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EVALUATION OF THE MEDICAL WASTE MANAGEMENT SYSTEM IN THE KYRGYZ REPUBLIC

Policy Brief

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List of Abbreviations

VC	–	Vertical Camera
WHO	–	World Health Organization
POL	–	Petroleum, oil, lubricants
ALV		Artificial lung ventilation
KR	–	Kyrgyz Republic
MW	–	Medical waste
WIP	–	Waste incineration plant
RLA	–	Regulatory legal acts
HCO	–	Health care organization (s)
UN	–	United Nations
PVC	–	Polymerized Vinyl Chloride
MAC	–	Maximum Allowable Concentration
GR	–	Government Regulation
UNDP	–	United Nations Development Programme
UHF furnace	–	Ultrahigh frequency furnace
PPE	–	Personal Protective Equipment
SL	–	Sanctioned landfills
POP	–	Persistent Organic Pollutant
SDW	–	Solid Domestic Waste
MWM	–	Medical Waste Management
CDPSSES	–	Center for Disease Prevention and State Sanitary and Epidemiological Surveillance
COVID-19	–	Coronavirus infection 2019

Topicality of the problem

The problem of medical waste management (MWM) is a topical issue for all countries of the world, including the Kyrgyz Republic. According to the European Union Commission, the amount of medical waste (MW) generated by hospitals in countries depend on their management practices as well as their level of national income. Thus, the volume of medical waste generated is lower in middle- and low-income countries than in high-income countries [1].

The intensive growth of medical waste in many countries in recent decades, including the Kyrgyz Republic, is directly related to the increase in the share of single-use medical devices and instruments in the structure of processing medical waste [2]. This problem is more urgent for large cities and megalopolises, since large medical institutions are concentrated there, as well as clinical bases of institutes, departmental medical organizations, and networks of private medical clinics. The World Health Organization (WHO) classifies medical waste as hazardous waste generated by epidemiological and chemical activities [3, 4]:

- for patients and personnel involved in collection, storage, and transportation of medical waste, and
- for the population living in the immediate vicinity of the places of their medical organizations, as well as places of their neutralization and/or destruction (landfills, combustion plants/ enterprises) [5, 6].

The epidemiological hazard of medical wastes lies in their increased infestation with microorganisms (bacteria, viruses, and fungi), whose content in uncontaminated medical waste is 1000 times higher than in other production and consumption wastes, in particular – solid domestic waste [7].

The environmental pollution risk associated with chemical substances in medical waste, such as toxic medicines, disinfectants, mercury-containing substances, toxic polymeric materials, etc., is also evident. Medical waste also causes the formation and unintentional release of persistent organic pollutants (dioxins and furans) into the environment, which have a significant negative impact on human health.

The UN Environment Programme adopted the “Technical Guidelines on the Environmentally Sound Management of Biomedical and Health Care Wastes” at a conference where participant countries ratified the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Geneva, 2002). This document outlines the basic principles and approaches to the proper management of medical waste [3]. At the same time, the organization of the medical waste management system is still an acute world problem due to methodological complexities, uncertainties in approaches in assessing the impact of waste on human health and the environment [8]. The vast majority of countries have ratified the Basel Convention in the organization of the medical waste management system, mainly based on its provisions, involving the use of modern non-combustible decontamination technologies for medical waste, which can achieve destruction of about 90% of the total waste and disinfection of the remaining 10%, followed by complete disposal [9].

Beginning in 2006, the Kyrgyz Republic gradually switched to a model of medical waste management based on non-incineration technology – autoclaving. At the same time, there remain many unresolved issues related to the safe and effective management of the full life cycle of all classes of medical waste in the country. This problem was particularly acute in 2020 during the COVID-19 pandemic.

The growth in the volume of hazardous medical waste, especially during the COVID-19 pandemic, requires the development of certain comprehensive solutions for the organization of the system of handling this type of production and consumption waste [10].

Despite the differences in the regulatory framework of different countries, regulating the collection, storage, disinfection (decontamination) and transportation of medical waste, the principles of these processes are standard and are aimed primarily at reducing the hazardous effects of medical waste on hospital staff involved in the medical waste management, as well as on the population as a whole [11].

Thus, at present, the Kyrgyz Republic is in dire need of comprehensive modernization and capacity building of the health care system through the implementation of the best available methods and environmental practices in the medical waste management system that can be used not only in medical institutions, but externally as well.

Analysis methodology

The following approaches were used to describe the national regulatory and policy framework for the existing medical waste management system in health care organizations of the Kyrgyz Republic. They were also used to detail the best practices used, available technologies and activities of the medical waste management system in health care facilities.

1. Familiarization with the reporting documentation

All available documents were studied: reports, orders of the Ministry of Health and Social Development of the Kyrgyz Republic, government regulations, standard operating procedures, reports of UNDP projects related to the medical waste management system. A review of the documents will provide a general understanding on the state of the medical waste management system in the health care organizations of the Kyrgyz Republic.

2. Observation of existing medical waste management practices

The practice of medical waste management was evaluated by observation. In the process of observation, all stages of the medical waste management cycle were taken into account: separation, identification, storage, processing, transportation of medical waste, as well as collection of information on the technical equipment of the medical waste management system. Observation was conducted in 10 health care organizations in Bishkek.

3. Interviews with key persons and staff involved in medical waste management

Specialists from the Ministry of Health and Social Development of the Kyrgyz Republic, involved in decision-making processes and management of safety measures, were interviewed to obtain qualitative information. These interviewees were representatives of the Ministry of Health and Social Development of the Kyrgyz Republic, “Preventive Medicine” Scientific and Production Association, and local health care organizations in Bishkek.

1. Research Results

1.1. Regulatory framework for medical waste management in the Kyrgyz Republic

The Kyrgyz Republic (KR) has signed all important conventions, including the Montreal Protocol, with the exception of the Minamata Convention. Kyrgyzstan ratified the Stockholm Convention on Persistent Organic Pollutants (POPs) on 17 July 2005, and approved the National Implementation Plan for this convention on 3 July 2006. The Rotterdam Convention was signed on 11 August 1999, and the Vienna Convention with the Montreal Protocol was signed on 31 May 2000. In 1996, the Kyrgyz Republic ratified the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the list of which opens with medical waste.

Realizing the importance of environmental safety issues for the health of the population, the Kyrgyz Republic adopted a law called the "On Production and Consumption Waste" (2001). According to Article 8 of this law, unauthorized placement of waste is prohibited if it can be a source of environmental pollution or is subject to burning on the immediate vicinity of enterprises, institutions, organizations and settlements.

