

Ecological Problems of Medical and Biological Waste Disposal in Medicine after Cardiac Surgery

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ABSTRACT

The World Environmental Forum, taking into account the global nature of most of the environmental problems of humanity, suggests using the term “global environmental safety” in international research. First of all, this is due to the strengthening of the economic and political split. Therefore, humanity, more than ever before, needs world leaders and major companies to take steps to address threats to climate, ecology, health and technological systems together, as part of achieving the Sustainable Development Goals. If cooperation is avoided, the world expects a further split and a slowdown in economic growth. Geopolitical turbulence makes international relations more unstable and leads to increased competition between the largest powers, while world leaders must focus on working together to combat common risks. For more information about the specifics, principles and directions of implementing such cooperation in the framework of achieving global environmental safety, see the following sections of the work. Scientists defines the features of environmental security that prove its cross-border nature, among them: diversity, interrelation of all elements of national security, compliance with environmental rights of all population groups, etc. Here it is worth adding that, given the cross-border nature of most environmental threats, environmental security as a category of “component of national security” should be considered in the plane of international relations. World leaders and the development of the international economy now put environmental issues at the head of a multi-faceted world policy. So, in 1957, when the EU was founded, there was no environmental policy, environmental bureaucracy and laws on nature protection. Today, the EU has one of the most progressive environmental policies in the world. The network of its environmental legislation covers all industries: Air Pollution Control, Water Environment, Waste Management, nature protection and chemical control, biotechnology and other industrial risks. The body of EU environmental law consists of more than 500 directives, regulations and decisions. It can be argued that environmental policy has thus become one of the main areas of European policy.

Keywords: ecological, waste, medicine, recycling.

INTRODUCTION

Safe and efficient disposal of medical waste over the past decade has been one of the most important challenges for many countries, including those with a high level of economic development. The amount and composition of waste generated in medical institutions varies depending on the level of development of the country, the type of medical institution, the Waste Management System, the level of environmental awareness of the staff and society as a whole. For Russia, this problem is urgent and requires an immediate solution.

In our country, there are 6.5 thousand legal and about 35 thousand illegal landfills with a total area of more than 43 thousand km². This is 1% of the territory of Russia and it is equal to the area of Denmark. At the same time, there are only 4 incinerators for this amount of garbage in Russia: in Moscow, Novosibirsk, Sankt-Peterburg and Sevastopol. However, only one of them operates – the Moscow plant “Energiya”. At the same time, there are 70 such plants in Germany and 100 in Japan. In Sweden, 99% of garbage is recycled. They heat homes and generate electricity. Due to the lack of garbage, they import

it from other countries and have long lived by the principle: “money-garbage-money”. The disposal of medical waste in them is a well-established and safe process for the population and the environment.

DISPOSAL OF MEDICAL WASTE

It is worth noting that the amount of medical waste generated daily during the maintenance of one patient, on average, in developed countries of the world is about 3 kg/patient per day. Based on reports and literature data, it is established that the amount of waste generated in hospitals in Russia is approximately 2 kg of waste per hospital bed per day.

Based on the experience of deploying military contingents in Afghanistan and Iraq in the field, when conducting combat operations, a military unit of 500 soldiers produces 1,000 kg of garbage per day, including medical waste. That is, on average, for 1 military unit – 2 kg of various waste that requires appropriate disposal. This is a generally accepted average for all armies in the world, and the disposal of such a large amount of waste in accordance with existing requirements is an important problem for them as well.

In particular, the Muller incinerator of the S.R. 50 M model (manufactured in France) ensures complete destruction of microorganisms, is environmentally safe and reliable in operation: if any emission parameter exceeds European standards, the system itself blocks the operation of the device. When incinerating contaminated medical waste, ash remains, which makes up only

5% of the total mass of waste and will be taken to a common landfill. The equipment is designed for incineration of organic solid waste (average specific heat of combustion of waste 3500 kcal/kg) by high-temperature pyrolytic combustion at temperatures up to 850 °C in the pyrolysis chamber, followed by afterburning of pyrolysis gases at t° 1100-1250 °C in the second chamber without the formation of “black smoke” and fine dust. The capacity of the incinerator is 50-60 kg/h, the Working Time is 8-12 hours/day with an average caloric content of waste of 3500 kcal/kg.

