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Thesis summary

Neutralization and monitoring methods of health care waste

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**CRAIOVA
2011**

SUMMARY

Introduction

Health care waste is hazardous both to the humans and the environment, exposing people to risk of infection. These types of waste are generated in all medical activities of the national public health: hospitals, nursing homes, orphanages, health centres, human and veterinary medical practices, dental offices, blood centres, public health laboratories, research centres in the field.

Internationally, health care waste is subject to numerous studies. International conferences held annually, discuss and examine issues of health care waste disposal and new practices and available facilities.

Numerous international organizations (e.g. World Health Organization and Health Care without Harm) lead a struggle to ensure a clean environment and to implement alternative facilities that doesn't pollute the environment and doesn't contribute to disease emergence.

At national level, Romania has to take actions for:

- Separate collection of hazardous waste in health care units;
- Separate collection of nonhazardous waste in health care units;
- Safety disposal of health care waste;
- Temporary storage of health care waste, in a good security;
- Prohibition of final disposal of hazardous waste without pre-treatment.

The lack of scientifically sound approaches for the use of monitoring systems to obtain data on medical waste leads to incomplete results, which cannot be connected or used for implementation of effective solutions for medical waste control.

In this context, the problem to be solved is the use of medical waste monitoring systems to correlate information and evaluating the effectiveness of the solutions applied in order to reduce waste.

Thesis structure

The thesis is divided into six chapters and makes contributions to the management system of medical waste generated in health units. There are 37 relations, 95 figures, 25 tables and 186 references positions.

In the *first Chapter*, I have identified the types of waste generated in health units, their main sources of production, to examine whether the waste codes of the European Waste List can be found in health units, to establish a medical waste classification based on multiple criteria.

In the *2nd Chapter*, I established the neutralization methods of medical waste without the incineration. I identified the existing facilities and examine how their functionality affects the environment or operators health. I studied the destruction of hazardous constituents in neutralization plants, the emissions released into the air and odours. I have established which plants remove residual liquid (usually water) from the treatment process and I analyzed the reduction degree of waste volume disposed in the output of neutralization.

In *Chapter 3*, I conducted surveys on environmental data and, in particular, adjustment of statistical relations in calculus of monitoring indicators necessary for medical waste. I identified the elements needed to monitor, I have established indicators to monitor medical waste and I proposed a list of responsibilities for staff involved in medical waste monitoring and reduce the number of people responsible with waste management.

In *Chapter 4* I have developed software for the quantities of waste generated in all health units producing medical waste. Based on indicators and statistical formulas applicable to medical waste, I created two automatic statistical processing programs. Chapter 4 makes reference to specify the issues to be monitored into a medical unit and in addition, I proposed a system of responsibility in the health unit, more efficient and streamlined.

Chapter 5 describes the monitoring system at source of waste generated in health facility. In this chapter are details on the optimal location of this monitoring, the structure and its composition and is detailed the local database structure.

Chapter 6 presents conclusions and author contributions.

Chapter 1

In Chapter 1 I have attempted to identify the types of waste generated in health units and identification of waste generators sources, correct determination of waste according to their codes, establishing a clear classification on multiple criteria. Knowing these elements is a first step to establish a proper waste management system developed in the health unit.

Health care facilities that produce waste can be classified into three categories: *large producers, average producers and small producers.*

Hazardous waste generated in health care units is approx. 20%. In figure 1.5 you can see the percentage of the main types of medical waste generated, in 2005.

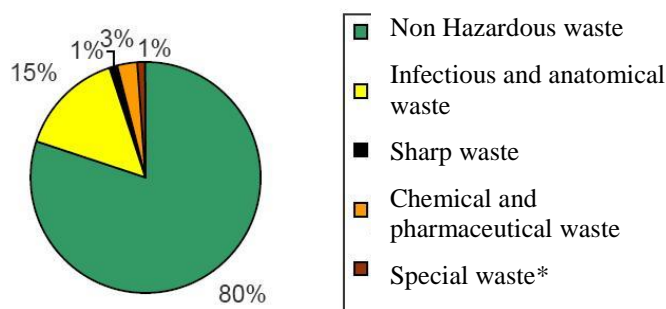


Fig. 1.5 Health care waste structure in 2005

* Chemotherapy, pressure vessels, broken thermometers, used batteries, waste from nuclear medicine laboratory work.