The issues of medical waste management are reflected in the Kyrgyz Republic's law "On protection of health of citizens in the Kyrgyz Republic" (2005). According to this law, the scope of authority of local state administrations and local governments in the field of health protection includes ensuring the destruction of biological materials and medical waste. Article 39 states that the use and storage of biological material and medical waste must carried out in accordance with the procedure determined by the authorized body of the Kyrgyz Republic in the field of health care, which is the Ministry of Health and Social Development of the Kyrgyz Republic.

Decree of the Government of the Kyrgyz Republic No. 396 dated 03.07.2013 "On Amendments and Additions to the Decree of the Government of the Kyrgyz Republic on Sanitary and Epidemiological Control to Ensure Sanitary and Epidemiological Welfare of the Population by Sanitary and Epidemiological Service of the Kyrgyz Republic" renewed the registration of potentially toxic chemicals imported into the Kyrgyz Republic.

Management of potentially infectious medical waste in health care organizations is regulated by the order of the Ministry of Health of the Kyrgyz Republic No. 59 dated 18.02.2013, at the level of departmental control and does not regulate the rules for handling other categories of medical waste.

Management of pharmaceutical waste is regulated by the Decree of the Government of the Kyrgyz Republic on the approval of "Regulations on the order of destruction (processing) of products (goods) recognized as unfit for sale" No.407 dated 09.07.1997, and on the approval of technical regulations "On the safety of medicines for medical use" No.137 dated 06.04.2011.

Radioactive waste management is regulated by the Laws of the Kyrgyz Republic: "On Radiation Safety of Population" (1999; 2014), Technical Regulations "On Radiation Safety" (2011); "On Licensing and Permitting Activities in the Kyrgyz Republic" (2013), as well as the "Code of rules to ensure radiation safety during radionuclide diagnostics with radiopharmaceuticals" (Orders of the Ministry of Health of the Kyrgyz Republic No. 227

dated 30.04.2015 and the Center for Standardization and Metrology under the Ministry of Economy of the Kyrgyz Republic No. 15 dated 22.05.2015.

"Program of the Government of the Kyrgyz Republic for the Proper Management of Chemicals in the Kyrgyz Republic for 2015-2017" was adopted in 2015 by Decree No. 91 of the Government of the Kyrgyz Republic in order to ensure minimization of chemicals' harmful effects on the environment and public health.

The Program of the Government of the Kyrgyz Republic, on the protection of public health and development of the health care system for 2019-2030 "Healthy person – prosperous country", planned the following: the development and implementation of modern, effective standards and criteria in ensuring the safety of medical procedures, control of nosocomial infections, and utilization of technologies for the disposal of medical waste in health care organizations.

Government Decree No. 719 dated 30.12.19 "On the issues of medical waste management and handling of mercury-containing products in health care organizations of the Kyrgyz Republic" approved the following: "Procedure for Handling Medical Waste" and "Procedure for Work and Handling of Mercury-containing Products". An important feature of this document is the obligation of all health care organizations to implement it, regardless of ownership. The document also introduces a ban on the use of medical waste incineration technology due to its environmental hazards and harmful effects on the environment and human health, which is in accordance with the Stockholm and Basel Conventions.

Order of the Ministry of Health of the Kyrgyz Republic No. 526 dated 17.07.20 "On approval of the 2nd edition of the temporary standard operating procedures for health care organizations of the republic during the COVID-19 pandemic", Appendix No.8 "Compendium of standard operating procedures for medical waste management" classifies all waste from COVID-19 patients as extremely epidemiologically hazardous waste of class "B". It describes the requirements for equipping inpatient and mobile teams, as well as the separation, identification, packaging, labeling, collection, and transportation of medical waste to the place of treatment (decontamination) and disposal.

A more detailed regulatory framework for medical waste management in the Kyrgyz Republic is presented in Appendix 1.

1.2. Health care organizations generating medical waste in the Kyrgyz Republic

The network of medical organizations providing medical and pharmaceutical services to the population in the Kyrgyz Republic is represented by state, departmental and private health care organizations. It consists of a three-tier system: primary (outpatient), secondary (inpatient) and tertiary (national and republican institutions).

The Ministry of Health currently has 136 state health care organizations, which have 25293 beds. Primary health care is represented by 76 centers of family medicine and their 718 groups of family physicians and 1045 feldsher-midwife stations. 35 state dental clinics also provide outpatient care. The remaining 219 health care organizations provide specialized medical care (including ambulance stations, disease prevention and state sanitary and epidemiological supervision centers, blood centers, etc.).

Departmental health care organizations (73) that provide various types of medical services exist in all ministries and departments.

Medical care is also provided in 40 sanatorium-type organizations, 13 boarding homes, 7 children's and 31 adult sanatoriums, 2149 schools, 111 vocational schools, 80 specialized secondary educational institutions, 47 institutions of higher education.

The private health care sector is represented by both legal entities and individuals. In total, 1249 licensees in the republic have licenses for private medical practice in 37 types of medical specialties. 2655 licenses have also been issued for the sale of medicines (pharmacies):

It should be noted that all health care organizations at the national, regional, city and district levels are involved in the process of medical waste management. At the same time, the medical waste management system is experiencing urgent public health issues in the Kyrgyz Republic due to the increasing volume of medical waste and its difficultly to control safely. In particular, the ineffective handling, methods of treatment, disposal and destruction, and insufficient funding are issues in adequately maintaining its infrastructure and administration.

In addition, the large amount of plastic containing polyvinyl chloride (PVC) in medical waste carries the potential for relatively high generation and unintentional emissions of persistent organic pollutants (POPs) that have a negative impact on human health and the environment.

1.3. Existing medical waste management system in health care organizations of the Kyrgyz Republic (including COVID-19 patient treatment centers)

Currently, in the context of the COVID-19 pandemic, hospitals in the Kyrgyz Republic generate large volumes of medical waste requiring their decontamination and further destruction or disposal. Before proceeding to describe the existing medical waste management system, it is necessary to present a clear explanation of what classes of medical waste are generated in the hospitals of the Kyrgyz Republic.

The provision of medical services in the health care organization of the Kyrgyz Republic generates medical waste is divided into two main streams according to their degree of danger to medical personnel, patients, population and the environment: non-hazardous (general, municipal) and hazardous (specific).

Non-hazardous medical wastes or class “A” wastes are wastes whose risks are comparable to those of conventional municipal waste or household waste (household garbage).

In health care organizations, general non-hazardous waste is collected separately in containers placed on special sites, which are then removed by a health care organization itself or under contract with utilities to the nearest landfill. Some health care organizations have an established practice of open burning of general non-hazardous waste.

