

HOSPITAL WASTE – LEGISLATIVE FRAMEWORK AND MANAGEMENT DIFFERENTIATIONS IN AUSTRIA, BELGIUM, GERMANY AND GREECE

Susanne N. Mahnik ^{1,*}, Marc Hofmann ², Norbert Fraeyman ³ and Dimitrios Komilis ⁴

¹ VAMED-KMB, Department for Environmental Management and Hazardous Goods Transport Management, Spitalgasse 23, 1090, Vienna, Austria

² Department of Environmental Protection, University Hospital Jena, Kastanienstraße 1, D-07747 Jena, Germany

³ Faculty of Medicine and Health Sciences, Ghent University, University Hospital, Ghent, Belgium

⁴ Department of Environmental Engineering, Democritus University of Thrace, Xanthi, Greece

Article Info:

Received:

4 May 2023

Revised:

6 December 2023

Accepted:

12 December 2023

Available online:

31 December 2023

Keywords:

Hospital waste

Hazardous medical waste

Classification

Legislation

Incineration

Sterilization

ABSTRACT

In this paper, the differences regarding hospital waste management, specifically regarding the legal and technical situation and the definition of hazardous hospital waste in four member states (Austria, Belgium, Germany and Greece) are presented. All countries follow the legal guidelines of the European Union, but the technical situation, especially the possibilities for thermal waste disposal in incineration plants are different. Also the definition and categories of hazardous medical wastes are different in the aforementioned four EU member states. The annual production amounts of medical waste in selected countries are presented, as well as criteria that lead to their classification as hazardous medical waste.

1. INTRODUCTION

Hospitals focus on the protection of public health. Therefore, no negative environmental effects or any hazards to the employees and in the environment should be caused by the provided services. The developments in medicine, which require highest medical and care services, have produced growing waste amounts in the last years. Different types of hospital waste have to be collected, transported, sorted and prepared for disposal. The different waste fractions range from waste similar to households like packaging material and paper through hospital hazardous waste like chemicals or infectious materials.

Solid medical waste management has gained considerable importance during the COVID-19 pandemic. The situation in crisis conditions during the pandemic is evidently not representative for the overall management of medical waste beyond pandemics, but nevertheless, a number of fundamental questions were asked, in particular, the question of the uniformization of waste management across countries. The aim of this position paper is to contribute to this request by comparing in some detail

the management of solid medical waste from legal and technical point of view in 4 European countries. To the best of our knowledge, a similar comparison was made already 20 years ago (Mühlich, Scherrer, & Daschner, 2003) and in view of the significant development of health care and interest in waste management in last decades, a new review was deemed necessary albeit with a limited number of EU member states.

On a European scale, many legal constraints on the management of waste in general and on medical waste are available. Hospital waste is classified according to the European waste catalogue 2000/532/EC (European Waste Catalogue 2000/532/EC). Applying the European directives is always an obligation of the EU members and differences in interpretation leads to differences in waste management among countries. Even within each member state, the application on the floor, i.e. among hospitals is on occasion different. The aim of this paper is to illustrate this diversity.

It is clear that this diversity is contra productive to contribute to the optimisation of the Sustainable Development Goals (SDG, Ranjbari et al., 2022) and the European Green deal. Adapting waste in this respect has been done for house hold waste (López-Portillo, Martínez-Jiménez,



* Corresponding author:

Susanne N. Mahnik

email: susanne.mahnik@vamed.com



Detritus / Volume 25 - 2023 / pages 71-77

<https://doi.org/10.31025/2611-4135/2023.18325>

© 2023 Cisa Publisher. All rights reserved

Ropero-Moriones, & Saavedra-Serrano, 2021), any attempt to reconsider medical waste from these perspectives is welcome. The wish of the EU to enforce the circular economy model in all branches of economic activity is appreciated, but it is clear that legal constraints are inhibitory in this respect.

This paper shows the current differences (in 2023) in Austria, Germany, Belgium and Greece for hospital waste management regarding:

- The legal situation,
- The technical disposal situation, and
- The definition of hospital (or medical) hazardous waste.

