Professional paper
https://doi.org/10.31784/zvr.13.1.13
Received: 3. 7.2024.
Accepted: 6. 3. 2025.

WASTE MANAGEMENT PRACTICES: A CASE STUDY OF KIKINDA GENERAL HOSPITAL, SERBIA

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ABSTRACT

Handling of medical waste presents a considerable challenge for the healthcare industry and the surrounding environment due to infectious properties and the presence of dangerous chemicals and medications. In accordance with the lack of literature related to practical example of the implementation of the hospital waste management systems, this professional paper presents an implementation of medical waste management practices at the Kikinda General Hospital in Serbia, which aligns with the economic conditions, the level of development of the healthcare services in the developing countries, and the current legal framework. This paper provides a practical example of procedures and protocols regarding the segregation, disposal, and handling of medical waste. The findings presented in this paper contribute to valuable insights and recommendations for enhancing medical waste management practices not only for hospitals but also for healthcare institutions globally. This study emphasizes the need for further education among staff and the broader community, highlighting the importance of waste separation for recycling.

Keywords: *medical waste, implementation, management practices, hospital*

1. INTRODUCTION

Managing medical waste poses a significant challenge for the healthcare sector (Perumal, Aljefri and Alsaifi, 2021) and ranks among the foremost concerns due to its potential to adversely impact patients, healthcare workers, medical facilities and wider environment. (Koo and Jeong, 2015; Xin, 2015). The surge in population growth and the disruptions caused by various events, including the global impact of COVID-19 and other human-made or natural disasters, has significantly heightened the need for medical services, whereby this increased demand has resulted in a notable upswing in the generation of medical waste (Nosrati-Abarghooee *et al.*, 2023; Singh *et al.*, 2022).

The crucial significance of effective medical waste management in hospitals becomes evident in mitigating potential adverse consequences arising from mishandling of medical waste. Effective medical waste management encompasses minimizing of the negative impacts on both individuals and the environment (Campion *et al.*, 2015). Medical waste that is not managed effectively brings a high probability of infection and injury for the working staff, patients and common people, and the spread of micro-organisms from medical waste can expose the public to some risks, as well (Su and Chen, 2018). Infectious medical waste management is a vital part of controlling of the epidemic disruptions that improper collection and improper treatment can boost (Madsen *et al.*, 2020). Sustainable medical waste management is necessary for all countries to prevent catastrophic accumulation of infectious waste (Jafarzadeh Ghoushchi *et al.*, 2022). The significance of medical waste management is particularly evident in developing countries like the Republic of Serbia, where, until 2009, there was no established protocol for managing medical waste in health institutions (Gavrancic, Simic and Gavrancic, 2012).

Medical waste can be hazardous due to infectious properties or the presence of dangerous chemicals and medications. Therefore, proper separation at the source (and pre treatment/ sterilization) is a prerequisite for reducing the amount of hazardous waste generated in healthcare (Bansod and Deshmukh, 2023). Better education of healthcare workers and standardized sorting of medical waste streams are key avenues for efficient waste management at healthcare facilities (Windfeld and Brooks, 2015). Lee & Lee identified medical waste management, operational management issues and training for medical waste management procedures as the most important factors for reducing medical waste (Lee and Lee, 2022)

Management methods and techniques have been actively used in waste management systems by health institutions (Makajic-Nikolic *et al.*, 2016). Some have tried to implement Total quality management (TQM) method to improve the management of infectious medical waste (Askarian, Heidarpoor and Assadian, 2010) while others have applied Fault tree analysis (FTA) as another method for identifying and prioritizing potential hazards (Makajic-Nikolic *et al.*, 2016). In order to analyze the management of medical waste Hazard analysis and critical control points (HACCP) was used, a method primarily intended for identifying food safety hazards identification (Kojima *et al.*, 2008). Failure mode and effects analysis (FMEA) is widely used in medical waste management to assess risk items during infectious waste treatment (Ho and Liao, 2011), and some authors have applied it to prioritize the barriers to applying

circular economy principles in the design of medical waste management system (Jafarzadeh Ghoushchi *et al*., 2022).

However, even though health institutions actively employ management methods and techniques, there is limited literature available on practical examples of the implementation of these methods within infectious healthcare waste management systems (Liu, Bi and Liu, 2023). In this paper, we aim to showcase such an example of the implementation of medical waste management practices at the Kikinda General Hospital, Serbia.