Due to the lack of security at the landfills of household waste, there is unrestricted access of unauthorized persons who collect secondary raw materials. It should be noted that all landfills in the Kyrgyz Republic are of the unmanageable type, and most of them are in unsatisfactory condition. Most landfills burn continuously as a result of spontaneous combustion due to the impregnation of waste by landfill gas. The burning of waste produces carbon dioxide and ammonia, as well as, depending on the chemical composition of the waste, other harmful chemicals. The presence of plastic in the waste also contain dioxins and furans,

which have an adverse effect on the environment and public health. Medical waste may contain decontaminated (by autoclaving or chlorination) polyvinyl chloride (PVC) products, which also produce dioxins and furans when burned.

Household waste landfills in settlements of the Kyrgyz Republic will be described in more detail below.

Hazardous (specific) medical wastes have classes “B”, “C”, “D” and “E”. Hazardous wastes include wastes that contain microorganisms, substances and compounds which pose a direct or indirect chemical and/or other hazard to human health and the environment, including as a result of their interaction with other substances.

Currently, health care organizations of the Kyrgyz Republic have adopted a modified classification of medical waste by allocating five classes of medical waste (Table 1), taking into account the recommendations of the Basel Convention on the Control of Transboundary Movement of Wastes and their Disposal

Table 1. – Medical waste classification adopted in the Kyrgyz Republic

Hazard class	Characteristics of morphological composition
Class A (epidemiologically safe waste with a composition similar to solid domestic waste)	Waste not in contact with biological fluids of infectious patients. Stationery, packaging, furniture, equipment that have lost their consumer properties. Food waste from the central food service units, as well as all units of the organization engaged in medical and/or pharmaceutical activities, except for infectious diseases, including tuberculosis. Empty ampoules for medicines.
Class B (epidemiologically hazardous waste)	B1 Human anatomical waste (tissues, organs, body parts, blood) and biological waste from vivariums. B2 Sharp-edged and cutting waste (needles, syringes, scalpels, scarifiers, microscopy glasses, etc.). B3 Potentially infected: waste containing blood and bodily fluids (materials contaminated with blood or other bodily fluids, vaccine ampoules). B4 Infected: all waste from infectious disease departments (including food waste), waste from parasitological and microbiological laboratories working with microorganisms of pathogenicity groups 1-2.
Class C (epidemiologically extremely hazardous waste)	Extremely hazardous infectious waste – infected waste of health care organizations, contaminated with pathogens of particularly dangerous infections or particularly resistant microorganisms. This class includes: • Materials in contact with patients with especially dangerous infections: dressing materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from infected patients with especially dangerous infections, **including COVID-19**. • Waste from laboratories working with microorganisms of 3-4 groups of pathogenicity. • Waste from phthisiatric, mycological hospitals, departments. • Waste from patients with anaerobic infections.
Class D (toxicologically hazardous waste 1-4 hazard classes)	Waste of health care organizations, whose composition is close to industrial waste, the handling of which is determined by the degree of toxicity, in accordance with the classifier of toxic industrial waste and other applicable regulations. D1 Pharmaceutical waste (expired drugs, waste drugs and diagnostic drugs). D2 Cytotoxic pharmaceutical waste. D3 Disinfectants not to be used, with expired shelf life. D4 Mercury-containing items, devices and equipment. D5 Other hazardous wastes typical not only for the healthcare sector, such as solvents, chemicals, batteries, fixatives, and other solutions used in analytical, clinical laboratories, etc.

Class E (radioactive waste)	All types of waste, in any aggregate state, in which the radionuclide content exceeds permissible levels established by radiation safety standards.

Herewith, two varieties of medical waste management system have been introduced in the practice of health care organizations in the Kyrgyz Republic:

1. "Cluster, centralized system" is used in health care organizations that do not, for various reasons, have their own medical waste decontamination facility. The most closely located hospitals are grouped into clusters; in each cluster, a centralized medical waste autoclaving facility is organized based on one large hospital, at which medical waste is transported from nearby (satellite) hospitals. In order to decontaminate medical waste exported from satellite health care organizations to a centralized point, it is necessary to establish a contract between the health care organizations. This principle of organizing the medical waste management system is used by private companies engaged in the decontamination and disposal of medical waste.
2. "Decentralized system" is used in health care organizations that have their own decontamination (autoclaving) facility for medical waste.

When health care organizations organize a centralized medical waste management system, it becomes necessary to store waste at the health care facility until it is centrally decontaminated or destroyed. In this regard, temporary storage facilities for hazardous medical waste are organized in health care organizations.

Herewith, these health care organizations comply with the basic requirements to ensure the safety of the temporary storage of non-decontaminated hazardous medical waste:

- Medical waste storage area is a separate item, or a room commensurate with the amount of medical waste produced and the frequency of its collection.
- Hazardous medical waste storage areas are organized away from clean areas (clinical departments) as well as the kitchen, and have appropriate warning signs (Figure 1.).
- Waste is stored in areas restricted from employees, patients and visitors at the medical facility.
- All tanks/containers are equipped with lids to prevent insects, rodents and other animals from accessing the waste.

No trespassing

Biohazard label for infected waste

Fig. 1. Signs placed outside and inside temporary storage facilities for infected waste

1.3.1. Organization of the medical waste management cycle in clinical departments of health care organizations

To protect medical personnel, patients, and the environment, clinical departments have organized a safe medical waste management system that includes: separation, identification, packaging, labeling, collection, and transportation of waste to a treatment/decontamination site ("Waste Neutralization Site").

Each workplace that generates medical waste is equipped with the necessary equipment for the appropriate types of waste: containers for collecting and transporting hazardous medical waste, needle punchers and special containers for collecting sharp instruments, a general waste garbage can with a plastic black bag inside.

Instructions/posters for identifying and separating medical waste into streams are posted at each workplace where medical waste is generated. Also, each workplace in health care organizations is equipped with the necessary equipment for the separate collection of appropriate classes of medical waste:

- containers (buckets) or polypropylene bags enclosed in containers (buckets) for collection of class "B" and "C" medical waste;
- needle punchers with puncture-proof containers for the collection of sharp-spitting waste (used needles of injection equipment, scarifiers, cutting part of scalpels, unused needles of injection equipment may not be cut from the cannula and with protective caps on, etc.);
- containers for the collection of class "A" medical waste with black plastic bags enclosed in them.

Diagrams of the order of separation and sorting of the corresponding classes of medical waste are posted at each place where medical waste is generated (Figure 1.2.).

