

IMPROVEMENT OF MEDICAL WASTE STORAGE PROCEDURES

Sančanin Branislav,¹ Sančanin Aleksandra²

¹ Union - Nikola Tesla University - Belgrade, Faculty of Management, Sremski Karlovci, Serbia

² Oncology Institute of Vojvodine, Sremska Kamenica, Serbia

Primljen/Received 29. 01. 2023. god.

Prihvaćen/Accepted 13. 02. 2023. god.

Abstract: Medical waste is all waste generated by healthcare institutions related to the performance of medical-technical actions in the field of diagnostics, therapy, or research activities. The adequate disposal of medical waste is an issue for virtually all South-eastern European countries primarily because these countries lack the necessary capacities for removing medical waste. The paper aims to review the results and experiences of treating medical waste, as well as the potential risks to patients and medical and non-medical personnel. Implementing a safe medical waste management system could significantly improve the quality of healthcare services and the health of patients, and preserve the environment. The use of steam sterilization has been suggested to reduce the content of biological agents in the waste to an acceptable level by thermal treatment, that is, to achieve biological inactivation.

Keywords: medical waste, storage, procedures, sterilization.

INTRODUCTION

Medical waste includes four types of waste: infectious waste, biohazard waste, pharmaceutical waste, and radioactive isotopes. Infectious waste includes all items that have been in contact with patients' blood (needles, syringes, bandages, gauze, scalpels, *etc.*), while biohazard waste includes organs, tissues, and amputated body parts, which are stored in cold storage and buried in city cemeteries under the supervision of sanitary inspection. Medicinal products returned from health institutions, as well as those that have expired, are classified as pharmaceutical waste. Radioactive isotopes are the remains of substances used in diagnostics and therapy and which, although unusable, contain a smaller or larger quantity of radioactivity (1).

The increase in the number of inhabitants in the European Union (EU) has been accompanied by an increas-

ing amount of waste. EU countries discard 1.3 billion tons of waste annually, of which 40 million tons belong to the category of hazardous waste, while more than 700 million tons originate from agriculture. This is a big challenge faced by EU countries, with a clear task to ensure the treatment and disposal of waste without any negative effects on human health and the environment (2).

The overall opinion is that waste generated in healthcare institutions is a mixture of municipal waste and hazardous medical waste resulting from the provision of healthcare services. Hazardous waste has the following characteristics that distinguish it from municipal waste: harmfulness, toxicity, carcinogenicity, and infectivity.

Harmfulness is reflected in a substance or waste that, when swallowed or inhaled or when it penetrates the skin, can cause danger to human health.

Toxicity means a substance or product that may contain toxic ingredients, which in case of inhalation, ingestion, or skin penetration, can cause severe, acute, and chronic health risks, even death.

Carcinogenicity encompasses substances or products that, if inhaled, swallowed, or when they penetrate the skin, can cause cancer or increase its spread.

Infectivity means substances or waste containing living microorganisms and their spores or toxins that we know or suspect cause disease in humans and other living organisms (3).

Ugrinov and Stojanov (3) indicate that medical waste includes all types in solid and liquid form, from hospitals, clinics, research institutions, and laboratories working within a health system. However, it should be noted that between 70 and 90 percent of medical waste is actually municipal waste.

The projection of the creation of medical waste in the Republic of Serbia depends on many factors, but the expected amount by 2030 is around 5 000 tons (4).

In most healthcare institutions, infectious waste, used needles, tampons, gauze, infusion systems, *etc.*, are

not separated from conventional garbage but are thrown together into plastic baskets and/or stronger polyethylene bags. Veterinary stations and clinics generate a certain quantity of biohazardous waste, which is disposed of in pits or burned in an uncontrolled manner (5).

It is necessary for the personnel in charge of medical waste management in healthcare institutions to acquire new knowledge and skills continuously, and to influence a reduction in medical waste, its classification, collection, storage, transport, processing, and temporary or final disposal. This means that, among other things, they must be provided with professional instructions and recommendations regarding the application of adequate methods and techniques for waste management. An important segment of their work is timely and comprehensive risk assessment, as well as the application of adequate prevention measures.

