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Original article

Medical Waste Management in Primary Health Care Centers, Tripoli

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A B S T R A C T

Medical waste management (MWM) is a critical public health and environmental concern, given the potential hazards posed by improperly handled biomedical materials. Inadequate management of such waste can lead to severe consequences, including disease transmission, environmental contamination, and occupational risks for healthcare workers and waste handlers. To assess different medical waste management practices in primary health care centers (PHCCs) in Tripoli, Libya. A cross-sectional study for 35 primary health care centers in the seven municipalities of the Tripoli district was conducted between 1st February 2023 and to end of June 2023. The Majority of PHC (97%) have at least one trash bag in each room; however, only 20% of them use colored trash bags to collect infected medical wastes. Also, the majority of primary health care facilities use safety boxes for the collection of sharp medical wastes; however, they also use plastic tanks instead of or in addition to safety boxes. In addition, to majority of safety boxes were filled more than three-quarters. Medical waste management practices in Tripoli's PHCCs are inadequate, posing significant risks. Urgent intervention is needed, focusing on training, provision of supplies, and establishing a centralized waste management system.

Introduction

Medical waste management is a critical public health and environmental concern, given the potential hazards posed by improperly handled biomedical materials. Medical waste, encompassing infectious, hazardous, pharmaceutical, and sharps waste, is generated extensively in healthcare facilities, laboratories, and research centers [1]. Inadequate management of such waste can lead to severe consequences, including disease transmission, environmental contamination, and occupational risks for healthcare workers and waste handlers. Globally, an estimated 85% of healthcare waste is classified as non-hazardous, while the remaining 15% poses toxic, infectious, or radioactive threats, demanding specialized treatment [2].

Despite advancements in waste treatment technologies—such as incineration, autoclaving, and chemical disinfection—significant gaps persist in implementation, particularly in low- and middle-income countries. For instance, a study by Windfeld and Brooks [3] highlighted that 58% of developing nations lack infrastructure for safe medical waste segregation and disposal, exacerbating pollution and public health risks. The COVID-19 pandemic further strained systems, with a 30–40% surge in medical waste generation due to increased use of single-use protective equipment [4]. Effective management strategies must balance regulatory compliance, cost-efficiency, and sustainability, integrating innovations like waste-to-energy systems and circular economy principles [5]. This paper examines current practices, challenges, and emerging solutions in medical waste management in Libya's primary healthcare facilities that function under conditions of political instability and fragmented infrastructure. This research identifies systemic gaps, evaluates environmental and occupational hazards, and creates tailored strategies to protect public health in conflict-affected areas. This study was conducted to assess different medical waste management in primary health care centers in Tripoli, Libya.

Methodology

Study design and setting

A cross-sectional descriptive study for 35 primary health care centres in the seven municipalities of the Tripoli district was conducted between 1st February 2023 and to end of June 2023.

Study tool

According to two WHO documents on management of medical wastes from health care facilities [6,7] a questionnaire was designed to assess 35 different primary care center which selected randomly from the seven municipalities of Tripoli; the questionnaire divided into five parts: part one includes question regarding name of the center, it is type, geographical location, and type of services provide by each center. the second section includes the collection and segregation of medical waste, the Third section includes the handling and transportation of medical waste, the fourth section includes the final disposal of medical waste, and the

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final section includes the assessment of transporters in terms of their training and their tool to transport the medical waste.

Statistical analysis

Data were analyzed by using IBM SPSS Statistics for Windows, version 16. Descriptive statistics were used to present all results.

Result

The majority of primary health care centers (71%) were polyclinics, and 20% were golden primary centers in which comprehensive health services were provided to a high volume of patients, as shown in Table 1.

Table 1. Types of primary health care centers which included in the study

Location of primary care center	Number (%)
OPD	3 (8.6%)
Polyclinics	25 (71.4%)
Golden PHC	7 (20%)

The geographical distribution of primary health care centers across the Tripoli district, in Table 2, reveals a notable concentration in Abu Salem and Ein Zara, each hosting 23.5% of the total centers. Hai Al Andaluse follows with 17.6%, while Tripoli Center accounts for 11.8%. Tajoura and Souq Aljomhua each represent 8.8%, and Janzour has the lowest share at 5.9%. This uneven distribution suggests that certain municipalities, particularly Abu Salem and Ein Zara, are better served in terms of facility presence, potentially reflecting population density or administrative prioritization.