2. MEDICAL WASTE

The World Health Organization (WHO) refers to medical waste as "the waste which is produced during the treatment, diagnosis, or immunization of humans or animals" (Windfeld and Brooks, 2015). According to European waste law, waste is defined as any material or object listed in the European waste catalog that the owner discards, intends to discard, or must discard in accordance with the law (European Parliament, 2008).

Medical waste generated in the provision of health services (diagnosis, prevention, treatment, and research in the fields of human and veterinary medicine) is a heterogeneous mixture of waste, with 10-25% constituting hazardous waste that poses a risk to human health and the environment (Marceta and Nađ, 2018). Essentially, there are two types of medical waste: Non-hazardous waste (waste that does not exhibit hazardous waste characteristics and is similar to waste generated in households) and Hazardous waste (waste that, by its origin, composition, or concentration of hazardous substances, can pose a danger to the environment and human health, and has at least one of the hazardous characteristics established by specific regulations, including packaging in which hazardous waste has been or is packed). These types of waste are further divided into subtypes using descriptors from the European waste catalog, which has been accepted as the most suitable waste classification system for use in the Republic of Serbia.

2. 1 Medical waste in Serbia

In healthcare institutions in Serbia, over 3,000 tons of medical waste are generated annually, with one-fifth classified as hazardous waste. According to the official data from the Environmental protection agency in 2019, Serbia produced 3,281.75 tons of medical waste. On average, 1.8 kg of medical waste is generated per hospital bed daily in Serbian hospitals (estimated to have around 60,000 hospital beds) (Đorđević *et al*., 2020).

The Government of Serbia adopted the National waste management strategy in 2003, although the management of this waste was introduced several years later. Until 2008, Serbia lacked a system for managing infectious medical waste. For years, needles, syringes, masks, gloves, bandages, and scalpels were improperly disposed of, mixed with municipal waste, and deposited in city landfills. Healthcare institutions themselves managed medical waste, operating with outdated equipment and lacking procedures for disposal and treatment.

Some facilities incinerated waste in their own incinerators, often at temperatures unsuitable for safe disposal, and only a small number of institutions could sterilize the waste beforehand.

The EU assisted Serbia in establishing a modern system for managing infectious medical waste, providing a donation of €13.5 million from 2007 to 2013 to implement a contemporary medical waste management system. The EU funded the development of a system for separating, collecting, labelling, storing, treating, and disposing of medical waste in Serbia.

In September 2008, the Ministry of health of the Republic of Serbia issued the National guide for the safe management of medical waste. Many healthcare institutions were part of a pilot program aimed at introducing safe medical waste management practices. This program included the collection, sorting, packaging, transportation, treatment, and disposal for all individual categories of medical waste. The separation of infectious medical waste from other types of waste began in both public and private healthcare institutions. By the end of 2015, 47 facilities in Serbia had received permits for the treatment of infectious medical waste.

In 2022, Serbia adopted a national waste management program for the period 2022-2031. General provisions regarding medical waste are outlined in the Waste management act, where medical waste (along with pharmaceutical waste) is distinguished as a separate type of waste. These provisions are implemented through two subordinate legal acts – the Waste Management Regulation and the Regulation on Methods and Procedures for Pharmaceutical Waste (Ministry of Environmental Protection, 2023). This has improved the existing waste management system in line with the EU standards.

In Serbia, there is still a lack of capacity for managing pharmaceutical, cytostatic, and chemical waste from hospitals. These waste streams are handed over to private operators for the management of hazardous waste. The existing medical waste management system in Serbia focuses on the treatment of infectious waste and consists of a network of central treatment points and local treatment points. Central treatment points are established in general hospitals, usually in the capital city or the seat of the district, while local treatment points are established in separate facilities, as well as in the largest healthcare institutions, including four clinical centers, which generate large quantities of infectious waste that require on-site treatment with a sufficient capacity system. Central treatment points are equipped with vehicles for collecting and treating infectious waste from numerous other healthcare institutions that do not have their own treatment equipment, while local treatment points handle their own waste.

Through projects funded by the European Union, several state hospitals, including the Kikinda General Hospital, were equipped with autoclaves for the sterilization of infectious medical waste. To achieve its goal of being a Local Treatment Site (LTS), the Kikinda General Hospital developed a medical waste management logistics system that helped meet the legal, institutional, and technical implementation conditions, ensuring that the entire medical waste management process is economically justified and environmentally acceptable.

