

# Assessment of Biomedical Waste Situation in Hospitals of Dolj District

Carmen Aurora V. Bulucea, Aida V. Bulucea, Marius C. Popescu, Anca F. Patrascu

**Abstract**— The purpose of this position paper will be to summarize the available scientific data regarding biomedical waste management with respect to the environmental impacts. Effective management of biomedical waste incorporates a waste reduction and neutralization component where appropriate. Examining various treatment options underscores the importance of considering the properties of different types of medical waste and matching them to the capabilities of the treatment technologies. An attempt has been made to critically review the current biomedical waste management practices followed by the hospitals of Dolj District – Romania. In the paper the assessment of biomedical waste situation in 11 hospitals of Dolj District will be presented. Following the rules and legislation both of Romania and of European Union, the methods for segregation, packaging, labeling and the treatment techniques for reduction in volume, neutralization and final disposal of the biomedical waste will be analyzed.

**Keywords**— Biomedical waste, Environment, Hospital, Waste treatment

## I. INTRODUCTION

**M**EDICAL care is vital for our life and health, but the waste generated from medical activities represents a real problem of living nature and human world. Consequently, scientists and public authorities around the world are realizing that human actions have to be responsible regarding not only the social and economic matters, but also the environment issues. For the moment, our correct activities must be referred into the frame of Sustainable Development. On a broader front, sustainable development policies encompass three general policy areas [1], concerning the economical development, the environmental issues and the social protection. It means that the vitality and perhaps the future survival of the society are strongly depending on the

management of physical, environmental and human resources. The living Nature and the human actions can not anymore be separated and most important roles belong both to management activities and to environmental education processes. Major components of environmental protection process are environmental law, environmentally sensitive planning, environmentally sensitive governance and environment consciousness [2], as it can be seen in Fig.1. The beginning of environmental protection process is the Environmental Law [3]. It determines a theoretical frame, including a number of rules for the environment protection. Policy concepts, public participation, environmental justice, and the polluter pays principle have informed many environmental law reforms in this respect [4].

An important issue of environmental protection process is the waste management that includes responsible planning of collecting, transporting, processing and disposing waste material [5],[6]. The purposes are to clean up the surrounding environment and to see that the waste does not have a detrimental effect on human being health. Within waste management (WM), the health care waste management (HCWM) is a process that helps to ensure proper hospital hygiene and safety of health care workers and communities. HCWM concerns about planning and procurement, staff training and behavior, proper use of tools, machines and pharmaceuticals, proper methods applied for segregation, reduction in volume, treatment and disposal of biomedical waste [7], [8].

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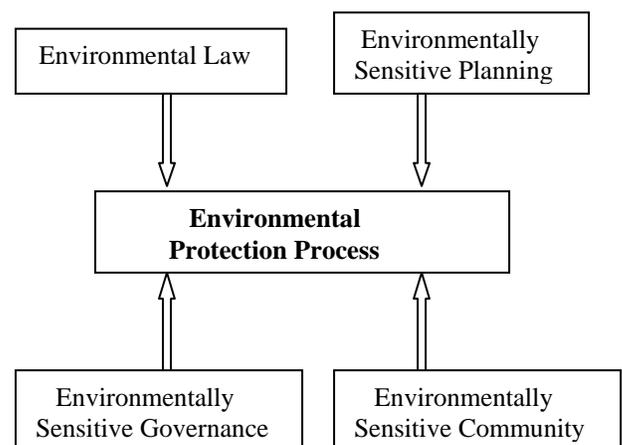


Fig.1. Environmental protection Process major components

## II. BIOMEDICAL WASTE DEFINING

Accordingly to concept definition, "Biomedical waste means any solid and/or liquid waste including its container and any intermediate product, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research pertaining thereto or in the production or testing thereof". The physic-chemical and biological nature of these components, their toxicity and potential hazard are different, necessitating different methods and options for their treatment and/or disposal [9],[10]. The basic components of hazardous biomedical waste consist in:

- \* human anatomical waste (such as, tissues, organs, body parts etc.);
- \* microbiology and biotechnology waste (such as, laboratory cultures, micro-organisms, human cell cultures, toxins etc.);
- \* waste sharps (such as, hypodermic needles, syringes, scalpels, broken glass etc.);
- \* discarded medicines and cyto-toxic drugs;
- \* soiled waste (such as, dressing, bandages, plaster cats, material contaminated with blood etc.);
- \* solid waste (disposable items like tubes, catheters etc.excluding sharps);
- \* liquid waste generated from any of the infected areas;
- \* animal waste (generated during research or experimentation, from veterinary hospitals etc.);
- \* incineration ash;
- \* chemical waste.

