REVIEW PAPER

Dental solid waste management in Iran: A systematic review

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ABSTRACT

The management of dental solid wastes (DSWs) in Iran has become essential in recent decades due to population growth and the increased access to dental services. DSWs include hazardous components such as infectious, toxic, chemical, pharmaceutical, and sharp wastes, which could potentially cause severe damage to humans and the environment. This systematic review aimed to investigate the quantity, quality, and status of DSW management in Iran. By identifying the keywords and defining a search protocol, the review was performed in five databases, including one Persian database, to retrieve the related articles regarding DSW in Iran. All the articles containing data on DSW quantity and management in Iran were obtained from Scopus, Web of Science, PubMed, Google Scholar, and SID. In total, 17 articles were selected, and the final articles were selected based on specific criteria. The quantity, composition, storage, and management of DSW management were considered in Iran as a developing country.

Keywords: Dental waste management, Waste management, Systematic review, Iran

Introduction

Dentistry is an important healthcare section in every community. The waste produced by medical activities, including dentistry, has the potential to damage human life and the environment.[1] Dental solid wastes (DSWs) are important medical wastes, which contain hazardous infectious wastes, sharp substances, amalgam, and blood-impregnated wastes.[1] The non-infectious part of DSWs is the common waste, which includes the waste produced in administrative sections through the general activities in dental centers.[1] If not mixed with infectious wastes, common waste could be managed along with municipal solid wastes.[2] Considering the significant hazard associated with dental infectious waste, its separation from other components of DSWs is essential.[2]

Sharpe wastes are an important component of DSWs, which are known to have the risk of injuries in waste collection and transportation and the potential to transmit various diseases, such as AIDS, hepatitis C, and hepatitis B.[3] For the storage sharp wastes, the use of special containers (safety boxes) has been reported in some studies.[4] Chemical and pharmaceutical wastes are also found in DSWs in relatively small proportions.[1, 2, 5, 6]

Considering the increasing production of DSWs in the world and the importance of this issue, several studies have been focused on these wastes across the globe.[4] Iran is a developing country with an increasing population in recent decades, and the increasing access to medical services,

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including dentistry, has led to the higher production of medical wastes in the country.

The present study aimed to systematically review the studies conducted in Iran regarding DSWs to identify the amount and quality of these wastes and determine the status of DSW management in Iran.

Materials and Methods

After defining the search protocol and identifying the keywords, the search for relevant articles was performed in five databases, including one Persian language database, in September 2018. The final articles were selected in three stages of screening, including title study, abstract study, and content study. In total, 17 articles were selected for the review. The inclusion criteria of the study were the articles containing data on the quantity of dental wastes and management of dental wastes.

Fig. 1 shows the search stage, number of the retrieved articles from the databases, and screening stages of the final articles.

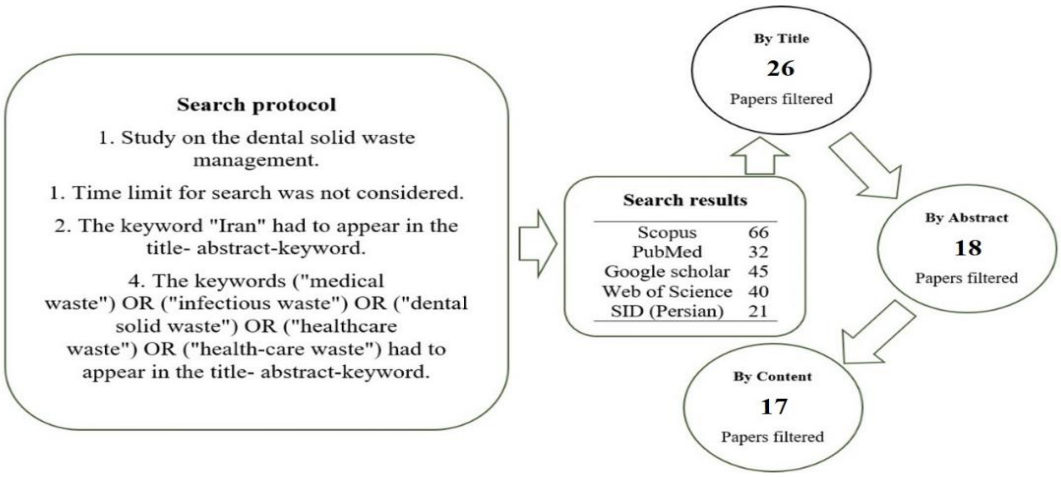

Fig. 1. Searching and selecting 17 final articles used in review

Fig. 2. Categorization of types of dental wastes in Iran[1, 3-6]

Literature review

In this review, we found the studies conducted in Iran to categorize and report DSWs in four general groups (Fig. 2). Table 1 shows the results of these reports in various dental centers. According to the information in Table 2, there were differences between the reports in terms of the DSW composition in Iran. The amount of DSWs was generally reported in an annual amount, and less per capita (per patient) waste production was used. The selected studies were carried out in only 12 cities in Iran, and the DSWs on a provincial scale were evaluated in only one province.