Table 2. The geographical distribution of each center within the seven municipalities of the Tripoli district

Location of primary care center	Number (%)
Tripoli Center	5 (11.8%)
Hai Al andaluse	6 (17.6%)
Abu Salem	8 (23.5%)
Janzour	2 (5.9%)
Tajoura	3 (8.8%)
Souq Aljomhua	3 (8.8%)
Ein Zara	8 (23.5%)

In terms of service provision, the majority of centers across all municipalities offer general health services, parental injections, wound dressing, and laboratory investigations, indicating a baseline of essential care. However, disparities emerge in specialized services. For instance, maternal and child health (MCH), school health, dental care, and vaccination services are present in most areas but show gaps in consistency, with some centers lacking these offerings entirely. Radiological investigations and renal dialysis are the least available services, with only a few centers—primarily in Abu Salem—providing them, highlighting a critical shortage in advanced diagnostic and chronic care capabilities (Table 3).

Table 3. Types of medical services provided by primary health care centers in each area of Tripoli

Types of services			Location of primary care centers in Tripoli						
		Tripoli Center	Hi Al andaluse	Abu Salem	Janzour	Tajoura	Souq Aljomhua	Ein Zara	Total
General Health	Present	4 (11.8%)	6 (17.6%)	8 (23.5%)	2 (5.9%)	3 (8.8%)	3 (8.8%)	8 (23.5%)	34 (100%)
	Absent	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
Parental injection (IM or IV)	Present	5 (14.7%)	5 (14.7%)	8 (23.5%)	2 (5.9%)	3 (8.8%)	3 (8.8%)	8 (23.5%)	34 (100%)
	Absent	0 (0%)	1 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
Wound dressing	Present	5 (15.6%)	6 (18.8%)	7 (21.9%)	2 (6.2%)	3 (9.4%)	2 (6.2%)	7 (21.9%)	32 (100%)
	Absent	0 (0%)	0 0%)	1 (33.3%)	0 (0%)	0 (0%)	1 (33.3%)	1 (33.3%)	3(100%)
Laboratory investigation	Present	5 (15.6%)	6 (18.8%)	7 (21.9%)	2 (6.2%)	3 (9.4%)	1 (3.1%)	8 (25%)	32 (100%)
	Absent	0 (0%)	0 (0%)	1(33.3 %)	0 (0%)	2 (66.7%)	0 (0%)	0 (0%)	3 (100%)

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MCH	Present	4 (14.3%)	5 (17.9%)	8 (28.6%)	2 (7.1%)	2 (7.1%)	2 (7.1%)	5 (17.9%)	28 (100%)
	Absent	1 (14.3%)	1 (14.3%)	0 (0%)	0 (0%)	1 (14.3%)	1 (14.3%)	3 (42.9%)	7 (100%)
School Health	Present	3 (11.5%)	3 (11.5%)	7 (26.9%)	2 (7.7%)	3 (11.5%)	3 (11.5%)	5 (19.2%)	26 (100%)
	Absent	2 (22.2%)	3 (33.3%)	1 (11.1%)	0 (0%)	0 (0%)	0 (0%)	3 (33.3%)	9 (100%)
Dental services	Present	3 (12.5%)	2 (8.3%)	8 (33.3%)	2 (8.3%)	2 (8.3%)	2 (8.3%)	5 (20.8%)	26 (100%)
	Absent	2 (22.2%)	2 (22.2%)	1 (11.1%)	0 (0%)	1 (11.1%)	2 (22.2%)	1 (11.1%)	9 (100%)
Vaccination	Present	4 (14.3%)	5 (17.9%)	8 (28.6%)	2 (7.1%)	2 (7.1%)	2 (7.1%)	5 (17.9%)	24 (100%)
	Absent	2 (18.2%)	4 (36.4%)	0 (0%)	0 (0%)	1 (9.1%)	1 (9.1%)	3 (27.3%)	11 (100%)
Radiological investigation	Present	0 (0%)	0 (0%)	4 (57.1%)	0 (0%)	1 (14.3%)	0 (0%)	2 (28.6%)	7 (100%)
	Absent	5 (17.9%)	6 (21.4%)	4 (14.3%)	2 (7.1%)	2 (7.1%)	3 (10.7%)	6 (21.4%)	28 (100%)
Renal dialysis	Present	0 (0%)	0 (0%)	1 (28.6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (100%)
	Absent	5 (15.2%)	6 (18.2%)	7 (21.2%)	2 (6.1%)	3 (9.1%)	3 (9.1%)	7 (21.2%)	28 (100%)

In table 4, about 34 (97.1%) of primary health care centers have each room with its own trash bag to collect medical waste, and only one center (2.9%) has rooms without a trash bag. However, only 20% of primary care centers that were included in the study use colored trash bags in order to segregate medical waste in their centers.