Figure 2. Example of a workplace in health care organizations equipped with a medical waste management system

1.3.2. Main flows of medical waste in the structural subdivisions of a health care organization

Medical wastes generated in health care organizations are divided into separate streams according to their hazard classes and are placed in special containers for their collection and transportation. The number of streams generated by medical waste depends on the profile of the health care organization. The main flows of medical waste generated in health care organizations of the Kyrgyz Republic are as follows:

– **Epidemiologically safe waste with a composition similar to solid household waste** (class A): paper, stationery, packaging material, etc. not contaminated with biological substrates.

- **Anatomical waste** (class B1).
- **Sharp-stabbing waste** (class B2) – needles from injection equipment, scalpels, etc.
- **Potentially infectious waste** (class B3) containing blood and/or other human body fluids (dressings, gloves, balloons, tampons, intravenous dispensers, etc., except patient personal hygiene items).
- **Plastic part of syringes** (class B3).
- **Infected waste** (class B4) all waste from infectious disease departments (including food waste), waste from parasitological and microbiological laboratories working with microorganisms of 3-4 pathogenicity groups.
- **Toxicologically hazardous waste of 1 - 4 hazard classes** (class D). This class includes toxicologically hazardous waste that are similar to industrial waste. They include:
- expired drugs and antiseptics;
- cytostatics and chemicals;
- mercury-containing items, devices and equipment;
- waste from pharmaceutical production;

Currently, in the Kyrgyz Republic, this class of medical waste is not recycled or neutralized, which is a violation of the law on production and consumption waste. Thus, the collection, temporary storage and transportation to the place of destruction or final disposal of pharmaceutical waste (D1) and Cytotoxic pharmaceutical waste (D2) is performed by pharmaceutical companies and health care organizations (owner, supplier). Destruction of pharmaceutical waste is carried out by commission in accordance with the Government Decree "On the procedure for destruction (processing) of products (goods) recognized as unsuitable for sale". The main method of disposal of pharmaceutical waste is crushing and burying (backfilling) in a landfill.

Drugs are incinerated along with the packaging, which can be paper, cardboard, glass, polyethylene, plastic, PEHD, rubber, etc. Boiler houses (at baths, saunas, thermal power plants) in which pharmaceutical waste is incinerated are usually located in residential areas.

Pharmaceutical waste generated by retailers and by patients' home use of medications is dumped without organization in general municipal waste.

Disinfectants not to be used (class C3) include used disinfectant solutions and disinfectants with expired shelf life. Waste disinfectant solutions and disinfectants with expired shelf lives are discharged into the sewage system or into drainage pits.

Chemical hazardous waste used in laboratories (class C5). Liquid chemical waste generated after laboratory tests (solvents, chemicals, fixatives, and other solutions) is mostly discharged into the sewer system or drain pits. In some health care organizations, such as the Center for Disease Prevention and State Sanitary and Epidemiological Surveillance, generated chemical wastes of organic origin (ether, chloroform, benzene, toluene) are collected in containers and stored in the premises of organization.

Due to the lack of mechanisms for recycling, destruction, and final disposal at the national level, these chemical wastes accumulate in health care organizations for many years.

Radioactive waste (class D – all types of waste containing radioactive components). In the health care sector, medical radioactive waste is generated in the nuclear medicine and radiotherapy departments of the National Center of Oncology (NCO) of the Ministry of Health of the Kyrgyz Republic. Currently, there are many problems with the destruction of this category of medical waste.

1.3.3. Used types of containers for medical waste collection at different organizational systems of medical waste management in health care organizations

Enameled buckets for collection and transportation of medical waste are used in health care organizations that have their own decontamination (autoclaving) facility for medical waste and only within the territory of health care organizations.

In health care organizations where enameled buckets are used, lids with the name of the department are inscribed on the bucket itself (Figure 3). Moreover:

- Enameled buckets for the collection of class "B" and "C" medical waste are marked with the inscription: "Hazardous Sharp Waste", "Biological Hazard" international sign in black on a yellow background.
- Enameled buckets for the collection of the plastic part of the syringes are marked with the inscription: "Hazardous Sharp Waste", "Biological Hazard" international sign in black on a yellow background, and an additional image of a "syringe" on the lid of the bucket.

Figure 3. Organization of manipulation sites and equipment for separate collection of class "B" and "C" medical waste

Polypropylene bags for collection and transportation of medical waste are used only in health care organizations that do not have their own decontamination (autoclaving) facility for medical waste and transport their medical waste under contract to decontamination (autoclaving) facilities of other organizations or to private companies for decontamination and destruction of medical waste. Polypropylene bags are placed in containers (buckets with a pedal-open lid or enamel buckets).

Polypropylene bags are yellow and have the following inscriptions: "Hazardous Sharp Waste" and "Biohazard" international sign in black on a yellow background. However, due to the high cost of such polypropylene bags, health care organizations uses transparent polypropylene bags without markings.

- Buckets, in which the polypropylene bag for the collection of class "B" and "C" medical waste are marked with the inscription: "Hazardous Infected Waste", "Biohazard" international mark in black on a yellow background.
- Buckets, in which a polypropylene bag is inserted to collect the plastic part of the syringes are marked with the inscription: "Hazardous Infected Waste", "Biohazard" international sign in black on a yellow background, and an image of a "syringe" on the lid of the bucket

Needle cutter containers for the collection of sharp-spiked medical waste are puncture-resistant, waterproof, have tightly closing lids and safe during transport.

The sorting and collection of medical waste in the structural subdivisions of a health care organization are carried out at the location of its formation by the personnel who produce this waste.

Immediately after using the injection equipment (syringe with a needle, intravenous system with a standard needle), the needle is separated from the plastic part with a needle cutter/needle-destructor and falls into a container that is attached to it. The plastic part of the syringe is dumped into a container with a syringe sign (enameled bucket or polypropylene bag inserted into the container) for subsequent recycling (disposal) after decontamination (autoclaving).

All other medical waste is collected in "C3" class medical waste containers. In this case, medical wastes of different classes are not mixed, and containers of class "B" and "C" medical waste are in the departments of the health care organization for no more than 24 hours and do not fill more than 3/4 of their volume.

1.3.4. Transportation of medical waste to the location of decontamination of health care organization

Medical waste is transported in the same containers from which it was collected and with their lids tightly closed. When transported in polypropylene bags, medical wastes are placed in containers with tightly closing lids and latches. When transporting class "B" and "C" medical waste within a health care organization, medical personnel use specialized carts or carry one transport container in one hand if transporting by hand.

Personnel use personal protective equipment: protective gloves, puncture-resistant shoes, masks or respirators (if necessary), protective clothing or aprons. Transportation of class "B" and "C" medical waste outside the premises of a health care organization is carried out by specialized sanitary vehicles with appropriate equipment and body markings (for health care organizations that do not have their own medical waste decontamination point).

