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Dental Office Waste and Its Risks on the Environment; a Narrative Review

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Abstract: This narrative review examines the risks posed by dental office waste on the environment. Dental care generates biomedical waste (BMW), which includes various materials such as anatomical parts, needles, and infectious waste. Improper disposal of BMW can lead to environmental and public health hazards. Studies have highlighted the significant quantities of solid dental waste produced daily, with varying rates reported across different regions. Awareness of biomedical waste management among oral healthcare providers remains inadequate in many areas, contributing to improper waste handling practices. Biomedical waste segregation is crucial to minimize health hazards, and proper training is essential for healthcare workers to ensure compliance with waste management protocols. Mercury from dental amalgam, hazardous chemicals in X-ray solutions, and single-use plastics contribute to environmental pollution and health risks. Occupational health hazards associated with handling biomedical waste underscore the importance of implementing safety measures in dental practices. Additionally, the review discusses the need for sustainable practices in dentistry to mitigate the environmental impact of dental waste.

Keywords: "Dental Office Waste," "Public Health," "Biohazards," and "Environmental.

1. Introduction

Importance of Dental Care

Dental care plays a crucial role in maintaining overall health and well-being. However, the procedures involved in dental surgery often lead to the generation of biomedical waste (BMW), which poses significant challenges for both the healthcare sector and the environment [1].

Nature of Biomedical Waste in Dental Practices

Healthcare waste generated in dental clinics and hospitals consists of solid and liquid materials, including anatomical parts, cotton, bandages, needles, syringes, and sharps contaminated with bodily fluids [2]. The World Health Organization defines healthcare waste as materials discarded from healthcare activities that have the potential to transmit infectious agents [4]. Dental facilities produce various types of waste, including hazardous, non-hazardous, biohazardous, pharmaceutical, and sharp wastes [5].

Quantification of Dental Waste

Studies have quantified the amount of solid dental waste generated per patient or procedure in different regions. For example, research conducted in Turkey found that university specialty clinics produced an average of 398.3 to 194.7 grams of waste per procedure over two months [6]. Similarly, studies in Greece and Iran reported production rates of 53.3 grams per patient per day and 193.5 grams per patient per day, respectively [7, 8].

Challenges in Biomedical Waste Management

Studies conducted in various countries, such as Palestine, Brazil, and Iran, have highlighted challenges in biomedical waste management in dental practices. These challenges include improper disposal practices, misclassification of waste, and inadequate adherence to waste management protocols [9-11].

Need for Improved Waste Management Practices

The findings underscore the need for improved waste management practices in dental facilities worldwide. Proper segregation, collection, transportation, and treatment of biomedical waste are essential to minimize environmental and public health risks associated with dental care [12].

2. Materials and Methods

To comprehensively review the literature on the dental office waste and its risks on the environment, an extensive electronic search was conducted covering publications from 2000 to 2023. This search spanned three major databases: PubMed, Cochrane Central Register of Controlled Trials, and Web of Science. Utilizing a combination of controlled vocabulary and free-text words, the search strategy was meticulously designed to capture relevant studies. The keywords employed in the search strategy included "dental office waste," "public health," "biohazards," and "environmental." The strategy aimed to encompass all relevant articles exploring the dental office waste and its risks on the environment.

3. Results

Study on Dental Health Care Providers in Jeddah, Saudi Arabia

A cross-sectional descriptive study conducted in Jeddah, Saudi Arabia, involved 314 dental health care providers from four dental colleges and 20 private dental clinics. Utilizing a pretested questionnaire comprising close-ended questions, the study examined various aspects of waste management practices among participants. The mean age of the participants was 27 years, with approximately 78% working in the public sector. Surprisingly, only 33.4% of the sample received professional training on waste management. Evaluation of behavior and knowledge scores revealed a mean of 3.7 ± 1.3 (out of 6) and 1.4 ± 1.3 (out of 8), respectively. While a statistically significant association was observed between gender and knowledge scores, no such correlation was found between gender and behavior scores. However, statistically significant associations were noted between both knowledge and behavior scores and factors such as rank, type of practice, and years of experience. The study highlighted a concerning lack of knowledge among oral health care providers regarding effective procedures for segregating, collecting, transporting, and treating dental waste, emphasizing the urgent need for policies and regulations for dental waste management in Saudi Arabia [12].