Appropriate management of medical waste can reduce total generated waste, as well as hazardous waste generated during the performance of healthcare activities. Therefore, medical waste is generated during diagnosis, treatment, or provision of medical care, but also during research conducted at health institutions. In this respect, we mean all waste generated, both in healthcare institutions and outside them, for example, during home care, in institutions for the accommodation of the elderly, or in institutions that provide any form of medical care.

Contamination of the environment by radioactive substances implies the presence of radionuclides in concentrations that exceed certain values. The level of radioactive contamination in imported food, medicines, medical aids, items in general use, and other goods must not be higher than that permitted for similar household items (5).

CLASSIFICATION OF MEDICAL WASTE

There are several criteria for sorting waste, but the most commonly used division is into non-risky and hazardous waste. Sorted medical waste is packed in accordance with the space that regulates the storage, packaging and labeling of hazardous waste. For certain types of medical waste, the packaging is managed in the following manner (6):

- communal waste - in black bags;
- sharp objects - in yellow containers (the bag is filled up to $\frac{3}{4}$, after which it is closed);
- pathoanatomical waste - in brown bags;
- infectious waste - in yellow bags or containers (the bag is filled up to $\frac{3}{4}$, after which it is closed);
- waste contaminated with blood and bodily fluids - in double bags or yellow containers.

Non-hazardous waste

A characteristic of non-hazardous waste is its similarity to waste generated in households. These include, for example, paper, glass, plastic, food, and wood (recyclable materials).

Hazardous waste

Hazardous waste is all waste with one of the above characteristics: explosiveness, flammability, corrosibility, and toxicity, which represents an additional risk to health and the environment. This also includes waste from radiology.

The World Health Organization divides medical waste into several groups (7):

1. Infectious: Complete waste contaminated with body fluids and especially blood, as well as infectious agents resulting from laboratory activities and waste from patients with infections;

2. Sharp objects: Any object that is used to pierce the skin and comes into contact with biologically hazardous substances as scalpels, needles, wires, lancets, blades, *etc.*;

3. Pathological: This group refers to samples taken from patients for laboratory analysis as organs or fluids, human tissues, body parts, and contaminated animal carcasses;

4. Radioactive: This includes products contaminated with radionuclides;

5. Chemicals: Healthcare facilities use a variety of chemicals to ensure adequate sanitation. Chemical waste such as solvents and reagents used for laboratory preparations, disinfectants, sterilization agents, and heavy metals contained in medical devices and batteries;

6. Pharmaceutical products: This category of waste includes used and unused medicines, vaccines, injections, as well as expired medicines and contaminated medicines;

7. Cytotoxic/genotoxic properties: This category represents one of the most dangerous forms of medical waste: it contains substances with genotoxic properties meaning that they are mutagenic, teratogenic, or carcinogenic;

8. Non-hazardous general waste: It is waste that does not potentially a risk to human health.

According to data from the World Health Organization, due to inadequate disposal of needles and syringes, 21 million people in the world were infected with the Hepatitis B virus, of which 32% were newly discovered cases, while two million were diagnosed with Hepatitis C, of which 40% were newly discovered, and 250 000 with a confirmed HIV infection, which is 5% of all newly diagnosed cases (8).

The amount of hazardous medical waste increases annually and threatens to seriously endanger the environment. This is one of the most important reasons that ever more attention is being paid to the disposal of medical waste. Thanks to scientific and technological discoveries, as well as raising environmental awareness to a higher level, significant progress has been made with three objectives in mind:

- To avoid, *i.e.*, reduce medical waste;
- To be used, *i.e.*, recycled and
- To be processed and finally disposed of in a safe manner.

The World Health Organization recommends incineration as a method of medical waste disposal. This method is promoted because it reduces its volume by 90% and destroys microorganisms. Savings are achieved due to a reduction in transport costs while the energy obtained this way can be used for heating (space, water, *etc.*). In addition to the above, a significant benefit is reflected in the efficiency of the method as incineration safely neutralizes the potential danger of infection.

However, it should be noted that incineration as a method also carries certain dangers, which are reflected in the emission of harmful and dangerous gases, while in some cases, improper disposal of ashes is a danger considering that ashes can have the properties of hazardous waste.

With the support of the European Union, a project was implemented at the Clinical Center of Kragujevac that marked a turning point in the treatment of medical waste, *i.e.*, the application of steam sterilization in a vacuum under pressure. This method transforms medical waste into harmless waste for human health

and the environment, and it is achieved by the process of heat treatment up to the level of acceptable reduction of biological agents in the waste (inactivation of spores defined by the test at $4 \log^{10}$ or a higher level of reduction). Only after that process, medical waste is acceptable for sanitary disposal, provided that its origin cannot be recognized (9).

