Holistic approach of biomedical waste management system with regard to health and environmental risks

Nikos E. Mastorakis, Carmen A. Bulucea, Tatiana A. Oprea, Cornelia A Bulucea, Philippe Dondon

Abstract An important issue of environmental protection process is the solid waste management (SWM), that includes responsible planning of collecting, transporting, processing and disposing of hazardous and non-hazardous solid waste material. A special concern focuses on effective management of biomedical waste. This article highlights a holistic approach of biomedical waste management, with regards to the chain of environmental and health risks and concerns, aimed in achieving the fundamental premises for a systemic approach of biomedical waste management. An attempt has been made to critically review the current biomedical waste management practices followed by some Romanian hospitals. Following the rules and legislation of both Romania and European Union, the methods for segregation, packaging, labeling and the treatment techniques for reduction in volume, neutralization and final disposal of the biomedical waste are analyzed.

Keywords Biomedical waste, Health care, Hospital, Waste management system

I. Introduction

Human beings are exposed to a huge variety of health risks over their entire life. Every day, relatively large amount of potentially infectious and hazardous waste are generated in the health care hospitals and facilities around the world [1]. A special concern of environmental and humankind protection focuses on effective management of biomedical waste, incorporating an appropriate waste reduction and neutralization component [2]. Along with this idea, a systemic approach of biomedical waste is compulsory, since without proper guidance, the hazardous medical waste management may compromise the quality of patient caretaking.

Medical 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. Main purposes of waste management are to clean up the surrounding environment and to identify the appropriate methods for waste neutralization, recycling and disposal [3]. 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 [4,5].

The literature studies [4,5,6,7,8,9,10] have been demonstrated that there is not a single method of biomedical waste treatment or disposal that completely eliminates all risks to humans or to environment. The first step of this approaching focuses on the risks caused by an inappropriate biomedical waste management.

II. Environmental and Health Risks Caused by Biomedical Waste

Biomedical waste is produced in all conventional medical units where treatment of (human or animal) patients is provided, such as hospitals, clinics, dental offices, dialysis facilities, as well as analytical laboratories, blood banks, university laboratories. Health care waste refers to all materials, biological or non-biological, that are discarded in any health care facility and are not intended for any other use [2]. Within a health care facility or hospital, the main groups submitted to risks are:

- Doctors, medical nurses, healthcare unit workers and maintenance staff;
- Patients;
- Visitors;
- Workers in ancillary services: laundry, medical supplies store, those charged with collecting and transporting waste;
- Service workers dealing with waste treatment and disposal of health unit.

Regarding the health care workers, three infections are most commonly transmitted: hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency (HIV) virus. Among the 35 million health care workers worldwide, the estimations show [2,8] that each year about 3 million receive hard exposures to bloodborne pathogens, 2 million of those to HBV, 0.9 million to HCV, and 170,000 to HIV.

Also, the workers involved in the collection and treatment of the biomedical waste are exposed to a certain risk.

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Table I presents the types of infections [8,9]determined by the contact with biomedical waste, pathogen agents and transmission.

TABLE I
TYPES OF INFECTIOUS CAUSED BY BIOMEDICAL WASTE

Infection Type	Pathogen Agents	Transmission Path
Gastrointestinal infections	Enterobacteria:Salmonell, Shigella spp. Vibrio cholerae Helminths	Faeces or/and vomiting liquid
Respiratory infections	Mycobacterium tuberculosis Measles virus Streptococcus pneumonae	Respiratory secretions, saliva
Eye infections	Herpes virus	Eye secretions
Genital infections	Neisseria gonorrhoeae Herpes virus	Genital secretions
Skin infections	Streptococcus spp.	Purulent secretions
Anthrax	Bacillus anthracis	Secretions of skin lesions
Meningitis	Neisseria meningitidis	LCR
AIDS	HIV	Blood, semen, vaginal secretions
Haemorrhagic fevers	Junin Viruses, Lassa, Ebola Marburg	Biological fluids and secretions
Septicemia	Staphylococcus ssp	Blood
Viral Hepatitis type A	VHA	Faeces
Viral Hepatitis type B and C	VHB, VHC	Blood, biological fluids

As a consequence, around the world there is seriously taken into consideration the implementation of immunization programs, along with a proper biomedical waste management.