Management Approaches for Dental Waste

The management of waste in dental practices is primarily determined by its type and source, with common methods including recycling, incineration, and landfilling. Dental waste presents a significant environmental risk due to the presence of hazardous and toxic substances, such as mercury (Hg) found in dental amalgam. Despite a lack of complete understanding of waste neutralization methods, practitioners acknowledge the environmental dangers posed by waste, with a notable interest in possibilities for recycling, reuse, and reintegration. This underscores the importance of promoting "green dentistry" practices, representing an essential step toward ecological professionalism [14].

Implications for Dental Waste Management

Studies investigating the awareness of biomedical waste management among dental residents have shown encouraging results, with a high percentage of awareness reported. However, there remains a need for further education, particularly regarding waste disposal color codes, to ensure comprehensive understanding among practitioners [15]. Previous research on dental waste management in medical facilities highlighted the lack of awareness among dental practitioners regarding impending health and environmental risks. Recommendations included categorizing dental waste based on identity, constituents, and hazards to facilitate safe handling and management [14]. Such insights underscore the importance of continuous education and regulation in promoting effective dental waste management practices.

Implications of biomedical waste

Potential risk to biomedical waste handlers

Infectious, contaminated sharps are the ones that cause higher risk associated with hospital waste. The health risk is associated with handling microbial waste. Health hazards are also associated with the high operating temperatures of incinerators and steam sterilizers and with toxic gases vented into the atmosphere after waste treatment (16).

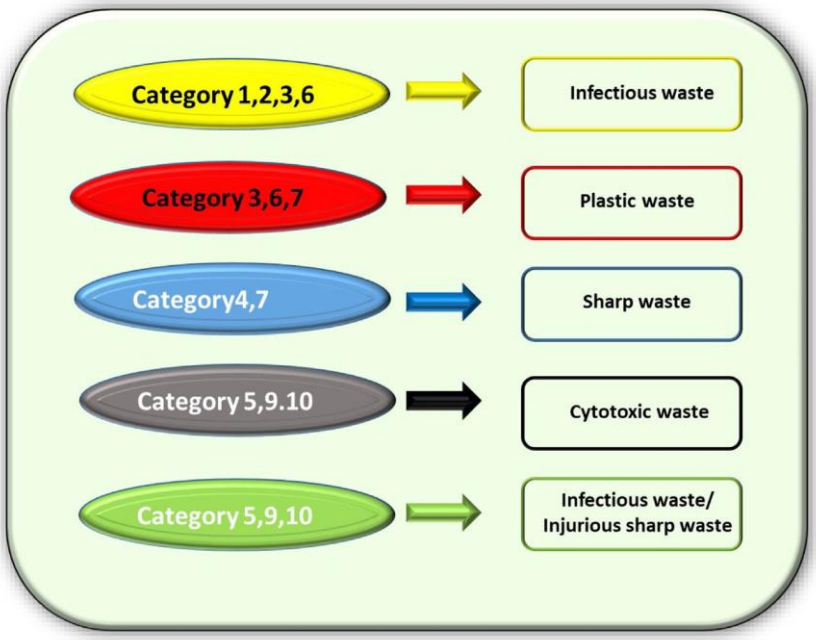

Fig. 1. Color codes for Biomedical waste

Environmental impact

This occurs due to the careless disposal and improperly operated incinerators or other medical waste treatment equipment (17) Major risk of nosocomial infections in patients who lack knowledge on proper.

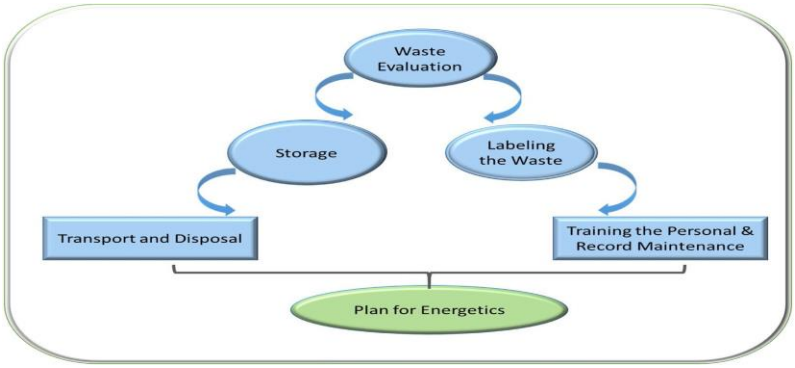

Fig. 2. Steps in handling biomedical waste.

Biomedical waste segregation

Biomedical waste segregation is important for the proper handling of these contaminated waste. It is of prime importance to minimize the quantity of infectious waste through proper mechanism. If it is not done properly, it will cause health hazards (18) According to different categories, the wastes were segregated in color-coded bins and bags. The health care workers must be created awareness and training in such a protocol to ensure the safety of their health (see Fig. 1).