Table 1. Amount and composition of solid waste of dentistry in Iran (O: dental offices, C: dental clinics, Pu: public dental clinics, Pr: private dental clinics)

Location	Dentistry type	Amount	Common waste (٪)	Infectious waste (٪)	Chemical and pharmaceutical waste (٪)	Toxic waste (٪)	Year	Ref.
Sistan and Baluchestan	Pr and Pu	0.170 kg/patient/d	11.3	80.3	6.3	1.7	2012	1
Bandar Abbas	C and O	0.498 kg/dental/d	40.9	48.5	6.7	-	2010	2
Hamadan	Pr, Pu and O	42 tone/year	71	21.4	7.2	0.18	2010	3
Urmia	Pr, Pu and C	58.9 kg/d	33.1	40.9	7.7	18.2	2013	4
Zabol	C	5.5 tone/year	43.6	47.2	7.2	0.34	2014	5
Qaem Shahr	O	357 kg/year	33	64	3	-	2018	6
Shahroud	C	2425 kg/year	43.8	46	9.2	1	2010	7
Hamadan	Pu	14662 kg/year	38.1	52	9.5	0.4	2009	8
Birjand	C	7848 kg/year	54.4	29.8	11.8	0.1	2017	9
Gorgan	Pr and Pu	15150 kg/year	44.3	47.1	8	0.7	2012	10
Yasuj	C	3.17 kg/dental/d	15.8	59.9	21.7	3.4	2015	11
Hamadan	O	24598 kg/year	91.14	2.14	6.7	0.02	2007	12
Hamadan	Pr	2685 kg/year	48.4	43.8	7.33	0.37	2007	13
Bojnoord	O	6162 kg/year	50	40.85	7.47	1.69	2014	14
Babol	Pu	11829 kg/year	52.5	42.5	4.7	0.3	2016	15
Babol	Pr	2831 kg/year	42.5	50	7	0.5	2016	15

Table 2. Ratio of various components of dental wastes in some reports (%; *ratio of components to category; #ratio of components to total dental wastes)

		Ref.				
		5	4	3	9	16
Household-like waste	Nylon	27.6	-	19.5	-	-
	Dental disposable tray	19.1	-	57.3	-	-
	Paper and newspaper	12.3	-	1.58	13.4	-
Potentially infectious	Latex gloves	33.6	6.42	41.1	10.8	30.6
	Blood-contaminated paper towel	9.9	11.33	12.9	4	5
	Plastic syringe	8.4	4.7	4.7	5.4	4.1
Chemical and pharmaceutical waste	Consumed ampoule	82.9	12.7	-		10.1
	Molding plaster	9.8	-	-	-	-
	Gutta-percha	3.7	-	-	-	-
Toxic waste	Lead cover of X-ray film	77.6	15.87	-	-	-
	Amalgam	22.4	40.78	-	-	-

The studies regarding DSWs in Iran only reported the waste management status, and no interventions were carried out by the researchers. In addition to the amount of DSWs, researchers have reviewed the status of the storage process of these wastes, some of which are presented in Table 3.

Results and Discussion

The awareness of the amount of DSW production has a significant impact on its management. According to the results of the present study, the rate of DSW production in the general and private clinics of Hamedan (Iran) has been estimated at 48.7 and 65.9 g person^{-1} day^{-1}, respectively,[3] while the amount has been reported to be 62.5 g person^{-1} day^{-1} in Birjand.[9] In Qaem Shahr, DSW production has been estimated at 242.2 g person^{-1} day^{-1},[6] while in Sari, Shahroud, and Yasuj, the rate has been reported to be 88, 80.8, and 72.2 g person^{-1} day^{-1}, respectively.[7, 11, 17] Therefore, it could be

inferred that DSW production in Iran is 60-80 g person^{-1} day^{-1}. The difference in the reported amounts of DSWs in various studies could be due to the differences in the research methodologies.

