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MANAGEMENT OF RADIOGRAPHIC WASTE IN DENTISTRY- A REVIEW

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Abstract

Radiographs are imperative part of the complete assessment and treatment in medical and dental fields. The attractiveness and expediency of x ray technology extends way beyond the medical fields. Despite the fact that the advent of medical imaging reached to digital radiography, conventional radiography is still used by the practitioners. Unfortunately conventional radiographic procedures potentially generate hazardous waste products that have an alarming impact on environment. The accumulated waste products from the conventional radiographic methods may risk the environmental systems. Proper waste disposal and management is required to resolve this inevitable problem. The main intention of this article is to deal with the hazardous consequences of radiographic waste produced in dentistry and to enlighten the management methods to settle the impact of harmful effects of radiographic waste generated during dental procedure.

Keywords: Conventional Radiography; Management of Solid Waste; Lead; Effluents; Silver Recovery.

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1. Introduction

The discovery of x rays as a diagnostic tool in the medical field revolutionized the growth of medical science [2]. Radiography is the use of x rays to visualize the internal structure of a patient. X rays are form of electromagnetic radiation produced from the x ray tube, passed through the patient's body and captured behind the patient by a detector, a film sensitive to x ray radiation or digital detector. Though the advancement of radiography is reached beyond the level of digital imaging, conventional radiography is still used by the practitioners. Conventional radiography involves the usage of x ray films as a detector followed by chemical processing for developing the captured image. Despite the fact that conventional radiography plays a major role in routine

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diagnostic examination in clinical practice, certain substances produced generated during radiographic procedure may challenge the environmental systems.

Although radiographic waste generated in dental procedures constitutes only small potential hazards, it should be discard properly. The primary ingredient of concern processing solution containing the dissolved silver found in used fixer. Another material of concern is the lead foil found in the film packets. The waste produced in the dental radiographic procedures can be solids or effluents. Examples of such waste materials include spent x ray processing solutions processing cleaners, lead foil, lead aprons, lead shields and used x ray films. Several means are available for proper disposing of the silver and lead [2.] Silver can contaminate the soil and ground water if it sent to a landfill [10.] Silver may be recovered from the fixer solutions by the use of electrolytic processing or metallic replacement. Lead foil is separated from the packet and collected until enough has been accumulated to sell to a scrap metal dealer.[2]

The radiographic waste management can be broadly categorized into management of solid waste and management of effluents .[3]

2. Management of Solid Waste

The solid waste components associated with conventional radiography are the film box made of cardboard, vinyl wrap, black paper, lead foil, film end boards, used lead aprons, lead boxes and packaging components of processing solutions. The methods discussed below details management of each of waste generated .[3]

Intra Oral Films and Packets

Used x ray film also contains silver, just like x ray fixer. If concentration is high enough, it is considered hazardous waste and must be treated as such. It is best disposed of through an experienced medical waste hauler or silver recycling facility[11].

Film packets and dental films should be segregated. Plastic end boards should be discarded in regular trash, which include outer vinyl cover, paper packet cover and interior black paper should be discarded. Intra oral dental packets that contains human blood, blood components or saliva should be considered a regulated medical waste and be discarded into specific red color disposal bag. [3]

Packaging Components of Processing Solutions

Chemicals are packed in bottles with caps. Caps are discarded with regular trash while bottles are reused thoroughly and then regulated.[3]

Silver Recovery from Radiographs

There are common methods used

- Thermal
- Biological
- Mechanical
- Chemical

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First method utilizes combustion for recovery of silver while other methods help recover silver and also recycle film base. The silver sludge, obtaining from latter three methods, is melted and further refined to form silver ingot[3].

3. Lead

Like silver, lead is considered a hazardous material. It's potential environmental concerns and risks posed to human and animal health are well documented. Lead poses heightened threat to children and pregnant woman, but also to adults in general. Exposure can cause behavior and learning problems lower IQ, hyper activity, slowed growth, hearing problems and anemia.[8]

Lead Foil in Intra Oral Radiograph Film Packets and Used Lead Aprons and Collars

Lead foil is used in intra oral films to protect the film from backscatter and secondary irradiation. The lead content of the foil is 69%-85% [2.] The lead foil from the film packets has to be collected and returned back to the manufacture for recycling. The only expense would be for postage. It appears that there is a lack of awareness among dentists about this service offered by the manufacturer. Even the lead aprons and lead shields should not be thrown into the garbage and they should be returned to the manufacturer[2].

Management of Effluents

Effluents are defined as liquid waste products that are discharged into a body of water .the harmful effluents that are associated with radiography are unused / used fixer solutions ,wash water and developer tank cleaning solutions .Waste having a silver concentration of 5 PPM (parts per million) or more , hazardous became they display the characteristic toxicity. Wastes that contain silver in concentrations greater than 5 PPM include fixer solution, solution from cleaning developer tanks [2].

Developer

Used developer is not typically 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 that would make it hazardous waste. developer solution are caustic in nature, that is they have a high a high pH of approximately 10. So the waste developer may be flushed down the drain, as long as the pH of the solutions does not exceed the pH standard of the local public waste water treatment authority. It is always better to check with local sewer authority before disposing [2].