Incinerator “Muller” Model S.R. 50 m destroys any type of organic waste that burns: hazardous medical waste, including those that pose an epidemiological danger (with the exception of radioactive), hazardous biological waste of veterinary medicine, animal husbandry, poultry, meat processing industry, slaughterhouses, expired pharmaceuticals and pharmaceutical industry waste, persistent organic pollutants, unsuitable and prohibited pesticides.

The problem of solving the disposal of medical waste in the field is also of particular importance in everyday military medical practice, since a significant part of it is “buried in the ground” or burned. So, according to investigations in Afghanistan and Iraq, the military dumped medical waste and garbage into large pits, doused it with aviation fuel and burned it. At the same time, both the waste combustion products themselves and carcinogenic derivatives of aviation fuel were toxic. As a result, the servicemen began to have mass diseases, including infectious ones. The problem turned out to be so serious that in 2012, the US Congress passed a bill to create a register

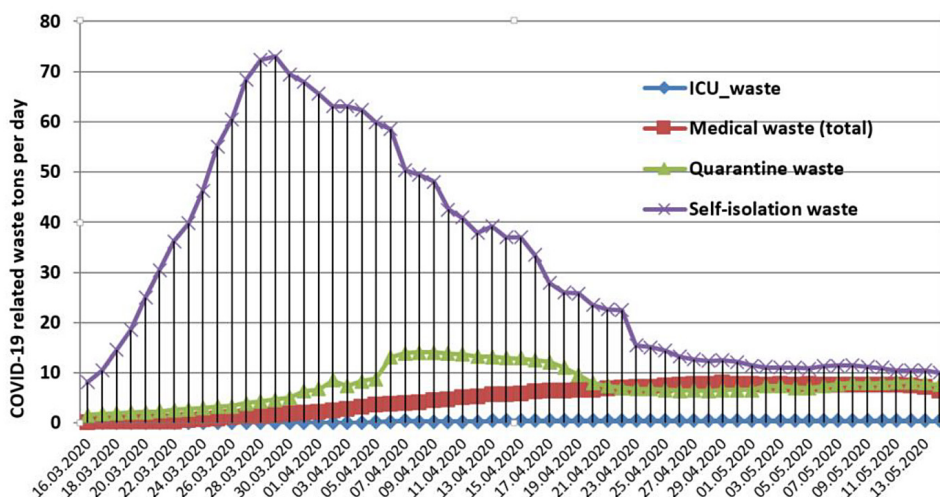


Figure 1. Elated waste flow in Europe in 2020

of military personnel affected by the incineration of medical waste and garbage in open pits. In 2014, more than 90,000 victims were registered in the register.

This experience shows that it is categorically unacceptable to incinerate waste in an open fire without observing the temperature regime and having an appropriate system for cleaning combustion products.

In the army of the Russian Federation, by order of the Ministry of Defense, a multifunctional mobile incinerator installation was created. The UUMO-01 incinerator meets the most stringent requirements of European standards both in terms of disinfection and environmental safety. Since 2016, a serial receipt for equipping troops is planned.

In NATO countries, there are sanitary requirements for waste management when placing medical units (institutions) in the field (according to STANAG 2982 “Essential field sanitary requirements” – compliance with sanitary and hygienic requirements in the field) (Makan, 2021).

STANAG 2982 notes that when deploying medical units (institutions) not in a hospital setting, a number of sanitary requirements for waste management must be met, in particular: measures for solid medical waste management:

- compliance with general occupational safety warnings when providing medical care to the wounded and sick and handling waste that occurs during this process (use of protective gloves, masks, aprons, etc. means that prevent the transmission of vector-borne diseases from patients);
- medical waste is sorted (separated) from general waste at the location of the medical unit (institution). Mixing of medical and other (common) waste is prohibited;
- special red bags (containers) or other puncture- and leak-resistant liquids of a certain color or appropriately labeled bags are used to store medical waste. As a rule, they contain waste that is contaminated (soaked) with blood, waste that can be compressed to release blood, objects with traces of baked blood. In most cases, items that are marked with a warning (gloves, masks, etc.) are classified as general waste (i.e., not medical). If bags (containers) of a color other than red are used, this color should be clearly indicated on them, and “hazardous medical waste” should be indicated on the bags (containers);

In the absence of plastic containers, use metal buckets with a lid. It is forbidden to empty the contents of a smaller container into a larger container (for example, waste from a bucket into a cylindrical barrel container). When disconnecting the needle from the syringe, follow the safety rules. Do not break the needles, they must be placed directly in containers for Sharp Objects.