The health care waste can be subdivided into hazardous and non-hazardous categories. Since, it would not be possible for each and every health care establishment to have its own full treatment and disposal system for biomedical waste, there would be need for common treatment and disposal facilities under the coordination of medical head coordination and under the supervision and guidance of the civic authority [11], [12]. A control strategy for biomedical waste management follows the basic steps of characterizing the stream in light of treatment alternatives, segregating some waste to facilitate management based on these characteristics, and looking "upstream" to discover any opportunities to reduce the volume and/or toxicity of biomedical waste [12],[13].

## III. BIOMEDICAL WASTE MANAGEMENT STRATEGY

An assessment of the biomedical waste situation obtained within a district or city hospitals as a whole is necessary before making any attempts for improvement [14], [15], [16], [17]. It means that there must be taken into account the essential steps:

- A. Biomedical waste generation;
- B. Biomedical waste segregation, collection and storage;
- C. Biomedical waste handling and transportation;
- D. Biomedical waste treatment and disposal.

### A. Biomedical Waste Generation

Accordingly to the European Legislation, each hospital or health care establishment has to chalk out a programme [15] for qualitative as well as quantitative survey of the biomedical waste generated, depending on the medical activities and procedures followed by it. The concerned medical establishment should constitute a team of its experts, concerned personnel and workers: doctors, chemists, laboratory technicians, hospital engineers, nurses, cleaning inspectors, cleaning staff. Also, the medical establishment has to earmark a suitable place where the qualitative and quantitative tests can be carried out. The biomedical waste generated by all the departments has to be collected according to the prevailing practices of collections [18] and then has to be sorted out into the different categories according to the rules of biomedical waste legislation [19].

It must be also said that, according to the legislation [15],[18] if an incinerator is operating within the hospital campus, then the incinerator ash produced every day has to be weighed. Regarding the liquid waste, it may be divided into liquid reagents/chemical discarded and the cleaning and washing water channeled into the drain. Hence, the category-wise survey of medical waste generation are: human anatomical waste, animal waste, microbiology and biotechnology waste, sharps waste, medicines and cyto-toxic drugs, soiled waste, solid waste, chemical waste, incineration ash, liquid waste.

### B. Biomedical Waste Segregation and Storage

The segregation of biomedical waste should be examined because facility standard operating procedures for biomedical waste segregation have a direct impact on type and cost of biomedical waste treatment [20]. Each category of waste has to be kept segregated in a proper container or bag as the case may be. Such container or bag should have certain properties: it should be without any leakage; it must be able to contain the designed volume and weight of the waste without any damage; the container should have a cover, preferably operated by foot; when a bag or container is filled at 3/4th capacity it must be sealed and an appropriate label has to be attached; taking into account the European and National Legislation [15], [18], an adequate symbol must be pictured for all type of biomedical waste, according to their code: 1) infectious waste; 2) pathological waste; 3) sharps; 4) pharmaceutical waste; 5) genotoxic waste; 6) chemical waste; 7) waste with high content of heavy metals; 8) radioactive waste.

Arrangement for separate receptacles in the storage area with prominent display of colour code has been made in accordance with the legislation: yellow for hazardous biomedical waste and black for the non-hazardous waste [18],[19].

### C. Biomedical Waste Handling and Transportation

This activity has three components: collection of different kinds of waste from waste storage bags and containers inside

the hospital, transportation and intermediate storage of segregated waste inside the premises and transportation of the waste outside the premises towards the treatment or final disposal. The biomedical waste has to be transported to the treatment or disposal facility site in a safe manner. The vehicle should have certain specifications [18]: it should be covered and secured against accidental opening of door, leakage etc.; the interior of the container without sharp edges or corners in the aim to be easily washed and disinfected; there should be adequate arrangement for drainage and collection of any leakage.

#### *D. Biomedical Waste Treatment and Disposal*

Different methods have been developed for rendering biomedical waste environmentally innocuous and aesthetically acceptable [20], [21]. The biomedical waste legislation [15], [18] has elaborately mentioned the recommended treatment and disposal options according to the different categories of waste generated in hospitals. Different methods and treatment technologies have been developed [13], [14]: (a) Incineration; (b) Autoclave treatment; (c) Hydroclave treatment; (d) Microwave treatment; (e) Mechanical/Chemical Disinfecting; (f) Sanitary and secured Landfilling; (g) General Waste.

(a) Incineration is a high temperature thermal process involving combustion of the waste under controlled condition for converting them into inert material and gases. Incineration of medical waste remains a prevalent treatment method around the world. The advantages of incinerating medical waste are those associated with incineration of any type of waste: significant volume reduction (by about 90% percent), assured destruction, sterilization, weight reduction, and the ability to manage most types of wastes with little processing before treatment [13], [22]. The disadvantages include potential pollution risks associated with incineration processes and increased costs associated with controlling pollution emissions. In some European countries had appeared that regional off-site incineration facilities have been encouraged to optimize the economical application of advanced pollution control technologies. In Romania, incineration continues to occur on-site in health care units, most of which having few or no pollution controls.