1.3.5. Safe destruction of biological substances

Liquid waste of classes "B" and "C" is disinfected by chemical methods (chemical disinfection). After decontamination, it is discharged into the centralized sewage system. Chemical disinfection is carried out in accordance with the existing regulatory documents of the Ministry of Health of the Kyrgyz Republic.

Anatomical medical waste of class "B" after treatment by chemical methods (chemical disinfection) is handed over to the Bureau of Anatomicopathological Examination. From there on, it must be buried in a specially designated area of the cemetery in accordance with the requirements of the legislation of the Kyrgyz Republic, without prior disinfection. Herewith, the medical waste management cycle in this bureau is not safe due to the lack of the necessary infrastructure.

1.3.6. Methods for decontamination (disinfection) of hazardous medical waste

Currently, there is no single technology for neutralizing hazardous medical waste in the Kyrgyz Republic that is ideal for all situations. In this regard, health care organizations, when selecting technologies for disinfecting various types of medical waste with various types of hazards, are based on the following principles:

- safety for the public and personnel;
- safety for the environment;
- reliability of processing and destruction;
- availability;
- effectiveness;
- prevention of reuse of medical waste.

At the level of health care organizations, only class “B” and “C” medical waste is decontaminated. Herewith, medical waste of these classes is decontaminated by two methods before being destroyed or sent to the place of final disposal (landfills) or for recycling (disposal):

1. Physical method of disinfection:
   - Autoclaving – if the health care organization implemented a system for decontamination of class “B” and “C” medical waste using an autoclave.
   - Microwave treatment – if a health care organization implemented a system for decontamination of class “B” and “C” medical waste using a microwave oven.
   - Pyrolysis destruction – if the health care organization does not have a medical waste decontamination facility and decontamination equipment (autoclave and/or microwave oven), and the health care organization has a contract with a medical waste recycling company.
2. Chemical disinfection – if a health care organization does not have a disinfection point for medical waste and equipment for disinfection (autoclave and/or microwave), or it has a point, but the equipment for disinfection is broken or temporarily not working due to various reasons (lack of electricity, calibration, etc.).

The most commonly used method of disinfecting class “B” and “C” medical waste in health care organizations that have a disinfection point is the autoclaving method. In 2021, microwave treatment was introduced in some health care organizations, in parallel with autoclaving.

Autoclaving is a safe and effective method of high-temperature steam decontamination of infected class “B” and “C” medical waste. However, this method does not reduce the volume of medical waste generated and does not solve the problem of their final disposal and reducing the volume of waste taken to municipal landfills.

Autoclaving of medical waste is carried out in an autoclave chamber, at high pressure (no lower than 2.2 atmospheres) and temperature (no lower than 132°C) in an atmosphere 100% filled with saturated water vapor. For this type of physical disinfection of medical waste, mainly small-volume gravity autoclaves of BK-75 brand are used in health care organizations, and as mentioned above, microwave disinfection was introduced in some healthcare organizations (Figure 4.).

Figure 4. Autoclave ВК-75 and microwave oven at medical waste decontamination points in health care organizations of the Kyrgyz Republic

After decontamination (autoclaving or microwave treatment), class “B” and “C” medical waste do not pose an epidemiological hazard, as they are equated with class “A” waste, and are removed from the premises of the health care organization as waste in composition are approximated to solid domestic waste by municipal services.

To reduce the volume of medical waste generated after decontamination, they must be given an unrecognizable appearance by shredding and pressing them. Currently, no health care organizations in the Kyrgyz Republic have a procedure for shredding medical waste, except for health care organizations that have installed microwave ovens, which press decontaminated medical waste, reducing its volume but not its weight.

Thus, the existing system of medical waste management in health care organizations of the Kyrgyz Republic fully complies with international requirements for the safe management of medical waste. However, there are many unresolved problems with managing pharmaceutical, anatomical, and radioactive medical waste.

1.4. Effectiveness of the medical waste management system in health care organizations involved in the fight against COVID-19 and the sanitary condition of solid waste dumps in settlements

In the context of the COVID-19-induced emergency state in the Kyrgyz Republic, UNDP, with national partners, carried out numerous activities aimed at strengthening the system of medical waste management in health care organizations, by improving its epidemiological and environmental safety.

The main purpose of these activities was to assess the effectiveness of the medical waste management system and sanitary condition of organized dumps in the settlements in

which health care organizations are involved in combating the COVID-19 pandemic in the Kyrgyz Republic.

UNDP also carried out work aimed at determining the volume of medical waste generated during the COVID-19 pandemic from health care organizations located in Bishkek.

The volume of class B and C medical waste generated during the COVID-19 pandemic was estimated using data from ten health care organizations whose patients with COVID-19 were treated for the period from 2020 - 2021. To assess the dynamics of change in the volumes of generated infected medical waste in these health care organizations, we used data on the volumes of generated medical waste in the same hospitals that was obtained in 2014 by the UNDP project "Protection of human health and the environment from unintentional releases of POPs and mercury from improper disposal of medical waste in Kyrgyzstan".

The assessment found that healthcare organizations that treated COVID-19 patients generated between 0.03 kg and 0.787 kg of infected medical waste per bed per 24 hours, which averaged **0.303 kg**, while in 2014, the hospitals in this study generated an average of **0.093 kg** of infected medical waste per bed per day.

Thus, it was shown that during the COVID-19 pandemic, the volume of generated infected medical waste increased by 3.3 times per bed per day (Figure 5).

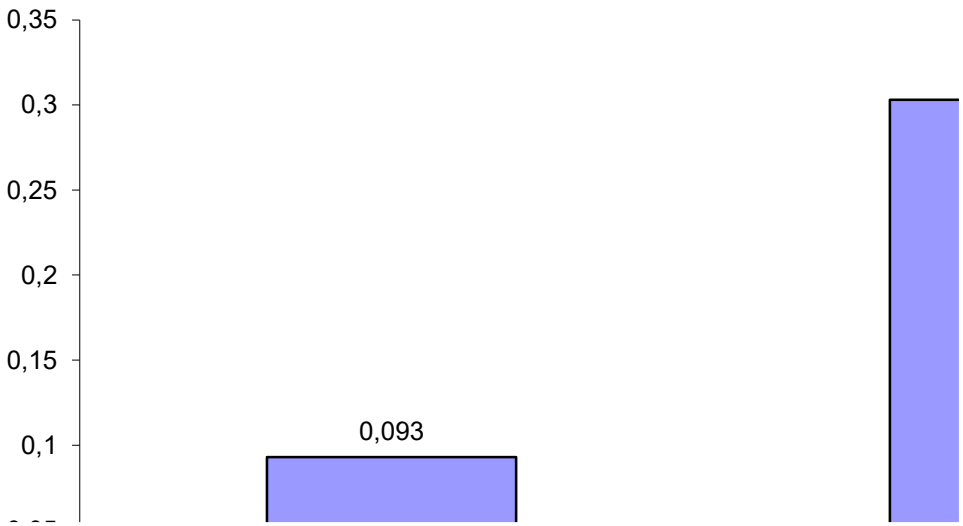

Figure 5. Average volume of infected medical waste generated per bed per day in Covidariums and regular hospitals

