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## STORAGE OF DANGEROUS MEDICAL WASTES IN MEDICAL SERVICE INSTITUTIONS

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**Abstract.** The problem of hazardous medical waste resulting from the provision of healthcare services by healthcare institutions is becoming increasingly relevant in the context of the need to ensure environmental protection and safety to human life and health. This requires efficient management of waste in order to minimise its level of hazard. The most common problems in this respect are found at the stage of the temporary storage of hazardous medical waste, as confirmed by irregularities reported over the last six years at healthcare institutions in the 388 (16.4%) from the Great Poland Province voivodship, which is the third voivodship in terms of hazardous medical waste generation in Poland. Violations of sanitary and building regulations in the storage of hazardous medical waste could lead to widespread infection and infectious diseases in humans and to the environment. This should be prevented through the introduction of continuing education for the personnel having direct contact with waste and for the management staff of healthcare institutions with a view to fostering awareness and responsibility regarding sanitary security and environmental protection.

**Key words:** waste, hazardous clinical waste, healthcare-institutions, waste management

### INTRODUCTION

Health care activities can result in generating various wastes which are hazardous for human life and health as well as for the environment [Chaerul *et al.* 2008]. This is connected with an increasing number of health care services as evidenced by the increasing number of chronic diseases and ageing of society. Generally, it is believed that increase in generation of medicinal wastes is due to several factors such as increase in population and number of health care institutions as well as erroneous segregation and classification of infectious wastes at source [Alagöz and Kocasoy 2008]. The additional exploitation of disposable appliances is another factor affecting a larger number of dangerous medical wastes due to the sanitary safety. Medical wastes are solid liquid and gas sub-

stances created from health services as a result of diagnosis, treatment, nursing and medical prevention as well as of carrying out investigations and scientific experiments in the medical area [Ustawa... 2012, Furtak-Niczyporuk 2013]. The wastes catalogue includes in subgroup 1801 13 kinds of medical wastes which are divided into dangerous and others [Rozporządzenie... 2014]. Considering physico-chemical properties wastes are classified as: dangerous – impose threat to human life and health as well as to the environment and the others which belong to the municipal ones. Classification of wastes is based on their origin properties responsible for being dangerous as well as components whose exceeding the boundary values of dangerous substances concentration can render the wastes hazardous [Ustawa... 2012]. Of special importance among medical wastes are dangerous medical ones possessing infectious properties. Their threat factor results from the content of pathogenic character which is associated with the contents of organic tissue, infections factors of biological type such as bacteria, viruses, fungi and dangerous chemical substances originating from exceeding the prescribed time limit drugs or those cytotoxic or cytostatic. The medical wastes catalogue includes seven kinds of dangerous medical wastes. They are: parts of the body and organs as well as blood containers; wastes which contain living pathogenic microorganisms or their toxins as well as other forms capable of genetic material transfer; chemical including reagents containing dangerous cytotoxic and cytostatic drugs, dental amalgam wastes, peloids of infections properties from medical care services, remains of food and other medical activities from contagious wards [Rozporządzenie... 2014]. The detailed catalogue and characteristics of dangerous medical wastes are presented in Table 1.

According to the latest data of 2014 in the European Union countries dangerous medical wastes constitute on the average 56% of medical and biological wastes [Eurostat 2017]. However, in Poland they made about 93% [GUS 2016]. As follows from the investigation results obtained from the Marshall Departments 272 000 tons of dangerous medical wastes were produced for 6 years from 2010 to 2015 [Furtak-Niczyporuk 2017a]. Average 45 334 tons of dangerous medical wastes are produced every year. Only in 2015 49 874 tons of these wastes were generated. Of the largest amount about 259 967 tons (95.57%) were the wastes of code number 180103 – other wastes including pathogenic microorganisms or their toxins as well as other forms capable of genetic material transfer. Average 43 328 tons of these wastes are generated every year. In the studied period their largest number was produced in the provinces: Masovion – about – 39 964 tons, Silesian – about – 29 027 tons and Great Polish – about – 23 588 tons.

