

## **Medical waste management in Greece: the case of Thessaly region**

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### **Abstract**

The main objective of this study is the evaluation of medical waste management in Thessaly region, Greece. Nowadays, medical waste treatment and disposal is one of the most important problems in many countries. The reason is simple. Medical waste and specifically infectious medical waste disposal could be extremely dangerous, especially if it is not controlled, according to the basic principles of waste management. Our research was carried out in the 5 hospitals (1 university and 4 general hospitals) that operate in the region of Thessaly and our findings have shown that most of hospitals use the method of steam sterilization in a mobile treatment unit for their waste treatment. More specifically, private companies, which deal with medical waste treatment, visit the hospitals once per week and sterilize the waste in the mobile unit. On the other hand, the university hospital uses the method of incineration for its waste treatment. Regarding the incinerator, it should be noticed that it is a double chamber incinerator. The primary combustion chamber is used for the waste incineration and the secondary combustion chamber is used for the incineration of the fumes. This incinerator operates without the necessary equipment for the air pollution minimization. The medical wastes that are produced in the other medical facilities in the region are disposed without specific care for the environment. It is the outcome of our research that planning about the optimal medical waste management is essential in the effort to achieve an integrated medical waste management according to the principles of sustainable development.

*Keywords: medical waste, Thessaly region, waste treatment, waste disposal, incineration, waste sterilization.*



## 1 Introduction

In recent years and particularly during the last two decades, the environmental dimension is considered as an extremely important dimension, which should be taken into account during the procedure of regional planning and development. The *new dogma* is, now, the securing of development sustainability, which is based on the fundamental ecological principles of solidarity between generations, resource renewal etc [1]. Taking in mind this evidence, we understand that waste management and especially medical waste management is by all means significant in an effort to achieve the desirable sustainable development.

Medical waste is generated by healthcare, veterinary and research centres, laboratories and pharmaceutical plants. This group also includes dispersed sources of residues from home treatment (dialyses, administration of insulin, etc). Medical waste is in fact a varied mixture of different kinds of rubbish – from typically municipal ones (food, secondary raw materials, etc), through toxic chemicals (drugs, reagents, etc), to infectious ones (syringes, instruments, post-surgical waste). Numerous studies [2, 3, 4] have shown that an estimated 75 – 90% of waste originating within medical facilities has a municipal character. The remaining 10 – 25% of waste (infectious, pathological, etc) is deemed to require special treatment. The reason is simple. Infectious medical waste is considered to be a special category of waste because of its high potential for contaminating the environment with pathogenic factors and bacteria and thus represents a higher risk to health. For example, contaminated needles and syringes represent a particular threat and may be scavenged from waste areas and dump sites and be reused. World Health Organization has estimated that, in 2000, injections with contaminated syringes caused 21 million hepatitis B virus (HBV) infections (32% of all new infections) and 2 million hepatitis C virus (HCV) infections (40% of all new infections) [5].

Taking into account all this evidence about infectious medical waste dangers, as well as the main philosophy of sustainability, this paper aims at presenting the problems related to medical waste management in Thessaly region, Greece and suggesting optimum solutions in order to minimize environmental and health hazards. It is essential to realize that an integrated management is desirable.

The problem in Greece is significant. Regarding medical waste management, there have not been a lot of studies not only in Thessaly region, but also in Greece. For this reason our search is considered to be important and our findings could be used from the qualified authorities as a base for strategic medical waste management planning, not only in regional level, but also in national level, since such planning does not exist at time.

## 2 Medical waste management in Greece

The total number of hospital beds in Greece reaches up to 57000, according to data collected in 1999. Taking in mind this number, as well as the fact that the average production quantity of medical solid waste per day in Greece is



2 kg/bed, we understand that about 114 tn of medical waste are produced every day in Greek healthcare centres [6]. The corresponding waste quantity per year is 14000 tn [7]. An estimated 15% of this quantity corresponds to infectious waste, while the remaining 85% corresponds to waste with a municipal character. The distribution of medical waste production to Greek regions is depicted in the following figure.