The collected medical waste is incinerated (sterilized) and then disposed of (or other alternative waste disposal technologies are used). The ashes of the burned medical waste are placed in an open cylindrical container (200 liters), which, after filling, is evacuated from the operating area and then buried in a sanitary landfill equipped in accordance with national standards. If there are no sharp medical objects (needles, scalpel blades, etc.) among the ash, then the ash can be regarded as general garbage, which can be buried in a certain place in the operational zone.

If it is not possible to incinerate medical waste, sterilization is recommended as an alternative. Autoclaves and steam sterilizers can be used for this purpose. After sterilization, the waste is treated as general garbage and disposed of in accordance with the established procedure. At the same time, observe the technique of handling sharp objects. It is forbidden to use field surgical or dental sterilizers for autoclaving medical waste. For this purpose, Special Field Medical sterilizers are used, designed to sterilize medical waste. It is forbidden to overload the sterilizers due to their possible premature failure. It is necessary to plan in advance the procedure for removing medical waste, taking into account the possible failure of steam sterilizers (Peng, 2020).

As with ash, sharp objects are evacuated outside the operating area after sterilization and removed as general waste. To remove medical waste, it is possible to conclude contracts with third-party organizations. The agreements specify the requirements for the disposal of medical waste. If there are no other ways to dispose of medical waste on site (in the operational zone), it is evacuated outside the operational zone. The least desirable option for disposing of medical waste is to dispose of it in a local sanitary landfill (after coordination with local health officials).

Based on the requirements of this order, it is clear that under such conditions only the stages of collecting, sorting and labeling waste in appropriate containers and their further evacuation outside the operational zone are appropriate (according to



Figure 2. Illegal dumping of medical and biological waste in Dobroiesti commune, Romania, in 2020 [National Environmental Guard]

the recommendations of STANAG 2982 “Essential field sanitary requirements” – compliance with sanitary and hygienic requirements in the field).

In the future, medical waste should be transported to disposal sites – mobile and inpatient hospitals, which should be equipped with mobile or stationary incinerators (in their absence, contracts are concluded with third – party institutions that have technical means for the safe disposal of medical waste).

OPTIONS FOR THE DISPOSAL OF BIOLOGICAL WASTE WITH AN EMPHASIS ON ECOLOGY

Russia has accumulated about 36 billion rubles. a ton of waste, or more than 50 thousand tons per 1 km² of the territory, of which only 30% of industrial waste and 4% of household waste are processed. The volume of creation, disposal, location and disposal of waste is constantly changing, taking into account the criteria for their belonging to types and hazard classes (Rhee, 2020).

Specific waste generation rates are approximately 220–250 kg/year per person, and in large cities – 330–380 kg/year. Solid household waste is buried in 6,700 landfills and landfills with a total area of about 9 thousand hectares. Only 3.5% of solid household waste is incinerated in two

incinerators. About 0.1% of household waste is hazardous. Medical waste containing dangerous pathogenic and opportunistic microorganisms poses a significant threat to the environment and biota. Every year, the state generates 350 thousand tons of medical waste, which pose a high risk of spreading infections and diseases (Sarkodie, 2020).

The composition of solid household waste includes the following main components: food – 35–50%, paper and cardboard – 10–15%, plastics – 9–13%, metals – 2%, glass – 8–10%, textiles – 4–6%, construction debris – 5%, wood – 1% and other waste – 10%. The total amount of accumulated household waste exceeds 3 billion rubles. (Tesfahun, 2016).

To date, the situation with the management of hazardous waste has worsened, the total volume of accumulation of which is about 1.6 billion rubles. tone, as well as with chemical plant protection products that are not suitable for use and are prohibited in use. These products, together with specific waste that is formed during the medical process maintenance, veterinary practice and related research work are stored in 4075 warehouses in violation of environmental safety requirements. And after they get into household waste containers and landfills and landfills, they can lead to various infectious diseases (Yang, 2021).