Discharging the developer solution with the waste fixer solution with the waste fixer solution with the waste fixer solution that leaves the recover units enable to bring the p H close to neutral or safe limits. The developer solution contains certain compounds like 1-5% hydroquinone, quinone, methol, sodium thio sulphate, sodium sulfite, elemental sulfur, acetic acid, sodium acetate, boric acid which may harm environmental systems. Hence photo oxidation is utilized for the destruction of organic compounds in effluents and utilizes ultraviolet light, iron hydrogen peroxide and is considered environment friendly and relatively cheap.[1,2,3]

Fixer

Used fixer is a dangerous waste because it contains high concentrations of silver-3000 to 8000 PPM and anything over 5 PPM is dangerous waste. Because of this high silver levels, its illegal to

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pour used fixer down the drain, into septic system or into the garbage[1]. The silver present in the fixer solutions mostly in the form of silver thiosulphate complexes which are extremely stable and have low dissociation constants. Waste water treatment process convert silver thiosulphate into silver sulfides which settles in sludge. In the aquatic life toxicity study found that silver sulfide was more than 15,000 times less toxic than free silver ions. So silver in fixer solutions has little adverse effect, but authorities in some areas impose limits on silver in waste water and in some cases mandate pretreatment.

Silver can be recovered from the spent fixer solution by electrolysis, metallic replacement, chemical precipitation reverse osmosis and ion exchange. the silver from the fixer solution is valuable resource that should be recycled. There are two basic management options for fixer.

1) Onsite treatment and disposal
2) Off site treatment and disposal

Onsite recovery of silver from the fixer involves either metallic replacement or electroplating methods. it can be transported to silver reclaiming facility or to the manufacturers or distributers 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. [2]

If the practice generates only small quantities of fixer it may be more cost effective and efficient to have the fixer transported to off site for removal. By opting off site disposal 100 %recovery of silver in x ray fixer is guaranteed. On site silver recovery is often an expensive alternate to off site, unless the practice generates large amounts of radiographic films.

Silver Recovery Methods from Fixer Solution

Silver can be recovered from the spent fixer solution by electrolysis, metallic replacement, chemical precipitation. [3]

1) Electrolytic Recovery

Electrolytic recovery is the most efficient technique for removing silver from silver rich waste solutions, metallic replacement. cartridges need to be used as a secondary recovery method subsequent to the electrolytic recovery equipment. In electrolytic recovery method silver bearing solution is passed between two electrodes attached to the source of direct electric current. silver then plates out on the cathode as almost pure metal. this most efficient for very large offices, clinics or dental schools.[3]

Advantages

- 98% purity is achievable
- The cathode can be cleaned and reused
- Does not produce any pollutants

Disadvantages

- High capital cost of equipment
- Operating cost due to electricity equipment
- Special electrical and plumbing requirement
- Requires monitoring and servicing to ensure high efficiency. [4]

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2) Metallic Replacement

It is a passive method suitable for treating small to medium volumes of effluent. the silver bearing solutions is poured a more reactive solid metal, such as iron. the silver in solution and the solid metal iron goes into the solution. The less active metal then becomes solid (silver sludge), which then settles to the bottom of the cartridge. After treatment through the silver recovery units, fixer solution is released to sanitary sewer as a non hazardous waste[3]

Advantages

- Low initial investment cost
- Low operating cost
- Low maintenance cost due to no mechanical parts and electrical connections
- Relatively high recovery efficiency

Disadvantages

- Not as efficient as other process
- Agitation is required to improve efficiency
- Impurities by presence of other metals in the silver sludge
- Recovered silver in the form of sludge and need further treatment[4]

3) Chemical Precipitation

Chemical precipitation method is one of the widely used and researched method for silver recovery. Silver can be readily recovered from photographic chemical effluent by sulfide precipitation with concentration low as 0-1 mg Ag/l.

Several chemicals including sodium sulfide, sodium dithionate, potassium bro-hydride and 2,4,6 – trimercarpto-s- triazine have been used as precipitating agents to recover silver from photo chemical processing waste.

The experiment achieved almost 99% silver recovery from effluent[4]

The main advantage of the chemical precipitation is easy to monitor performance and low silver concentration in effluent. However careful control of precipitation process as well as the sulfide dosing process is required to prevent the release of poisonous sulfide gas.

Silver Recovery by Alkaline Precipitation

Studies conducted by Van Ryan Kristopher R Galapak and Girlic D Deopoldo showed that silver can be recovered from used fixer solution by alkaline precipitation (sodium hydroxide precipitation method), which is cost effective.[7]

X Ray System Cleaners

Many cleaners for automatic processors contain chromium which is a hazardous waste when discarded. Unused developer system cleaners may contain chromium at a high concentration of 5PPM. As an alternative, it is easier and cheaper to use a system cleaner that does not contain chromium.[3]

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4. Conclusion

Radiographic technology involves diagnosis or treatment of patients by recording images of the internal structure of the body to assess the presence or absence of disease, foreign objects and structural damage or anomaly. Conventional radiographic procedure involves x ray films and processing solutions which eventually produce radiographic waste[3] which may eventually challenge the environmental systems. Although individual practitioner or institution produce only a small amount of waste it should be properly disposed for the safety of future[2]. The x ray processing solutions hold high amount of silver metal .Anything over 5ppm is dangerous waste it is illegal to put used fixer solution down the drain into a septic system or garbage, so one should switch to digital imaging rather than the photographic x ray machine[6]. Transfer of conventional radiography involving x ray films to digital analog radiography is the possible and manageable method to clear up the issues created by radiographic waste. The additional benefits of the digital radiography involves radiation protection, less exposure time, image accuracy. The dentists are liable to take an action to minimize the hazardous effects of radiographic waste by proper management of the same and promoting the usage of digital radiography.

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