2. LEGAL SITUATION

2.1 Europe

A number of European regulations and directives govern waste disposal. The basis is the Waste Framework Directive 2008/98/EC (Directive 2008/98/EC), which defines the main waste-related terms. The Waste Framework Directive (2008/98/EC) must be separately transposed into the national law by each European member state.

2.2 Austria

In Austria, the legal basis for waste management is the “Austrian Law on Waste” (Abfallwirtschaftsgesetz 2002). A national law is complemented by 9 different state laws. The Austrian Law on waste contains basic regulations concerning waste management, waste separation, handling of hazardous waste, official data sheets for hazardous waste and regulations about the waste manager. It has been updated and revised several times to include the legal requirements of the European Union, e.g. waste framework directive.

The legal regulations are amended by various special waste regulations and the “Austrian Standardization Guideline for the Medical Field” (ÖNORM S2104, 2020). Waste from Medical institutions, Austrian Standards International, 2020). It contains exact regulations regarding types of waste, waste definition, waste collection and disposal and is authored by a board of experts from waste management, disposal engineers, hygiene experts, medical doctors, users, etc. it also contains the Austrian waste catalogue numbers, which are relevant for medical institutions.

The Federal Ministry of Austria Climate Action, Environment, Energy, Mobility, Innovation and Technology assume the legal responsibility for medical waste management. The ministry is supported by the Federal Environmental Agency. Waste data is reported to the Federal Ministry of Austria Climate Action, Environment, Energy, Mobility, Innovation and Technology.

2.3 Germany

Germany supports sustainable waste management concepts for obtaining raw materials or energy from waste with the Waste Management Act (Kreislaufwirtschaftsgesetz – KrWG); it entered into force on 1 June 2012. A waste hierarchy that lays down a fundamental series of steps comprising waste prevention, reuse, recycling, and other elements besides, including energy recovery, and fi-

nally waste disposal. The Waste Management Act supplemented is fleshed out by a number of other regulations in Germany and is further differentiated by the waste management acts of the 16 federal states.

The European waste catalogue classified healthcare and hospital waste in chapter 18. Furthermore, classifications and categorization of those waste streams are laid down in the German guideline for disposal of wastes from healthcare facilities established by Federation/Länder Working Group on Waste (LAGA M18, 2021).

2.4 Belgium

Belgium is a country with three different governments depending on the geographical location: Flanders (northern part), Wallonia (southern part) and Brussels (in between). Each of the governments is responsible for managing waste including medical waste. Hence, three different law-systems have to be considered. Hereafter, medical waste is discussed, excluding radioactive waste. This type of waste is still the responsibility of the Belgian federal government overruling the 3 separate governments.

The legal basis for the management of medical waste in Flanders is described in the “Flemish law on waste of 17/2/2012 subdivision 5.2.3 (VLAREMA, 2012). Medical waste is produced during medical treatment or diagnosis of humans and animals in hospitals or in private practices, during pharmaceutical and biological research in laboratories and during routine home-treatment of patients by specialized personal. The law distinguishes household and industrial waste; medical waste is considered as industrial waste. Within the category industrial waste, the distinction is made between special waste and others. Medical waste is considered as special waste.

The legal basis in Wallonia is the decree of 30/6/1994, which has been modified on several occasions e.g. 4/7/2002, 3/6/2010 and 13/7/2017 (Decree 30/6/1994). The follow-up is done by the “Directorat Général de l'Agriculture, des Ressources naturel et Environment which is founded in 2008. Waste from clinical activities is classified according to the risks for the community. The legal basis for medical waste in Brussels is the decree of 23 March 1994 (Decree 23/3/1994). Recent laws related to waste in general are implied in 13/1/2017 (“BRUDALEX”) with emphasis on the responsibility of the owner of the waste, i.e. the head of the hospital (BRUDALEX 13/1/2017). At the same time, 11 older decrees are suspended with this new law. Within this law, both specific items (i.e. use of reusable plastic bags) and more general rules (i.e. on the traceability of medical waste, transport...) are mentioned.

2.5 Greece

The main Greek legal regulation concerning medical waste management was first issued on 2003 and was then updated on 2012 (HCMD, 2012) with the title “Measures and terms for the management of wastes from health-care facilities”. The circular of 2012 and the circular of 2013 provide more details on the management of the medical wastes in Greece. A minor update of the principal 2012 decree was issued on 2017 (HCMD, 2017) that modified operational issues (temperature, volume) related to the on-

site storage of medical waste prior to their transport for further treatment.

