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KNOWLEDGE OF DENTISTS IN MEDAN CONCERNING GREEN DENTISTRY ON RADIOLOGICAL WASTE MANAGEMENT

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KEYWORDS

Conventional radiography, digital radiography, green dentistry, radiological waste

ABSTRACT

Introduction: The radiographic procedure is hazardous waste because it uses toxic materials. According to the concept of green dentistry, appropriate and efficient waste management needs to be carried out to avoid risks to human health or the environment. This study aims to determine the knowledge level of dentists in Medan concerning green dentistry in the management of radiological waste. **Methods:** A descriptive study was used as a study method, and purposive sampling was used to choose samples. The total sample consisted of 31 dentists in Medan who owned radiographic equipment. Data were obtained from direct questionnaires. The data were analyzed univariately and calculated in a frequency and percentage table. **Result:** The results showed that 100% of dentists knew about the definition of green dentistry, 83.9% about the 4R principle of green dentistry, 96.8% about the green dentistry recommendation for radiological waste management, 100% about the benefit of digital radiographic images, 93.5% about paper waste management of digital radiography, 35.5% about the silver-containing hazardous waste solution, 90.3% about how to dispose of fixer solution, 71.0% about disposing of developer solution, 93.5% about disposing of x-ray films, 71.0% about disposing of lead foil, and 45.2% about good x-ray cleaners. **Conclusion:** This study concludes that 87.1% of dentists in Medan had a knowledge level of green dentistry on radiological waste management in the good category, 9.7% in the fair category, and 3.2% in the less category.

INTRODUCTION

Green dentistry is a recent innovation in dentistry that is environmentally friendly and uses technological advances. It aims to reduce waste, pollution, toxic medical materials, save energy and water.[1] Waste management is one of the concerns of green dentistry.[2] Waste is the final product of health care activities that has a negative impact if disposed of without processing.[3] The implementation of the 4R method—reduce, reuse, recycle, and rethink—can minimize said impact.[4] Basically, the technique used to obtain radiographic images is the exposure of radiographic films to x-rays, followed by

conventional film processing. The conventional radiographic procedure involves x-ray film, developer, fixer, lead, and cleaner that can produce hazardous waste due to toxic materials. According to the green dentistry concept, appropriate and efficient waste management is needed to prevent risks to human health or the environment.[5]

Febrian et al. studied 37 dentists in Bukittinggi and found that 24.3% of dentists had low knowledge of green dentistry and 75.7% had high knowledge. The knowledge of conventional radiographic film material waste management was in a low category, which consisted of 45.9% of dentists. Knowledge of waste management, according to green dentistry, was also low, at 6.2%.[3]

Alencar et al., in their research of 80 dentists in Recife, Brazil, said that 81.6% of participants collected used x-ray films for correct processing, and 18.4% disposed of them in public dumpsters.[6] A study by Da Silva et al. on 100 dentists in São Luís reported that 92% of participants believed that radiographic waste could damage the environment. As many as 43% of participants disposed of the fixer directly through the sink; 36% mixed the solution with water and then disposed of it in the sink; 14% disposed of it in a special container; and 7% used other methods. Concerning developers, 42% of participants disposed of it in the sink, 36% mixed it into water and then disposed of it, 13% disposed of it in a special container, and 9% used other methods. Fifty-one percent of participants disposed of x-ray films directly in the disposal bin, and 49% went through special processing.[5]

Salim et al. studied 142 dental students at Universitas Trisakti and showed that 57.7% of them understood the benefits of conducting intraoral radiography using digital radiography. The use of digital radiography can minimize lead foil waste contained in x-ray films and reduce radiation exposure to patients.[1] This study aims to determine the knowledge level of dentists in Medan concerning green dentistry on radiological waste management.

METHODS

This research is a descriptive study with a cross-sectional approach. The study was conducted in dental clinics in Medan from February to March 2022. Thirty-one dentists with radiographic equipment were taken as samples, according to Roscoe.[7] Samples were chosen using the purposive sampling method with the inclusion criteria of cooperative dentists who had conventional or digital radiography and were willing to participate, and the exclusion criteria were dentists that were not present when the study was carried out. This study employed a questionnaire comprising 11 items. This study received approval from the Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara, numbered 73/KEPK/USU/2022.

RESULTS

There were 26 (83.87%) participants who used digital radiography and 5 (16.13%) participants who used conventional radiography (Table 1). The frequency of right and wrong answers, along with the percentage of questions answered by 31 dentists in Medan concerning green dentistry on radiologic waste management (Table 2). The frequency of participants based on the knowledge level of dentists in Medan concerning green dentistry on radiological waste management showed that 87.1% were good, 9.7% were fair, and 3.2% were less (Table 3).