Risks generated by the chemical and pharmaceutical waste are associated to the potential traits of characteristics, such as: toxic, genotoxic, corrosive, flammable, explosive, teratogenic, mutagenic.

The sources of pharmaceutical waste are represented by:
- drugs administered intra venous;
- payment/ breakage of containers;
- partially used vials;
- unused or undated medications;
- expired medicines.

Larger amounts of such biomedical waste occur when unwanted or expired chemical and pharmaceutical products are removed. These can cause poisoning by absorption through the skin or mucous membranes, by inhalation or by ingestion. Chemicals and pharmaceuticals may also determine lesions of skin, eye, and respiratory mucosa. The most common injuries are the burns. Chemical waste removed by drainage system may have toxic effects on ecosystems and water where are discharged. Similar effects may have the pharmaceuticals which contain antibiotics or other drugs, heavy metals, disinfectants and antiseptics.

Risks associated to final elimination of biomedical waste should be also considered within a health care and environmental protection program. Incineration of medical waste containing plastic with chlorine composition determines the dioxin generation. Dioxin is a known carcinogen. Once formed, dioxin is linking to organic particles, that are carried by wind, deposited on land and in water. The half-life of dioxin is estimated at 25-100 years. Dioxin binds to nuclear DNA. It acts as a potential cancer promoter, weak-delete immune response and is associated with many negative effects both on human health (endometriosis, birth defects, low testosterone levels) and on environment. All these effects occur when exposure to low levels of dioxin. Incineration of biomedical waste with heavy metals content is forbidden.

III. HOLISTIC APPROACH OF BIOMEDICAL WASTE

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 [10,13]. 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, scalps, 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 healthcare 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 [13,14,15]. 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 [10].

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 [16,17,18]. 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.

TABLE II
TYPES OF HAZARDOUS WASTE GENERATED WITHIN OBSTETRICS-GYNAECOLOGY HOSPITALS

Blood, blood products, other biological fluids	Human blood discarded, blood components or products, various materials soaked with blood, or blood products, or fluids, or impregnated with dried blood	Generated in almost all medical clinics
Sharp tools	Syringes, pipettes, scalpels, vials, needles, capillary tubes, broken glass objects	Generated in almost all clinics
Anatomical and anatomo-pathological waste	Tissues, organs, natomical parts, including organic liquids removed during surgery or other medical procedures	Generated mainly in surgery and pathology clinics
Waste from isolation wards	Materials contaminated with blood, excreta etc. from isolated patients suffering from contagious diseases	Generated mainly in infectious diseases clinic
Waste from surgery wards	Materials to be removed, including soiled dressings, sponges, gowns, gloves	Generated mainly in surgery clinics
Waste from laboratory wards	Wastes that have been in contact with infectious substances, such as blades, cultures, reagents	Generated in laboratories
Waste from intensive therapy wards ICU	Effluents and equipment came into contact with the blood of patients	Generated in intensive therapy clinic ICU
Cultures of microorganisms	Cultures of infectious agents	Laboratory and research department
Sanitary materials contaminated	Vacuumtainers, blood bags, containers for suction, drainage systems, dialysis lines	Generated in almost all clinics
Chemo-therapeutics		Generated in oncology clinics

A. Biomedical Waste Generation

Accordingly to the European Legislation, each hospital or health care establishment has to achieve a program [11,12] for qualitative as well as quantitative survey of the biomedical waste generated, depending on the medical activities and procedures followed by it [20,21].

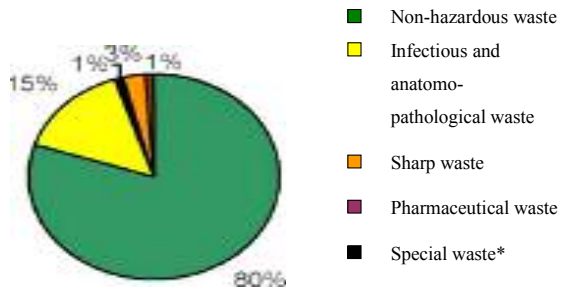

Fig. 1 Biomedical waste structure

** cytostatics, pressurized containers, broken thermometers, used batteries, radioactive waste.*

The biomedical waste structure [1,8] is presented in Fig.1

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 [12] and then has to be sorted out into the different categories according to the rules of biomedical waste legislation [17]. It must be also said that 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 [17]. 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 $3/4^{th}$ capacity it must be sealed and an appropriate label has to be attached; taking into account the European and National Legislation [11,12,17,18], 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 [17].