The legal regulation applies to healthcare facilities, dental practices and veterinary clinics for the entire country. It covers furthermore definitions, classification, source separation, storage, collection and transport, treatment, disposal and obligations of producers.

The Hellenic Ministry of the Environment and Energy and the Hellenic Ministry of Health have the legal responsibility for medical waste management. Waste generation and composition data is reported currently to the Hellenic Ministry of the Environment and Energy.

3. DEFINITION OF HAZARDOUS MEDICAL WASTE

3.1 Austria

In Austria, the legal basis for the definition of waste from medical institutions is the ON S2104 (ÖNORM S2104, 2020). Here, the types of waste are listed, that are possibly produced in hospitals and medical institutions.

The official definition of hazardous medical waste is waste that poses a risk inside and outside of medical institutions and therefore requires special treatment in both areas. Following this classification “Waste with certain infectious virus” is collected, e.g. black death, anthrax, rabies, tuberculosis, dengue fever etc., not included are HIV and hepatitis. For the list of virus that are important for the definition of hazardous medical waste see Table 1.

According to the “Austrian Waste Catalogue Number” the waste is classified with the number “97101”, following the European Waste Catalogue it is classified as “180103”, wastes whose collection and disposal is subject to special requirements in order to prevent infection.

This waste is collected and disposed in compliance with certain conditions:

- Collection in special one-way containers;
- Containers cannot be re-opened;
- Carriage as hazardous materials transportation (following ADR law in UN class 6.2-compliant containers).

Disposal is dedicated to be carried out in a special incineration plant for hazardous waste without opening. There is only one plant in Austria, where all the hazardous medical waste is incinerated. The disposal costs are summed up to approximately 1000 €/t (without transport etc.).

The other types of waste produced in hospitals have to be collected separately as well following the classification criteria and waste catalogue numbers in the ON S2104 (ÖNORM S2104, 2020), e.g.:

- Pharmaceutical and cytotoxic waste (Austrian waste catalogue number 53510, EWC 180108);
- Body parts and organs (Austrian waste catalogue number 97103, EWC 180102);
- Sharp waste (Austrian waste catalogue number 97105, EWC 180101);
- Disinfectants, chemical waste, mercury waste, batteries, electronic waste.

In Austria, approximately 1.070 t of hazardous medical waste was produced in 2020. The amount of sharp waste (Austrian waste catalogue number 97105 and EWC 180101 respectively) ranged from 1.140 in 2018 to 1.170 t in 2020, which was in the same magnitude as disinfected waste (1.050 t in 2018 – 1.030 t in 2020). In 2020, the amount of body parts was 50 t. The amount of non-hazardous hospital residual waste varied from 43.830 t in 2018 to 42.420 t in 2020 (Austrian waste catalogue number 97104 and EWC 180104 respectively). The total amount of medical waste ranged from 46.960 t in 2018 to 45.740 t in 2020. Table 2 shows the medical waste data of Austria in 2018 – 2020 (Bundesabfallwirtschaftsplan, 2023) considering the impact of Covid 19 pandemic (Fraeyman N., et al., 2022).

3.2 Germany

The term “hazardous waste” refers to various types of waste with defined hazardous properties that are harmful for the environment and/or human health such as:

- infectious (EWC 180103*, EWC 180202*),
- cytotoxic and cytostatic medicines (EWC 180108*),
- chemicals consisting of or containing dangerous substances and
- amalgam waste from dental care (EWC 180110*).

The needs for waste management EWC 180103* describes the following. While defining EWC 180103* wastes (wastes whose collection and disposal is subject to special requirements in order to prevent infection) it is assumed from knowledge or to be expected from medical experi-

TABLE 1: List of virus for the definition of hazardous medical waste (EWC 180103*) in Austria (ÖNORM S2104, 2020) and Germany (LAGA M18, 2021).