In the COVID-19 pandemic, medical wastes generated in Covidariums are eventually taken to solid waste landfills, having undergone prior decontamination by chemical disinfection or autoclaving. These plastic medical devices and medical waste treated with chlorinated disinfectants are burned in addition to the constant burning (self-igniting gases) of many household waste landfills, causing increased emissions of persistent organic pollutants (POPs) dioxins and furans. In this regard, their morphological composition was studied in order to understand the extent to which medical waste from Covidariums contributes to increased POPs emissions.

As a result, it was found that all medical waste exported from covidariums to dumps contained large quantities of disposable medical devices made of soft plastic and often treated with the following chlorine-containing disinfectants:

- Protective coveralls (40-50% of all medical waste).
- Respirators and medical masks.
- Gloves, caps and disposable medical gowns.
- Injection equipment (syringes, catheters, IV systems).
- Masks for artificial respirators, intubation tubes.
- Urinary catheters, nasal cannulas from oxygen concentrators, etc.
- Packaging from PPE and medicines.

Assessment of the state of medical waste management system in 42 health care organizations of the Kyrgyz Republic was carried out using the assessment tool "Monitoring and Assessment of Medical Waste Management System". This tool included 80 assessment criteria which grouped into 11 functional sections that affect the entire cycle of the medical waste management system.

In the course of assessment, certain achievements in the development of the medical waste management system were identified. The medical waste management system functioned in all 42 health care organizations and there existed medical waste decontamination points. Thus, the system in health care organizations functioned more effectively in comparison to the Center for Disease Prevention and State Sanitary and Epidemiological Surveillance, which are supervisory bodies exercising sanitary and hygienic control of health care organizations.

However, along with the achievements noted, problems have also been identified. One of the gross violations revealed was the incineration of medical waste, both medical and CDPSSES, on the grounds of health care organizations. It was found that the overall percentage of fulfilling the criteria of effective functioning of the medical waste management system for all 42 health care organizations was 79.1%. This percentage is relatively low because it did not reach the minimum desired level of 85%, and ideally, all measures of medical waste management should be performed at 100%. The rate was 84.2% for health care organizations providing inpatient care and 58.2% (Figure 6) – 1.4 times lower – for Centers for Disease Prevention and State Sanitary and Epidemiological Surveillance.

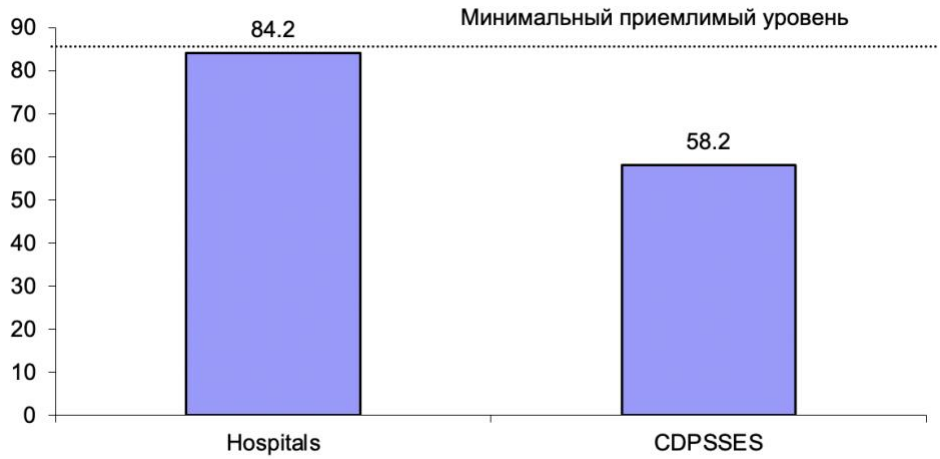

Figure 6. General performance indicators of the functioning of the medical waste management system for hospitals and CDPSSES in the Kyrgyz Republic

A parallel assessment of the sanitary and hygienic state of sanctioned landfills showed that all 24 settlements had landfills sanctioned by local authorities located outside settlements but could hardly be called landfills of solid domestic waste (SDW) due to their organization (compliance with existing regulations – RLA). This is primarily due to the organization of the process of storage, decontamination and destruction of SDW. In this framework, a garbage dump is an area for dumping human waste. Herewith, a sanctioned landfill is an unsettled, legalized territory by local authorities, for placing SDW, and operated in violation of the current regulatory legal acts.

At the same time, a SDW landfill is a permitted environmental structure that performs three important functions:

- collection of wastes;
- their storage;
- prevention of environmental pollution.

The solid domestic waste landfill must additionally be equipped with engineering structures, special machines, equipment and have a separate enclosed area.

Thus, all of the solid waste disposal facilities included in the study refer to sanctioned landfills (SL) rather than solid domestic waste landfills. A sample photo report of the monitoring of sanctioned landfills is presented in Appendix 2.

All 24 sanctioned landfills were located outside of populated areas, at a distance ranging from a several hundred meters to 30 km. Only 20 (83.3%) of the 24 sanctioned landfills had a sanitary protection zone of 500 meters or more from populated areas.

A visual assessment of the sanctioned landfills revealed that all of the sanctioned landfills:

- Have no weight control (no weighing of SDW).
- Have no control and disinfection zone, and the wheels of garbage trucks were not disinfected.
- Have no regular monitoring of water bodies, as there were no wells or boreholes to monitor groundwater.
- Do not monitor air, soil, plant, etc. pollution.
- Do not organize the sorting of SDW.

All of the SL lacked the following important structural units, such as engineering structures, which are communications that support the life of the facility and are located throughout the territory:

- channel for draining water (precipitation), arranged along the perimeter;
- rampart of soil that serves as a protection of the drainage channel from debris;
- internal control pond, rainfall catchment;
- pond or containers of water in case of fire;
- observation wells to control the appearance of water in the ground;
- communications supporting the operation of the facility (water supply, power line, sewerage);
- fences, barriers, signs;
- asphalted access and additional roads.