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 [17]: it should be covered and secured against accidental opening of door, leakage etc.; the interior of

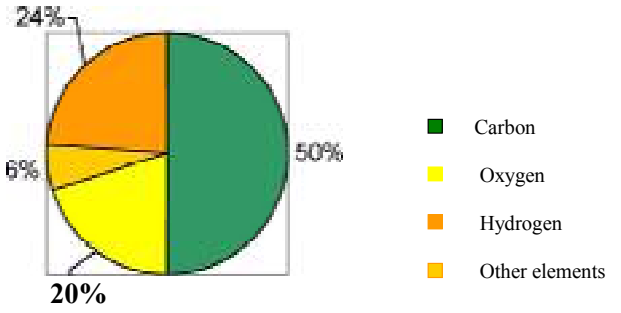

Fig.2 Chemical composition of biomedical waste

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 [10,13,19,20,21,23,25].

The biomedical waste legislation [11,12,17] 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 [2,10,13], starting from the chemical composition and hazardous traits of biomedical waste: (1) Incineration; (2) Autoclave treatment; (3) Hydroclave treatment; (4) Microwave treatment; (5) Chemical disinfecting; (6) Sanitary and secured landfilling; (7) General Waste.

Incineration is a high temperature thermal process involving combustion of the waste under controlled condition for converting them into inert material and gases. Incinerators [25] can be oil fired or electrically powered or a combination thereof. On a broader front, three types of incinerators are used for hospital waste [10,13,25]: 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 [17,18,20,21], incineration it is recommended for human anatomical waste, animal waste, cyto-toxic drugs, discarded medicines and soiled waste.

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. 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 [10,13] for microbiology and biotechnology waste, waste sharps, soiled and solid waste.

Hydroclave Treatment is based on an innovative equipment named Hydroclave, for steam sterilization process (like autoclave) [10]. 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 [10,21].

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. 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 [10,13,19]. According to legislation, the microbiology and biotechnology waste, the soiled and solid waste are permitted to be microwaved [20,21].

Chemical Disinfecting 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 [2,10,13,21].

Sanitary and Secured Landfilling is necessary under certain circumstances [10,13,20,21]:

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

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 composting of green waste, and 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 [17,18,33].

IV. Case Study in Romanian Hospitals. Biomedical Waste Assessment

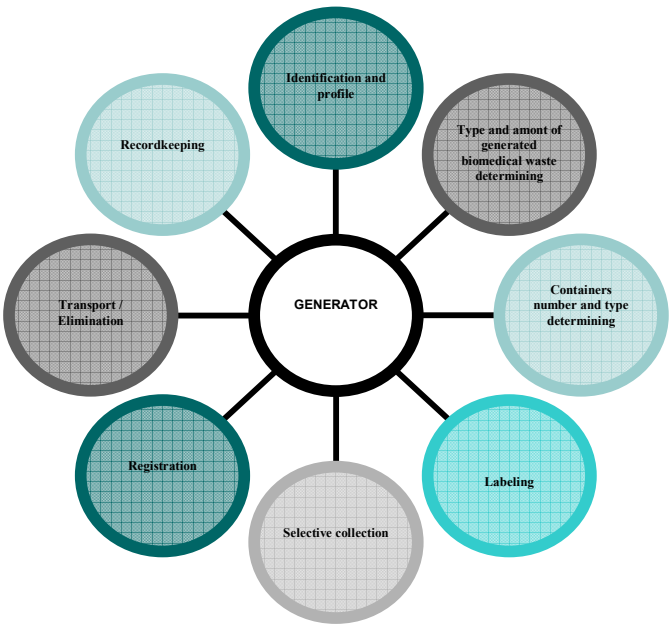

Fig. 3 Responsibilities in biomedical waste management

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 [19,20]. 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 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.