Chapter 2

In Chapter 2, I examined neutralization plants in terms of environmental impact and degree of neutralization of infectious agents. I determined the existence of air emissions, liquid removal from the neutralization degree of reduction of infectious agents of medical waste and degree of volume reduction after treatment process.

I have analyzed the influence of operating temperature on the degree of microbial inactivation in neutralization facilities of medical waste. I established a separation of facilities in response to the treatment used to neutralize medical waste.

All studied plants have at least level III in microbial inactivation and fit to international standards. As figure 2.20 shows, the degree of infectious agents destruction increases as the temperature of neutralization process increases.

There may be risk of toxic contamination of water, air, or waste resulting from the treatment method of neutralization at low temperature, if the treated waste containing hazardous substances.

Any odours emitted by studied plants do not present a health hazard. Waste volume reduction is insignificant when they are treated by the method of neutralization at low temperature (Fig. 2.21).

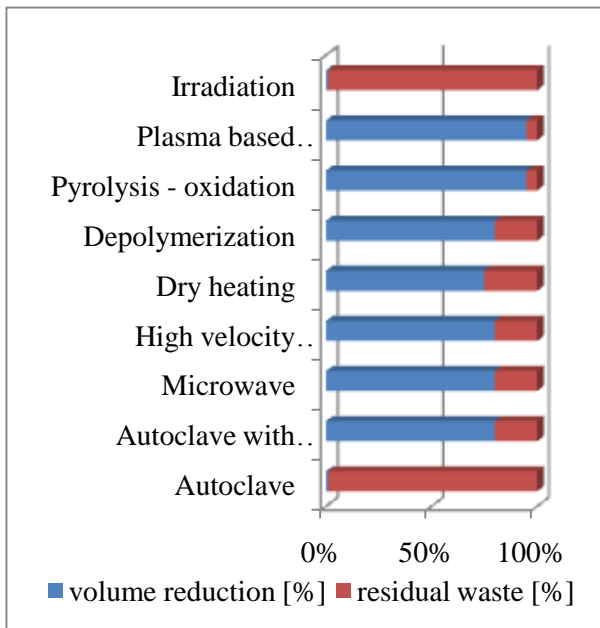


Fig. 2.21 Waste reducing after treatment process

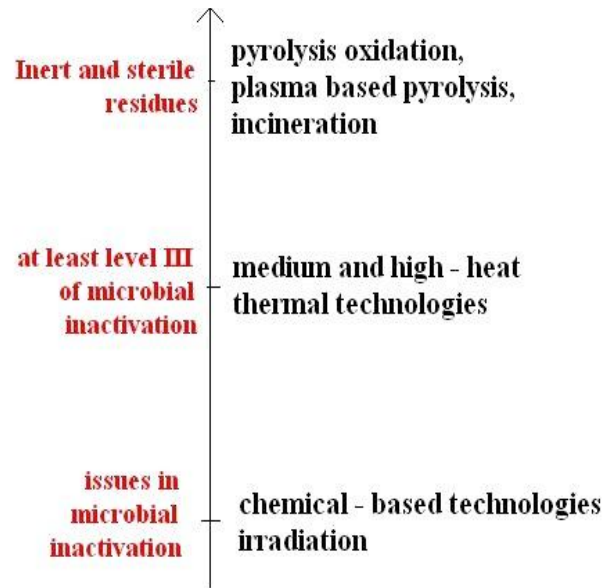


Fig. 2.20 Efficiency of treatment methods based on microbial inactivation

There are facilities (autoclave, dielectric heating installations and radiation facilities) that expose the operators of these facilities to *risks and accidents*.

For medical waste neutralization *may be recommend* moist heat methods (*autoclave neutralization*), *dry heat treatment* method and microwave method, under the conditions of operation and achieving the optimum temperature recommended during treatment. Neutralization method least recommended is *irradiation*: no sterilization efficiency above average (not killing germs pumilus), there is ozone in the air, imposes high costs of facilities acquisition and high operating costs and expose operators to radiation.

Sharp and infectious waste can be treated by any facility, however waste containing mercury, VOCs, containers or vessels are prohibited from treating in the studied plants.