A section of the implemented medical waste management system will be presented in the next chapter.

3. IMPLEMENTATION OF THE MEDICAL WASTE MANAGEMENT SYSTEM IN KIKINDA GENERAL HOSPITAL

The primary goal was to introduce a health-safe and environmentally acceptable approach, suitable for the institution's economic situation and the level of healthcare service development.

The logistical steps in implementing the Medical Waste Management System included:

a) Staff training: The training, conducted by BATUT, involved three workers for operating the autoclave (technician for medical waste) and one worker who underwent training as a supervisor for medical waste management.

b) Medical waste management supervisor training: The appointed supervisor conducted training sessions for all hospital employees. Upon completing the training, all employees took a test to assess their knowledge of medical waste management.

c) Equipment acquisition: The hospital acquired equipment, including a treatment plant and shredder, yellow-lidded containers, yellow bags and containers for sharp objects, labels, protective equipment for the Medical Waste Technician, color-coded bags and containers for chemical, cytotoxic, and pathological waste.

d) Team establishment: A Medical Waste Management Team was appointed, led by the responsible person for medical waste management, with members including the person responsible for workplace safety, the head pharmacist, the medical waste technician-operator, and the head nurse of the hospital.

e) Development and adoption of hospital procedures for medical waste handling.

f) Medical waste management plan: A plan was written and submitted to relevant ministries (Ministry of Health and Ministry of Environmental Protection) for approval. The plan received approval and adoption by the hospital's board.

g) Work plan for the medical waste treatment plant: A detailed work plan for the treatment plant was developed.

h) Appointment of the responsible person for medical waste management.

i) Establishment of written documentation: Waste flow documentation was organized, and regular reports were submitted to the Environmental Protection Agency, as required by law.

j) Characterization of hazardous waste: Hazardous waste was classified and handed over to an authorized operator – a company licensed for waste collection, transportation, and disposal.

k) Confirmation document: The hospital receives a document confirming the proper disposal of hazardous waste.

l) Handling of hazardous waste: Only medical staff handle hazardous waste, while hygiene staff manage municipal waste.

m) Waste flow management: Medical waste movement within the hospital follows a clean-to-dirty workflow and a time-scheduled route to prevent cross-contamination.

Following project implementation, medical waste management at Kikinda General Hospital operated as follows:

Infectious medical waste (IMW) generated by the hospital, acting as a local treatment site, is managed within the treatment facility through the sterilization process. The sterilized-treated waste, no longer infectious, undergoes characterization to confirm its non-infectious properties. After treatment, it is repackaged into black bags, labelled as sterile, and disposed of in a separate container from other municipal waste. The municipal waste management company collects it twice a week from the hospital area, following waste management documentation and transportation procedures.

In accordance with the guidelines for handling infectious and medical waste issued by the Ministry of Environmental protection of the Republic of Serbia, all waste generated from patients infected with the coronavirus is considered infectious medical waste, i.e., hazardous waste. Therefore, it must be treated before disposal.

Chemical, pharmaceutical, and cytotoxic waste is handed over to the collection station within the hospital premises. From there, with proper documentation, it is transferred to an authorized company, which takes further steps in compliance with the law. The hospital receives information about the final disposal of this waste through a document confirming the ultimate disposal.

Pathological waste from the pathology department is submitted with accompanying documentation to the hospital's central morgue. From there, a funeral company, with proper documentation about waste movement and pickup, transports it to the city cemetery for burial in accordance with legal requirements.

3. 1 Flow of medical waste within the institution

Medical staff is responsible for the movement of infectious, chemical, cytotoxic, cytostatic, pharmaceutical, and anatomical waste through the department where it is generated. The responsibility for properly labelling containers and bags when handing them over to the operator lies solely with the waste producer, i.e., the medical staff.

Operators, workers performing the treatment of infectious waste, are responsible for collecting and transporting properly sorted and labelled infectious waste through the institution to the treatment site. They are also responsible for cytotoxic, cytostatic, and pharmaceutical waste. Full yellow containers with dots (infectious waste) are replaced once a day or more frequently if needed.

For treated infectious waste (treated waste) in the autoclave, operators are responsible. They ensure proper packaging and disposal of this waste at the Central landfill within the hospital premises.

