MANAGEMENT OF DENTAL RADIOGRAPHIC WASTE: A REVIEW

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Abstract

In most cases, radiographies are used by dentists for the diagnosis and/or treatment of patients, so that they may be considered as a third eye for the dentist. Unfortunately, the radiographic procedures generate certain substances with potential challenge to the environment. Although individual dentists generate only small amounts of environmentally hazardous wastes, the accumulated waste produced by their profession may have a significant environmental impact, which in turn may pose risks to human health. This paper addresses the environmental impact of dental radiographic waste and describes measures that can be taken by dentists and their team to reduce the production of potentially harmful wastes.

Keywords: radiographic waste, dental lead, film, silver

1. INTRODUCTION

The discovery of X-rays has revolutionized the field of medicine and, consequently, dentistry. Radiographies, now largely used by dentists for the diagnosis and/or treatment of patients, have become a third eye for the dentist. Basically, the technique performed to obtain radiographic images involves exposure of radiographic films to X-rays, followed by their conventional processing, including image developing, washing, fixing, final washing and drying [1]. Unfortunately, these radiographic procedures generate certain waste substances with potential challenge to the environment. Examples of such waste materials include spent X-ray processing solutions, processor system cleaners, lead foil, lead aprons, lead shields and used X-ray films. Although individual dentists generate only small amounts of environmentally hazardous wastes, the accumulated waste produced by their profession may have a significant environmental impact which, in turn, may pose risk to human health [2].

If discharged into a sewer system, hazardous liquid wastes can potentially impact the waste water treatment plant and/or pass through the treatment plant into bays, oceans, rivers, or other receiving waters. Alternatively, if materials are disposed of in the trash, they may eventually contaminate the soil, ground water, creating public health problems. Most of the radiographic waste generated in the dental office can be managed as non-hazardous waste, if proper disposal guidelines are followed. For example, the slightly basic lead waste can be recycled, as well as silver-containing waste, while the liquid developer can be disposed down the drain if local pH limits are not exceeded [3]. The present paper addresses the environmental impact of dental radiographic waste and describes measures that can be taken by dentists and their team to reduce the amount of potentially harmful wastes.

2. LEAD WASTE

The lead-containing products used in dentistry are lead foils, shields and aprons.

Lead foil is used in intraoral films to protect them from backscatter and secondary irradiation. The lead content of this foil is between 69 and 85% [4]. Most dentists prefer to discard the lead foil in the common garbage, thinking of the small amount of examinations they performed [1]. Based on the studies of Tsuji et al., about 11.2 g of lead waste would be produced during examination of a new patient with full mouth radiographies. The lead contained in the foil can be leached from the landfills if no leachate collection system is activated. During the
anaerobic acid subphase of the degradation process, microorganisms break down the organic material, producing organic acids, such as acetic acid, which results in a pH drop. This acidic pH can cause significant dissolution of lead from the radiographic foil in only 17 hours. Thus, lead enters the ecosystem [4]. No safe level of exposure to lead was found out, lead being toxic even in low doses. Lead poisoning in adults can affect the peripheral and central nervous systems, kidneys, blood pressure and the reproductive systems. Children are more sensitive to lead than adults, as their exposure is increased by their hand-to-mouth activity, their gut absorbing lead more readily than an adult. The developing CNS is more vulnerable to toxicants than a mature CNS [5, 6].

According to a study done by Carvalho et al., [1] more than 72% of dentists reuse the lead foils for bite registration, which put at risk patient’s health, as lead can be easily dissolved by human saliva. Additionally, some dentists or the supporting staff do not wash their hands nor change their gloves after processing intraoral films. Lead oxide might adhere to the gloves or hands and can be introduced onto instruments and dental paraphernalia used in the mouths of patients. Dental films stored in certain lead-lined film containers were also identified as a potential source of lead exposure for patients and practitioners, as a white layer of approximately 80% lead covered the dental film [4].

Reducing environmental lead contamination is an easy and inexpensive task for dentists. The lead foil from film packets has to be collected and returned back to the manufacturer for recycling. The only expense would be for postage. It appears that there is lack of awareness among the dentists on this service offered by manufacturers, as the companies report that only about 5% of the sold products are returned [2, 7]. Even lead aprons and lead shields should not be thrown into the regular garbage, yet returned to the manufacturer. [3, 8].