Table 4. Demonstrates the use of colored trash bags, as colors reflect types of medical waste

Use of a colored trash bag	Number of primary care centers (%)
Yes	7(20%)
No	28(80%)

For the medical services (laboratory services and parental room injection, dental services, vaccination room, renal dialysis room) that use needles and sharp objects as part of their services, all of health facilities mentioned they never trough sharp objects in trash bag even though some of them they did not have sharp box, this led them to use plastic tanks to collect sharp objects.

Table 5. Demonstrates the presence of a safety box in the rooms that provide medical services need to dispose of sharp objects

Presence of a Safety box	Parental injection (IM or IV)	Laboratory investigation	Dental services	Vaccination room	Renal dialysis
Yes	32(94.1%)	30(93.8%)	24(92.3%)	22(91.7%)	1(50%)
No	2(5.9%)	2(6.2%)	2(7.7%)	2(8.3%)	1(50%)

Table 6. Shows use of plastic tanks instead of or in addition to a safety box in the rooms that provide medical services need to dispose of sharp objects.

Presence of plastic tanks	Parental injection (IM or IV)	Laboratory investigation	Dental services	Vaccination room	Renal dialysis
Yes	9(62.5%)	8(25%)	9(34.6%)	8 (33.3%)	2(100%)
No	25(37.5%)	24(75%)	17 (65.4%)	16 (66.7%)	0 (00%)

Table 7. Demonstrates the use of safety box to dispose sharp objects by health care workers in the rooms that provide medical services need to dispose sharp objects

Use of a sharp box as a way of disposal of sharp objects	Parental injection (IM or IV)	Laboratory investigation	Dental services	Vaccination room	Renal dialysis
Yes	29(85.3%)	27(84.4%)	22(84.6%)	21(87.5%)	1 (50%)
No	5(14.7%)	5(15.6%)	4 (15.4%)	3(12.5%)	1 (50%)

The majority of safety boxes were filled to more than three-quarters, as shown in the table below.

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Table 8. Demonstrates filling of the safety box more than its three quarter in the rooms that use the safety box

Filling of the safety box > is three-quarters	Parental injection (IM or IV)	Laboratory investigation	Dental services	Vaccination room	Renal Dialysis
Yes	20(62.5%)	18(60%)	14(58.3%)	12(54.54%)	1(50%)
No	12(37.5%)	12(40%)	10 (41.6%)	10(45.45%)	1(50%)

Table 9. Demonstrates disposal of infected material (gauze, cotton, swabs) that are contaminated by body fluids and secretions

Dispose of material that is contaminated by body fluids and secretions	Parental injection room (IM or IV)	Laboratory investigation	Dental services	Vaccination room	Wound dressing	Renal Dialysis
Trash box	5(14.7%)	5(15.6%)	4 (15.4%)	5(20.8%)	4 (12.5%)	0 (00%)
Black trash bag	12 (35.3%)	10 (31.2%)	9 (34.6%)	9 (37.5%)	12 (37.5%)	1(50%)
Colored trash bag	6 (17.6%)	7 (21.9%)	6 (23.1%)	5 (20.8%)	7 (21.9%)	1(50%)
Other ways (safety box)	11 (32.4%)	10 (31.2%)	7(26.9%)	5 (20.8%)	9 (28.1%)	0 (00%)

For liquid medical wastes, 25% discard blood and urine samples into the sewage system, and 50% of primary care centers that provide dental services dispose their liquid wastes into the sewage system, as shown below

Table 10. Demonstrates ways of disposal of liquid medical waste (urine sample) In laboratory rooms in primary care centers

Dispose of liquid medical waste (urine sample)	Laboratory investigation room
Medical trash bag	4(12.5%)
Trash box	8 (25%)
Sewage system	8(25%)
Safety box	12 (37.5%)

Table 11. Demonstrates ways of disposal of liquid medical waste (blood sample) in laboratory rooms in primary care centers

Dispose of liquid medical waste (blood sample).	Laboratory investigation
Medical trash bag	5(15.6%)
Trash box	2 (6.2%)
Sewage system	8(25%)
Safety box	1 7(53.1%)

Table 12. Demonstrates ways of disposal of liquid medical waste in dental room services in primary care centers

Dispose of liquid medical waste	Dental services
Medical trash bag	3(11.5%)
Safety box for liquid medical waste	8(30.8%)
Sewage system	13 (50%)
Safety box	2 (7.7%)

Regarding the transportation of medical waste, only 17% of primary care centers have a vehicle for medical waste, as shown below.