Incinerators [23], [24] can be oil fired or electrically powered or a combination thereof. On a broader front, three types of incinerators are used for hospital waste [14],[25]: multiple hearth type, rotary kiln and controlled air types. All the types can have primary and secondary combustion chambers to ensure optimal combustion. In the multiple hearth incinerator, solid phase combustion takes place in the primary chamber whereas the secondary chamber is for gas phase combustion. There are referred to as excess air incinerators because excess air is present in both the chambers. The rotary kiln is a cylindrical refractory lined shell that is mounted at a slight tilt to facilitate mixing and movement of the waste inside. It has provision of air circulation. The kiln acts as the primary solid phase

chamber, which is followed by the secondary chamber for the gaseous combustion. In the third type, the first chamber is operated at low air levels followed by an excess air chamber. Due to low oxygen levels in the primary chamber, there is better control of particulate matter in the flue gas. According to the legislation [15], [18], incineration it is recommended for human anatomical waste, animal waste, cyto-toxic drugs, discarded medicines and soiled waste.

The increasing concern over incineration in general and particularly for biomedical waste has resulted in the encouragement for developing alternative treatment technologies. Hence, several interrelated factors account for the likely decreased dependence on incineration:

- 1) the increased cost of incineration due to increased equipment needs to meet new emissions standards;
- 2) siting and permitting difficulties associated with incineration requirements at the local and national levels of government;
- 3) the increasing availability of nonincineration alternative treatment of biomedical waste.

(b) Autoclave Treatment is a process of steam sterilization under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. Autoclaving has been used as a treatment method in laboratory settings to sterilize microbiological laboratory cultures. Autoclaving is a process by which wastes are either sterilized or disinfected prior to disposal in a landfill. Autoclaving can be a sterilization process if all microorganisms are exposed to the steam for a sufficient temperature/pressure/time period to assure their destruction. There are also of three types: gravity type, pre-vacuum type and retort type. In the Gravity type, air is evacuated by help of gravity alone. The system operates at temperature of 121 deg.C and steam pressure of 15 psi for 60-90 minutes. In the Pre-vacuum type, vacuum pumps are used to evacuate air from the pre-vacuum autoclave system so that the time cycle is reduced to 30-60 minutes. It operates at about 132 deg.C. The Retort type autoclaves are designed to handle much larger volumes and operate at much higher steam temperature and pressure. Autoclave treatment is recommended [14], [18] for microbiology and biotechnology waste, waste sharps, soiled and solid waste.

(c) Hydroclave Treatment is based on an innovative equipment named Hydroclave, for steam sterilization process (like autoclave) [14]. Hydroclave is a double walled container in which the steam is injected into the outer jacket to heat the inner chamber containing the waste. Moisture contained in the waste evaporates as steam and builds up the requisite steam pressure (35-36 psi). Sturdy paddles slowly rotated by a strong shaft inside the chamber tumble the waste continuously against the hot wall thus mixing as well as fragmenting the same. In the absence of enough moisture, additional steam is injected. The system operates at 132 deg.C and 36 psi steam pressure for sterilization time of 20 minutes. The total time for a cycle is about 50 minutes,

which includes start-up, heat-up, sterilization, venting and depressurization and dehydration. The treated material can further be shredded before disposal. The expected volume and weight reductions are up to 85% and 70% respectively. The hydroclave can treat the same waste as the autoclave plus the waste sharps (also fragmented). This technology has certain benefits, such as, absence of harmful air emissions, absence of liquid discharges, non-requirement of chemicals, reduced volume and weight of waste etc.

(d) Microwave Treatment is again a wet thermal disinfection technology but unlike other thermal treatment systems, which heat the waste externally, microwave heats the targeted material from inside out, providing a high level of disinfection. Powered by electricity, the unit shreds the waste in a controlled environment; the waste then enters the chamber for exposure to the microwaves. The disinfection process takes place through microwave heating and wetting and shredding the waste to facilitate heating and steam penetration of the waste. The material is discharged to a storage bin for ultimate disposal. Microwave technology has certain benefits, such as, absence of harmful air emissions, no requirement of chemicals, reduced volume of waste. However, the investment costs are high at present. According to legislation, the microbiology and biotechnology waste, the soiled and solid waste are permitted to be microwaved.

