

Hazardous Private Healthcare Waste Management and Forecast of Medical Waste Generation

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The paper presents some considerations about medical waste management in private medical facilities which are considered to be small generators of such waste. The regulations are also applicable in these facilities and the management must develop strategic plans for minimizing the amount of medical waste. Some examples are revealed and a statistical analysis is conducted in order to reveal the efficiency of the medical waste management system. A forecast of hazardous medical waste is determined using the moving average method.

Keywords: medical waste management, minimizing plan, private cabinets

Medical waste refers to all waste materials generated by healthcare facilities, medical research facilities and medical laboratories [1]. In Romania, the definition, classification and management of medical wastes are covered by Minister Decision no. 1226/2012 regarding the management of waste from medical activities issued by the Ministry of Health in December 2012 [2], and their neutralization and disposal must be carried out in compliance with Law 278/2013 [3].

The goal of this paper is to identify the ways in which private healthcare facilities follow the aforementioned regulations by monitoring their implementation of hazardous waste legislation, and to provide instruction and tools designed to minimize risk factors for medical personnel and for the general public in the short term and to reduce the environmental impact of medical waste in the long term.

The main objective of this study is to analyze hazardous medical waste management in private healthcare facilities. The specific objectives related to the main objective consist of:

- collecting different types of hazardous medical waste;
- checking the assumption that private health units are concerned with the reduction of dangerous medical waste.

Government Decision no. 856/2002 for waste management, including hazardous waste, classifies medical waste as either hazardous or non-hazardous [4].

Hazardous medical waste, according to the World Health Organization [5], includes:

- *infectious waste*: waste contaminated with blood and/or other body fluids, cultures and stocks of infectious agents (viruses, bacteria, parasites and toxins from laboratory work), and waste and equipment from isolation wards (swabs, bandages, and disposable devices);

- *pathological waste*: human tissues, organs or organ fragments, body parts, body fluids, and contaminated animal carcasses. This type of waste is considered hazardous because it contains viable microorganisms known to cause illness in humans or other living organisms [6];

- *sharps*: syringes, needles, disposable scalpels and blades, and any other sharp tools used in medical practice which may cause mechanical damage by puncturing or cutting. Sharps are considered infectious or hazardous if they come in contact with body fluids or hazardous substances [7, 8];

- *chemicals*: disinfectants, substances used in laboratory preparations, and toxic substances (such as heavy metals) contained in broken medical equipment and batteries [9-13];

- *pharmaceuticals*: expired and unused drugs and vaccines;

- *genotoxic waste*: highly hazardous chemical agents, including mutagenic, teratogenic, and carcinogenic substances [14, 15];

- *radioactive waste*: products contaminated by radionuclides including radioactive diagnostic material or radiotherapeutic materials [17].

Not all waste generated by medical facilities is dangerous. WHO estimates that the amount of general, non-hazardous waste represents roughly 85%, while other sources place this amount at 75-80% [5]. Non-hazardous waste includes common domestic material which does not pose any biological, chemical or radioactive threat and which can be collected by public sanitation services provided it has not been contaminated due to inadequate collection.

Medical waste prevention refers to all measures taken before materials, substances or products become medical waste. These preventative measures aim to minimize medical waste by reusing medical products, by extending the life cycle of these supplies, and, most importantly, by ensuring the proper separation of hazardous wastes from those non-hazardous ones [17].

All medical facilities which generate medical waste must separate non-hazardous items from hazardous ones. This is called *source separation*. While source separation is required for all generators, some health facilities like hospitals and clinics must implement medical waste reduction plans and submit annual reports regarding waste reduction [18]. It is advisable that private healthcare providers take steps to reduce the amount of waste they generate [6].

Most hazardous medical wastes are toxic, cytotoxic, chemical, flammable or radioactive, and can often be considered infectious. This is why each hospital must formulate a hazardous waste management plan based on direct on-site collection, to be submitted for approval to the relevant authorities. The plan is also intended to reduce the costs of the final waste disposal. In all healthcare facilities, activities related to the management of waste

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are part of professional duties and must be included in each job description.

Annually, all medical facilities are obliged to develop a plan which addresses the following points:

- clear and transparent examination of current medical waste practices and management;
- analysis of available resources for the improvement of waste management processes;
- preparation and implementation of proper waste management measures, which must concentrate on the following aspects: staff training, identification of new opportunities for waste disposal and usage of appropriate equipment, and must include a detailed description of the stages of implementation.

An effective waste management plan must take into account all other activities which take place in a medical facility, which makes it an important part of the overall management strategy.