The most important component of efficient use of secondary raw materials is the availability

of separate waste collection systems by the population. In the presence of such systems, waste is recycled in the most suitable state. There are practically no separate solid waste collection systems in Russia. Pilot projects are being implemented in some small towns and microdistricts of large cities.

Hazardous and toxic waste includes radioactive, toxic, medical and other types of waste. Medical waste containing dangerous pathogenic and opportunistic microorganisms poses a significant threat to the environment and biota. Hazardous and toxic waste disposal technologies are special cost-effective technologies that ensure maximum completeness of waste disposal.

Technologies for the disposal of valuable and resource waste are special technologies that are individual for each type of waste, which ensure the maximum completeness of the extraction of valuable components from waste. With the development of innovative processing technologies, waste that is currently stored in man-made deposits can pass into this category.

The sphere of hazardous waste management as part of household waste is complex, the total volume of their accumulation is about 1.6 billion rubles. For example, chemical plant protection products and specific waste generated in the course of medical care, veterinary practice and related research work are now stored in violation of environmental safety requirements in 4075 warehouses and are unsuitable for use and prohibited for use. And after getting into containers of household

waste and landfills and landfills, they can cause various infectious diseases (Yang, 2021).

Hazardous waste is waste that has such physical, chemical, biological or other hazardous properties, constitutes or may pose a significant danger to the environment and human health and requires special methods and means of handling them (Zambrano-Monserrate). Hazardous household waste generated in the residential sector includes: lacquers, paints, solvents, lubricants, oils, acids, batteries, batteries, neon lamps, kinescopes, waste of electronics and computer equipment, mercury thermometers, glass wool. The main problem is the transportation of hazardous waste and its disposal along with other household waste in landfills.

It should be noted that radioactive waste is characterized by a wide variety of composition, physico-chemical and other properties, depending on the place, conditions and source of their occurrence. In particular, a large amount of radionuclides in waste. In order to simplify the management of such a variety of radioactive waste and standardize methods, such as treatment, conditioning and disposal, the waste generated should be divided into categories according to its properties and potential hazards (Agamuthu, 2020). To describe the sources of radioactive waste, we can use the scheme of dividing the spheres of their origin (Ali, 2017):

- waste generated at all stages of the nuclear fuel cycle (YAPC);
- waste not related to YAPC (waste from scientific and research centers, medical institutions,

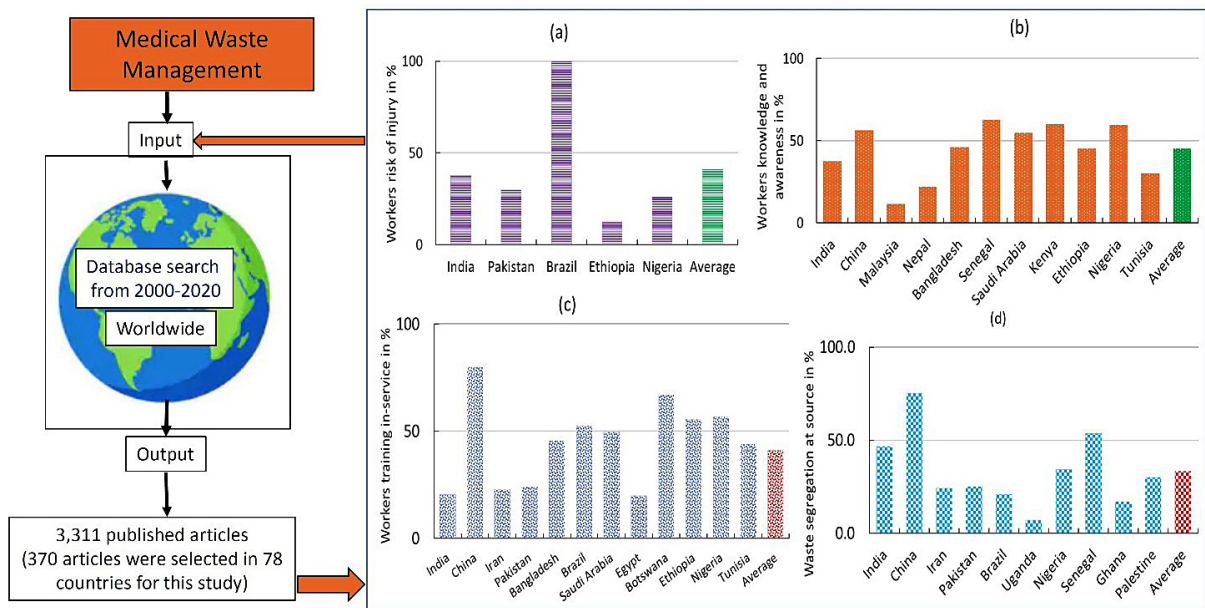


Figure 3. Medical waste management in different countries

industries, waste from economic activities, including domestic ones, etc.);