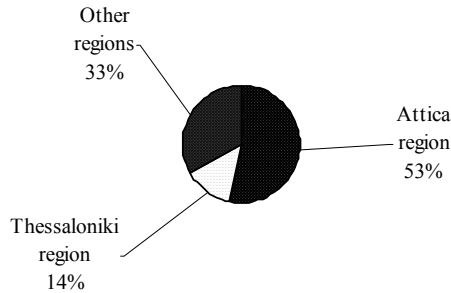


Figure 1: Distribution of production quantity of medical waste per year in Greek regions.

According to specific data collected from a statistic research, which was held in 1998, the 37% of all healthcare centres in Greece uses the method of incineration for its waste treatment [6]. The corresponding incinerators are very old and they operate without the necessary equipment for air pollution minimization. Normally, the toxic emissions and especially dioxin and furan emissions from such incinerators are important because of the high percentage of plastic (i.e. PVC) in medical waste composition [2]. The remaining 63% of Greek healthcare centres disposes its waste without care for the environment and without any prior treatment (Figure 2). This evidence shows that great threats for public health and environment are thus arising.

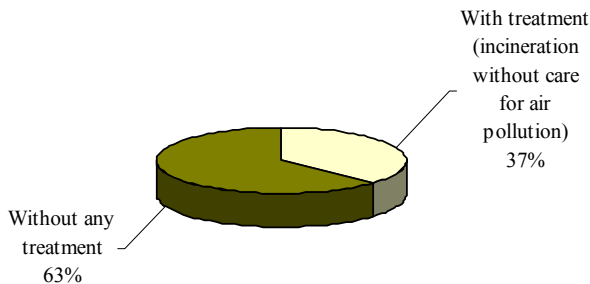


Figure 2: Medical waste treatment in Greek healthcare centers (1998).

One incineration unit, which is equipped with all essential instruments for air pollution minimization, as well as an electronic system for on-line controlling of pollutant emissions, was constructed in recent years in Attica prefecture. Unfortunately, a few hospitals carry their waste in this unit because of the high economical cost. Still, the majority of Athens hospitals treats its waste in very old incinerators without the necessary equipment for air pollution minimization or disposes its waste without any prior treatment. It should be mentioned that the corresponding unit treats usually 3 tn of medical waste per day, while its treatment capacity reaches up to 30 tn of waste per day [8].

### 3 Medical waste management in Thessaly region

The region of Thessaly is situated in the central eastern part of Greece and includes prefectures of Larissa, Magnesia, Trikala and Karditsa (Figure 3). The population of the region in 2001 reached up to 754393 inhabitants within an area of 14037 Km<sup>2</sup> (53.7 inhabitants/km<sup>2</sup>).



Figure 3: Location of Thessaly region in Greece.

According to data collected from the National Statistic Office of Greece, 37 healthcare centres operate in Thessaly region at time. These include 4 general hospitals, 1 university hospital (in Larissa city), 1 military hospital (in Larissa city) and 31 private healthcare clinics. 17 primary health-care centres operate in region, too [9].

Our research regarding medical waste management was carried out in 2004 in the 5 hospitals (4 general and 1 university) of the region. Information and data was gathered mainly from personal interviews from qualified authorities in hospitals, as well as from official documents and scientific literature.

#### 3.1 University hospital of Larissa city

The total number of beds in Larissa university hospital is 645. Taking into account this number, as well as the fact that the average production quantity of medical solid waste per day in Greece is 2 kg / bed [6], we understand that about 1290 kg of medical solid waste are produced every day in this hospital. The

193.5 kg correspond to infectious wastes, while the remaining 1096.5 kg correspond to municipal ones.

The hospital has put into practice the segregation at source. More specifically, small bins of different colour are placed in specific rooms inside the hospital in order to enable the personnel to dispose the different waste fractions at suitable places. For example, the red bins (Figure 4) are used for the infectious waste collection, while the black ones are used for the municipal waste collection. Special plastic bins for the collection of syringes and sharps (Figure 5) are not used. This is a very important disadvantage, since sharps and especially syringes represent a great threat for the public health.



Figure 4: Example of red bins for the collection of infectious waste.



Figure 5: Special bins for the collection of sharps.

Some other disadvantages that have been noticed in this hospital are related to the improper segregation. During our research, we have found out that the real daily quantity of infectious waste, which is collected in the red bins, is about 900 kg. If we compare this quantity with the value of 193.5 kg (see above), we can clearly understand that the segregation is not applied according to the basic guidelines of medical waste treatment.