Types of virus - Austria	Types of virus - Germany
Anthrax	AIDS/HIV
Aphthous fever	Brucellosis
Brucellosis	Cholera
Cholera	Diphtheria, Leprosy
Dengue Fever	Dysentery
Glanders	Glanders
Haemorrhagic fever	Haemorrhagic fever
Jakob-Creutzfeld disease	Hepatitis virus
Leprosy	Meningitis/encephalitis
Paratyphoid A, B, C	Polio
Pest	Psittacosis
Polio	Q-Fever, Rabies
Psittacosis	Rabbitfever
Q-fever	Smallpox
Rabies	Spleen, Plague
Tuberculosis	TSE – (Transmissible spongiform encephalopathy); Creutzfeldt-Jakob disease
Tularemia	Tuberculosis
Typhus abdominalis	Typhus/Paratyphoid

TABLE 2: Medical waste data of Austria in 2018-2020 (Bundesabfallwirtschaftsplan, 2023).

Waste	Mass (t) 2018	Mass [t] 2019	Mass [t] 2020
SN 97101 (Hazardous medical waste) – EWC 180103	890	890	1.070
SN 97102 (disinfected Waste)	1.050	930	1.030
SN 97103 (Body parts and organs) EWC 180102	50	60	50
SN 97104 (Hospital residual waste) EWC 180104	43.830	43.960	42.420
SN 97105 (sharp waste) EWC 180101	1.140	1.190	1.170
SN 97105 g (hazardous sharp waste)	<1	<1	<1
Total	46.960	47.030	45.740
% hazardous amount	1,9%	1,9%	2,3%

ence that these wastes are contaminated with germs of specific diseases mentioned in the guidelines and that it can be feared that these wastes will cause the diseases to spread.

With reference to the Infection Protection Act and LAGA M 18 a list of diseases / germs, seen in table 1, is given in the guidelines which have to be considered for:

- the danger of infection (contagiousness, infections dosage, epidemic potential),
- the survival capacity of the germ (incubation period),
- the mode of transmission,
- the extent and type of potential contamination,
- the quantity of contaminated waste and
- the gravity of the disease possibly caused and the possibility of treatment,
- special requirements for their prevention (LAGA M18, 2021).

The collection of infectious and cytotoxic waste operates separately with type-approved waste bins. Thus, wastes go directly to incineration (without any compression) for transporting hazardous goods according to ADR (Accord européen relatif au transport international des marchandises Dangereuses par Route).

Wastes that are not in accordance to the EWC 180103* criteria are listed in EWC 180104 (wastes whose collection and disposal is not subject to special requirements in order to prevent infection). Wastes listed in EWC 180104 that contain facultative pathogenous germs, could cause nosocomial infections in patients. They are only dangerous for immune suppressed patients and only if a direct or indirect contact via a medium takes place. A clinical case study at Jena University Hospital for example aimed to investigate the influence of waste container construction on the release of microorganisms in a hospital setting (Büchner et al., 2021).

Table 3 shows medical waste data about selected waste types in 2019 and 2020 in consideration of the circumstances corona/covid pandemic (Datenbank des Statistischen Bundesamtes, 2022). The amount of hazardous hospital waste (EWC 180103) ranged from 8.900-10.800 t in 2019-2020, the amount of sharp waste (EWC 180101) was 800-900 t in 2019 and 2020. In 2019 386.200 t of non hazardous hospital waste (EWC 180104) was produced, in 2020 382.000 t.

3.3 Belgium

There are some differences in identifying the waste depending on the region: In Flanders, medical waste is further categorized as either “risk waste” or “non-risk waste”. Medical risk waste has risks for infection or can cause wounds to those involved in the management of the waste. Waste that poses specific ethical problems (recognizable body parts, placenta...) is also considered as risk waste.

In addition to the law, several extended documents are available; the most recent is the “code of good practice” (2014) written by OVAM which is the managing organization of medical waste in Flanders (Code of good practice, 2014). This is a joint effort of the government, medical institutions, federation of industries active in environmental issues and federations of hospitals. It also takes into consideration the law on the transport of dangerous goods. The content comprises waste types, hazards, very detailed regulations, and scientific support from VITO (Flemish Institute for Technological Research). In Wallonia, medical waste is either class A: comparable to household waste or class B2: infectious waste. Any other type of waste is class B1. Within class B2, medical waste further contains (1) needles, bistoury and alike, (2) infected, contaminated material including anatomical waste, (3) waste from medication, cytotoxic waste, heavy metals, chemical waste, (4) containers under pressure and (5) radioactive material. A specific regulation for anatomical waste was set up. For each class, specific regulations on handling, transport and elimination are given. Medical waste of class B2 might be transformed into class A of B1 provided the transformation is certified

TABLE 3: Medical waste data in 2019 and 2020 at Germany (Datenbank des Statistischen Bundesamtes, 2022).