All the contaminated waste like IV tubes, catheters, syringe, gloves are recyclable waste and must be disposed of in a red-colored bag. Anatomical waste (human, animal origin) certain solid waste which includes body fluids, cotton swab, expired medicines, liquid waste, laboratory waste is disposed of in yellow bags. Incineration ash, solid waste is discarded in a black bag. Infectious sharps like scrapples, needles are disposed of in white bags, and implants, glassware, vials, ampoules are discarded in blue bags, as depicted in Fig. 2.

Dealing with a risk: Occupational health hazards due to BMW

Hospital, construction, manufacturing, private industry are most prone to occupational health hazard. The injury and illness rate in hospitals remains nearly double the rate for private industry as a whole. Occupational health and safety audits are required to ensure safety in the working environment (19). OHSAS 18001 is a global standard that is specifically designed to help the health care organization to prevent injury and follow a healthy work environment). Health and safety at work affect everyone. Implementing an occupational health and safety management system is now a legal requirement in many countries (20). An OHSAS 18001 standard demonstrates that an organization adheres to high standards with regards to health and safety, thus enabling it to enhance the reputation. The organization must identify the hazards and assess the occupational health and safety risks related to its activities and services, and it also determines the necessary controls and to set clear objectives and targets to improve its performance (21). In OHSAS 18001, assessment and mitigation of risk is the important step, by dealing with this element hospital environment will require special considerations. With patients, visitors, and employees all requiring consideration as interested parties.

Germ-free areas

In hospitals, some of the restricted areas that manage infectious diseases must be kept without public access. It is important that the health care workers in the hospital are trained well and follow proper guidelines and internal process in order to ensure the infectious waste are not transmitted to the environment and cause community spread. In terms of risk assessment, health care organizations must analyze the potential risk and the solution to overcome risk [20].

Hazards through use of equipment

The technology has made equipment is increasingly complex, and, while that is hugely advantageous in general, it can lead to danger if improperly handled. Training, consultation, and participation are all elements that can be used effectively to make certain that employee competence is sufficient to ensure safe working is maintained [21].

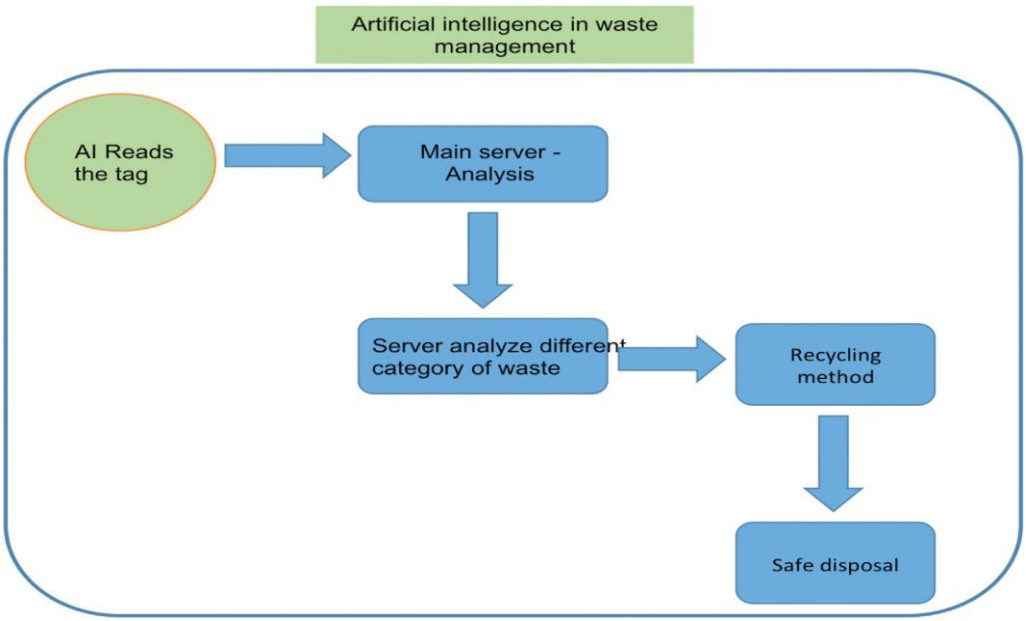

Fig. 3. Steps—Artificial intelligence in biomedical waste handling.

4. Discussion

Awareness Discrepancies in Waste Management Policies

The study reveals notable differences in the awareness of waste management policies among dentists across different cities. While 56.1% of dentists in the current study were aware of documents outlining dental waste management policies in their facilities, studies conducted by Kesavan et al. (22) in Chennai City and Kishore et al. (23) in New Delhi reported awareness rates of 72% and 36%, respectively. These findings underscore the variability in waste management awareness among dental practitioners in different urban settings.