Chapter 3

Monitoring of medical waste in Romania is done through statistical surveys based on questionnaires, which requires a very high response time, sometimes incorrect reports, which is why this type of monitoring has a number of shortcomings and cause problems in monitoring waste.

Thus, in Chapter 3 I reviewed the applicable environmental statistics and I have established a list of indicators to monitor medical waste. Identified data needs of the practical problems arising from the central authorities, is the starting point for the indicators. The proposed indicators are *key indicators* (quantitative data and represent the result from the application of statistical analysis to medical waste) and *associated targets indicators*.

In this thesis I adapted statistical relations for calculating basic indicators to monitor medical waste.

Chapter 4

In Chapter 4, I proposed an administrative system for monitoring the waste quantities generated at source. Considering the flow of medical waste in health units, I have identified important aspects for waste monitoring: minimizing and separate waste collection system, waste transport to

temporary storage area and monitoring the neutralization facility, for situations where the health unit have such facilities.

In figure 4.4 is presented medical waste collection system applicable to health units, which I proposed improvements in accordance with the monitoring system developed in this thesis. Thus, to include a branch in the temporary storage of waste, for recording data in database design and I proposed a system of responsibilities, which fits perfectly to waste monitoring system.

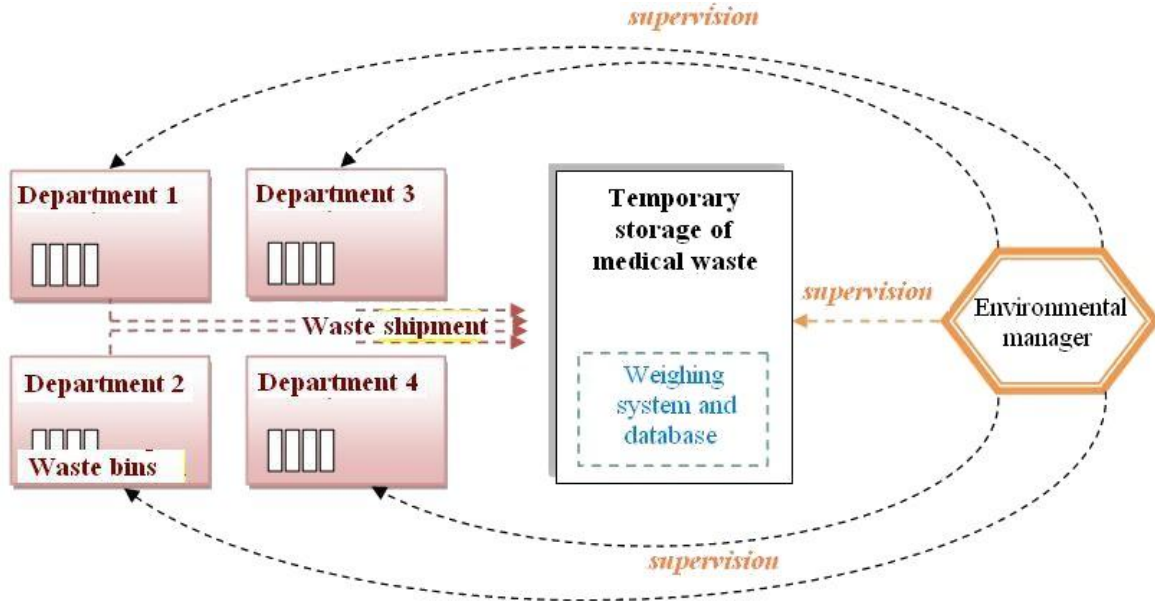


Fig. 4.4 Collecting system of waste bags

Also, I developed a database accessible to both the medical unit level and at national level, and two programs of statistical indicators calculation which provide statistical results.

Figure 4.10 shows the structure of accessing the monitoring reports:



Fig. 4.10 The structure of accessing the monitoring reports

In figure 4.11 is shown the relationship schema between database tables.