Waste	Mass [t] 2019	Mass [t] 2020
EWC 180101	800	900
EWC 180102	3.100	2.800
EWC 180103*	8.900	10.800
EWC 180104	386.200	382.000
EWC 180108*	2.300	2.300
EWC 180109	7.900	16.000
EWC 180110	100	100
EWC 180202*	700	600

(e.g. treatment in an autoclave). In all cases, the incineration is controlled as far as temperature and the exhaust of environmentally burdensome compounds like dioxins, some gases such as sulfur dioxide, hydrogen chloride, nitrogen oxides, hydrogen fluorides, total organic carbon etc.

Identification and categorization of Medical waste in Brussels are nearly identical to the waste in Wallonia. Two different kinds of medical waste are considered: special waste, which is equivalent to the B2 type of waste in Wallonia and includes needles, body parts, blood, infectious waste from laboratories, and cultures of a specimen from patients infected with specified diseases (e.g. anthrax, cholera, tuberculosis, Creutzfeldt Jacob). Non-special waste is waste comparable to household waste but produced during medical activities. Non-risk waste which is comparable to the B1 type of waste in Wallonia is collected in grey plastic bags with specifications; specific waste is collected in yellow containers. Both are incinerated. Risk waste (Flanders) or B2 waste (Brussels and Wallonia) that has been decontaminated by autoclaving or any other method for sterilization is considered non-risk waste or B1 type of waste provided the decontamination process is validated. The collection of risk waste is identical in the three regions. The waste with risks is collected in yellow 60 or 30-liter one-time-use containers with self-closing covers. Solid waste but also fluids of different kinds (blood, perfusion liquid, urine, gastric fluid after lavage etc...) and mixtures can be stored in these containers. As an alternative, non-fluid or semi-fluid risk medical waste can be collected in plastic bags, which are inside a cardboard box, both with technical specifications. Non-risk waste is collected in blue plastic bags again with technical specifications. Waste classified as risk waste and fluid or semi-fluid non risk waste must be incinerated. Sharp waste is collected in specific small yellow plastic boxes, which are put into the large yellow containers. Waste with risks can be decontaminated (e.g. steam sterilization) provided evidence for the decontamination process is delivered.

3.4 Greece

According to the principal Greek legislation on medical waste management of 2012 (HCMD, 2012), hospital or medical waste belongs to chapter 18 of the EWC with the two main categories being the human-related healthcare waste (18 01) and the animal related healthcare waste (18 02). However, the categorization below, as described in HCMD (2012), diverts a little from the codes of chapter 18 of the EWC, as the three main fractions of the medical waste are:

- municipal type medical waste,
- hazardous medical waste (HMW), which is comprised of the following three sub-fractions:
 - infectious waste,
 - mixed waste (infectious and other hazardous waste),
 - other hazardous waste,
- special waste streams (e.g. radioactive waste, batteries, pressurized cans, WEEE etc.) may or may not contain hazardous materials.

In particular, the three sub-fractions of the hazardous medical waste stream are described as follows:

- medical waste with infectious properties that exhibit only the HP9 (infectious) hazardous property (e.g. body tissues, blood, fecal and urine samples from patients with an infectious disease, needles etc.), Infectious waste should be either sterilized and then landfilled, or be incinerated.
- mixed hazardous medical waste that exhibit both the HP9 property as well as at least one additional hazardous property (e.g. chemotherapy related waste, waste from bio-pathology and histology laboratories etc.). Mixed hazardous medical waste should be only incinerated.
- other hazardous medical waste that exhibit one or more hazardous properties other than HP9 to which incineration or material recovery can be applied.