(e) Mechanical/Chemical Disinfection represents a technology which has been available since 1980s and is referred to as “mechanical/chemical” because of mechanical maceration and chemical disinfection (a result of forcing a reaction that occurs to volatilize waste material and expose all of the pathogens to a chemical disinfectant in a controlled environment) [15],[26],[27]. Chemical disinfecting process is a treatment recommended for waste sharps, solid and liquid waste as well as chemical wastes. Chemical treatment involves use of at least 1% hypochlorite solution with a minimum contact period of 30 minutes or other equivalent chemical reagents, such as, phenolic compounds, iodine, hexachlorophene, iodine-alcohol or formaldehyde-alcohol combination. A number of factors should be considered regarding the effective use of chemical disinfection, including: the types and biology of microorganisms in the wastes; degree of contamination; type of disinfectant used and its concentration and quality; the contact time.

(f) Sanitary and Secured Landfilling is necessary under certain circumstances [ 28]:

- 1) deep burial of human anatomical waste, when the facility of proper incineration is not available – Secured landfill;
- 2) animal waste, under similar conditions as above
- 3) Secured landfill;
- 4) disposal of autoclaved / hydroclaved / microwaved waste – Sanitary landfill;
- 5) disposal of incineration ash – Sanitary landfill;
- 6) disposal of sharps – Secured landfill.

(g) General Waste includes the waste material generated

from the office, kitchen, garden, store etc., which are non-hazardous and non-toxic.

General waste may be taken care of:

- 1) composting of green waste;
- 2) recycling of packaging material.

In both cases, certificate indicating origin and non-contamination, issued by the concerned medical authorities of the health care establishment is essential from the point of safety.

Examining various treatment options underscores the importance of considering the properties of different types of medical waste and matching them to the capabilities of the treatment technologies. An important issue is the viability of the pathogens during treatment and disposal and their potential to transmit disease [13]. Also, the basic physical forms of medical waste (solid, liquid or gas) should be taken into account for their handling and treatment. Hence, both physical characteristics of waste components and the biological and chemical composition of the waste are important determinants of the most appropriate treatment technology and have important impacts for that treatment.

#### IV. CASE STUDY IN DOLJ DISTRICT.RESULTS, ISSUES AND TRENDS

Source reduction or prevention of biomedical waste encompass the activities that reduce the toxicity or quantity of discarded products before the products are purchased, used and discarded [26], [29]. Source reduction can be achieved by: 1) manufacturers considering biomedical waste issues in designs of current and planned medical and health-care products and their packing; and 2) consumers of medical and health-based products (e.g., hospitals) directing their purchasing decisions, product use and discarding of products towards waste reduction goals. The two fundamental characteristics of biomedical wastes that are focus of reduction efforts are: toxicity, i.e., eliminating or finding benign substitutes for substances that pose risks when they are discarded; and quantity, i.e., changing the design or use of products to minimize the amount of waste generated when they are discarded.

This case study present the analysis results of biomedical waste (hazardous and non-hazardous) generated in 11 hospitals of Dolj District, Romania [30]. Although the medical waste stream is heterogenous, the focus of concern was on the portion of the waste stream termed “hazardous” and how these wastes are classified. The category-wise survey of hazardous medical waste generation were:

- 1) infectious waste, described as waste suspected to contain pathogens (e.g. laboratory cultures, waste from isolation wards, tissues, materials or equipment that have been in contact with infected patients);
- 2) pathological waste, consisting in human tissues or fluids (e.g. body parts, blood and other body fluids, fetuses);
- 3) sharps, meaning sharp waste (e.g. needles, infusion sets, scalpels, blades, broken glass);
- 4) pharmaceutical waste, described as waste containing

- pharmaceuticals (e.g. discarded medicines that are expired or no longer needed);
- 5) genotoxic waste, that means waste containing substances that are capable of causing damage to DNA (e.g. waste containing cytostatic drugs, genotoxic chemicals);
  - 6) chemical waste, that is waste containing chemical substances (e.g. laboratory reagents, film developer, disinfectants that are expired or no longer needed, solvents);
  - 7) waste with high content of heavy metals, including batteries, broken thermometers, blood-pressure gauges);
  - 8) pressurized containers, meaning gas cylinders gas cartridges, aerosol cans;
  - 9) radioactive waste, which refers to waste containing radioactive substances (e.g. unused liquids from radiotherapy or laboratory research, contaminated glassware, packages or absorbent paper, urine and excreta from patients treated or tested with unsealed radionuclides).

In Table I and Table II, respectively, are presented the survey results of average daily biomedical waste (amount and composition) generated and waste handling corresponding to a month (January and February, respectively) of observation.