TABLE III
Average Daily Biomedical Waste Generated in Hospitals of Dolj District

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	765
2	Municipal Clinical Hospital of Craiova	539	461	71.5	321.5
3	Infectious Diseases Clinical Hospital of Craiova	480	361	336	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	4.5	13.25
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	22.75	84
11	Hospital of Dabuleni	80	92	7.77	71

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	Outside Hospital Incine-ration	Neutrali-zation kg/24 h
0	6	7	8	9	10
1	0.178	-	-	YES	-
2	0.894	1.05	-	Munici-pal 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 Munici-pal 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	-	-

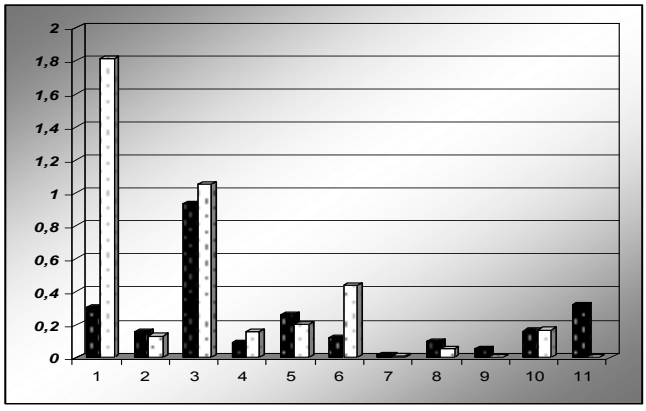

Fig.4 Average daily biomedical Waste generated in Dolj District Hospitals

Knowing the types and quantities of waste generated, as well as the management, transport and final disposal is the obligation of each producer (generator) [17,18,20,21,27].

This case study present the analysis results of biomedical waste generated in 11 hospitals of Dolj District, Romania [15,22], as well as the results of biomedical waste management project implemented within the Hospital of Obstetrics-Gynaecology of Ramnicu-Valcea [23].

Data recording is how to control the waste cycle of generation, segregation, transportation, neutralization, recycling and final disposal by the healthcare unit Head.

Determining the types and quantities of waste generated in the healthcare facility is achieved by monitoring daily, monthly and quarterly, based on the methodology of collecting data for national database of medical waste. The methodology is the annex 2 of the Order of the Ministry of Health no.219/2002 with subsequent amendments. Also, under the same regulations, health unit must develop and implement its own plan for waste management. The management plan shall be reviewed annually or whenever needed.

In Table III and Fig.4 are presenting the analysis results of average daily biomedical waste generated within a month of observation in the hospitals of Dolj District [15,22].

In Table IV and Fig.5 are presented the analysis results of average daily biomedical waste generated within the Hospital of Obstetrics Gynaecology of Ramnicu Valcea [23].

TABLE IV
AVERAGE DAILY MEDICAL WASTE GENERATED IN HOSPITAL OF OBSTETRICS GYNAECOLOGY OF RAMNICU-VALCEA

Health care unit (number of beds)	Non-hazardous waste (kg/24 hours)		Hazardous waste (kg/24 hours)	
785 beds	1.Paper	50	Anatomo-pathological waste and anatomical parts	61
	2.Plastic	80	Infectious waste	60
	3.Sterile packaging	42	Sharp waste	25
	4.Disposable equipment uncontamined with biological fluids	20	Chemical and pharmaceutical waste	6
	5. Leftovers	154	Pharmaceutical waste	7
	6. Household waste, waste assimilated household waste	87	Chemical waste	5
	10. Dangerous goods that were not used in the initial purpose and will be returned to the producer	36	Hazardous chemical waste	20
	12. Waste with the pH > 6,0 and < 8.5	15	Special waste	18
	Total (kg/day)	482	Total (kg/day)	202