CATEGORIES OF MEDICAL WASTE FROM THE EUROPEAN CATALOG

The European Commission adopted a single European waste catalog to introduce common terminology and improve waste management (Council directive No. 2000/532/EC, 1994). This document is a list of waste and is not final but is periodically supplemented and changed.

In the European Catalog of waste, medical waste is defined as waste generated in medicine and veterinary medicine during the provision of health care and bears the number 18 00 00 with subsets (10).

Subsection No. 18 01: Waste from hospitals and/or health centers, waste generated during diagnosis, treatment, or preventive health services for people (in human medicine).

Subsection 18 02: Waste generated during the provision of veterinary healthcare.

Source: (11)

The European Waste Catalog defines each type of waste through a six-digit numbering (example 18 01 03). In the case of some categories of waste, in addition to the classification number of six digits, an asterisk from the numbers is categorized as hazardous waste (example: 18 01 03*, Infectious waste).

Table 1. Waste generated in healthcare institutions (human medicine)

18 01 01*	Sharp objects (not included 18 01 03)*)
18 01 02	Body parts and organs, bags with blood and blood derivatives (not included 18 01 03*)
18 01 03*	Infectious waste is waste that is subject to special requirements to prevent the spread of infection
18 01 04	Non-infectious waste
18 01 06*	Chemical waste with hazardous substances
18 01 07	Other chemical waste
18 01 08*	Cytotoxic drugs and cytostatics
18 01 09	Medicines except those from 18 01 08
18 01 10	Amalgam waste in use in dentistry

Table 2. Waste generated by veterinary institutions

18 02 01	Sharp instruments (not included 18 02 02)
18 02 02*	Waste is subject to special requirements due to infection
18 02 03	Waste that is not subject to special requirements to prevent infection
18 02 05*	Chemicals that contain or are hazardous substances
18 02 06	Different chemicals compared to 18 02 05
18 02 07*	Cytotoxic and cytostatic drugs
18 02 08	Other medications from those listed in 18 02 07

MEDICAL WASTE STORAGE

Before organizing the transport, treatment, or handing over of hazardous medical waste, it is required that this waste be stored in a location that is predetermined and arranged only for that purpose.

The location for the storage of medical waste must be fenced in and must represent a separate area or facility known to the personnel involved and intended exclusively for that purpose. The storage space should meet the following conditions:

1) to be of adequate size in relation to the quantity of waste produced and its frequency of collection and removal;

2) to have water supply and drainage for cleaning and maintenance purposes;

3) to be clearly and visibly marked with a notification of the purpose of the space, prohibition of entry by unauthorized persons, as well as a warning about the possibility of endangering people's health;

4) to be built to have impermeable and resistant floor surfaces, as well as smooth wall surfaces that are easy to clean and disinfect;

5) to be easily accessible to health service personnel in charge of waste management;

6) to be locked, that is, to prevent access to unauthorized persons;

7) to be easily accessible to carts and waste collection containers inside health service and waste transport vehicles;

8) to be inaccessible to animals and other carriers of infectious agents;

9) to be well-lit and equipped with natural or artificial ventilation;

10) to ensure protection from atmospheric influences;

11) to be sufficiently removed from fresh food storage and food preparation areas, patient and visitor routes;

12) to have fire protection in accordance with separate regulations.

The place for storing infectious waste must be disinfected at least once a week and more often, if necessary. Pharmaceutical waste is always stored separately from other types of medical waste, and unused medicines from facilities where health care is provided should be stored in a separate area or a room in those facilities. To avoid unwanted chemical reactions, chemical waste of different compositions should be stored separately. Cytotoxic and cytostatic waste is stored in separate rooms, spaces, or facilities, separate from other types of medical waste. Spilled, contaminating drugs, as well as packages containing drug residues from facilities where health care is provided, are

packed in adequate packaging, at the place of origin, before storage (12).