Table.I Average Daily Biomedical Waste Generated in Hospitals of Dolj District on January 2005

Sr. No	Health Care Unit	Beds No.	Average beds no./ 24 h	Hazardous waste amount kg / 24 h	Non-hazard. waste amount kg/ 24 h
0	1	2	3	4	5
1	Emergency Clinical Hospital of Craiova	1452	1452	443,375	765,475
2	Municipal Clinical Hospital of Craiova	539	461	71,67	321,5
3	Infectious Diseases Clinical Hospital of Craiova	480	361	336,45	10
4	Neuro-psychiatry Clinical Hospital of Craiova	370	365	32,95	244
5	Lung-physiology Hospital of Leamna	200	190	53	8,9
6	Municipal Hospital of Calafat	285	223	26,5	88,5
7	Psychiatry Hospital of Poiana Mare	500	457	4,512	13,255

8	Urban Hospital of Segarcea	80	99	10	2
9	Urban Hospital of Filiasi	162	160	8,6	144
10	Urban Hospital of Bailesti	140	121	22,742	84
11	Hospital of Dabuleni	80	92	7,767	71

Sr. No	Average Hazardous Waste Amoun kg / bed/24 h Current Year	Average Hazardous Waste Amount kg / bed/24 h Previous Year	Elimination Method		
			Hospital Own Incinerator	Off-site Hospital Incinerati on	Neutra- lization kg/24 h
0	6	7	8	9	10
1	0,305	1,814	YES	-	104,8
2	0,155	0,131	YES	-	12
3	0,931	1,05	NO	Municipal Incinerator	25,5
4	0,09	0,16	NO	Municipal Hospital Incinerator	13,65
5	0,258	0,200	YES	-	7,9
6	0,119	0,441	YES	-	-
7	0,020	0,009	Crema- tory	-	-
8	0,10	0,056	YES	-	4
9	0,054	-	YES	-	-
10	0,161	0,168	YES	-	-
11	0,319	-	YES	-	-

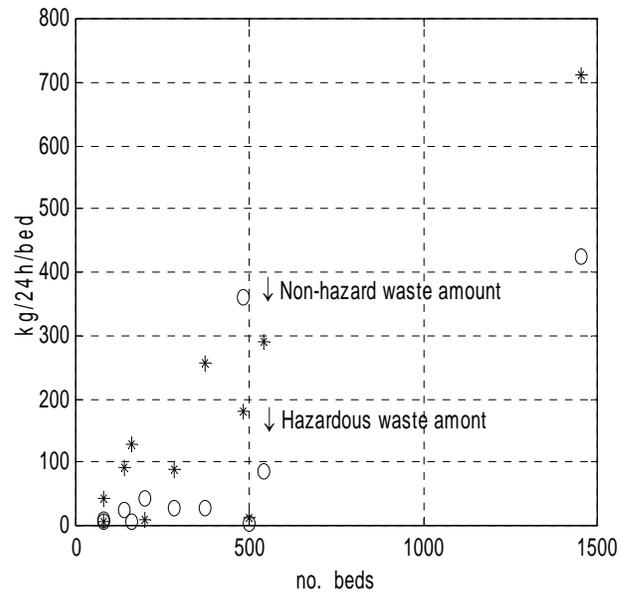


Fig.2. Medical Waste Amount Generated in Dolj District Hospitals during January 2005

In Fig. 2 and Fig.4 the amount of hazardous and non-hazardous medical waste generated during January 2005 and February 2005, respectively, are presented.

In Fig.3 and Fig.5, comparisons of the amount of hazardous medical waste generated in the same months of

2005 and 2004 are realized.

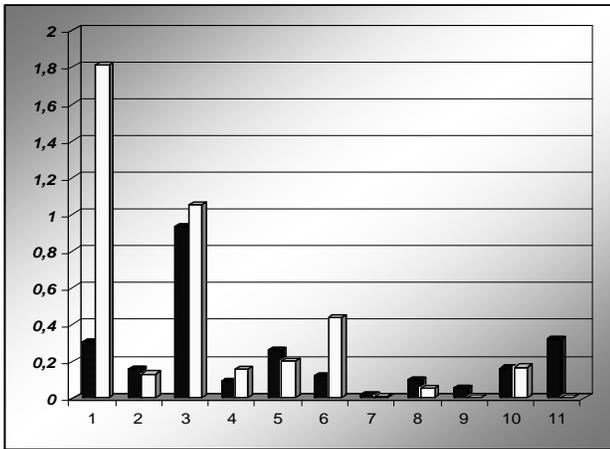


Fig.3. Comparison of Hazardous Waste Amount Generated in January 2005 and in January 2004

Table.II Average Daily Biomedical Waste Generated in Hospitals of Dolj District on February 2005