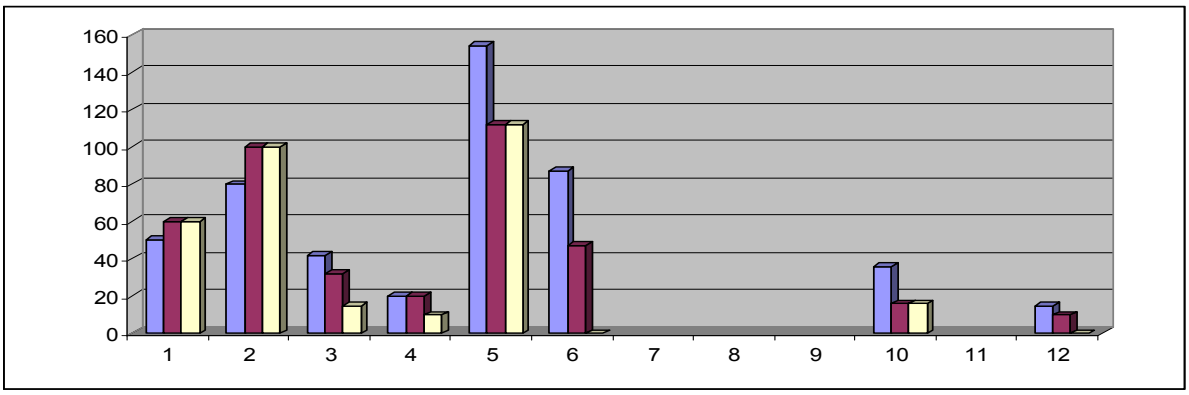

Fig.5 Medical waste amount generated within the Hospital of Obstetrics Gynaecology of Ramnicu-Valcea

Amount of non-hazardous medical waste generated before the implementation of waste management system

Amount of non-hazardous medical waste generated after the implementation of waste management system

Amount of non-hazardous medical waste recycled after the implementation of waste management system

The starting point of implementation of biomedical waste management program (Fig.6) within the Obstetrics-Gynaecology Hospital of Ramnicu Valcea was based on the most important legislative in the field of biomedicale waste:

- Basel International Agreement on 1989 (Program Coordinator of United Nations Environmental Programme (UNEP), which refers to the transboundary movement of hazardous wastes)
- Biological Agents Directive 90/679/EEC
- Hazardous Waste Directive 91/689/EEC
- Health and Safety Framework Directive 89/391/EEC
- Waste Directive 75/442/EEC
- Waste Oils Directive 75/439/EEC
- Packaging Waste Directive 94/62/EC
- Carcinogens Directive 90/394/EEC
- Dangerous Substances Directive 76/769/EEC
- Natural Habitats Directive 92/43/EEC
- Protective Equipment Directive 89/656/EEC
- PPE Directive 89/656/EEC

An effective and efficient program for the management of healthcare waste is an important component of the hospital management system [2,28,29,30,31,32,33,34]. As consequence, identifying the waste categories and the strategy to be development to prevent and minimize the waste amount, as well as the objectives, actions and term limits are encompassed within the framework program of biomedical waste management of Obstetrics-Gynaecology Hospital of Ramnicu-Valcea.

Issues to be considered are regarding:

a) Input data:

- Information on hospital organization
- Information on processes
- Documentation of equipment and medication suppliers
- Information on diagnostic and analysis equipment
- Legislation and regulations
- Contractual documents

b) Activities in the process:

- Identifying environmental aspects and associated impacts
- Environmental impact assessment
- Significant environmental aspects database

The environmental analysis is performed:

- Initially, when the decision of biomedical waste management system is done

- Whenever significant changes occur in the organization (organizing structure changes, new departments, necessary materials, equipment, range of tests made, changes or appearances of new regulations in the environmental and sanitation field) that may influence the initial analysis.

Each Clinic Head identifies and lists for the department that coordinates all operations performed, and then determining the corresponding products using a form list of activities, products and waste from the clinic. This list is reviewed by the Environmental Officer. Heads of clinics develop input-output analysis to identify environmental issues as a form. As inputs will enter materials, as well as medicines, equipment, hazardous substances etc. As outputs will be identified both waste and other outputs, like expired medicines, laboratory calibration equipment. Further on, these forms will be sent to the environmental officer, who completing the form identification of environmental aspects and impacts associated based on information drawn from input-output analysis and submit it for review of Environmental Manager and approval of Hospital Director.