According to the Greek Hazardous Waste Management Plan of 2016 (HCMD, 2016), the total annual amount of solid hazardous medical waste (estimates are for year 2011) was 16.300 t, from which around 80% was infectious waste and 20% was mixed hazardous and other hazardous waste. The liquid (wastewater) hazardous medical waste was estimated to be around 41.300 L/d, from which 40% was the infectious liquid waste and 60% was the mixed and other hazardous liquid waste.

Hazardous medical waste (HMW) in Greece is treated by either incineration or steam sterilization. Sorting within the healthcare facilities is realized successfully and efficiently for the past 10 years. There is one medical waste incineration unit in Greece (Athens) which receives hazardous medical waste from public and private hospitals all over Greece. Apart from the above incineration unit, there are also six (6) sterilization units, which receive only infectious medical waste. Five of the above sterilization units can also store medical waste, if needed, for long term. On site (within the hospitals) sterilization, that used to exist in some public hospitals in the past, is not applied anymore as the requirements for sterilization are now quite strict.

The hazardous medical waste (HMW) is source separated, stored, collected, transported, treated and disposed of, according to technical specifications described in the HCMD (2012). Special color-coded containers are used in all healthcare units (public and private) to separate the HMW in the aforementioned three categories, with sharps sorted separately in rigid plastic containers (but still treated as infectious waste usually via autoclaving in the above six sterilization facilities). Medical waste can be stored for up to 30 days at low temperature rooms within the hospitals. The transport of HMW is conducted according to "European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)". All types of hazardous medical waste (infectious, mixed, other) can be incinerated; however, the medical waste that is solely infectious can be alternatively sterilized (via autoclaving with the use of steam), which is a technology less expensive than incineration. After sterilization, infectious waste is rendered non-hazardous and can be

disposed of into a MSW (non-hazardous waste) sanitary landfill, which is the dominant type of solid waste landfill now in Greece. Tests are sometimes performed on sterilized infectious HMW, typically at the landfill gate, to validate the effectiveness of sterilization. Medical waste incinerator ash, if rendered hazardous, is currently exported to other European countries, but plans are under way to develop an ash treatment facility and a hazardous waste landfill in Greece.

The HMW treatment costs in Greece are currently up to 700 €/t for sterilization, up to 1.700 €/t for incineration, with an overall cost that is roughly estimated to range from 700 to 3.500 €/t, when collection and transportation costs are included.

4. TECHNICAL DISPOSAL SITUATION FOR HEALTHCARE WASTE

4.1 Austria

In Austria, medical waste has to be incinerated (ÖNORM S2104, 2020). Therefore, one incineration plant for hazard-

ous hospital waste and about 10 for non-hazardous hospital waste are available in the whole country. Furthermore, several treatment plants for chemical waste, other hazardous waste and recycling waste are used for the correct disposal of the different waste types (Bundesabfallwirtschaftsplan, 2023).

4.2 Germany

In Germany most noninfectious healthcare waste can be disposed of or recycled at thermal waste treatment plants. Currently there are 68 municipal waste incineration facilities (Umweltbundesamt, 2015).

In accordance with the LAGA guideline M 18, infectious healthcare waste is to be collected separately and thermally treated as hazardous waste using the mandated Robert-Koch-Institute procedures such as sterilization, steam disinfection, or incineration (Robert-Koch Institut, 2017). Infectious waste for incineration is thermally disposed of separately in purpose-built hazardous waste incineration facilities, after being transported in UN class 6.2-compliant containers.

TABLE 4: Summarizing table – legislation, classification and management of hazardous hospital waste in Austria, Belgium, Germany and Greece.