Medical waste management stages

The most important stages in medical waste management are as follows [19, 20]:

- generation of medical waste and segregation at source. Segregation is the separation of waste into different classes based on various high-risk properties and must be applied at source. Processing and disposal costs can be significantly reduced if an adequate isolation method is employed;
- packaging of medical waste using color-coded containers, bags or cardboard boxes;
- temporary storage of medical waste on site, ensuring that hazardous and non-hazardous waste is stored separately. Certain storage conditions must be met in order to prevent the spread of infections and access to these storage spaces must be limited to authorized personnel;
- waste transport. According to current regulations, in order to ensure the safety of medical personnel, of the general public, and of the environment, the transport of hazardous medical waste to the final disposal place must be performed using authorized vehicles. Waste transport must be carried out by contracted authorized economic operators, under specific regulations [2, 3]. Whoever takes over such activities, including the transportation, packing, loading, filling or unloading of dangerous waste, shall designate one or more advisers who will be responsible for the prevention of inherent risks;
- waste treatment and disposal must ensure the rapid disposal of agents which can affect human health and the environment.

Stages in developing a medical waste management plan

Efficient waste management in healthcare facilities is possible only if there are strategic and operational plans in place [21].

The first stage in developing an effective plan entails a proper understanding of the regulations governing medical waste handling, which are focused on the following aspects: formulating a clear and consistent definition of medical waste and focusing on individual steps (which include on-site treatment, storage and regulations) as well as on overall management. A coordinator responsible for the development, monitoring and daily operation of the medical waste management plan must be appointed.

The second stage includes the analysis of current situation to identify directions for further improvement. The following points must be considered:

- general information: types of waste, number of beds, number of patients, number of medical wards, etc.;

- a detailed study of medical waste, referring to sources, nature, amount and chemical composition;

- a pertinent analysis of current state of waste management, highlighting weaknesses and deficiencies;
- a quantitative analysis of medical waste including evolution over time, in order to identify future trends;
- analysis of medical waste management costs;
- assessment of existing risks, as well as of safety and protection measures;
- evaluation of measures in emergency cases;
- medical staff training;
- the preparation of diagrams displaying hazardous waste storage areas, on-site waste processing areas, waste collection and transportation routes, disinfection areas for waste trolleys, etc.

The third stage consists of setting up an action plan. Based on the results of the first two stages, medical facility managers must develop strategies for improving medical waste management. These strategies should include specific tasks for each employee involved in waste management, as well as terms and responsibilities.

The fourth stage involves the drafting of a medical waste management plan, based on prior analysis. All plans must include the following elements:

- critical analysis of the current situation of medical waste management (stage 2);
- analysis of available resources and options for improvement (stage 3);
- preparation of a detailed set of measures aimed at improving waste management, including: staff training, creation of new storage spaces, better handling, acquisition of processing and disposal equipment, and the drafting of an implementation schedule.

The fifth stage involves the approval of the plan and its implementation. The operation of medical waste management in a particular healthcare facility may not be effective or optimized in the long term if the medical waste management plan is not periodically reviewed. Medical waste managers should organize brainstorming sessions to determine the efficiency of their plan.

Medical waste minimization

Medical waste minimization involves several steps [19]:

- a. Reducing the medical waste at source, this is achieved by: purchasing materials which generate small quantities of waste; using modern equipment and methods that do not generate hazardous chemicals, such as replacing traditional chemical disinfection by ultrasound or steam disinfection, replacing mercury thermometers with electronic ones, and using computed or true digital radiography instead of conventional film-based radiography; proper management of materials and reagents [22-24].
- b. Segregation at source, ensuring that waste is collected in proper recipients, according to current legislation;
- c. Waste treatment using thermal decontamination [25];
- d. Final disposal using appropriate methods, after reducing the waste amount. Treated wastes will be disposed of using methods which have a minimal impact on the environment [22, 26, 27].

Experimental part

Material and methods

Five private health care facilities were included in this study. Data was collected monthly and statistical analysis was performed in order to reveal the efficiency of implementing a minimization plan for hazardous medical waste or to reveal the future trends of the amount of

medical waste. The moving average method and the regression method were used for future trend estimation. Moving average is the average of any sub-set of numbers and it is very useful for measuring long term trends.

Results and discussions

The analysis of data collected from the four private clinics and individual private office shows that in year 2 the amount of waste decreased by 4.33% compared to year 1. The amount of sharps decreased by 39.45 kg in year 2, which represents 27.75%, and infectious waste decreased by 95.5kg, representing a rate of 3.21% in year 2 compared to year 1 (fig. 1).