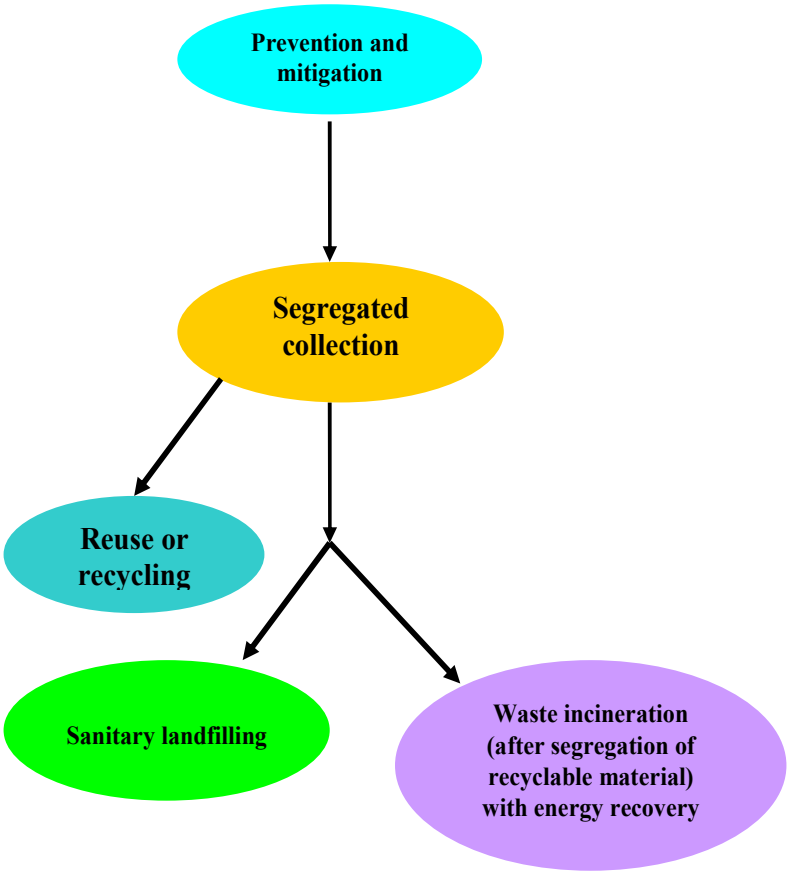

Fig. 6 Biomedical waste management implementation

Specify operating conditions: normal (N), abnormal (A) and urgency (U). For all operating conditions (both the normal and in case of abnormal and emergency), environmental officer will determine the environmental impact and the environmental factor (air, water, soil) affected by each environmental aspect identified.

V. Conclusion

During the study, it was observed that the analyzed Romanian Hospitals have been properly managing their biomedical waste. 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 color coding, in accordance with the legislation. The hospitals also followed the regulation tables given in the legislation. Temporary storage of waste currently generated within the analyzed Romanian Hospitals is performed in special places that are sanitary authorized, and the storage time not exceeds 72 hours (48 hours within the hospital, 24 hours for transport and final disposal). The hospitals have maintained the practice of decontamination of biomedical waste before disposal or storing of the waste for 48 hours.

Transportation is carried out only by authorized companies, with cars specially equipped for biomedical waste types, marked when is necessary by "biohazard" symbol, on designated routes and endorsed by ASP.

Within the Obstetrics-Gynaecology Hospital of Ramnicu-Valcea, after a period of three months following the waste management implementation, a analysis performed had shown a 17% reduction in the quantity of non- hazardous waste, of which 67% were recycled. The amount of hazardous waste has not been reduced, but the measures taken have led to their entirely neutralization and sanitary disposal.

Final elimination can be done through several processes: incineration in approved incinerators that comply with environmental and health legislation, or neutralization by autoclaving, microwave disinfection, encapsulation, irradiation, this way the medical waste becomes non-hazardous waste, equivalent to those households that can be landfilled together with municipal waste.

By introduction a sustainable system of biomedical waste management, significant quantities of hazardous biomedical waste generated will not be stored out of control, but will be recovered, treated, neutralized and recycled, secure in terms of environmental protection. Therefore, on one hand the impact on Ecosphere will be significant decreased, and on other hand,

by waste recycling the depletion of Earth resources will be slowed.

The proper health care waste management system can help the control diseases (hospital acquired infections), can reduce community exposure to resistant bacteria, and could reduce HIV/AIDS, sepsis, and Hepatitis transmission from dirty needles and other improperly cleaned or disposed medical items. Regarding the humankind and environmental issues, a correct and sustainable management system of biomedical waste 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. In line with this idea, one could assume 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.

Following analysis of hospital management, the functioning of biomedical waste management system should be periodically reformulated, in accordance with the situation changes.

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