Table 3. Status of dental waste management in some cities in Iran

Location	Number of studied centers	Remarks	Ref.
Sistan and Baluchestan	159	In dental units, there are a few beneficial actions to reduce (3.3%), separate (36.6%) and recycle (3.8%) wastes. Wastes were daily collected by 98% and there were temporary storage facilities in 36% of dental centers. 38% of the centers used safety boxes and 56% of them used special colored containers to storage all kinds of wastes.	1
Qaem Shahr	21	In dental units, there are facilities for waste reduction (52.4%), separation (71.4%) and recycling (66.6%).	6
Hamadan	28	In private dental units, there are activities for waste reduction (0%), separation (0%) and recycling (12.5%), while in public dental units waste reduction (10%), separation (30%) and recycling (0%). Safety boxes were used in 16.7 and 40% of private and governmental centers.	3
Birjand	48	In just 20% of the clinics, a waste recycling plan was performed and, in 54% of the clinics, no action was done for reducing the generation of wastes. But waste separation was conducted at all the studied clinics.	9

The investigation of DSW management in Iran has been carried out by the direct sampling of DSWs and completion of questionnaires by dental staff, yielding variable results. The seasonal variations in the amount of the DSWs produced in Iran have also been observed, indicating that DSW production is higher in spring compared to winter due to the effects of weather and changes in daylight in different seasons.[1] In addition to the variable quantity, the composition of the DSWs in the cities of Iran has been reported differently (Table 4). Variables such as study design, type and procedure of the selected dental centers, and definition of infectious wastes affect the composition of DSWs.[4] Differences in the composition of the DSWs in the cities in Iran could be attributed to several factors, such as different hospital specializations, hospital size, economic, social, and cultural status of patients, waste management practices, and utilization of reusable materials.[1] Furthermore, the amount of the produced waste in general dentistry has been shown to be higher compared to specialist dentistry in Iran, with the of ratio 3:7.[3, 4]

Yellow leak-proof plastic bags should be used for the storage of infectious wastes, and collected wastes should be incinerated/autoclaved and landfilled eventually. Sharp objects should be collected in puncture-proof containers (safety boxes), incinerated/autoclaved, and landfilled. Pharmaceutical wastes could be collected in black plastic bags and disposed by encapsulation.[16] The reviewed studies indicated that the production rate of DSWs in Iran is extremely low.[3, 4, 8] The contents of DSWs are also smaller compared to municipal solid wastes; nevertheless, their effective management is considered vital.

According to the information in Table 1, infectious and common wastes constituted the most important components of DSWs. In various studies, the contribution of these components to total DSWs has been reported to be 80-90%. In Iran, ratio of infectious waste to the common waste of dental centers depends on the rate of waste separation. In the present study, the comparison of the remarks outlined in Table 3 with the ratios shown in Table 1 confirmed that by increasing waste separation in dental centers, the ratio of infectious wastes in total DSWs could decrease. In a research sample in Shahroud (Iran), it was stated that with the waste separation in dental centers, up to 46% of infectious wastes could be reduced.[7] Therefore, the prohibition of mixing multiple gradients of DSWs plays a key role in the management of DSWs. The separation of

various DSW components is considered to increasing the efficiency of DSW management in Iran.[1, 8] The rate of waste separation in Hamedan, Shiraz, and Gorgan has been reported in 30, 10, and 0% of dental clinics, respectively.[3, 10, 16] To increase the level of waste separation in dentistry in Iran, raising the awareness of staff regarding DSW management has been considered effective.[1] In Sistan and Baluchestan province, despite a training plan for staff in 57% of dental centers, only 36% of the centers perform appropriate waste separation.[1] Fig. 3 shows the ratio of DSW components in Iran based on the reviewed studies.

Table 4. Ratio of some components of dental wastes in Iran (%)

Type of waste	Ref.						
	5	4	6	9	10	8	12
Tooth extracted	0.41	2.59	2.74	-	0.06	0.64	27.4
Latex gloves	16.1	0.02	2.85	10.8	14.4	20.1	18.6
Mouth stick	3.08	-	-	3.6	3.88	4.81	8.12
Blood-contaminated waste	7.09	10	4	9.2	2.37	0.45	19.2
Plastic syringe	4.04	0.02	-	5.4	1.96	2.14	10.9
Nylon gloves	3.1	2.75	3.86	16.7	4.14	3.44	0.26
Suction tip	3.31	-	3.68	-	3.94	5.86	-
Needles and sharp objects	3.97	-	2.87	3	1.97	1.66	8.42
Dental mirrors	1.3	3.67	2.75	-	0.34	-	2.08
Saliva-contaminated waste	3.35	9.87	16	11.8	8.22	11.2	4.84
Paper and newspaper	5.38	-	-	13.4	1.97	5.37	-
Nylon	10.2	-	-	6.4	9.68	12.4	-
Consumed ampoule	6.47	0.81	-	-	-	7.1	-
X-ray film	0.27	3.16	-	-	0.54	0.02	-
Molding plaster	0.77	-	-	-	-	2.34	5.13
Amalgam-contaminated waste	-	0.05	-	-	-	0.27	-