After having been collected in the red bins, the infectious waste is lead to the treatment unit. This is a double chamber pyrolytic incinerator, which operates at a temperature of 1100°C. The primary combustion chamber is used for the waste incineration while the secondary one is used for the incineration of the fumes so as the air emissions to be minimized. Normally, waste is introduced into the primary chamber that is heated up to a sufficient temperature in order to distil the waste. Gases leaving the distillation chamber are mixed with a continuous airflow in the afterburning chamber and held at a temperature of 900°C – 1100°C by co-firing of natural gas. Essential equipment for air emission minimization does not exist, as well as a modern on-line gas emission measurement system. This system is required for the continuous monitoring of air emissions, which contain fly ash (particulates) composed of dioxins, furans, heavy metals, and gases such as oxides of nitrogen, sulfur, carbon, and hydrogen halides.

### 3.2 General hospitals

There are 4 general hospitals in Thessaly region, each in every capital of prefecture. The capacity (number of beds) of the general hospital of Larissa city is 300 beds, as well as the capacity of the general hospital of Volos city. The corresponding capacity of the general hospital of Karditsa city is 240 beds, while general hospital of Trikala city capacity is 221 beds. A quantity of 600 kg of medical wastes and more specifically 90 kg of infectious wastes and 510 kg of municipal ones are being produced every day in the general hospital of Larissa city, as well as in Volos city hospital. On the other hand, in the hospital of Karditsa city about 72 kg of infectious wastes and 408 kg of municipal ones are being produced every day, while in the hospital of Trikala city about 66.3 kg of infectious wastes and 375.7 kg of municipal ones are daily being produced.

All these hospitals use the segregation at source, too. The procedure is the same as in university hospital. There are red and black bins in every hospital for the collection of infectious and municipal waste respectively. The method of treatment that is used in all these hospitals is the method of steam sterilization in a mobile treatment unit. More specifically private companies visit each hospital one or two times per week and sterilize the infectious waste in the mobile unit. Steam sterilization is based on exposure of shredded infectious waste to high-temperature and high-pressure steam. It inactivates most types of microorganisms, if temperature and contact time are sufficient. The sterilization process requires that waste be shredded before treatment. The main disadvantage of this method relates mainly to the fact that the process is inappropriate for the treatment of anatomical waste and animal carcasses, and it does not efficiently treat chemical or pharmaceutical wastes [2]. Regarding the sharps, it should be noticed that there are significant concerns if the sterilization method can inactivate the pathogenic microorganisms because the formulation of the syringes, for example, prevents in many cases the entrance of steam in the interior area of the syringe.

The main problems that have been noticed in these hospitals relate also to the improper segregation. We have found out that the quantity of infectious waste that is being sterilized is greater than the normal quantity, which can be estimated by the values (quantity/bed) that were taken from the Greek scientific literature [6] (see above).

### 3.3 Other healthcare centres in the region

As mentioned above, our research about the medical waste management in Thessaly region was carried out in the university hospital of Larissa city and in the 4 general hospitals, each in every capital of prefecture. Although, during this research we have found out that most of the other healthcare centres that operate in the region, from primary healthcare centres to the private clinics, do not perform proper management of their waste and dispose them without care for the environment. It is worth mentioning that the doctors in private clinics do not segregate their waste, so the infectious wastes are disposed usually together with the domestic ones.



The main results of our research are depicted in Figure 6 and Table 1.

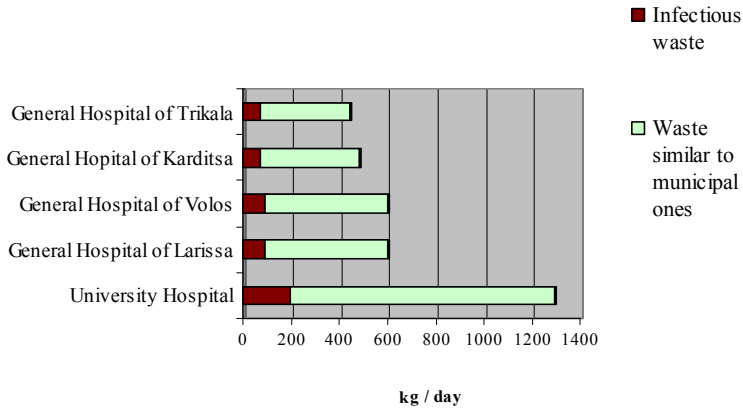


Figure 6: Waste production quantity per day in the hospitals of Thessaly region.