	Austria	Germany	Belgium	Greece
Legislation	- Waste Framework Directive 2008/98/EC - Austrian Law on Waste (2002) - Austrian Standardization Guideline for the medical field (2020)	- Waste Framework Directive 2008/98/EC - Kreislaufwirtschaftsgesetz (2012) - German guideline for disposal of healthcare wastes from healthcare facilities (2021)	- Waste Framework Directive 2008/98/EC - Flemish Law on Waste (2012) for Flanders - Decree 30/6/1994 for Wallonia - Decree 23/3/1994 for Brussels	- Waste Framework Directive 2008/98/EC - Hellenic Common Ministerial Decision (2012)
Classification of (Hazardous) Medical Waste – Main hospital Waste Types	A. Hazardous medical waste - waste that poses a risk inside and outside of medical institutions and therefore requires special treatment in both areas (equivalent to EWC 180103) B. Cytotoxic waste (equivalent to EWC 180108), C. Body parts and organs (equivalent to EWC 180102), D. Sharp waste (equivalent to EWC 180101), E. Chemical and other wastes, e.g. disinfectants, chemical waste, mercury waste, batteries, electronic waste	A. Infectious wastes whose collection and disposal is subject to special requirements in order to prevent infection (EWC 180103) B. Cytotoxic and cytostatic medicines (EWC 180108*), C. Chemicals consisting of or containing dangerous substances and D. Amalgam waste from dental care (EWC 180110*).	<u>Flanders:</u> A. Risk Waste (risks for infection, ethical problems) B. Non Risk Waste <u>Wallonia:</u> A. class A: comparable to household waste B. class B2: infectious waste - (1) needles, bistoury and alike, (2) infected, contaminated material including anatomical waste, (3) waste from medication, cytotoxic waste, heavy metals, chemical waste, (4) containers under pressure and (5) radioactive material. C. class B1: any other type of waste. <u>Brussels (identical to Wallonia):</u> A. Special waste (needles, body parts, blood, cultures etc.) B. Non special waste (comparable to household)	A. Municipal type medical waste, B. Hazardous medical waste (HMW), 1. infectious waste, 2. mixed waste (infectious and other hazardous waste), 3. other hazardous waste, 4. special waste streams (e.g. radioactive waste, batteries, pressurized cans, WEEE etc.)
Management of hazardous medical waste	Medical waste has to be incinerated. 1 Incineration plant for hazardous hospital waste 10 Incineration plants for non hazardous hospital waste	Medical waste has to be thermally treated. 68 municipal waste incineration facilities for non-infectious healthcare waste - Thermal treatment for infectious healthcare waste (Robert-Koch Institute Procedures sterilization, steam disinfection or incineration)	Hazardous waste has to be incinerated in a plant with permission: 2 incineration plants for hazardous medical waste	Hazardous medical waste has to be thermally treated: 1 incineration plant 6 sterilization facilities

4.3 Belgium

Hazardous waste has to be legally incinerated in a plant with a permission to treat this type of waste. In Belgium two incineration plants are available for hazardous medical waste, one in Flanders, one in Wallonia.

4.4 Greece

In Greece, there exists one incineration plant dedicated to thermally treat all types of hazardous medical wastes generated by the public and private health care facilities in the country. It is located in the Prefecture of Attica (near Athens). Also, there exist six (6) sterilization facilities (Volos, Rhodes, Salonica, Larisa, Crete, Tripoli) that can treat only the infectious fraction of the hazardous medical waste.

5. CONCLUSIONS

In this paper, the legal and technical bases for hospital waste management have been presented for Austria, Germany, Belgium and Greece. As you can see in Table 4, which gives an overview about legislation, classification and management of hazardous hospital waste, even though all the countries are members of the European Union and follow European regulations, the national specifications are different due to variable legal requirements, existing technologies and technical facilities, and options for waste disposal. In addition, even though the members of the European Union seek to harmonize concepts and modes of action, in this context, this harmonization is not totally achieved. But irrespective of the different waste definition, hazardous medical waste in all four member states under study is sorted and collected separately and then is either thermally treated (principal method) or sterilized.