Due to a great risk which dangerous medical wastes impose for human life and health as well as environment it is essential to ensure their proper management [Makajic-Nikolic *et al.* 2016, General Assembl 2011]. Management of dangerous medical wastes consists of the successive stages: collecting, home trans-

Table 1. Classification and characteristics of dangerous medical waste in subgroup 1801

Code No.	Kind of wastes	Characteristics of wastes
180102	Parts of body and organs as well as blood containers and preservatives for its storage	Human tissues and organs; post autopsy and postoperation materials, containers in which there was blood.
180103	Other wastes containing living pathogenic microorganisms or their toxins as well as other forms capable of genetic material transfer	Material, disposable utensils medical products, other wastes coming from infections patients; worn out dressings, tampons dirty with infectibus material, body fluid, excretions and excrements of patients; blood and its products containing plasma and serum, active vaccines laboratory and diagnostically investigated body fluids; biological preparations.
180106	Chemicals including chemical reagents and dangerous substances	Radioactive wastes, worn out solvents and chemical reagents; toxic isotopic substances.
180108	Cytotoxic and cytostatic drugs	Immunomodulating and anti-tumorous drugs.
180110	Dental amalgam wastes	Filings containing amalgam with mercury
180180	Worn out peloids after medical treatment of contagions character	Used up treatment baths being biologically active of contagious character.
180182	Remains of patients nourishment from isolation wards	Remains of nourish of infections patients.

port, temporary storage, transport for utilization, utilization, supervision and neutralization [Ustawa... 2012]. These are identification activities included into waste management processes [Korzeniowski 2014]. They are defined by Legal norms and they should take into account generally accepted rules of protective activities based on the current state of knowledge [Górski 2009]. In the stage of collecting wastes temporary storage may take place. This problem afflicts mainly treatment institutions of stationary and a day and night's medical services: hospitals, care and treatment services, hospices or so called in-patient medical service. Moreover, these are also medical institutions providing out-patient medical services in outpatients' service or in the patient's call place as well as services provided by medical specialists that is the out-patient medical service.

#### MATERIAL AND METHODS

The objective of investigations were the results of inspection of health care institutions providing stationary and day and night as well as out-patient health services as for as medical wastes management is concerned made by the National Great Polish Province Sanitary Inspection (WPWIS). The choice of investigations area allowed to establish circumstances of dangerous medical wastes storage in

health care institutions in the Great Polish Province which is the third one in Poland producing the largest amount of wastes. The investigations included the results of 388 inspections during which abnormalities in the temporary storage of medical wastes were found. Totally 2368 institutions, in which abnormalities in medical wastes management were found, were inspected. The investigation period included the years 2011–2016. The investigations were carried out based on the analysis of documents rendered accessible by WPWIS. Additionally the analysis of literature and legal documents concerning medical wastes management was made.

### RESULTS

For six years from 2011 to 2016 WPWIS inspected 49813 medical institutions including 697 providing health care services within the in – patient medical service (1.4%) and 49116 within the out – patient medical service (98.6%). At that time as regards medical wastes management WPWIS inspected 21500 medical institutions (43.2%) including 537 the in – patient medical service (2.5%) and 20963 the out – patient medical service (97.5%) ones. The detailed information about the supervised and inspected medical institutions is presented in Table 2.

Table 2. Number of medical institutions based on the kind of activity as well as those inspected by WPWIS regarding medical wastes management including dangerous ones in individual years

Year	Kind of activity	Number of medical institutions as recorded	Number of medical institutions as regards medical wastes management	Total number of inspected medical institutions
2011	In – patient medical service	96	75	4041
	Out – patient medical service	7651	3966	
2012	In – patient medical service	103	83	3801
	Out – patient medical service	7917	3718	
2013	In – patient medical service	117	89	3650
	Out – patient medical service	8112	3561	
2014	In – patient medical service	119	98	3459
	Out – patient medical service	8297	3361	
2015	In – patient medical service	133	93	3375
	Out – patient medical service	8536	3282	
2016	In – patient medical service	129	99	3174
	Out – patient medical service	8603	3075	

Of the inspected 21500 medical institutions, irregularities in medical wastes management were found in 2368 (11.0%). That included 131 medical institutions working as in – patient medical service (5.5%) and 2237 as out –

patient medical service (94.5%). Of the medical institutions with irregularities in medical wastes management, as many as 388 (16.4%) had problems with proper storage of medical wastes including dangerous ones.