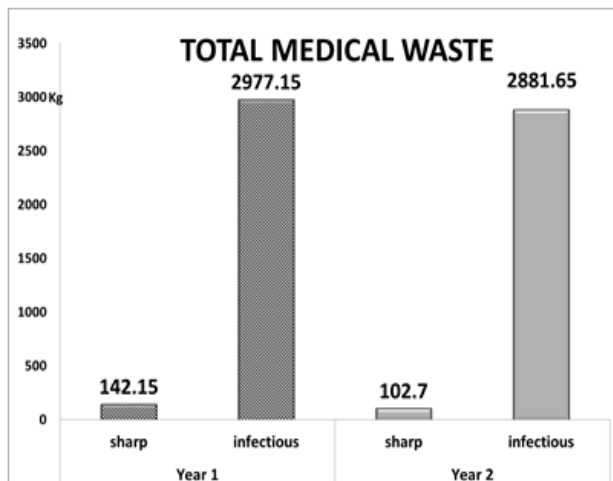


Fig. 1. Total medical waste in year 1 and year 2

As far as sharps are concerned, the efficient management of clinic 4 resulted in a 39.06% reduction for this type of waste, while clinic 2 registered a 38.52% decrease. A smaller decrease for sharp waste was achieved by clinic 1 (19.1%) and the individual medical office (2.96%), while sharp waste generated by clinic 3 grew to 2.96% (fig. 2).

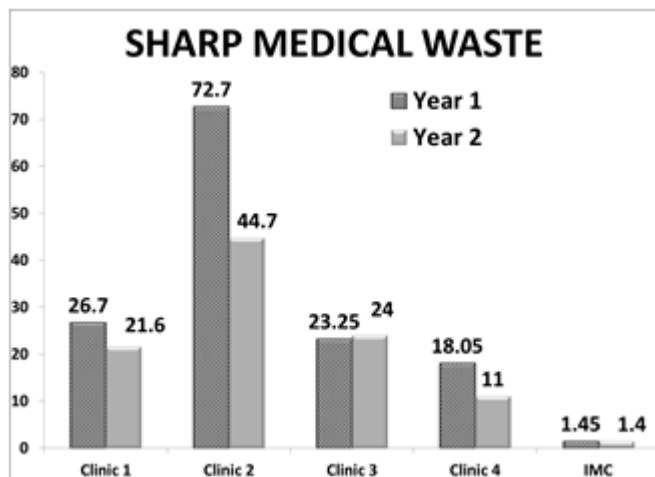


Fig. 2. Sharp medical waste in year 1 and year 2

Regarding infectious waste, the most significant reduction in year 2 was recorded at clinic 4 (17.61%), which used good practices of infectious waste management, thereby considerably reducing the amounts collected. Smaller drops in the amount of infectious waste collected were recorded for clinic 3 (7.36%), clinic 1 (3.47%) and the individual medical office (2.96%), while clinic 2 recorded an increase of 5.44%, showing poor management of infectious waste (fig. 3).

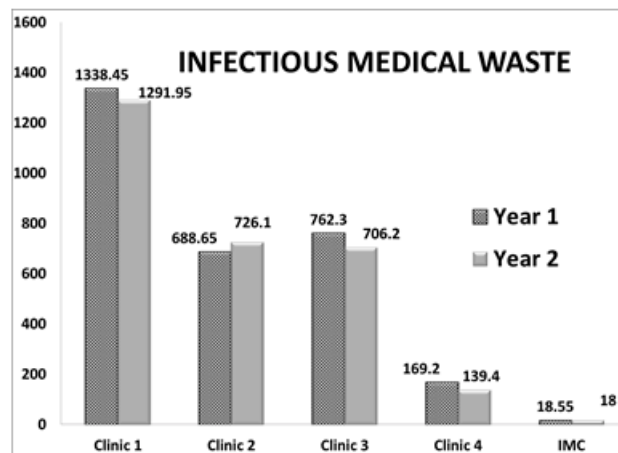


Fig. 3. Infectious medical waste in year 1 and year 2

Another analysis based on the time series method, on moving average series and on regression allows us to forecast numbers for year 3. Thus, for clinic 1 the analysis reveals a decreasing trend for hazardous sharp medical waste in year 3 (fig.4) and the same for the infectious medical waste (fig.5). The maximum and minimum values are estimated to be reached in November (112.72) and December (81.3) respectively for infectious medical waste, while for sharp medical waste the maximum value was predicted for March (1.72 kg) and the minimum value was predicted for August (1.01 kg).