Hygiene staff takes care of packaging and disposing of exclusively municipal waste at the Central landfill within the Kikinda General Hospital and is not responsible for any other type of medical waste stream.

All packaged medical waste, excluding municipal waste, must be clearly labelled with a correctly chosen sticker.

3. 2 Sorting and packaging of waste

Waste sorting involves separating different types of waste into defined groups with similar characteristics and/or hazards (referred to as waste streams). Various waste streams require different types of packaging, handling, transportation, and storage. Different waste streams also necessitate different treatment/disposal procedures; proper sorting of medical waste ensures that each waste type is processed/disposed of according to its characteristic hazards. Efficient waste separation is crucial as it protects the health of employees and patients, enhances waste handling safety, reduces costs, and promotes recycling.

When sorting medical waste, the following basic rules will be observed:

- Sorting is the responsibility of the waste producer (duty of care principle).
- Sorting should be conducted as close to the point of generation as possible (proximity principle).
- If there are any doubts during classification, the waste should be categorized into the next higher-risk category (precautionary principle).
- Mixing hazardous and non-hazardous waste is prohibited.

Different types of waste require different types of packaging to ensure the safety of those who come into contact with the waste. Sorting areas throughout the facility will be equipped with sufficient quantities of appropriate packaging to facilitate successful sorting according to the plan and ensure the safety of all participants.

When packaging medical waste, the following basic rules will be followed:

- Use only packaging intended for the purpose and suitable for its intended use.
- Bags and containers for sharp waste should only be filled up to 3/4 of their volume to allow proper sealing.
- Once sealed, containers should never be reopened (not even to correct sorting mistakes).
- Infectious waste is packed only in bags approved for use with the appropriate treatment facility (autoclave, etc.).

- Medications with expired expiration dates, in their original unopened packaging, are returned to the pharmacy.
- Different chemicals are never mixed in the same container.

3. 3 Arrangement of bags and containers for medical waste collection

At every medical waste generation point, suitable packaging for waste disposal is provided. The waste collection schedule is as follows:

a) Infectious waste and sharp objects - Collected every day of the week from 06:00 to 07:30 in the new hospital building and the old hospital buildings, from 10:00 to 12:00. In case of urgency, transport outside these hours can be arranged by phone. Operators are responsible for transportation within the facility, as well as collection and treatment.

b) Chemical waste - Collected daily in the service area generating it, using temporary packaging obtained from an authorized transporter. Daily records of waste creation and disposal, along with accompanying documentation of waste movement, are maintained. Transport occurs once a month based on a contract with an authorized company, complying with legal documentation.

c) Pharmaceutical waste - Collected once a week from each department and stored temporarily within the hospital premises, with accompanying documentation. Transported from the hospital to the waste management company once a month, according to the contract and regulatory documentation.

d) Cytotoxic waste - Deposited in temporary storage every working day from 06:00 to 07:30 or by arrangement with the operator. Transported once a month based on a contract with an authorized company. Law-mandated waste movement documentation and daily creation records are maintained.

e) Pathological waste - Handed over to the Pathology Department with accompanying documentation. Stored in a refrigerator before being transported by the funeral service to the city cemetery for burial, as per contractual agreements and legal requirements. Documentation accompanies the disposal of pathological waste.

f) Municipal waste - Collected daily from all workspaces, patient areas, and the hospital premises several times a day. The hygiene staff is responsible for transporting it to the central municipal landfill within the hospital premises. The municipal waste is taken from the central landfill to the city landfill by the municipal sanitation company every working day.

The staff involved in collection is instructed not to collect medical waste that is not correctly labeled and safe for transportation. Any irregularities in waste streams are reported to the coordinator using the internal form of the Kikinda General Hospital, following the medical waste management plan.

Temporary storage areas for infectious waste are marked with infectious waste labels, accessible only to employees, providing safe storage before transport to the central treatment and disposal facility. These temporary storage areas are located on all floors of the new hospital building, the ground floor, the basement, and the old part of the hospital. A sufficient number of yellow containers with dots of 120 and 240 liters are provided for this purpose.

3. 4 Classification and testing of waste in accordance with special regulations

Waste classification is conducted according to the Waste catalog, at the location where the waste is generated and by the employees in whose service the waste is created. Waste is classified in accordance with regulations that govern waste categories, testing, and classification.