Table 1: Infectious medical waste treatment methods in Thessaly region.

Healthcare center	Treatment method
University hospital	Daily incineration in a double chamber incinerator
4 general hospitals	Steam sterilization in a mobile treatment unit 1 time per week
Rest healthcare centres	Disposal without treatment

## 4 Conclusions and suggestions

In this study, the medical waste management in Greece and more specifically in Thessaly region was examined. Our main conclusion is that the problem of medical waste management in Greece is extremely significant. The reasons relate to insufficient methods of treatment and improper segregation.

Bearing in mind all this evidence, we easily understand that the formulation of objectives and planning for their achievement are important for improving medical waste management at national and regional level. Planning requires the definition of a strategy that will facilitate careful implementation of the necessary measures and the appropriate allocation of resources according to the identified priorities. This is important for the motivation of authorities, healthcare workers, and the public, and for defining further actions that may be needed.

First of all, it is important that all the qualified hospital authorities should focus in the proper medical waste segregation and especially in sharps

segregation. No matter what final strategy for treatment and disposal of wastes is selected, it is critical that wastes are segregated (preferably at the point of source) prior to treatment and disposal. This most important step must be taken to safeguard the occupational health of hospital workers, as well as public health. Education and training of all hospital personnel is a very important step for the segregation success. It is really important that all the qualified authorities can really understand the contribution of a successful segregation at source to the minimization of infectious waste stream, and thus to the most efficient and least expensive treatment and normally to less health and environmental risks.

On the other hand, establishing clear guidelines, which emphasize at waste reduction, will keep waste management problems in focus. New emphasis needs to be put on waste reduction of hazardous materials. For example, hospital waste management would benefit from a policy of a phase out of mercury-based products and technologies. Digital and electronic technology is available to replace mercury-based diagnostic tools. This would also be a purchasing and investment decision.

Research for detecting the real advantages and disadvantages of the existent treatment methods is essential, as well as research for discovering new more effective treatment methods. It would also be helpful, if the use of PVC plastic in the healthcare tools construction were forbidden in every country. It is widely known that the incineration of such plastic produces dioxins and other pollutants, which pose serious human health risks not only to workers but also to general public through food supplies.

At national level, the corresponding Greek Ministry of Health should develop clear plans and policies for the proper management and disposal of wastes. A national management plan will permit healthcare waste management options to be optimized on a national scale. A national survey of healthcare waste will provide the relevant agency with a data base for identifying actions on a district, regional, and national basis, taking into account conditions, needs, and possibilities at each level. An appropriate, safe, and cost-effective strategy will be concerned principally with treatment, recycling, transport, and disposal options. Education and training of hospital personnel is also significant, in order to assure that these plans will be put into practice and maintained. The establishment of a system of continuous controls in the Greek hospitals for the assurance of the implementation of the above plans is significant as well.

The regional planning of medical waste management represents another crucial point, which should be paid attention to. We mean that the corresponding ministry should decide whether it is better to construct one medical waste treatment unit in each region or every hospital should treat its waste separately. This decision may only be made through a cost-benefit analysis in order to determine which scenario is more effective.

At regional level, every hospital should develop one specific plan for its waste management. The main guidelines of this plan will be similar to the guidelines of the national plan. The commitment of responsibilities by the hospital authorities regarding the infectious waste management is by all means desirable. An effective cost-benefit analysis should also be developed in every hospital in order





to determine the most effective treatment method, not only from a cost – benefit aspect, but from an environmental point, too.

The private clinics and the primary health care centres should be forced to implement the segregation at source. Private qualified companies should provide secure collection and transportation of infectious waste from the private clinics or the primary health care centres to one hospital treatment unit. This measure represents a very significant step and it should be considered carefully from the responsible authorities.

In general an integrated system of medical waste management in the whole of Greece and more specifically in the area of Thessaly region has to be achieved through the commitment of responsibility both by doctors, hospital personnel, responsible authorities and the local society. Education of doctors and hospital personnel represents a very significant point in this process. The media should also contribute in the effort for effective medical waste management by informing the local society how important such management could be for the protection of public health and environment.

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