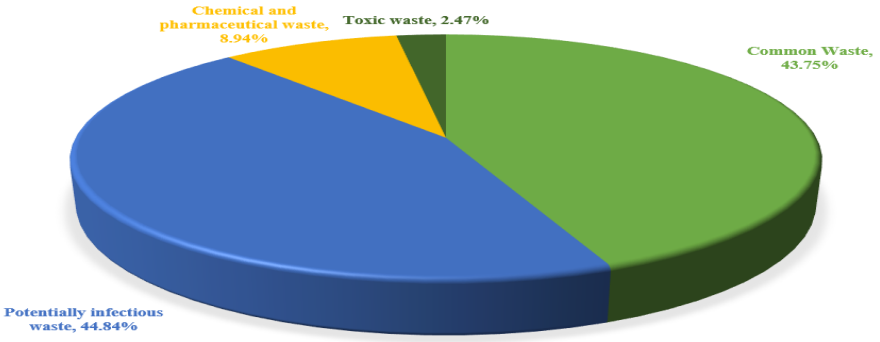

Fig. 3. Different ratios of dental waste components in Iran based on reviewed studies

In order to manage DSWs, some strategies could be considered with caution, including reduction, separation, reuse, and recycling. Waste reduction may be performed through less hazardous materials via smaller contents of packaging and generation of less materials.[2] The removal of some raw materials (e.g., amalgam) or the use of small amalgam capsules instead of powdered amalgam could be effective in the reduction of DSWs and their hazard potential in dental centers.[3, 8] In addition, reducing the use of disposable materials in dentistry has been proposed by researchers to reduce these wastes in Iran.[3, 14] However, the reports in Iran have indicated the lack of a DSW reduction plan in the studied cities, and the waste reduction programs in the dental centers of Sistan and Baluchestan, Urmia, and Qaem Shahr have been reported in 3.3, 0, and 52.3% of dental centers, respectively.[1, 4, 6]

Given the importance of the storage and proper collection of needles due to the risk of blood contamination, the use of safety boxes in dental centers is paramount, and the use of safety boxes in Sistan and Baluchestan, Hamedan, and Birjand has been reported to be 38.7, 40, and 100%, respectively.[1, 3, 9] In Iran, the management of DSWs in public centers is more efficient compared to private centers. For instance, the use of safety boxes has been reported in all the public dental centers in Gorgan, while only 20% of the private centers use safety boxes.[10] The recycling of recyclable DSWs could improve the status of DSW management in Iran. In addition, the recycling of DSWs is effective in the reduction of environmental pollution. For instance, the lack of amalgam recycling system may lead to the release of various environmental contaminants, thereby threatening human health. However, there have been no plans for amalgam recycling in any of the dentistry centers in Sistan and Baluchestan.[1] This deficiency has also been observed in DSW management in the other cities in Iran, while the amalgam recycling program in Qaem Shahr, Birjand, and Shiraz has been reported in 66, 20, and 10% of the dental centers, respectively.[6, 9, 16] On the other hand, no amalgam recycling activities have been reported in Gorgan and Hamedan.[3, 10]

Conclusion

The status of DSW management in Iran was reviewed in this study, and few studies have been focused on DSW in proportion to the Iranian population. In total, 15 articles regarding this issue had good distribution in different locations of Iran. All the articles and studies regarding DSWs in Iran provided a report on the quantity and proportion of DSW components, while none of the interventional studies aimed at improving or changing the current situation. This could be due to the unavailability of official data or the lack of cooperation between scholars and organizations. The DSW production rate in Iran has been estimated at 60-80 g person^{-1} day^{-1}, 90% of which consists of common and infectious wastes. According to the results, the lack of the proper separation of DSWs in Iran and their mixed storage has increased the proportion of infectious wastes ratio in DSWs. In addition, the less common use of safety boxes, which has been reported to between 0% and the maximum of 50%, increases the potential for disease spread and risk of injuries during the collection and disposal of DSWs in Iran. The lack of a DSW reduction program and inattention to recycling also lead to increased costs and risks in the management of DSWs in Iran. By increasing the research in Iran in this regard and efforts to implement waste reduction programs, waste segregation and recycling could increase, thereby improving the DSW management status in Iran.

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Ethical Issues

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies were completely observed by the authors.

Author Contributions

Conceptualization: Javad Torkashvand, Mahdi Farzadkia and Ahmad Jonidi Jafari; methodology: Javad Torkashvand, Hasan Pasalari and Jamal Mehralipour; investigation: Majid kermani, Ahmad Ghalkhanbaz and Javad Torkashvand; data curation: Javad Torkashvand and Ahmad Jonidi Jafari; writing, original draft preparation and review and editing: Hasan Pasalari, Javad Torkashvand, Jamal Mehralipour, Mahdi Farzadkia, Ahmad Ghalkhanbaz and Majid kermani; supervision: Mahdi Farzadkia. All authors have read and agreed to the published version of the manuscript.

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