There was also no asphalt utility area, which should include the following facilities:

- administration building;
- guard desk;

- radiation, biological, chemical control station;
- weighing station;
- garage of special equipment;
- warehouses of fuels and lubricants, building materials, overalls;
- auxiliary workshops;
- ancillary facilities.

Visual inspection revealed that only 7 (29.2%) of the 24 SL had a perimeter fence, and in many of which this was the case, the fence was dilapidated and did not protect against access by unauthorized persons and animals. At 22 (91.7%) of the SL, people, at the time of the assessment, were engaged in unorganized sorting of plastic and metal, and pets were eating food waste. Identifiable medical waste was found in 62.5% of the SL that had not been given an unrecognizable appearance when removed from the health care organization. Herewith, many medical waste was incinerated by a health care organization in an SL at the recommendation of local government.

On the territory of 16 (66.7%) SL, fires of SDW were found and were not extinguished. The SDW removed from the SL site is buried by unloading it with subsequent bulldozer tamping, while only in 4 (16.7%) SL, SDW was previously sprinkled with soil, and in 5 (20.8%) SL, specialized compaction equipment was available on site.

The access roads to all of the SL were not asphalted, which creates dusty conditions in the summertime.

1.5. Other countries' experience in organizing medical waste management systems in hospitals

In developed European countries (Germany, Austria, France, Italy), Eastern European countries (Czech Republic, Slovenia), Israel, Northern countries (USA), and some countries of South-East Asia (Thailand, Japan) the principles of organization of medical waste management system have their specificities like in the Kyrgyz Republic.

After analyzing the general principle of organization of the medical waste management system, it can be noted that almost all of the above countries have a combined system with a predominance of a decentralized or centralized component.

The medical waste management system in Germany is a well-developed and well-organized process of a predominantly centralized type [12]. Separate collection of uncontaminated medical waste at the places of formation is carried out in labeled bags of different colors, which are then placed in dense bags of larger size in order to move them to a single collection point for further removal from the location of the medical organization. Then they are put into special containers (rectangular boxes), which, according to the contract between the medical organization and the decontamination company, are taken out not more often than once every 2-3 days. Medical waste is transported by specialized vehicles to centralized sites equipped with high-performance specialized sterilizers for the decontamination of medical waste with powerful industrial shredders or to incineration plants, the number of which in recent years in Germany has declined sharply. Decentralized decontamination areas for medical waste are created only in medical institutions specializing in infectious diseases or working with blood donors [13, 14].

In Italy, however, the number of decentralized decontamination areas for medical waste is constantly increasing; areas are being set up in both public and commercial medical

institutions. The active development of the decentralized component is facilitated not only by the availability of locally produced units (Newster, Converter, Cisa, Stilko, etc.), but also by the high cost of transporting uncontaminated medical waste. Due to the almost complete absence of specialized enterprises for medical waste incineration, the latter is delivered to a general-type incinerators. Using special lifting devices, they are loaded in a separate flow to the incineration chamber in a strictly defined proportion – no more than 5% of the volume of solid municipal waste [15].

Israel's medical waste management system is close to that of Italy: many decentralized sites with locally produced units (Tuttnauer) are located on the grounds of hospitals, equipped with powerful presses, which after decontamination, reduce the volume of medical waste and allow the waste to be taken to landfills as part of household waste. Institutions that do not have decentralized sites transport their waste-to-waste incineration plants in reusable containers or to a nearby centralized medical waste decontamination site as part of the contracts stipulates.

In France, it is considered appropriate to equip only large medical centers with units. The collection and transportation of medical waste from other facilities is carried out in reusable containers by specialized transport to centralized sites (usually one for several settlements) or to specialized plants for medical waste incineration. According to the current requirements, group I and II wastes (infected and potentially infected) are to be incinerated at specially equipped facilities; group III wastes (generated during cleaning of wards, canteens, administrative offices, and hospital territory) are to be collected separately and neutralized at general waste treatment facilities (no more than 5% of medical waste in the total volume of incinerated waste) [16, 17]. The cost of incineration at non-specialized plants is significantly lower (by 25-30%) than at specialized plants. Medical institutions that are located within a radius of up to 100 km receive a quota for cheaper incineration of some medical waste. Ash residue is widely used in the secondary market, for example, for construction, including road pavements, and some production technologies. There are companies that convert the high heat capacity of medical waste into electricity for the needs of the local power grid. The latter significantly reduces the cost of medical waste incineration services. However, due to the high cost of building and operating such facilities, as well as the negative attitude towards them from the Basel Convention, their number remains overall insignificant in France.

Austria has a single centralized medical waste management system. In all places of primary formation of medical waste, non-disinfected wastes are collected in soft containers (bags). They are then packaged in a specially designated room as they enter disposable containers of various sizes (from 3 to 60 liters), which are provided by the transport company, that cannot be opened after closure. Afterwards, according to schedule, medical wastes are transported by specialized transport to places of neutralization – specialized waste processing enterprises designed for this purpose, or to general waste processing enterprises with additionally organized separate loading streams for medical waste. On-site collection is partially separate: PVC-containing, latex, as well as paper, glass, and bandaging material are sorted into different bags. However, this practice is present only in large medical institutions and is not mandatory. It serves rather the function of optimizing the loading of disposable containers for transportation, which constitute a significant part of the cost of transportation and decontamination services.

In Eastern European countries (Czech Republic, Slovakia), the system of medical waste management tends to be of a centralized type. Centralized sites, located more often in landfills, are mostly equipped with locally produced incinerators. However, decentralized sites operate in large cities with medical campuses or clinical research centers on their territory. In order to reduce transportation costs, these countries have created a network of

waste transfer stations where batches of medical waste are consolidated and then transported to the final neutralization sites [12].

The American system of medical waste management is fundamentally different from the aforementioned cases. Until the early 1990s, most of the waste generated in the United States was neutralized by incinerators. However, a program was developed to abandon combustion technology. According to the Environmental Protection Agency, the number of incinerators in the United States decreased 50-fold over the past 15 years, and this trend has continued [18]. The U.S. Environmental Protection Agency has developed the Federal Medical Waste Management Act, which applies to all states [17]. The new doctrine, first, is based on the principle “it is better to decontaminate locally than to move epidemiologically hazardous medical waste”. Therefore, blood transfusion stations, dental departments, etc. units for hardware decontamination of small size and low capacity are placed internally in laboratories, operating rooms, manipulation rooms, hemodialysis, and plasmapheresis departments. The decontaminated waste is further included in the household waste chain.