Table 1. Frequency of respondents who own radiography

No.	Radiography	Dentist	
		N	Percentage (%)
1	Digital radiography	26	83,87%
2	Conventional radiography	5	16,13%
	Total	31	100%

Table 2. Knowledge of dentists in Medan concerning green dentistry on radiological waste management

No.	Question	Total	Answer			
			Correct		Incorrect	
			N	%	N	%
1	Definition of *green dentistry*	31	31	100	0	0
2	4R principle used by green dentistry for an environmentally friendly concept		26	83,9	5	16,1
3	Recommendation according to the green dentistry concept for radiological waste management		30	96,8	1	3,2
4	Benefits of digital radiographic images compared to conventional		31	100	0	0
5	Management of printed digital radiographic images		29	93,5	2	6,5
6	Silver-containing hazardous waste solution after radiographic image processing		11	35,5	20	64,5
7	How to dispose of used fixer solution		28	90,3	3	9,7
8	How to dispose of developer solution		22	71,0	9	29,0
9	How to dispose of x-ray films		29	93,5	2	6,5
10	How to dispose of lead foil		22	71,0	9	29,0
11	Good x-ray cleaner		15	45,2	17	54,8

Table 3. Individual knowledge level of dentists in Medan concerning green dentistry on radiological waste management

No.	Knowledge Level Categories	Score		Dentists	
		Total Value	Percentage (%)	N	Percentage (%)
1	Good knowledge	8-11	76%-100%	27	87,1
2	Fair knowledge	6-7	56%-75%	3	9,7
3	Less knowledge	0-5	<56%	1	3,2
	Total			31	100%

DISCUSSION

There were 83.87% of participants used digital radiography, and 16.13% used conventional radiography (Table 1). This showed that the participants have used digital radiography as a substitute for film-based conventional radiography to reduce waste while processing radiographic films.

The knowledge of participants of the definition of green dentistry was considered good because 100% of participants answered correctly (Tabel 2). This result may be due to their already hearing or reading about the concept of green dentistry. Another possibility is that the meaning of the word made it easier for the participants to answer correctly. Green dentistry is an approach to combining dental practice and environmental conservation.[4] Green dentistry can provide an environmentally friendly dental practice with advanced technological innovation to reduce waste production, pollution, toxic medical ingredients, save energy and water.[1] The results of this study are the same as the research of Al-Qarni MA et al. (2016), who found that 98.75% of dentists, dental students, and dental nurses understood the definition of green dentistry.[8]

The frequency of participants who answered right on the 4R principles used by green dentistry for the environmentally friendly concept was 83.9% and was included in the good category. Waste reduction is one way to achieve environmentally friendly practices by implementing the 4R principles: recycle, reduce, reuse, and rethink.[4] Reduce means reducing waste and pollution, such as the use of single-use items and the waste of materials, the use of paper, and the use of technology. Reuse is to reuse biodegradable materials that can still be used. Recycle is recycling by collecting materials to be recycled, then creating something new to resell. Rethinking means finding a way to reduce, reuse, and recycle while carrying out dental practice to be more environmentally friendly.[9]

The knowledge of the participants concerning recommendations according to the green dentistry concept for radiological waste management was considered good; 96.8% of participants answered correctly because they knew that to achieve an environmentally friendly dental practice, waste management is needed by using digital radiography. Digital radiography substitutes film-based conventional radiography that does not require film processing, which has the potential to produce hazardous waste. For those who still use conventional radiography, special care is needed for waste from fixer, developer, and lead foil from x-rays.[10] This is different from the research of Febrian et al. (2020), who found that only 16.2% of dentists understood the management of waste according to the green dentistry concept.[2]

The knowledge of the participants concerning the benefits of using digital radiographic

images compared to conventional images was considered good because 100% of participants answered correctly. The participants understood that digital radiography can reduce radiation exposure by 50% compared to conventional radiography. However, good protection is still needed. Digital radiography does not use x-ray films, thus reducing lead paper waste that can pollute the environment. The contrast and sharpness of the images were also optimal. It is easy to use and more environmentally friendly due to the lack of chemical processing involved.[11,12] This study is in line with research by Pallavi C et al. (2020), who found that 94.3% of dentists understood that digital radiography can reduce radiation exposure to patients.[13] This is also in line with Salim RC et al. (2021), who found that 57.7% of dental students understood that the use of digital radiography can reduce radiation exposure to patients and reduce lead foil waste in x-ray films.[1]

The frequency of knowledge of the participants concerning waste management of printed digital radiographic images was 93.5% and was considered good. Technology advances enable radiographic images to be stored on a computer, leading to better archiving and allowing them to be seen anytime on the monitor. Digital radiography can transmit the results of x-ray images in the form of a computer file stored on a hard disk or can be sent in a JPG, BMP, or JPEG image to dentists who will refer it to laboratories or hospitals. This was aimed at reducing waste on printed radiographic images.[14]