Environmental Threats Posed by Dental Amalgam

Dental clinics serve as uncontrolled sources of mercury, posing significant global environmental threats. Mercury, present in dental amalgam, can lead to environmental contamination through spills and during the extraction of amalgam-filled teeth. Elemental mercury can convert into methylmercury upon contact with aquatic fauna, further exacerbating environmental hazards. Proper disposal of mercury waste from dental clinics is imperative to mitigate these risks. Dental amalgam waste, categorized as any waste contaminated with amalgam, must be securely stored in designated containers with mercury suppressants to prevent health risks associated with mercury vapor exposure. Installation of amalgam separators in dental chairs facilitates the removal of amalgam particles from wastewater, enabling proper collection and disposal of amalgam waste as hazardous waste. Additionally, proper management of dental mercury waste involves maintaining unused mercury in tightly sealed containers and ensuring the appropriate disposal of extracted amalgam-filled teeth (Agarwal et al., 2012).

Hazards of X-ray Solutions and Plastic Waste in Biomedical Waste

X-ray fixer solution, containing high silver content, is classified as hazardous waste due to its environmental implications. When mixed with developer solution, it can further contaminate wastewater, necessitating separate treatment. X-ray cleaner solutions often contain chromium and should be disposed of as hazardous waste or replaced with non-chrome alternatives. X-ray lead foils and shields, composed of pure lead, are recycled for their scrap metal content or disposed of as hazardous waste. Exposure to lead poses significant health risks, including neurological disorders. Plastic waste, a major concern in biomedical waste, poses environmental hazards, particularly during incineration. Burning medical devices made of polyvinyl chloride can release dioxins, which are harmful to health.

Importance of Proper Segregation and Disposal of Biomedical Waste in Dental Practices

Given the hazardous exposures inherent in dental practice, proper segregation and disposal of biomedical waste are paramount. Survey responses regarding attitudes toward biomedical waste management indicate a positive outlook among dentists. While dentists express uncertainty about waste recycling opportunities in dental work, a significant percentage (95%) report selectively collecting household and dental practice waste. However, only 26% of dentists suggest possible reuse of waste from dental offices, highlighting opportunities for improvement in waste management practices within dental practices (27).

Single-Use Plastic Waste in Dental Practices

Research has highlighted the substantial quantity of single-use plastics used in dental practices, contributing to clinical waste [28]. The escalation of personal protective equipment (PPE) usage during the COVID-19 pandemic significantly adds to this issue, as PPE is employed for each clinical procedure [29]. While certain single-use plastics are indispensable for maintaining high-quality healthcare standards, alternatives such as paper cups could replace disposable plastic ones without compromising safety [30].

Hazardous Wastes in Dentistry

Hazardous materials like dental amalgam pose potential carcinogenic risks [31]. Dental amalgam, containing mercury, is highly toxic and volatile, contributing to environmental mercury release due to improper disposal practices in dental facilities and industries. Additionally, materials containing chloride, such as gloves and rubbers,

when incinerated, emit dioxins, which can lead to various health effects, including cancer and reproductive disorders [32].

Infectious Risks from Dental Waste

Dental waste harbors microorganisms like bacteria, fungi, and viruses, posing infection and disease transmission risks [33]. The infectiousness of these agents depends on factors like microbial dose, portal of entry, virulence factors, and host immune response. Approximately 10 to 25% of waste generated in healthcare facilities constitutes infectious waste, further highlighting the significance of proper waste management [33].

- **Environmental Impact of Dental Waste**

Despite the seemingly insignificant waste produced by individual dentists, cumulative dental waste poses substantial environmental risks due to its hazardous and toxic nature. Available statistical data underscore the urgent need to address dentistry's environmental impact and implement measures to reduce toxic waste production [34]. Legal mandates should require dental practitioners to responsibly collect and dispose of dental waste, especially when viable solutions are available.

5. Conclusion

Dental waste poses significant environmental and public health risks due to improper disposal practices and the presence of hazardous materials. Efforts to improve awareness and training among oral healthcare providers are essential to ensure proper biomedical waste management. Sustainable practices, such as recycling and reducing the use of single-use plastics, are crucial to minimize the environmental impact of dental waste. Legislative measures and guidelines are needed to enforce proper waste disposal protocols in dental practices. By addressing these issues, dental practitioners can contribute to reducing the environmental burden and promoting a healthier future for both patients and the planet.

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