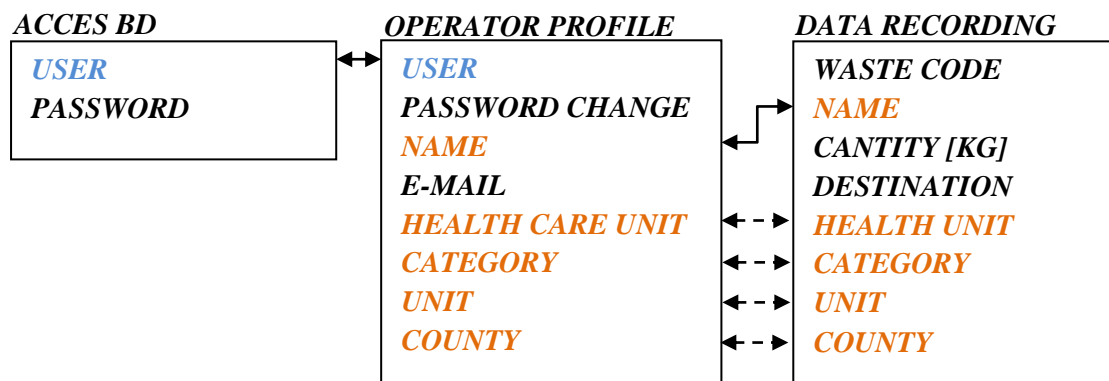


Fig. 4.11 Relational schema of the online database

Figure 4.13 presents the page to access the database, which is available on the web:

<http://med.vfp.ro>



Fig. 4.13 Software accessing page

Because the monitoring at health care units different by regional or national level, I created two statistical programs, one for each type of monitoring, which are presented below.

a) The statistical program in health care unit

The program was made in Microsoft Excel 2007. The data processed by this program are the monitoring indicators from sanitary unit (fig. 4.21) which were presented in Chapter 3.3.

Indicadori de monitorizare		
Nr. CRT.	INDICATOR MASURABIL DENUMIREA	UNITATEA DE MASURA
LA NIVELUL UNITATII SANITARE		
1.	CANTITATEA TOTALĂ DE DEȘEURI MEDICALE GENERATĂ ÎNTR-O UNITATE SANITARĂ	TONE/AN
2.	CANTITATEA TOTALĂ DE DEȘEURI ÎNȚEPĂTOARE - TĂIETOARE GENERATE ÎNTR-O UNITATE SANITARĂ	TONE/AN
3.	CANTITATEA TOTALĂ DE DEȘEURI INFECȚIOASE GENERATE ÎNTR-O UNITATE SANITARĂ	TONE/AN
4.	CANTITATEA DE DEȘEURI MEDICALE GENERATE ÎNTR-O ANUMITĂ SECȚIE	TONE/AN
5.	CANTITATEA MEDIE DE DEȘEURI MEDICALE GENERATĂ DE UN PACIENT ÎNTR-O ZI, LA NIVELUL UNEI SECȚII	KG/PACIENT/ZI
6.	CANTITATEA MEDIE ZILNICĂ DE DEȘEURI MEDICALE GENERATĂ, LA NIVELUL UNEI UNITĂȚI SANITARE	KG/ZI
7.	CANTITATEA MEDIE ZILNICĂ DE DEȘEURI INFECȚIOASE GENERATĂ, LA NIVELUL UNEI UNITĂȚI SANITARE	KG/ZI
8.	CANTITATEA MEDIE ZILNICĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATĂ, LA NIVELUL UNEI UNITĂȚI SANITARE	KG/ZI
9.	CANTITATEA MEDIE LUNARĂ DE DEȘEURI MEDICALE GENERATĂ, LA NIVELUL UNEI UNITĂȚI SANITARE	KG/LUNĂ
10.	CANTITATEA MEDIE LUNARĂ DE DEȘEURI INFECȚIOASE GENERATĂ, LA NIVELUL UNEI UNITĂȚI SANITARE	KG/LUNĂ
11.	CANTITATEA MEDIE LUNARĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATĂ, LA NIVELUL UNEI UNITĂȚI SANITARE	KG/LUNĂ
12.	CANTITATEA DE DEȘEURI DESTINATĂ UNEI ANUMITE OPERAȚII DE TRATARE	TONE/AN

Fig. 4.21 Display system for monitoring indicators related to health units

b) The statistical program at central level

Data processing program, entitled „Statistica nationala” contains 6 spreadsheets: indicators, total county, category, treatment, percent and database.