Waste collection from private medical facilities complies with legislative requirements and is mainly carried out by specialized companies.

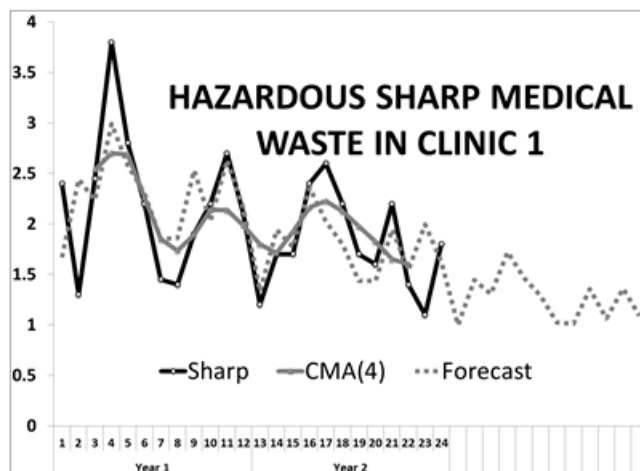


Fig. 4. Forecast of hazardous sharp medical waste

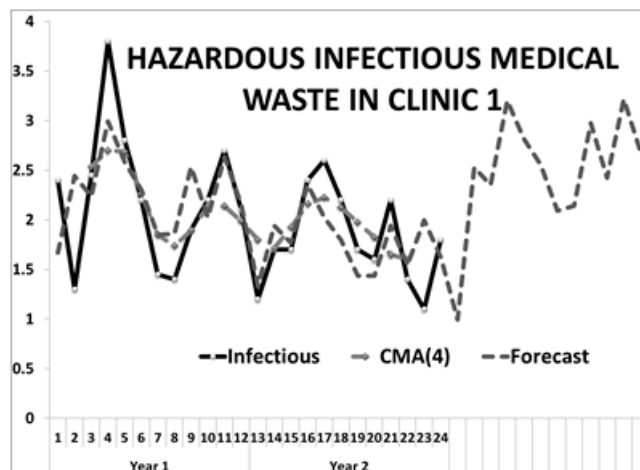


Fig. 5. Forecast of hazardous infectious medical waste

Such companies provide hazardous waste collection, transportation and disposal services. The operating cycle includes:

- consulting, instruction, training and assistance of staff regarding the handling, collection, packaging, and labeling of hazardous waste;

- collection and storage in temporary storage space.

The contracting authority must provide the necessary packaging for the separate collection of various types of medical waste;

- transportation;

- final disposal using incineration methods.

After the contract has been signed, the contractor regularly provides advice, training, and assistance sessions regarding the proper handling, collection, packaging and labeling of hazardous waste. Written instructions, overviews and details are also provided.

Upon receipt of medical waste, the representatives of the medical facility and of the authorized company are required to fill out and sign a reception protocol form regarding the delivery of hazardous medical waste, evaluated in accordance with current regulations. The reception protocol must include the following fields: beneficiary and service provider identification data; quantity of medical waste, expressed in kilograms; date and time of pick up; name (legible) and signature of person making the delivery and name (legible) and signature of recipient.

Incineration is the only acceptable method of eliminating all types of medical waste according to Romanian regulations.

Four private clinics and an individual medical practice were analyzed. The analysis focused on medical waste management and policies aimed at minimizing the amount of medical waste. Data was collected over a two-year period.

Conclusions

Waste management policies in healthcare facilities focused mainly on minimizing risk factors for employees and the public (in the short-term) and reducing environmental impact (in the long term). The principal objectives are as follows:

- minimizing the amount of generated medical waste;

- practicing differentiated waste collection, setting up on-site storage and identifying safe routes for transportation;

- creating temporary storage units and safely handling waste stored in the area;

- treatment and disposal of hazardous waste by choosing cheap and convenient solutions according to regulations, after proper recycling.

The benefits of waste minimization are environmental protection, better human health protection, reducing waste management costs in healthcare facilities, better communication and improved relations with community members.

The clinics analyzed in year 1 and year 2 have struggled to manage medical waste collection and rationally managed it, succeeding in significantly reducing the amounts of medical waste collected in year 2 compared to year 1.

The time analysis reveals that in year 3 the sharp waste in clinic 1 will decrease by 43.3% compared to year 1 and by 29.9% compared to year 2, showing the efficiency of their medical waste management plan.

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