Sr. No.	Health Care Unit	Beds Number	Average beds no./ 24 h	Hazardous waste amount kg / 24 h	Non-hazard. waste amount kg / 24 h
0	1	2	3	4	5
1	Hospital of Dăbuleni	80	75	6,655	42,5
2	Infectious Diseases Clinical Hospital of Craiova	480	353	361,8	179
3	Emergency Clinical Hospital of Craiova	1452	1445	423,725	712,75
4	Urban Hospital of Filiasi	162	137	6,1	128,45
5	Municipal Hospital of Calafat	285	199	26,5	88,5
6	Lung-physiology Hospital of Leamna	200	188	43,75	10,45
7	Psychiatry Hospital of Poiana Mare	500	454	3,545	12,275
8	Neuro-psychiatry Hospital of Craiova	370	355	26,2	256,51
9	Municipal Clinical Hospital of Craiova	539	447	86,53	291,26
10	Urban Hospital of Segarcea	80	92	9	6
11	Urban Hospital of	140	162	24,685	92,95

	Bailesti			
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Sr. No	Average Hazardous Waste Amont kg/bed/24 h Current Year	Average Hazard. Waste Amont kg/bed/24 h Previous Year	Elimination Method		
			Hospital Own Incine-rator	Off-site Hospital Incine-ration	Neutrali-zation kg/24 h
0	6	7	8	9	10
1	0,178	-	-	YES	-
2	0,894	1,05	-	Municipal Incine-rator	YES 22,5kg/ /24 h
3	0,293	1,814	YES 62 kg/ /24 h	-	Sterili-sation 45 kg/ /24 h
4	0,044	-	YES 6,1 kg/ /24 h	-	-
5	0,133	0,441	YES 19 kg/ /24 h	-	-
6	0,107	0,125	YES 43 kg/ /24 h	-	-
7	0,025	0,010	YES	-	-
8	0,007	0,16	-	YES Craiova Municipal Incine-rator	4,62kg/ /24 h
9	0,193	0,131	YES 45 kg/24 h	NO	YES 14 kg/ /24 h
10	0,11	0,056	YES 9kg/24 h	NO	YES 3 kg/24 h
11	1,599		YES 24,85 kg/24 h	-	-

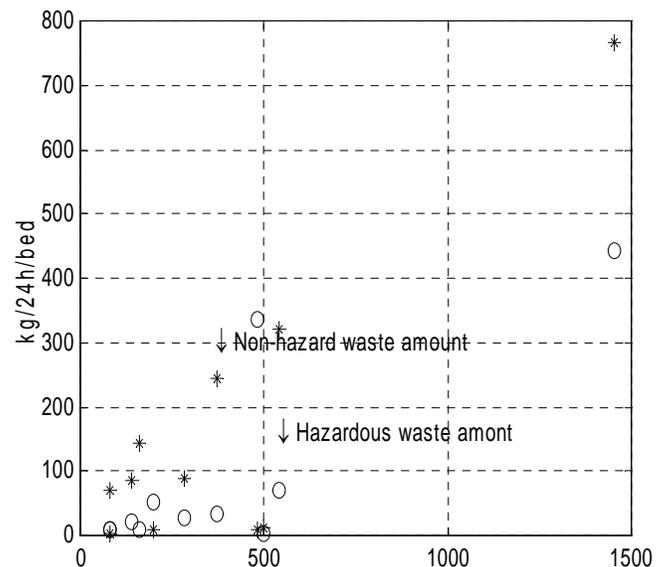


Fig.4. Medical Waste Amount Generated in Dolj District Hospitals during February 2005

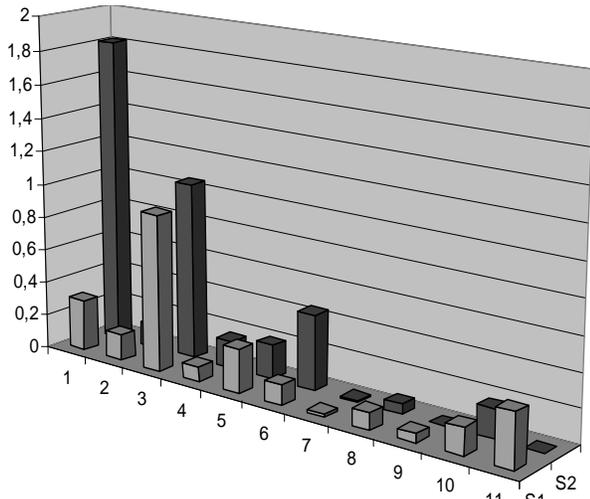


Fig.5. Comparison of Hazardous Waste Amount Generated in February 2005 and in February 2004

In Tabel III and Table IV, respectively, are presented the survey results of daily hazardous biomedical waste amount generated, corresponding to a trimester of observation, during 2007 and 2006, respectively.