- waste generated during decommissioning of nuclear installations;
- waste generated during the elimination of radiation incidents and anomalies (Cheval, 2020).

Closed radiation sources, which consist of radionuclides with a longer Half-Life, are used for the therapeutic treatment of patients as both permanent and temporary implants, as well as for teletherapy and sterilization of blood samples, syringes and surgical instruments. Sources whose radioactivity has decayed to levels that make them unacceptable for medical use should also be treated as radioactive waste. Often there is a situation when medical waste ends up in a container for general garbage collection and is buried in landfills. In such cases, it is necessary to provide a special container and protect vehicle operators from exposure by using specialized vehicles.

The Basel Convention on the control of Transboundary Movement of hazardous wastes and their disposal is the most global agreement on the transport of hazardous and other wastes. In addition, this convention regulates the transboundary transport of hazardous and other wastes. The parties to the Basel Convention have made joint commitments to reduce the volume of hazardous waste to a minimum and implement it in such a way that it does not pose a threat to human health and the environment (Eroglu, 2020).

In terms of waste recycling, sorting and recycling, our state occupies one of the last places in Europe. Unfortunately, most household waste is stored in landfills or spontaneous landfills. One of the main reasons for such waste management is the imperfect legal framework, weak regulatory policy of the state and insufficient funding for state waste sorting programs.

Separate collection of solid household waste is the first and main step towards solving the problem of chaotic accumulation in landfills and loss of resource – valuable components. Both state financial incentives for the introduction of appropriate technologies and the development of a strict system of responsibility for improper waste management are necessary. It is necessary to review the specifics of bringing to legal responsibility for environmental offenses.

The results of studies (Fan, 2021) reflect the use of peat for cleaning filtrate from a small landfill of household waste in rural areas. Following

the award of grant assistance under the EU LIFE Program, a full-scale filtrate treatment plant was built using local untransportable peat as a treatment medium. It was found that filtrate from landfills can be successfully treated using peat with 100% removal of both hazardous substances and ammonia.

The work (Khan, 2019) is devoted to the study of biological treatment of landfill filtrates. High-Cod filtrate was pretreated by coagulation flocculation using lime, followed by removal of ammonia in air at PH = 12. Nutrient removal from the pretreated filtrate was performed using a laboratory sequential reactor (SBR). Adding domestic wastewater and powdered activated carbon to the pre-treated filtrate was found to improve nutrient removal during five-step treatment. Thus, the study of the physical and chemical properties of landfill filtrates and the migration of their hazardous components to the hydrosphere and biosphere is an urgent problem in the global context.

As a result of the conducted research (Kulkarni, 2020), the authors identify two stages in the problem of eliminating environmental hazards caused by filtrates of the Moscow city landfill. The first stage is cleaning of accumulated filtrates, in order to implement landfill reclamation. The second stage is the purification of filtrates, which will constantly form in the body of the reclaimed landfill. These stages differ in the volume of filtrate that goes to processing, its physico-chemical properties characteristics and implementation time of each of them. That is why it is inefficient to provide for one technology from a technological and financial point of view to implement these two stages.

CONCLUSION

It is proved that a two-stage integrated technology can be an effective method for cleaning landfill filtrates. The first stage. This is biological purification in aerated lagoons, and the second is reagent coagulation flocculation (RKF) purification using a modified Fenton method. According to the authors, after the introduction of the proposed technology, the treated infiltrates should be fed for final post-treatment to Annino (Moscow district) sewage treatment plants through a pipeline. All the above studies are certainly relevant, however, over time, the physico-chemical properties of filtrates change.

In this regard, constant monitoring of landfills is necessary. Numerous studies of the Annino landfill have established that it does not meet construction and environmental standards and violates the requirements for the operation and management of household waste.

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