Second, the doctrine implies zeroing the epidemiological risks associated with transportation. In the wards, domestic and medical wastes are collected together in one pedal container. At sites not equipped with automated facilities, medical waste is collected in bags, which are then vacuumed, sealed, labeled in a production facility, and stored awaiting removal. Prolonged storage, more than three days, is carried out in conditions of low temperatures. U.S. health legislation does not limit storage below -18°C in time. However, the current practice establishes a deadline of no more than 7-10 days.

At the same time, WHO recommends temporary storage of infected waste prior to decontamination: in a cool place or in a refrigerator at 3°C to 8°C for no more than one week; storage of uncontaminated waste outside refrigeration is permitted, but storage time should not exceed 72 hours in winter and 48 hours in summer in temperate climates; 48 hours in winter and 24 hours in summer in warm climates [2].

Third, the doctrine ensures compliance with the most stringent requirements of environmental legislation regarding emissions of hazardous compounds into the atmosphere. Reduced in volume, hermetically sealed medical waste is transported by specialized transport to the waste processing plant, operating on plasma combustion technology (unlike most European recyclers using pyrolysis technology), which ensures environmental safety due to ultra-high temperatures, excluding the formation of volatile organofluorine and organochlorine compounds during combustion [19, 20].

Japan's medical waste management system is probably the most cost-effective. It completely revolves around the idea of promoting recycling decontaminated waste. Medical waste is collected separately at primary medical waste sites. Textiles, dressings, personal care products and other nonwoven medical supplies are intended for centralized decontamination and industrial recycling. Plastic, composite materials, latex, and rubber are collected separately and sent for subsequent high-temperature incineration or to centralized decontamination areas. Afterwards, they are subjected to degradation and go to recycling for the production of industrial raw materials (pellets). Uncontaminated medical waste is transported by special vehicles to centralized collection points and then to the incineration plant. The ash residue is used to make special concrete blocks that serve the purpose of strengthening the shoreline.

Discussion of the analysis and conclusions

The examination of the experience of several countries provides a unique opportunity to further improve the medical waste management system in the Kyrgyz Republic, which at this stage, is focused only on class “B” and “C” medical waste and minimally addresses other classes of medical waste. Therefore, it becomes clear that there are a number of serious unresolved problems in the management of medical waste, including the management of mercury-containing, pharmaceutical and other chemical medical waste, which require urgent solutions:

- Incomplete regulatory framework in the field of medical waste management. For example, there are no regulatory documents on the handling of chemical and pharmaceutical wastes, as well as on their accounting, registration, monitoring and inspection; on technologies for their processing; lack of approved standards for the formation of medical waste; lack of approved values of maximum allowable concentrations (MAC) of chemical substances in the environment.
- No reliable data on the quantity and classes of all medical waste generated, due to the lack of a national system for recording, registering, reporting, and monitoring medical waste generated (except for radioactive waste).
- No accurate data on the number of medical products and devices containing polyvinyl chloride and mercury imported into the country and used in health care organizations.
- The analytical laboratories available in the republic do not have instruments and equipment for assessing dioxin/furan and mercury emission levels.
- Gaps in ensuring the full cycle of handling pharmaceutical, anatomical and radioactive medical waste (sorting, identification, labeling, treatment, transportation, storage and final placement/destruction and disposal) both within and outside of healthcare organizations.
- The system for handling infected medical waste in remote primary care health care organizations (groups of family physicians and feldsher-midwife stations) has not been perfected.
- Syringes in immunization programs are either collected in specialized safe disposal boxes and incinerated at the health care facility, are collected in specialized safe disposal boxes and incinerated at the health care facility or turned in to incinerator baths for incineration.
- Adequate funding requirements for health care organizations to provide measures for the management of medical waste have not been identified. Most public health organizations in the country do not have the necessary resources, technology, and practices to meet their obligations to prevent the unintentional formation and release of persistent organic pollutants such as dioxins/furans and mercury.
- The problems of managing, destroying, storing, cleaning, and phasing out mercury-containing medical devices and products have not been solved.
- Lack of public awareness of the dangers of medical waste and the existing risks to public health and environmental pollution.
- The market for services for the production of consumables (containers, bags, boxes, etc.), equipment and transport for the collection and transportation of medical waste is not developed.
- The existing landfills do not meet sanitary and environmental standards and regulations.
- Insufficient attention is paid to the management of medical waste on the part of local authorities, no financial support is provided to health care organizations, the operations of

municipal landfills are not improved, and the timely removal of household waste is not ensured.

- There are no incinerators or recycling plants in the country, so some medical waste ends up in uncontrolled landfills, where there are spots of burning waste.
- There is a lack of infrastructure and technology for environmentally safe extraction of mercury from waste containing it, demercurization, handling, disposal and recycling of mercury.
- Having a significant number of stakeholders whose roles have included the proper management of medical waste does not ensure full responsibility for all aspects of chemicals management throughout their lifecycle.
- Insufficient knowledge of personnel and/or lack of practical skills for the safe handling of medical waste. Difficulties in training staff due to lack of material and technical resources.

Practical recommendations

To improve the efficiency of the medical waste management system in the Kyrgyz Republic and to minimize and prevent their negative impact on human health and the environment, it is necessary to, foremost, create a favorable legislative environment. Based on the existing analysis of regulatory legal acts, it is necessary to harmonize policies and strengthen institutional capacities in the field of health, environmental protection, and tools by creating a network of intersectoral interaction to implement and promote environmentally sound management of medical waste, with the possible involvement of the business sector. It is necessary to coordinate between the partners a list of bylaws to be developed and implemented and to draw up an action plan with control at the government level. It is recommended to develop regulatory documentation to implement a complete closed-loop, environmentally sound medical waste management system in the country.

At the same time, based on the experience of other countries, it is necessary to develop and implement modern, science-based best practices of medical waste management at all stages: separation, collection, transportation, temporary storage, decontamination, final disposal and/or recycling in hospitals in the Kyrgyz Republic. It is recommended to develop and implement best practices standards for handling with:

- anatomical/biological waste;
- pharmaceutical waste;
- chemical waste;
- vaccination waste;
- radioactive waste

Furthermore, it is necessary in the Kyrgyz Republic to introduce the best environmental practices at the stage of final disposal of all classes of medical waste in order to form a closed cycle of treatment and reduce the negative environmental impact of disposal in landfills. Therefore, it is necessary to pay close attention to the problem of organization as well as the sanitary and environmental condition of existing landfills in settlements, where medical waste from hospitals is removed. In the course of the UNDP assessment, many violations of sanitary and environmental legislation of the Kyrgyz Republic were revealed. Identified violations, without the appropriate improvements, can currently lead to environmental pollution and directly and indirectly influence the non-infectious morbidity of people.

From the People of Japan

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