Tabel.III. Average Daily Biomedical Hazardous Waste Generated in Hospitals of Dolj District on First Trimester of 2007 and 2006

Sr. No.	Health Care Unit	Beds Number	Average beds no./ / 24 hours
0	1	2	3
1	Emergency Clinical Hospital of Craiova	1398	1398
2	Municipal Clinical Hospital of Craiova	519	481
3	Infectious Diseases Clinical Hospital of Craiova	435	313
4	Neuro-psychiatry Clinical Hospital of Craiova	395	388
5	Municipal Hospital of Calafat	265	184
6	Urban Hospital of Segarcea	80	89
7	Urban Hospital of Filiasi		
8	Psychiatry Hospital of Poiana Mare	500	452
9	Urban Hospital of Bailesti	519	481
10	Lung-physiology Hospital of Leamna	200	139
Sr. No.	Hazardous waste amont kg / 24 hours	Average hazardous waste amount kg/24 h/bed current year (2007)	Average hazardous waste amount kg/24 h/bed previous year (2006)
0	4	5	6
1	562	0,402	0,370
2	68,512	0,142	0,131
3	79,3	0,253	0,446
4	13,87	0,97	0,004
5	9,15	0,05	0,441
6	14,500	0,325	0,144

7	5,475	-	-
8	31,200	3,140	0,005
9	68,512	0,142	0,131
10	36,1	0,259	0,107

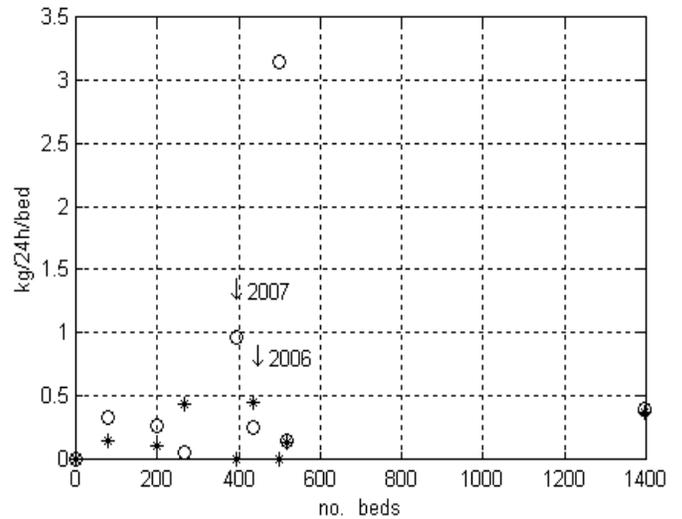


Fig.6 Average Amount of Hazardous Medical Waste Generated during First Trimester of 2007 and 2006

Tabel.IV. Average Daily Biomedical Hazardous Waste Generated in Hospitals of Dolj District on Second Trimester of 2007 and 2006

Sr. No.	Health Care Unit	Beds Number	Average beds no./ / 24 hours
0	1	2	3
1	Emergency Clinical Hospital of Craiova	1398	1291
2	Municipal Clinical Hospital of Craiova	519	457
3	Infectious Diseases Clinical Hospital of Craiova	465	327
4	Neuro-psychiatry Clinical Hospital of Craiova	395	370
5	Municipal Hospital of Calafat	265	193
6	Urban Hospital of Segarcea	80	92
7	Urban Hospital of Filiasi		
8	Psychiatry Hospital of Poiana Mare	500	452
9	Urban Hospital of Bailesti	128	128
10	Lung-physiology Hospital of Leamna	200	146
Sr. No.	Hazardous waste amont kg / 24 hours	Average hazardous waste amount kg/24 h/bed current year (2007)	Average hazardous waste amount kg/24 h/bed previous year (2006)
0	4	5	6
1	489	0,383	0,370
2	71,455	0,156	0,131

3	65,7	0,200	0,446
4	14,01	0,97	0,052
5	15,65	0,081	0,441
6	10,00	0,11	0,144
7	5,475	-	-
8	31,200	3,140	0,005
9	27,100	0,211	0,127
10	25,45	0,174	0,265

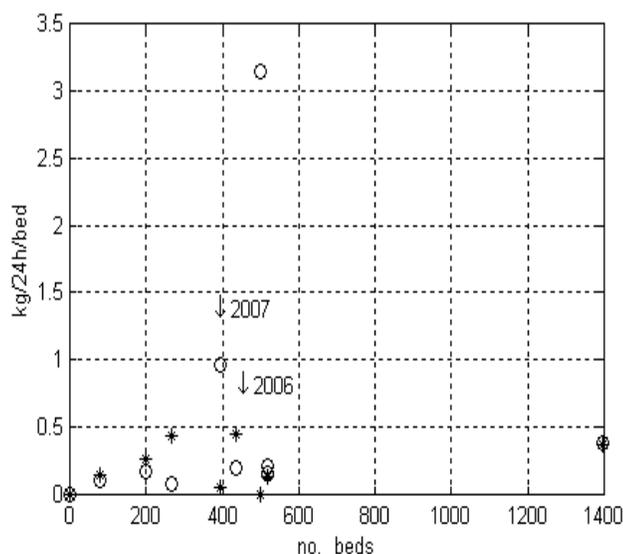


Fig.7. Average Amount of Hazardous Medical Waste Generated during Second Trimester of 2007 and 2006

In Fig.6 and Fig.7 the results of the survey of hazardous biomedical waste generated within the hospitals of Dolj District during first trimester of 2007 and 2006, and within second trimester, respectively, are presented.