CRT	INDICATOR MASURABIL	UNITATEA DE MASURA
-	DENUMIREA	
LA NIVEL NAȚIONAL		
1	CANTITATEA TOTALĂ DE DEȘEURI GENERATĂ ÎNTR-UN JUDEȚ	TONE/AN
2	CANTITATEA TOTALĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATE ÎNTR-UN JUDEȚ	TONE/AN
3	CANTITATEA TOTALĂ DE DEȘEURI INFECȚIOASE GENERATE ÎNTR-UN JUDEȚ	TONE/AN
4	CANTITATEA DE DEȘEURI GENERATE ÎN FUNCȚIE DE CATEGORIA DE UNITATE SANITARĂ	TONE/AN
5	CANTITATEA MEDIE DE DEȘEURI MEDICALE GENERATĂ DE UN PACIENT ÎNTR-O ZI, LA NIVELUL UNUI JUDEȚ	KG/PACIENT/ZI
6	CANTITATEA MEDIE ZILNICĂ DE DEȘEURI MEDICALE GENERATĂ, LA NIVELUL UNUI JUDEȚ	KG/ZI
7	CANTITATEA MEDIE ZILNICĂ DE DEȘEURI INFECȚIOASE GENERATĂ, LA NIVELUL UNUI JUDEȚ	KG/ZI
8	CANTITATEA MEDIE ZILNICĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATĂ, LA NIVELUL UNUI JUDEȚ	KG/ZI
9	CANTITATEA MEDIE LUNARĂ DE DEȘEURI MEDICALE GENERATĂ, LA NIVELUL UNUI JUDEȚ	KG/LUNĂ
10	CANTITATEA MEDIE LUNARĂ DE DEȘEURI INFECȚIOASE GENERATĂ, LA NIVELUL UNUI JUDEȚ	KG/LUNĂ
11	CANTITATEA MEDIE LUNARĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATĂ, LA NIVELUL UNUI JUDEȚ	KG/LUNĂ
12	CANTITATEA MEDIE ANUALĂ DE DEȘEURI MEDICALE GENERATE LA NIVELUL UNUI JUDEȚ (MEDIA ARITMETICĂ, MEDIA GEOMETRICĂ)	TONE/AN
13	CANTITATEA MEDIE ANUALĂ DE DEȘEURI INFECȚIOASE GENERATE LA NIVELUL UNUI JUDEȚ	TONE/AN
14	CANTITATEA MEDIE ANUALĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATE LA NIVELUL UNUI JUDEȚ	TONE/AN
15	CANTITATEA DE DEȘEURI MEDICALE GENERATE ÎNTR-UN JUDEȚ, RAPORTATĂ LA CANTITATEA TOTALĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATĂ LA NIVEL NAȚIONAL	
16	CANTITATEA DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATE ÎNTR-UN JUDEȚ, RAPORTATĂ LA CANTITATEA TOTALĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATĂ LA NIVEL NAȚIONAL	
17	CANTITATEA DE DEȘEURI INFECȚIOASE GENERATE ÎNTR-UN JUDEȚ, RAPORTATĂ LA CANTITATEA TOTALĂ DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE GENERATĂ LA NIVEL NAȚIONAL	
18	PROCENTUL CANTITĂȚII DE DEȘEURI INFECȚIOASE DIN CANTITATEA TOTALĂ DE DEȘEURI MEDICALE	%
19	PROCENTUL CANTITĂȚII DE DEȘEURI ÎNȚEPĂTOARE – TĂIETOARE DIN CANTITATEA TOTALĂ DE DEȘEURI MEDICALE	%
20	CANTITATEA DE DEȘEURI DESTINATĂ UNEI ANUMITE OPERAȚII DE TRATARE	TONE/AN
21	FRACTIA DE DEȘEURI INCINERATE DIN TOTAL DEȘEURI MEDICALE (CANTITATE DEȘEURI MEDICALE INCINERATE/CANTITATE TOTALĂ DE DEȘEURI MEDICALE GENERATE X 100)	%

Fig. 4.31 Display indicators monitoring system

Data processed by this program are monitoring indicators from national level (fig. 4.31), determined in Chapter 3.3. Their variation depends on the quantities of waste generated in health unit. The proposed centralized monitoring system brings many benefits, is a highly original, new and easily accessible, unlike the current system. This leads to effective management of environmental and medical waste management system.