The issue of treating household medical waste is particularly important. Namely, home care services are crucial for helping patients who, for objective reasons, are unable to go to a health facility on their own, and in this sense, there is a continuous need to protect medical staff, patients, and their families. The results of research carried out in Brazil between December 2020 and January 2021 warn that the main weaknesses are the lack of training of healthcare workers and the absence of instructions that should be shared with patient caregivers regarding the treatment of medical waste. In addition to sharp waste, all other households' medical waste management practices have also been shown to be inadequate and pose a threat (13).

European Union legislation in the field of medical waste management

The countries of the European Union are the largest exporters, but also importers of waste categorized as non-hazardous, before the USA and China, and therefore it is one of the relevant topics to which great attention is paid. Therefore, it is expected that other important goals are recognized through the shipment of waste, such as ensuring maximum safety for people and the environment, and it applies to all international shipments for all purposes, inside or outside the EU. The European Union incorporated the Basel Convention on the Control of Transboundary Movement of Hazardous Waste and its Disposal. In this way, the convention is applied in all EU member states (14).

The modern medical waste management system is based on a strictly defined treatment of waste: from its origin to the location designated for disposal. Implementing the complete management of a large amount of municipal waste could require fewer funds for disposing of medical waste, which is the task of the legal framework and concrete implementation in practice.

European Union's foundation for waste management policy is the Resolution of the Council of Europe on waste management strategy (97/C76/01), which is based on the framework waste directive (75/442/EEC) and other regulations on waste management in the EU.

Five basic principles were established (15):

- Hierarchy of waste management;
- Self-sustaining disposal facilities;
- The technology that is the most adequate in the given circumstances;
- Proximity to waste disposal;
- Manufacturer's responsibility.

The European Union has ambitions to regulate as many activities as possible that affect its function-

ing with laws and regulations. That is precisely why today in the EU legislation, we have legislation that effectively regulates the situation and directs waste management. In this context, five profiled categories are differentiated, where the first is the General Framework, which includes strategies and measures related to the reduction of certain types of waste, and decisively states the types of landfills, as well as methods for continuous disposal control. Other categories are focused on the characteristics of waste and its management.

Specificity waste category deals with the treatment and disposal of oil, metal and packaging waste, old tires, sewage water, batteries and accumulators, electrical and electronic waste, as well as PVC, which is seen not only through the problem of a long half-life, but and because of its composition.

The hazardous waste category defines the process of managing that waste, specifying the actions of waste separation, treatment, and disposal. The segment of the Regulation on the transport of said waste, known as the Basel Convention, is particularly emphasized here.

Although treated as hazardous waste, *radioactive waste and radioactive substances* are separately separated, given that this type of waste is subject to special legislation, from the management of waste nuclear fuel and radioactive waste, to the transportation of such waste and to rigorous control to protect against ionizing radiation.

The incineration of the waste category is considered the method of choice in the final treatment of waste, and the reason is that it ensures the most significant reduction in the volume of waste and toxic substances and is also considered the most beneficial for human health and the environment (16).

Sažetak

UNAPREĐENJE PROCEDURA ZA SKLADIŠTENJE MEDICINSKOG OTPADA

Sančanin Branislav,¹ Sančanin Aleksandra²

¹ Univerzitet "Union - Nikola Tesla" - Beograd, Fakultet za menadžment - Sremski Karlovci, Srbija

² Institut za onkologiju Vojvodine, Sremska Kamenica, Srbija

Pod medicinskim otpadom podrazumevamo celokupan otpad nastao u zdravstvenim ustanovama, a koji je u vezi sa obavljanjem medicinsko-tehničkih radnji u oblasti dijagnostike, terapije ili istraživačkih aktivnosti. U gotovo svim zemljama jugoistočne Evrope odlaganje medicinskog otpada ne obavlja se na odgovarajući način, pre svega jer ne postoje potrebni kapaciteti za uklanjanje medicinskog otpada. Cilj rada je sagledavanje rezultata i iskustava u tretmanu medicinskog otpada, kao i potencijalnih rizika za pacijente,

CONCLUSION

Pollution from healthcare institutions can be dangerous for the health of those who work in those institutions, the patients, as well as for the environment. Precisely due to the potential danger, a strict obligation to properly handle medical waste has been imposed.

The method of disposal and storage of medical waste represents one of the biggest challenges, as it must be safe and efficient and should not endanger the environment. Concern for the safe management of medical waste should be the most important guide when collecting, storing, disposing, and transporting waste.