During the study, it was observed that the Dolj District Hospitals have been properly managing their biomedical waste [31]. The hospitals have been segregating the biomedical waste every day, in accordance with the biomedical waste categories, collected in the appropriate type of container and specified colour coding, in accordance with the legislation. The hospitals also followed the tables given in the legislation. The hospitals have maintained the practice of decontamination of biomedical waste before disposal or storing of the waste for 48 hours.

Regarding the capabilities and risks of biomedical treatment alternatives, it must be emphasized that the only treatment technologies that are usually used to treat pathological waste are the incineration and mechanical/chemical disinfection systems. Depending on the type of incinerator and the nature of its controls, incineration is the one treatment alternative that could manage all of biomedical wastes. An important issue concerning the incineration of biomedical waste is to identify the combustion pollutants, which include dioxins and furans, pathogens (entities with infection potential), metals (as cadmium), acid gases (e.g. hydrogen chloride, nitrogen

oxides, and sulfur dioxides) which can cause acute effects (such as eye and respiratory irritation), and possible responsible for chronic health effects, can contribute to acid rain, and may enhance the toxic effects of heavy metals. It must be notified that the higher concentrations of hydrogen chloride (HCl) in emissions, on average, from biomedical waste incinerators compared with MSW incinerators may be due to the higher levels of polyvinyl chloride (PVC) plastics in medical wastes. Almost all of the chlorine in these wastes is converted to HCl during the combustion process (assuming a high combustion efficiency). In this way, chlorinated plastics contribute to the high emission rates of HCl and possibly the formation of dioxins (particularly if combustion is low).

Incineration technology continues to evolve, and more sophisticated pollution control equipment is becoming available. Still, a source of concern is the potentially hazardous nature of incinerator ash. A trend may be emerging for medical waste to recover energy and include front-end waste separation and recycling efforts.

From other perspectives, nonincineration alternatives may have advantages over incineration. On one hand, there are more serious emissions concerns associated with incineration than most alternatives. But, on the other hand, because incineration is a more established technology, emissions concerns have been more clearly identified.

Valid comparisons of various treatment alternatives for biomedical waste are problematic because different types of treatment goals are served by different technologies (e.g. the goal can be treatment to render wastes non-infectious; or non-infections and non-toxic). This means that different techniques may be appropriate for different waste types. Treatment alternatives will differ in the nature of the emissions that warrant test protocols, control measures and operating parameters specific to each technology. Also, costs and risks associated with the alternatives will vary. Comparisons between off-site and on-site applications of various alternatives can be problematic. With all of these differences, clearly, comparisons of the treatment technologies must be made carefully.

Around the world, and particularly in Dolj District hospitals, a concerning issue of biomedical waste management is that whatever treatment alternative is used, some form of additional solid waste disposal must occur. In all cases, ultimately, some degree of dependency on landfills remains. For biomedical waste incineration, the ash becomes a waste product requiring landfilling. For autoclaving, microwaving and irradiation either incineration and/or landfilling is necessary. The residue from the chemical and mechanical treatment alternative has to be discharged to the sewer or landfilled.

## V. CONCLUSION

The key challenges which need to be resolved for biomedical waste management are regarding:

- better defining hazardous waste,
- improving the segregation of medical waste, and
- identifying appropriate treatment alternatives.

However great the achievements of reduction and recycling efforts, there will continue to be a need for effective treatment and disposal for wastes that cannot be recycled. Although incineration remains, and is likely to continue to remain, a number of other treatment alternatives are available and will supplement incineration technology. One of the most critical issue regarding biomedical waste management is which technologies are appropriate for treatment. Factors as particular circumstances of the medical waste generator, the quantity and types of the medical waste, the availability of permitted landfill space, the demographic and geographic factors need to be considered when selecting the most appropriate management strategy. Safety, reliability and costs of alternative treatment methods also affect selection of treatment alternatives.

Regarding the people and environmental issues, a correct Health Care Waste Management (HCWM) will avoid the negative long-term health effects, from the environmental release of toxic substances such as dioxin, mercury and others. From both volume and toxicity perspectives, the use of plastics in society is a focus of waste management concern. The type of plastic used and its impact on waste treatment is one example of how waste reduction efforts focused on reducing certain emissions can link pretreatment and treatment management efforts.

Further on, achieving the HCWM strategy requires first to know the applicable regulatory requirements and then to assess the capabilities, costs and associated health and environmental risks of various treatment technologies.

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