The knowledge of the participants concerning silver-containing hazardous waste solutions after radiographic film processing was considered less, as only 35.5% of participants understood. The participants may answer incorrectly because they did not remember that the fixer solution from x-ray processing is a hazardous waste because it contains 3.000–8.000 ppm of silver concentration, which is considered high. Waste that contains more than 5 ppm of silver is considered hazardous.[15] Fixer waste contains a high silver level, which is mostly in the form of silver thiosulfate complex, which is very stable and has a low dissociation constant. There is almost no free silver ion in the used fixer solution, thus no side effects for the environment.[16]

The knowledge of the participants concerning how to dispose of used fixer solutions was considered good because 90.3% of participants understood. Fixer solution is a hazardous waste. Mittal et al. stated that the recommendation on fixer solution waste management was to give it to the silver recovery unit to be recycled.[9] Used fixer solution is a hazardous waste because it contains a high silver content, which is more than 5 ppm. Therefore, it is illegal to dispose of waste directly into the sewer, septic system, or disposal bin. Fixer solutions require processing before disposal. Several

techniques are available to collect silver from the fixer solution. The used fixer was separated from the developer solution and put in a marked container. A waste management agency can be contacted to restore silver by recycling or disposal.[15] Two options for basic management of fixers include on-site and off-site treatment and disposal. On-site treatment and disposal means a recycling method that uses equipment (silver recovery), and off-site treatment and disposal is carried out by separating fixer solution from other materials, then giving it to recyclers. Cost-wise, off-site recovery would be more effective for clinics that do not produce much waste. On-site recovery is an alternative with a considerable cost, except for practices that use many radiographic films. Silver can be recovered from used fixer solutions using electrolysis, metallic replacement, and chemical precipitation.[16,17] The results are different from the research of Da Silva et al. (2012), who found that 43% of dentists dispose of fixer solutions directly into the sink.[5]

The knowledge of the participants concerning how to dispose of developer solutions was considered fair because 71.0% of participants understood. The developer solution is not a hazardous waste because it has a low silver content (usually below the regulatory limit of 5 mg/l of silver). However, the lack of constituents and other characteristics makes it a hazardous waste. Developer solution must be neutralized before disposal because it has a high pH of approximately 10. This solution must be processed before disposal in the sewer because it contains materials such as hydroquinone, sodium thiosulfate, sodium sulfite, quinone, menthol, elemental sulfur, acetic acid, sodium acetate, and boric acid.[16,17] The results in this study are different from the research of Da Silva et al. (2012) because only 13% of dentists gave developer solutions to the management agency. [5]

The knowledge of the participants concerning how to dispose of x-ray films was considered good because 93.5% of participants understood. Used films must not be disposed of in public dumpsters because they contain unreacted silver, which can be toxic to the environment. Used or expired x-ray film waste can be managed by disposing of it safely through a certified waste carrier to be disposed of or recycled.[16,17] This is in line with research by Alencar et al. (2020), who found that 81.6% of dentists collect x-ray films and manage wastes.[6] These results are different from the research of Da Silva et al. (2012) because only 49% of dentists dispose of x-ray films through special management.[5]

The frequency of knowledge of the participants concerning lead foil disposal was 71.0% and was included in the fair category. Lead foil is used in intraoral films to protect them from backscatter and secondary irradiation. The lead content inside the foil is around 69%–85%. When disposed of in the regular disposal bin, it will end up in the soil. In low pH conditions, the melting of lead from

radiographic foil will occur, thus penetrating the ecosystem and damaging the environment. Lead foil from the film package needs to be collected and given to the management agency for recycling.[9,16,17]

The knowledge of the participants concerning a good x-ray cleaner was 45.2% and was considered less. Participants mostly answered incorrectly because they did not remember the content of a good x-ray cleaner. An x-ray cleaner that contains chromium is hazardous waste if disposed of carelessly, and many x-ray cleaners use chromium. The use of digital radiography and non-chromium x-ray cleaners is a way to minimize radiological waste.[16,17]

The results of this study showed that the highest knowledge was concerning the definition of green dentistry (100%) and the benefits of conducting digital radiography compared to conventional radiography (100%). The participants answered correctly because there have been many media for information; thus, participants found it easy to increase their knowledge. This study also showed the least participant knowledge of silver-containing hazardous waste solutions after radiographic image processing (35.5%). Participants might have answered incorrectly because 83.87% of them used digital radiography and 16.13% used conventional radiography. The participants would understand more about digital radiography, while film processing is related to conventional radiography.

The category of good knowledge level was 87.1%, the fair was 9.7%, and the less was 3.2% (Table 3). Inequality of participants knowledge might be caused by a lack of materials on green dentistry on radiological waste management during academic years. This depends on the understanding of each participant. Other factors include 83.87% of participants using digital radiography and 16.13% using conventional radiography. The questionnaire consisted of questions related to conventional and digital radiography. The most incorrect answers were in questions related to conventional radiography because the participants no longer use this type of radiography. Participants will focus more on the radiography method that they use now; however, they also understand conventional radiographical waste.

CONCLUSION

The level of knowledge of dentists in the city of Medan regarding green dentistry in radiological waste management shows that most are in the good category and very few are in the fair and less categories.

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