REFERENCES

- Abfallwirtschaftsgesetz 2002. <https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20002086>.
- BRUDALEX 13/1/2017. https://document.enviroment.brussels/opac_css/elecfile/IF_Dejets_BRUDALEX_FR
- Büchner, F.; Hoffman, M.; Dobermann, H.D.; Edel, B.; Lehmann, Th.; Kipp, F. 2021. Do closed waste containers lead to less air contamination than opened? A clinical case study at Jena University Hospital, Germany. *Waste Management* 136, 11-17. <https://doi.org/10.1016/j.wasman.2021.09.031>.
- Bundesabfallwirtschaftsplan 2023. https://www.bmk.gv.at/themen/klima_umwelt/abfall/aws/bundes_awp/bawp2023.html
- Code of good practice, 2014 (<https://publicaties.vlaanderen.be/view-file/16289>)
- Datenbank des Statistischen Bundesamtes, 2022. <https://www-genesis.destatis.de/genesis/online?operation=previous&levelindex=0&step=0&titel=Statistik+%28Tabellen%29&levelid=1678879796635&acceptscookies=false#abreadcrumb>.
- Decree 23/3/1994. http://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=nl&la=N&cn=2016120133&table_name=wet
- Decree 30/6/1994. <http://environnement.wallonie.be/legis/legdecw8.htm> or <http://environnement.wallonie.be/legis/dechets/de-gen019.htm>
- Directive 2008/98/EC of the European Parliament and of the Council. <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008L0098&rid=9>.
- European Waste Catalogue 2000/532/EC. <https://eur-lex.europa.eu/eli/dec/2000/532/oj>
- Fraeyman N., Van Braeckel E., Verhasselt B., De Waegemaeker P., Mahnik S., Hoffmann M., Gemmel P., Eeckloo K. and Mortier E., 2022. Solid medical hospital waste in times of corona: increased volume but no increased biohazard risk. *Detritus* 19, 94-103. <https://doi.org/10.31025/2611-4135/2022.15197>.
- Hellenic Circular 119061/23-12-2013 of the Hellenic Ministry of Health "Management of Hazardous Medical Waste from Healthcare Facilities" (in Greek)
- Hellenic Circular 29960/3800/15-6-2012 of the Hellenic Ministry of Environment, Energy and Climate Change "Typical categories of healthcare wastes – Typical methods to manage health care wastes – Clarifications over certain requirements of the HCMD 146153/2012", (in Greek).
- Hellenic Common Ministerial Decision 146163/2012 (Official Government Gazzette 1537 B' 8-5-2012) "Measures and Terms for the Management of Wastes from healthcare facilities" (in Greek)
- Hellenic Common Ministerial Decision 41848/1848/2017 (Official Government Gazzette 3469 B' 16-10-2017) "Modification of the ministerial decision 146163/2012 – Measures and Terms for the management of waste from healthcare facilities" (in Greek).
- Hellenic Common Ministerial Decision 62952/5384/2016 (Official Government Gazzette 4326 B' 30-12-2016) "Approval of the National Plan for the Management of Hazardous Waste according to article 31 of Hellenic Law 4342/2015" (in Greek).
- LAGA M18, 2021. https://www.laga-online.de/documents/laga-m-18_stand_2021-06-23_1626849905.pdf. or <https://www.rki.de/DE/Content/Infekt/Krankenhaushygiene/Kommission/Downloads/LAGA-Rili.pdf>.
- López-Portillo, M. P., Martínez-Jiménez, G., Ropero-Moriones, E., & Saavedra-Serrano, M. C. (2021). Waste treatments in the European Union: A comparative analysis across its member states. *Heliyon*, 7(12), 11. doi:10.1016/j.heliyon.2021.e08645
- Mühlich, M., Scherrer, M., & Daschner, F. D. (2003). Comparison of infectious waste management in European hospitals. *Journal of Hospital Infection*, 55(4), 260-268. doi:10.1016/j.jhin.2003.08.017
- ÖNORM S2104. Waste from Medical institutions, Austrian Standards International, 2020.
- Ranjbari, M., Esfandabadi, Z. S., Shevchenko, T., Chassagnon-Haned, N., Peng, W. X., Tabatabaei, M., & Aghbashlo, M. (2022). Mapping healthcare waste management research: Past evolution, current challenges, and future perspectives towards a circular economy transition. *Journal of Hazardous Materials*, 422, 18. doi:10.1016/j.jhazmat.2021.126724
- Robert Koch Institut 2017. https://www.rki.de/DE/Content/Infekt/Krankenhaushygiene/Desinfektionsmittel/Desinfektionsmittelliste/Desinfektionsmittelliste_node.html.
- Umweltbundesamt, 2015. <https://www.umweltbundesamt.de/en/topics/waste-resources/waste-disposal/thermal-treatment#thermal-treatment-of-municipal-waste>
- VLAREMA, 2012. Flemish Law on waste. <https://codex.opendata.api.vlaanderen.be/api/WetgevingDocument/1021756>