Hazardous medical waste is classified based on its origin, characteristics, and composition. If hazardous waste consists of multiple types of waste, its classification is carried out in accordance with specific regulations that govern waste categories, testing, and classification. At the hazardous waste sorting location, there are instructions and internal procedures of the Kikinda General Hospital, specifying the procedures for staff involved in waste collection and sorting.

Measures of prevention are taken when managing sharp objects, and these items are collected separately in a dedicated yellow container for sharps, following the institution's procedures and tracking the infectious waste stream. Infectious, cytotoxic, and cytostatic waste is collected in a way that prevents direct contact with the personnel handling it, and unpacking or repacking it is strictly prohibited.

In case non-hazardous medical waste gets mixed with hazardous waste for any reason, the precautionary principle is followed, meaning it is further managed as hazardous waste.

To determine the hazardous characteristics of waste, in accordance with the law, the Kikinda General Hospital will conduct waste testing. A sample is submitted to an authorized laboratory, which then performs waste identification, determines the waste category, and, depending on the hazard level (inert, hazardous, non-hazardous), establishes the hazardous characteristics of the waste.

The Kikinda General Hospital possesses reports on tested waste, including treated infectious waste, chemical waste, cytotoxic waste, and cytostatic waste.

3. 5 Waste sorting and collection at the place of generation, packaging, labeling, temporary storage, and transport within the healthcare facility

Waste generated in the Kikinda General Hospital is collected and sorted as close to the point of generation as possible, within the respective department. It is deposited in appropriate containers, properly filled, labeled with suitable stickers, and temporarily stored at the designated waste collection point, meeting the regulations for the disposal site within that

hospital department. Each hospital department has a place for the temporary storage of hazardous waste generated in that department. These places are secured, accessible only to the medical staff of that department and operators, i.e., workers responsible for transporting the temporarily stored waste from hospital departments to the central disposal site within the hospital premises.

Transport of medical waste within the institution is carried out using equipment designated exclusively for this purpose. The equipment is lightweight for easy loading and unloading, easy to clean and maintain, without sharp edges, and with smooth impermeable surfaces. Transport is always conducted following the "clean-dirty" pathway.

For each waste stream, there is a written procedure outlining the proper handling.

Transport of hazardous waste will comply with all national guidelines and international agreements where applicable. The movement of hazardous waste outside the institution is reported to the Environmental Protection Agency, as mandated by the law.

Transport outside the institution is organized with companies holding the necessary permits for waste collection and transport, and there is a technical-business cooperation agreement with these firms.

Workers from the hygiene department are responsible only for sorting, collecting, packaging, labeling, and disposing of municipal waste.

3. 6 Types of Waste Treatment

Kikinda General Hospital is a local treatment facility for infectious medical waste (LMW). The hospital holds a permit for the storage and treatment of infectious medical waste at its location, issued by the Provincial secretariat for urban planning, construction, and environmental protection for a period of 10 years.

3. 7 Infectious medical waste treatment

The Unit for the treatment of infectious waste (LMU - Local Treatment Unit) is responsible for the safe treatment of infectious waste generated in the Kikinda General Hospital. This includes the collection, transport, treatment, and disposal of treated infectious waste. Employees at LMU are responsible for assessing the quality of packaging and labeling of waste received for treatment, and they have the right to refuse waste if the required standards are not met.

The working hours of the infectious medical waste treatment unit are from 06:00 to 18:00 every day. The waste treatment plant can only accept infectious waste.

All waste received in the treatment unit must be properly packed, labeled, and accompanied by the correct documentation. Before receiving waste for treatment, the operator will conduct the following verification procedures:

- Visual inspection of waste to ensure it is properly packed and safe for handling/ treatment.
- Verification of whether the packaging is labeled and the label is readable.
- Verification of correct documentation.
- Assessment of the waste content, to the extent possible without opening the waste container.

Waste that does not meet the standards will be rejected, and a Waste rejection notice will be completed, clearly stating the reason(s) for rejection.