Chapter 5

Issues discussed and proposed in this chapter refer to improved monitoring in the temporary storage of medical waste. In this regard, I proposed a system of monitoring the amount of medical waste generated at source, even before their temporary storage to avoid contamination or exposure to disease of operators during weighing and recording of waste.

The waste monitoring system consists of:

- Weigher (fig. 5.2);
- Computer (CPU);
- Local database.

The purpose of this system is to facilitate the registration data in the database, using an automatic system. Also, the computer will act as local server, where the information will be saved periodically.



Fig. 5.2. The general scheme of the monitoring at source

The database has 4 tables:

- one table for operators identification (fig. 5.17);
- table of configuration data;
- table for waste codes;
- table for records waste quantities.

Errors related to medical waste generated are minimized by the existence of connection between the weigher and computer.

Thus, errors are avoided by introducing incorrect data in the database, because the weigher automatically transmits information on weight recorded to database system.

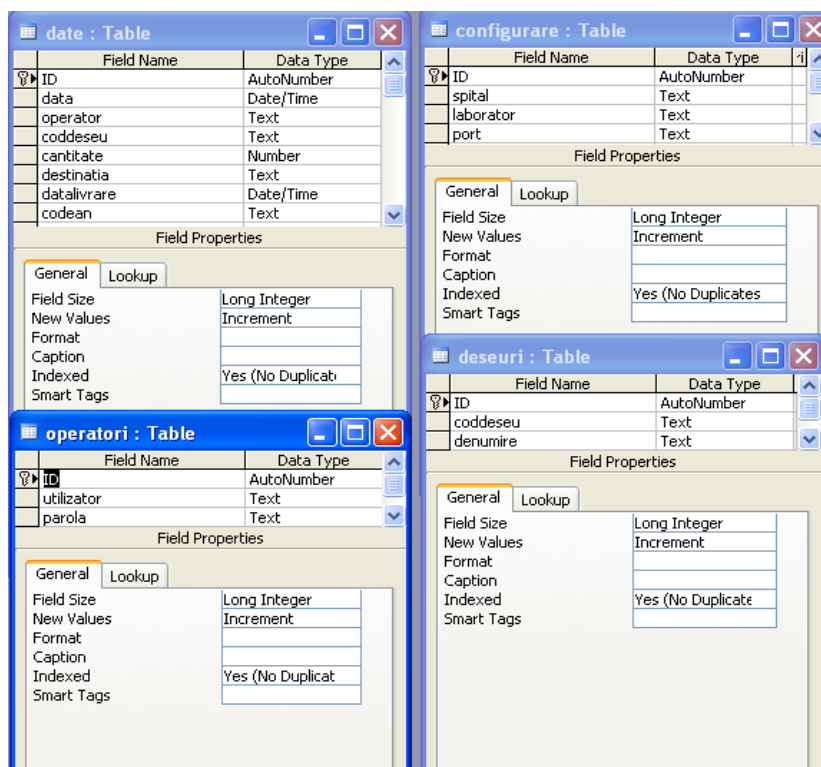


Fig. 5.17 Database structure

Implementation of this monitoring system will lead to many benefits: environmental management in health care units will become more efficient, and the waste management system will improve.

The results obtained in this thesis *were disseminated* through various channels, with different target groups. There were three articles published in magazines and one on the web, nine lectures were held at national and international conferences, 4 lectures in the expert study visit in Hungary, Serbia, Moldova, Turkey and several interventions and proposals amending existing legislation in five working groups at national and international experts.

Overall, *personal contributions* can be summarized as follows:

- Analysis of neutralization facilities depending on the environmental impact and the degree of neutralization of infectious agents;
- Preparing a new list of indicators to monitor medical waste;
- Demonstrate that statistical formulas are equally applicable to medical waste statistics;
- Proposing an administrative system to monitor the quantities of waste generated at source;
- Design a database accessible to both the health unit level and at national level;
- Design of two computer programs of statistical indicators and reports provide results;
- Implementing a monitoring system to source the amount of medical waste generated in the health unit.

The results *are useful* only on the environmental and public health authorities and health care units. The contributions completes and improves the current monitoring system, reflects the current situation regarding the types of waste generated in health units, define parameters to be monitored and signals problems that some neutralization plant can create if the conditions of operation are respected. The results by creating the online database and the monitoring system at source *can be applied immediately* in order to solve problems of data collection at the central authorities.