Of crucial importance is the obligation to create rehabilitation programs that offer technologically safe and environmentally acceptable solutions for all future locations. It is necessary to further affirm the approach according to which rehabilitation is carried out at the location itself, whereby it is expected that the rehabilitation program is harmonized with the spatial and urban plans of the local community within whose territory the disposal area is located.

In addition, it is necessary to create as many opportunities as possible for the reuse of materials, as well as to establish a concept of continuous site monitoring accompanied by regular reporting.

Acknowledgment: None.

Conflict of Interests: The authors declare no conflicts of interest related to this article.

Funding: None

Licensing: This work is licensed under a Creative Commons Attribution 4.0 International (CC BY4.0) License.

medicinsko i nemedicinsko osoblje. Implementacija bezbednog sistema upravljanja medicinskim otpadom moglo bi značajno da unapredi kvalitet zdravstvenih usluga, zdravlje pacijenata i sačuva okruženje. Sugerise se upotreba sterilizacije parom, kako bi se termičkom obradom na prihvatljiv nivo sveo sadržaj bioloških agenasa u otpadu, odnosno dostigla biološka inaktivacija.

Ključne reči: medicinski otpad, skladištenje, procedure, sterilizacija.

REFERENCES

1. Radenović S. Medical waste as a bioethical problem. *Socijalna ekologija*. 2008; 17(3): 297-304.
2. Savić D. European ecological values for the benefit of the citizens of Serbia, with special reference to the practice of handling waste. *Proceedings: European standards in Serbia*. 2009: 66-79.
3. Ugrinov D, Stojanov A. Dealing with medical waste materials as a category of dangerous waste. *Zaštita materijala*. 2011; 52(1): 55-60.
4. Government of the Republic of Serbia. Waste management program in the Republic of Serbia for the period 2022-2031, 2018.
5. Ministry of Health of the Republic of Serbia. National Guide to the Safe Management of Medical Waste - Safe Management of Medical Waste, 2008.
6. Official Gazette of the Republic of Serbia. Rulebook on medical waste management, 2019(48).
7. World Health Organization. Health care waste: Types of waste, 2018. Available at: [https://www.who.int/en/news-room/fact-sheets/detail/health-care-waste\[09.01.2023\]](https://www.who.int/en/news-room/fact-sheets/detail/health-care-waste[09.01.2023]).
8. Borovina B. Reverse logistics in healthcare - medical waste management. 6th Scientific meeting with the international participation of Synergy, 2010: 280-8. Bijeljina.
9. Djordjevic Z, Djonovic N. A new method of treatment of infectious medical waste in the Clinical Center Kragujevac. *Zdravstvena zaštita*. 2010; 39(1): 55-63.
10. Eurostat. Guidance on classification of waste according to EWC-Stat categories, 2010.
11. Official Gazette of the Republic of Serbia. Rulebook on conditions and methods of sorting, packaging, and storage of secondary raw materials, 2001;55.
12. Official Gazette of the Republic of Serbia. Rulebook on medical waste management, 2010; 78.
13. Silva T, Maciel R, Florencio L, Santos SM. Strategies for the improvement of home medical waste management during the COVID-19 pandemic. *J Air Waste Manag Assoc*. 2022; 72(3): 222-34. doi: 19.1080/10962247.2021.1982794.
14. Castillo AP. EU waste legislation: current situation and future developments, Special report 18/32, 2014: 26-31. European Trade Union Institute.
15. Čustović A, Hažić S, Arnautović E, Burgić M, Arpadžić E, Šećerkadić A et al. Handbook of good medical waste management practices. Society for Research and Development, 2012.
16. Marinković N, Vitale K, Janev Holcer N, Dzakula A. Medical waste management: the law and its application. *Arhiv za higijenu rada i toksikologiju*. 2006; 57(3): 339-45.

Correspondence to/Autor za korespondenciju

Branislav Sančanin, Ph.D., Assistant Professor
Faculty of Management,
Njegoševa 1a, 21 205 Sremski Karlovci, Serbia
e-mail: branislav.sancanin@famns.edu.rs
ORCID ID: 0000-0002-4255-2634

How to cite this article: Sančanin B, Sančanin A. Improvement of medical waste storage procedures. *Sanamed*. 2023; 18(1): 65-70. Doi: 10.5937/sanamed0-42519.