Incorrect storage of medical wastes including those dangerous was found in 80 medical wastes including of in – patient medical service (20.6%) during the last six years. In 2011 of 96 medical institutions 75 (78.1%) were inspected. In 33 institutions (44.0%) there were found irregularities in management of dangerous medical wastes and 17 (51.5%) concerned their storage. The next year the number of medical institutions increased by 7 (to 103) and 8 more (83) were inspected than a year earlier. Here there was an increase up to 36 (43.4%) of those which had irregularities in managing dangerous medical wastes and in 18 (50.0%) wrong storage of the wastes was found. In 2013 the number of medical service institutions was already 117 but 89 (76.1%) were inspected. Of thorn incorrect wastes management was disclosed in 9 (10,1%) medical service institutions of which 5 (55.6%) had wastes storage problems. In the successive year the number of institutions increased up to 119 and the number of inspections increased by 9 (98) compared to the year earlier (82.3%). There was also observed an increase in the number of medical service institutions up to 11 (11.2%) of which 6 (54.5%) had problems with storage of dangerous medical wastes. In 2015 the number of such institutions was 133 and the inspection was made in 93 (69.9%). Incorrect management of dangerous medical wastes was discovered in 27 (29.0%) institutions of which 23 (85.2%) showed storage abnormalities. In 2016 99 (76.7%) institutions were inspected out of 129 where 15 (15.1%) had bad management of medical wastes and 11 (73.4%) stored the wastes improperly. Table 3 shows the detailed analysis of inspected medical service institutions as regards management of medical wastes including those with improper storage of dangerous medical wastes in individual years.

However, in the out – patient medical service institutions incorrect storage of medical wastes including incorrect storage of medical wastes including the dangerous ones was found in 308 (79.4%) of them during the last six years. In 2011 3966 (51.8%) of 7651 ones were inspected. Of them 1745 (44.0%) disclosed irregularities in management of medical wastes and improper storage of dangerous medical wastes was found in 70 (4.0%). Next year the number of medical service institutions (7917) increased by 266 but the number of inspected ones bopped by 248 compared to that (3718) in the year before. Here there was observed decrease up to 114 (3.1%) of the institutions with bad management of medical wastes, however, only 42 (36.8%) of them included storage of dangerous medical wastes. In 2013 there were already 8112 medical service institutions of which 3561 (43.9%) were inspected. Improper management was found in 86 (2.4%) including bad storage of dangerous medical wastes in 48 (55.8%). In the successive year the number of medical service institutions was still growing and reached 8297 being larger by 185 than the year earlier. 118 (3.5%) institutions, by 32 more

Table 3. Number of institutions providing the in – put medical service in which there was found improper management of medical wastes including those with bad storage of dangerous medical wastes in individual year

Year	Kind of activity	Number of medical institutions with improper management of medical wastes	Share % of the institutions with improper management of medical wastes	Number of institutions with improper of storage of dangerous wastes medical wastes	Share % of institutions with improper storage of dangerous medical wastes
2011	In – patient medical service	33	44.0	17	51.5
2012	In – patient medical service	36	43.4	18	50.0
2013	In – patient medical service	9	10.1	5	55.6
2014	In – patient medical service	11	11.2	6	54.5
2015	In – patient medical service	27	29.0	23	85.2
2016	In – patient medical service	15	15.1	11	73.4

Table 4. Number of out – patient medical service institutions in which bad management of medical wastes including in – proper storage of dangerous medical wastes was found in individual years