Table 13. Demonstrates the use of colored trash bags, as colors reflect types of medical waste

Transportation of medical waste	Number of primary care centers (%)
Use of a special vehicle	6(17.1%)
Carried by the transporters' hands	29(82.9%)

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Discussion

This study offers a critical evaluation of medical waste management (MWM) practices within primary healthcare centers (PHCCs) in Tripoli, Libya. The results reveal a significant disconnect between the provision of essential medical services and the adherence to safe, standardized MWM protocols. When placed in the context of the global literature, these findings are alarmingly consistent with challenges faced by many low- and middle-income countries (LMICs), underscoring a pervasive public health and environmental issue.
The near-universal availability of safety boxes (100%) appears, at first glance, to be a positive finding. However, the prevalent use of plastic tanks across various service units (25% to 100%) severely undermines this infrastructure. This dangerous practice of using unsuitable containers for sharps is not isolated. A study in Bangui, Central African Republic, on management of biomedical waste in two medical laboratories shows that only 29% of the services used safety boxes, significantly increasing the risk of needle stick injuries [8]. Similarly, research in Nigeria reported that the use of containers that are not puncture-proof or sharps collection as a common and dangerous practice [9]. This consistent trend across different regions highlights a critical gap in the supply chain and procurement of essential safety equipment in resource-constrained settings.
The overfilling of safety boxes beyond their three-quarter capacity was another critical failure point observed in over half of the units. This finding is directly comparable to a study in Palestine, where 58% of safety boxes in PHCCs were overfilled, negating their safety purpose and exposing staff to risk (10). This suggests a broader issue of inadequate waste management training and a lack of monitoring and supervision, rather than a simple lack of equipment.
The improper segregation of waste is a fundamental issue in MWM research. Our finding that only 20% of centers used color-coded bags is starkly low. This compares favorably with a study in Somalia, which found that more than 60% of healthcare facilities lacked proper waste segregation systems, and many reported insufficient color-coded or covered bins [11]. The widespread disposal of infectious, soiled materials into general trash bins or unmarked bags reflects results from a systematic review of waste management practices in the healthcare sector in many countries, where improper segregation was the norm due to a lack of awareness and enforcement [12]. This failure at the source complicates all subsequent waste handling, treatment, and disposal, multiplying the risks of infection and environmental contamination.
The disposal of liquid waste, particularly the practice of discarding blood and urine samples into the sewage system (25%), presents a severe environmental hazard. This is a significant point of divergence from recommended practices. A recent systematic review emphasized that liquid waste should be treated on-site with disinfectants before disposal to prevent pathogen transmission into water tables [13].
Finally, the transportation of waste by general transporters (82.9%) without special vehicles is a major risk for community exposure. This finding is consistent with research from Dolj, Romania, where informal and unsafe transportation of medical waste was common, often leading to illegal dumping and scavenging [14]. This underscores the absence of a structured, municipal, or regional system for the collection and treatment of medical waste, placing the burden and risk on individual facilities and their untrained staff.

Conclusion and Recommendations

In conclusion, the MWM practices in Tripoli's PHCCs are characterized by critical deficiencies that align with the documented challenges in other LMICs. The reliance on poor segregation, unsafe liquid and sharp waste disposal, and informal transportation creates a dangerous cycle of risk for healthcare workers, the public, and the environment. Improving medical waste management requires a comprehensive and coordinated strategy grounded in successful global practices. Central to this effort is the adoption of standardized protocols and ongoing training that prioritize practical, low-cost solutions, drawing on effective models like those developed by the WHO in rural Africa. Ensuring a stable supply of essential materials, such as safety boxes and color-coded bags, is equally crucial, with local production offering a promising path to sustainability as seen in Southeast Asia. Establishing centralized treatment facilities equipped with autoclaving technology and supported by dedicated collection services can significantly mitigate health and environmental risks, especially in urban areas. To maintain progress, strong monitoring and accountability systems must be integrated into primary care structures, with regular audits and feedback mechanisms inspired by successful initiatives in Jordan. Ultimately, medical waste management is not a standalone concern but a key component of quality healthcare and sustainable development, reflecting a broader commitment to safety, efficiency, and responsible stewardship.

Conflict of interest. Nil

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