxide emissions resulting from disposal methods, with consequent financial gains.

3.6 Infectious waste

The materials used during patient care such as sucker tubes, anaesthetic tubes, masks, gloves, gauze, cotton balls, etc., were discharged into the regular bin.

Those disposable materials used in dentistry should be disposed of in rubbish yellow leak-proof plastic bags labelled as ‘contaminated’ [1, 2]. However, such a recommendation was not observed at the health centre, since all material used was disposed of in the regular trash similar to other research [20, 21].

Infectious waste poses a potential risk to public health and the environment due to the presence of pathogenic micro-organisms, which, depending on the type, survive for days, months or years in the trash. Thus, when in contact with human beings, they can cause gastrointestinal, respiratory, eye and skin infections; anthrax; meningitis; AIDS; haemorrhagic fever; hepatitis A, B and C; avian influenza, etc [49].

The seizure of hospital waste such as sheets, pillowcases, towels, rugs and dirty uniforms, sold as faulty cotton fabrics and used for making clothes in developing countries, which were not responsible for manufacturing them, has been of great concern to those destination countries of waste [50]. This represents a great problem of public health due to the possibility of spreading disease, even at a global level, which increases the need for the greater attention of customs officials.

4 Conclusions

Waste generated by dental activity is related to public health since it can cause harm to the health of the population and animals as well as the environment. The ignorance on procedures recommended by health authorities is responsible for most of the negligent actions taken in dentistry. Knowledge about the importance of the proper disposal of waste should begin in professional training courses.

Therefore, the reduction of the environmental impact generated by dental waste requires a participative and conscientious attitude in managing the working environment from the professionals of this sector, respecting the law and the environment and contributing to sustainable development.

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