3. X-RAY FILM PROCESSING WASTE

Dental hospitals that operate conventional imaging use chemicals like developer, fixer, and equipment cleaner. Each of these chemical solutions is unique and requires special handling and disposal procedures [3].

4. DEVELOPER

Typically, the used developer is not a hazardous waste, because of its low silver content (usually below the regulatory level of 5 mg/l silver) and lack of other constituents or characteristics that would make it dangerous. Developer solutions are caustic in nature, i.e., they have a high pH, of approximately 10. Consequently, the waste developer may be flushed down the drain, as long as the pH of the solution does not exceed the pH standard of the local public waste water treatment authority. It is always better to check with the local sewer authority before disposal [3].

Dental hospitals working with individual septic disposal systems should not pour this material into the drain because developer solutions are composed of aromatic phenolic compounds and aminoacid salts whose chemical oxygen demand is high, and the products of its reactions can harm the septic system. They should contact an industrial wastewater disposal company for disposal of these wastes [1].

5. FIXER

Fixer solutions remove approximately 35-45% of the undeveloped silver halide compounds from the film emulsion, depending on the object exposed [9]. Spent x-ray fixer contains high levels of silver, occurring mostly in the form of silver thiosulphate complexes, which are extremely stable and have low dissociation constants. There are virtually no free silver ions in the used fixer solution. Waste water treatment processes convert silver thiosulphate to silver sulfide, which remains in the sludge. An aquatic life toxicity study using fathead minnows showed that silver thiosulphate was more than 17,500 times less toxic and silver sulfide was more than 15,000 times less toxic than the free silver ions. Consequently, silver in fixer solutions has little adverse environmental effects. However, sewer authorities in some areas impose limits on silver.
Silver from the used fixer is a valuable resource that should be recycled. There are two basic management options for this: (1) onsite treatment and disposal; (2) offsite treatment and disposal. Whichever the treatment, silver is easily and economically recyclable, recycling remaining the preferred method [3, 12].

If the practice generates only small quantities of fixer, it may be more cost-effective and efficient to have the fixer transported off-site for silver removal. By off-site disposal, 100% recovery of silver in x-ray fixer is guaranteed. It can be transported to silver reclaiming facility or to the manufacturers or distributors of fixer solutions. Some of them apply the “take back” policy for solutions purchased from them. When storing the fixer for off-site treatment or disposal, remember to collect and store the fixer in a closed plastic container. Label the container “Used fixer” along with the date when it was first added to the container [10].

On-site recovery of silver from the fixer involves either metallic replacement or electroplating methods [13]. Metallic replacement uses cartridges through which silver-containing used fixer solutions are poured. The silver in solution and the solid metal (iron) interact and the more active metal (iron) goes into solution. The less active metal then becomes solid (silver sludge), being settled to the bottom of the cartridge. In the electroplating method, the waste solutions come into contact with two electrodes, through which a current passes. The cathode captures the silver. In either case, scrap silver can be sold to silver refiners and buyers [10,13].

On-site silver recovery is often an expensive alternative to off-site treatment unless the practice generates large amounts of radiographic films, yet it can be considered when there is no off-site disposal system, to comply with the local sewer authority regulations.

6. DENTAL FILM

Neither the unused film should be placed in the general waste, as it contains unreacted silver that can be toxic for the environment. Safe disposal can be generally accomplished by simply contacting the supplier of the product and returning the waste for recycling. Alternatively, a certified waste carrier can be contacted to dispose off the waste, ideally by recycling [8].

7. X- RAY SYSTEM CLEANERS

Many cleaners used for automatic processors contain chromium, which is a hazardous waste when discarded. As an alternative, it is easier and cheaper to use a system cleaner that does not contain chromium [3].

8. CONCLUSIONS

Dentists have moral and professional responsibility towards the dental as well as the general health of the patients they care. This should extend beyond the radiation safety procedures normally adopted within the dental office to a more generalized consideration of the environmental impact of the potentially hazardous waste products resulted from these procedures. The preferred solution is to shift to digital x-ray systems, which replace the film-based technology with computer-based devices that use electronic or storage phosphor receptors to record the radiographic image in digital format. This eliminates the wastes associated with conventional film processing, along with many other advantages, such as lower time consumption and image manipulation. So, it is the responsibility of the dentists to save the environment by proper waste disposal while using conventional imaging and shift to digital imaging as early as possible.

References