Year	Kind of activity	Number of institutions with bad management of medical wastes	Share (%) of institutions with bad management of medical wastes	Number of institutions with improper storage of dangerous medical wastes	Share % of institutions with improper storage of medical wastes
2011	Out – patient medical service	1745	44.0	70	4.0
2012	Out – patient medical service	114	3.1	42	36.8
2013	Out – patient medical service	86	2.4	48	55.8
2014	Out – patient medical service	118	3.5	60	50.8
2015	Out – patient medical service	82	2.5	63	76.8
2016	Out – patient medical service	92	3.0	25	27.2

than the year earlier, were inspected as regards medical wastes management and bad storage of dangerous medical wastes was found in 60 (50.8%). In 2015 the number of medical service institutions was already 8536, by 239 more than the year earlier. However, 3282 (38.4%) institutions by 79 fewer than the year earlier, were inspected. Then 82 (2.5%) revealed improper management of medical wastes including bad storage of dangerous medical wastes in 63 (76.8%). However, in 2016 there were already 8603 medical service institutions, by 67 more than the year earlier and of which 3075 (35.7%) were inspected. Improper management of medical wastes was found in 92 (3%) institutions with bad storage of dangerous medical wastes in 25 (27.2%). The detailed analysis of the number of out – patient medical service institutions inspected by WPWIS as regards management of medical wastes including storage of dangerous medical wastes in the individual years is presented in Table 4.

The inspection by WPWIS regarding storage of dangerous medical wastes covered the sanitary and technical conditions of premises for stores or cooling devices. The most frequent irregularities were:

- in the in – patient medical service institutions: improper, high temperature of wastes storage; the lack of temperature monitoring in the premises and cooling devices; improper frequency of wastes transportation for utilization; dirty, shrivelled up walls and ceilings; losses in plaster as well as falling off wall paint, ruined concrete floor, overfilled containers boxes for wastes accumulation a lack of cleaning agents such as: disposable towels, chemicals for hands disinfection as well as tap warm or cold water, damaged or cracked wash – basin, a lack of possibility of unconstrained entry and exit as well as accessibility of personnel to the storage room, a lack of functionality of storage places because of steep stairs on which there was installed an unfolded platform for carts to get in and, no protection for personnel, entrance into the storage room with a low threshold. What is more, the storage room was used for washing and disinfection of carts for wastes transport while its area did not allow for a separate part so called the clean part;

- in the out – patient medical service – improper temperature in the storage rooms and cooling devices; too long storing up of wastes; damaged lining on the on the walls and floor; accumulation of bags with wastes directly on the damaged floor, cooling devices filled up with wastes; containers with wastes left in the rooms not adapted for them e.g. the staircase, hygienic – sanitary premise for the personnel a lack of protecting cooling devices with wastes against access of unauthorized people, rugged floor in cooling devices, dirty cooling devices; using cooling devices for wastes also for other purposes.



## DISCUSSION

Storage of dangerous medical wastes consists in cooling in their temporary keeping till the time of their delivery to the outer firm to be transported for utilization. Wastes storages is in separate and adapted to this and premises or portable cooling devices when the amount of wastes is small. Both premises and devices for wastes storage must satisfy very strict requirements of the sanitary and building laws [Ustawa... 1994, 2008]. Improper storage of dangerous medical wastes by the medical service institutions in the Great Poland Province for the last six years was found in 388 (16.4%) inspected institutions out of 2368 which proves serious problems in this aspect. Irregularities, though not so numerous, were found also in other provinces. For example in Lublin Province they included 65 (6.2%) institutions out 1045 inspected during the last five years [Furtak-Niczyporuk 2017b]. this evidently implies the need to introduce improvement in storage of dangerous medical wastes by medical service institutions. In order to active better agreement with the legal requirements, it is essential to initiate regular internal audits [Botelho 2012]. The results of investigations indicate first of all a lack of internal system of monitoring teams or individuals responsible for sanitary and epidemiological conditions of medical service institutions. This is a direct result of bad sanitary and technical conditions of premises for wastes storage without walls and floors made of smooth and easily wasted as well as enabling disinfection materials which allows to keep them clean. Dirty and shrivelled up walls caused multiplication of pathogenic microorganisms on all these surface areas which is risky for those working with wastes storage. It was also possible for wastes effluents to get out the storage room among others through the damaged floors. This was more likely to take place where bags with dangerous wastes were stored directly on such floor but not in special boxes or containers moreover, the premises for wastes were used for washing carts already used for wastes transportation. Here where there was not a threshold at the entrance to the storage room, the contaminated water could leak outside. Every time the emptied cart or container with dangerous medical wastes should be disinfected and washed carefully in the special room prepared for it. As a result, the transportation carts cleaned under such conditions remained contaminated. Afterwards they were pushed to hospital wards and outpatients' surgeries to take next bags and containers with dangerous medical wastes. It should be stressed here that the lack of hygiene and safety for people working in wastes storage rooms causes their serious risk of infection due to dangerous medical wastes. The reason is also the lack of warm and cold water agents for washing and disinfection of hands as well as disposable towels and a lack of sanitary joint which should be closet the wastes storage. Thus the pathogens in the wastes can get into the organism through the skin damaged from perforation or detrition, mucous membrane inhalation or accidental consumption. Work with