3. 7. 1 Document management and records keeping

The department generating waste maintains records of the type and quantity of waste it generates, sorts, packages, labels, and delivers, as well as the person who performed these actions. The operator working at the Infectious Medical waste treatment facility keeps a daily record of collected and treated infectious medical waste (IMO). Records of waste produced, transported, treated, recycled, and disposed of within the General hospital will be kept and sent to the competent ministry and organizations (Ministry responsible for environmental protection, Environmental protection agency (SEPA), Republic institute for statistics, Institute of public health of Serbia Batut, etc. as defined by law. It is the responsibility of the coordinator to ensure that these records are accessible and stored in accordance with applicable legal regulations. The forms used for this purpose are the DEO1 form, DEO3 form, GIO1 and GIO3 forms, as well as waste movement documents with notification and confirmation through the SEPA information system, in the case of hazardous waste. Kikinda General Hospital receives and retains a document on the final disposal of hazardous waste, which is submitted to an authorized operator.

3. 7. 2 Prevention measures for injuries with sharp objects and infection prevention:

Injuries with needles or sharp objects must be reported immediately by recording them in the documentation according to the Protocol for adverse events of the Kikinda General Hospital. The responsible person for Occupational health and safety (BZNR) will create a report about it. If there is an injury with needles or sharp objects, the following procedure should be followed:

a) Allow the injury to bleed freely; do not apply pressure, do not squeeze blood, and do not suck the wound.
b) Rinse the wound with soap and water.

Universal precautions when working with potentially infectious materials, including waste, include the following precautions:

- Always wear gloves and other protective clothing if there is a possibility of exposure to infectious materials.

- Containers for sharp objects should be kept temporarily closed between uses.
- Never replace caps on needles.
- Never push hands into containers with sharp objects.
- Never attempt to catch falling instruments.
- Sharp objects should be disposed of exclusively in approved containers for sharp objects (not in bags).
- Always wash hands after handling potentially infectious materials.
- Containers for infectious waste should be hermetically sealed before transport.
- Reusable containers should be disinfected after each use.
- The room/place for storing hazardous waste should be cleaned and disinfected every day.

Health and safety measures for workers involved in the management of medical waste:

In the context of health and safety protection for workers engaged in the management of medical waste, the following protective measures should be taken:

Needle and Sharp Object Disposal:

- Used needles and sharp objects are to be deposited in designated yellow containers for sharp objects.
- Prohibition of putting the cap back on a used needle.
- Injury from Contaminated Sharp Objects:
- In case of injuries from contaminated sharp objects, follow the prescribed procedure for reporting professional exposure to infectious and potentially infectious agents.
- Spills of Infectious or Hazardous Waste:
- In the event of spills of infectious or other hazardous waste, follow the established procedure.
- All employees are obligated to participate in mandatory and recommended immunizations for healthcare workers, including hepatitis B, seasonal flu, COVID-19, etc.
- Repackaging and pouring waste from one bag to another are strictly prohibited.
- Precautionary Principle in Waste Sorting:
- Adhere to the "precautionary principle" when sorting medical waste.
- Wear Personal Protective Equipment (PPE) at all times when working with medical waste.
- When storing and working with chemicals, follow the manufacturer's warnings and instructions for use.
- All employees handling cytotoxic drugs must undergo specific training for the job.
- Reconstitution of cytostatics is to be carried out exclusively in the designated digestor.
- Access to reconstitution is allowed only for trained personnel.
- Eating, drinking, and smoking are strictly prohibited during work.

- When reconstituting cytotoxic drugs, specific personal protective equipment must be used, including a gown, mask, cap, and two pairs of gloves, with changes every 30 minutes.
- Regularly monitor and control the segregation, collection, labeling, treatment, and safe disposal of medical waste.

All employees involved in waste handling must consistently use appropriate Personal Protective Equipment (PPE), following all relevant procedures and training protocols.

3. 7. 3 Environmental protection measures and pollution control

In order to protect the environment and reduce potential negative impacts during the medical waste treatment process, it is necessary to adhere to the following protection measures during regular operations:

- Prevent unauthorized entry into the facility where sterilization and shredding processes are carried out by individuals not qualified for safe handling of infectious medical waste.
- Utilize biodegradable disinfectants according to the manufacturer's instructions, ensuring minimal negative impact on the environment.
- Completely clean and disinfect the interior of the facility daily and more frequently if necessary.
- Ensure that facilities housing treatment equipment are at a sufficient distance from vulnerable areas (such as food preparation and handling areas) to avoid cross-contamination.
- Regularly inspect and maintain sterilization and shredding equipment in proper working condition.
- Facilities should be equipped with hot water, sanitation, proper ventilation, and acoustic isolation of compressors to reduce noise pollution.
- Implement suitable equipment and technical solutions to ensure that emissions into the air comply with prescribed emission limits.
- In the event of equipment failure or process disruption leading to exceeding emission limits, the project owner must promptly rectify the malfunction, adjust operations, or suspend the process to bring emissions within permissible limits.
- If the process generates unpleasant odors, measures should be taken to reduce odors and ensure emitted materials in the waste gas are below emission limits.
- Individuals exposed to contact with hazardous medical waste, including accidental exposure within healthcare activities, as well as those managing or exposed to negligent handling of infectious medical waste, are considered vulnerable.
- After ceasing operations, disinfect all existing facilities and accompanying contents with biodegradable agents.

These measures collectively contribute to safeguarding the people, and mitigating the potential environmental impact of medical waste treatment processes.

4. CONCLUSION

In this paper, we showed an example of the implementation of medical waste management practices at a general hospital in Serbia. The hospital management recognized the importance of waste management and took significant steps to organize this part of the hospital's operations in compliance with the legal regulations. There is a well-developed awareness among employees at the hospital about the need for proper separation, disposal, packaging, and delivery of hazardous medical waste. However, much remains to be done in the management of medical waste in Serbia and at the Kikinda General Hospital. The management team, acknowledging the significance of developing collective awareness of proper waste disposal, has employed an Environmental Protection Officer since January 2022, with plans to establish a dedicated service for a more effective and environmentally friendly way of disposing non-hazardous waste. Despite these efforts, there is still a belief among employees that more can and should be done, especially in the area of non-medical waste management in the hospital. They emphasize the need to educate both staff and the general public, including patients, regarding the separation of municipal waste for recycling, and research has shown that the best way to do this is through ongoing training programs (Omran & Mohammed, 2020) and staff training obligations (Navazeshkhah et al., 2019). Additionally, they suggest an increase in the number of bins for plastic waste in various hospital departments, placed closer to the point of waste generation. Delegation of waste separation tasks, especially to the hygiene staff, is considered problematic due to their diverse responsibilities. Despite financial constraints in healthcare institutions, it is believed that with proper logistics and investments in recycling, financial gains can be achieved. Funding for necessary waste disposal equipment, which is according to some authors, a crucial challenge for efficient medical waste management system implementation (Tushar et al., 2023), could be obtained through programs approved by the Ministry of health or the Provincial secretariat for health. The hospital could also apply for EU-funded projects related to environmental protection, securing substantial initial funding. It is anticipated that, once logistics objectives are established, the hospital may generate financial benefits. Finally, education for both staff and patients is crucial to raising awareness of ecology and a cleaner community, potentially positioning Kikinda General Hospital as an environmentally conscious healthcare institution.

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Stručni rad
https://doi.org/10.31784/zvr.13.1.13
Datum primitka rada: 3. 7. 2024.
Datum prihvaćanja rada: 6. 3. 2025.

PRAKSE GOSPODARENJA MEDICINSKIM OTPADOM: STUDIJA SLUČAJA OPĆE BOLNICE KIKINDA, SRBIJA

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SAŽETAK

Zbrinjavanje medicinskog otpada predstavlja značajan izazov za zdravstvenu industriju i okolni ekosustav zbog zaraznih svojstava te prisutnosti opasnih kemikalija i lijekova. S obzirom na nedostatak literature koja se bavi praktičnim primjerima provedbe sustava upravljanja medicinskim otpadom u bolnicama, ovaj stručni rad prikazuje implementaciju praksi upravljanja medicinskim otpadom u Općoj bolnici Kikinda u Srbiji. Prikazana praksa usklađena je s ekonomskim uvjetima, razinom razvoja zdravstvenih usluga u zemljama u razvoju te važećim pravnim okvirom. Ovaj rad donosi praktičan prikaz postupaka i protokola vezanih uz razvrstavanje, odlaganje i rukovanje medicinskim otpadom. Nalazi predstavljeni u radu doprinose vrijednim uvidima i preporukama za poboljšanje upravljanja medicinskim otpadom, ne samo u bolnicama, već i u zdravstvenim ustanovama na globalnoj razini. Studija naglašava potrebu za daljnjom edukacijom osoblja i šire zajednice, ističući važnost odvajanja otpada radi recikliranja.

Ključne riječi: *medicinski otpad, implementacija, prakse gospodarenja, bolnica*