such wastes can lead too serious risk of infection and bloodlike contaminations such as HCV, HBV and HIV [Prüss-Üstün *et al.* 2005, Insa *et al.* 2010]. Furthermore, the inspection showed insufficient frequency of transportation of waste from the storing place for utilization as confirmed by filled up containers and boxes as well as cooling devices. Also high temperature of wastes storage in premises and cooling devices as well as possibility of actual monitoring were found. That indicated exceeding the admissible temperature for string parts of the body and organs up to 10°C not longer than 72 hours and other dangerous medical wastes up to 10°C not longer than 30 days or in the temperature range from 10°C to 18°C for 72 hours. Obviously keeping proper storage temperature requires under pressure ventilation with air filtration as well as which these institutions did not possess. That was drastic violation of law and serious threat to human life and environment. As follows from the investigations it is essential for the storage of dangerous medical wastes to be kept for a permissible period of time till their safe removal [Hassan *et al.* 2008].

What is more it was found in the out – patient medical service institutions that containers and cooling devices with dangerous medical wastes were left in prohibited places and premises such as the staircase of hygiene and sanitary rooms for workers. At the same time containers and cooling devices with wastes were not protected against opening so not authorized people could have access to wastes. That resulted from the lack of sanitary safety due to not observing required sanitary procedures [Ustawa... 2008]. Another violation of law was using cooling devices for other purposes.

#### CONCLUSIONS

1. It is advisable to develop awareness and responsibility of the staff managing the medical service institutions keeping the storing rooms with dangerous medical wastes in proper hygienic, sanitary and building conditions in order to prevent dissemination of infections and infectious diseases.

2. There should be introduced cyclic training courses for the personnel servicing the storing rooms with dangerous medical wastes how to manage them and to make them aware of the risk of infection due to applying wrong procedures.

3. It is necessary to appoint the staff for internal sanitary inspection to control prevent threat to human life and health as well as the environment.

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## MAGAZYNOWANIE NIEBEZPIECZNYCH ODPADÓW MEDYCZNYCH W PODMIOTACH LECZNICZYCH

**Streszczenie.** Niebezpieczne odpady medyczne powstające w wyniku udzielania świadczeń opieki zdrowotnej przez podmioty lecznicze stają się istotnym problemem w kontekście zapewnienia bezpieczeństwa życia i zdrowia ludzi oraz ochrony środowiska. Wymaga to prawidłowego gospodarowania tymi odpadami, tak aby zminimalizować zagrożenia. Najczęściej występujące problemy stwierdzone są na etapie czasowego magazynowania niebezpiecznych odpadów medycznych. Potwierdzają to nieprawidłowości w tym zakresie stwierdzone w ciągu ostatnich sześciu lat w 388 podmiotach leczniczych (16,4%) z województwa wielkopolskiego, które jest trzecim województwem w kraju wytwarzającym najwięcej niebezpiecznych odpadów medycznych. Rażąco naruszenia prawa sanitarnego i budowlanego przy magazynowaniu niebezpiecznych odpadów medycznych mogły prowadzić do szerzenia się zakażeń i chorób zakaźnych u ludzi oraz zagrożenia dla środowiska. Należy temu zapobiegać poprzez wprowadzenie kształcenia ustawicznego personelu mającego bezpośredni kontakt z odpadami, a także kadry zarządzającej podmiotem leczniczym, celem zwiększenia świadomości i odpowiedzialności za bezpieczeństwo sanitarne oraz ochronę środowiska.

**Słowa kluczowe:** odpady, niebezpieczne odpady medyczne, podmioty lecznicze, gospodarka odpadami