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OVERVIEW OF PRINCIPLES AND METHODS OF MEDICAL WASTE MANAGEMENT AND THEIR APPLICATION FOR DATABASE DESIGN

Abstract. The article deals with the problem of medical waste management and the need to create a scientific and methodological base for the development of a data collection mechanism related to their formation, collection, transportation and disposal. The introduction of digital technologies and the integration of data on all stages of medical waste management will create an effective management system. The main focus is on system, process and risk-based approaches, as well as data collection methods at various stages. The article focuses on the problems and prospects of implementing digital solutions and automating medical waste management processes. The article examines the database structure, key parameters and relationships, as well as data modeling with an emphasis on logical and physical structure.

Keywords: medical waste, methods, database, transportation, disposal.

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Introduction. The introduction presents the problem of medical waste management, which is one of the most relevant and significant in the field of healthcare and ecology. To fulfill the tasks set out in the Concept of the Green Economy of Kazakhstan [1], it is necessary that the level of recycling reaches 40% by 2030 and 50% by 2050. In this regard, the waste management system in the country needs more stringent legislative measures and effective implementation of these standards. In addition, international experience and research indicate that improper handling of medical waste poses serious risks both to the health of employees and to society as a whole [2]. Medical waste includes a wide range of materials that can pose a threat to both the environment and human health. These include used syringes, infected materials, pharmaceutical products, chemicals, and even radioactive materials. Improper handling of medical waste can lead to serious consequences: the spread of infections, contamination of soil and water resources,

as well as the risk of poisoning and chemical burns among health workers and the public [3].

The rules concerning the collection, disposal and storage of waste in healthcare institutions are defined by the sanitary norms "Sanitary and epidemiological requirements for healthcare facilities". These standards were approved by the order of the Minister of Health of the Republic of Kazakhstan on August 11, 2020 under the number KR DSM-96/2020 [4]. They regulate in detail the procedures regarding medical waste at these facilities.

Information on medical waste is provided in accordance with the order of the Minister of Health of the Republic of Kazakhstan dated November 30, 2020 No. KR DSM-219/2020 "On the procedure for providing information on medical waste" [5]. These provisions are of key importance for the collection of data on medical waste and contribute to more effective control and supervision in the field of sanitation and epidemiology.

In recent years, the issue of medical waste management has become even more relevant against the background of global events such as the COVID-19 pandemic [6], which has significantly increased the volume of waste related to medical activities. The increased use of personal protective equipment (masks, gloves), disposable medical instruments and other materials has contributed to an increase in the volume of waste that needs to be efficiently collected, transported and disposed of.

Materials and methods. The main goal of developing a mechanism for collecting data on medical waste is to create a unified system that will ensure transparency, reliability and efficiency of data at all stages of waste management: from their formation in medical institutions to final disposal. Such a mechanism is necessary for:

– Process monitoring: timely and accurate tracking of all stages of waste management.

– Ensuring safety: minimizing risks to human health and environmental protection.

– Improving efficiency: optimizing waste management processes through the use of digital technologies and automation.

– Compliance with regulatory requirements: ensuring compliance with international and national standards governing the management of medical waste.

Currently, there are various methods and systems for managing medical waste, which vary depending on the region, the level of infrastructure development and regulatory requirements. Among the main methods, the following can be distinguished:

1. Segregation of waste by hazard classes. This method involves sorting medical waste at the stage of its formation into categories (non-hazardous, infectious, toxic, radioactive), which allows appropriate treatment measures to be applied to them. This is an important first step to minimize the risk.

2. *Waste transportation*. Medical waste requires special transportation services, including airtight containers and compliance with strict sanitary standards. There is a need for transport monitoring systems to ensure the safe delivery of waste to the disposal site.

3. *Disposal methods*. There are various approaches to the disposal of medical waste, such as incineration, burial, autoclaving and chemical treatment. Each method is selected depending on the type of waste and the degree of its danger. For

example, hazardous and infected waste is most often destroyed by high-temperature incineration, while non-hazardous waste can be recycled.

4. *Digitalization and automation.* In recent years, digital medical waste accounting systems have been introduced in some countries, which include the use of specialized software, sensors and monitoring technologies. These systems allow you to track the movement of waste in real time and provide accurate data for reporting and control.

However, despite existing methods, many countries, especially those with limited resources, face problems in the management of medical waste. These problems include a lack of financial resources, insufficient technical base, weak control and monitoring of processes, which leads to risks to health and the environment. Therefore, the development of more efficient, integrated medical waste data management systems using modern technologies remains a key challenge [7].

The classification of medical waste is the basis for the development of effective waste management methods, since different types of waste require different approaches to their treatment, transportation and disposal. The classification may include the following main categories:

– Class A (safe) waste: These wastes do not pose a threat to human health and the environment. This category includes materials that have not been biologically contaminated, such as used paper packaging, sterile bandages and non-infectious items. Their disposal can be carried out in standard ways, such as recycling or landfill disposal.

– Waste of class B (infectious): These wastes can be dangerous, as they may contain infectious agents that threaten human health. This includes used syringes, surgical instruments, materials used during operations. Their processing requires the use of special precautions, such as hermetically sealed containers and sterilization before disposal.

– Waste of Class C (toxic): This group includes waste with dangerous chemicals such as reagents, chemotherapeutic drugs or heavy metals. Their disposal requires specialized approaches, for example, chemical neutralization or special disposal to prevent environmental pollution.

– Waste of class D (radioactive): These wastes contain radioactive substances and require strict control and specialized handling. Special technologies and procedures aimed at minimizing the risk of radiation contamination are used for their storage and disposal [8].

The classification of medical waste not only helps in the organization of the management process, but also in determining the necessary resources and technologies used at each stage of their treatment. At the stage of medical waste generation, it is important to accurately record the amount and types of waste generated as a result of medical activities. This ensures proper planning and management of waste management processes.

Research results. In modern conditions, when environmental and public health problems are becoming more and more urgent, effective management of medical waste requires the use of advanced information technologies. Information systems and software solutions make it possible to optimize the process of collecting, processing and analyzing data on the formation, collection, transportation and disposal of medical waste. This article discusses the key aspects of using information technology to manage waste data, including software solutions and database design.

Designing a database for accounting for medical waste is an important step in managing the waste management system in healthcare. This database should ensure effective storage, processing and analysis of information about medical waste at all stages of its life cycle: from education to disposal. In this section of the article, we will look at the database structure, key parameters and relationships, as well as conduct data modeling with an emphasis on logical and physical structure. In addition, we will give examples of the implementation of databases and their adaptation to the needs of the healthcare system.

Database structure: key parameters and relationships.Let's create a semantic model of the domain. The database structure should be organized in such a way as to ensure effective management of medical waste data. The key elements of the database structure are tables, fields, and the relationships between them within the ER model. The ER model is based on concepts such as essence, attribute and relationship, while the subject area appears as a collection of entities with their attributes and the relationships established between them. Currently, there are several notations for visualizing ER diagrams. According to Martin's notation, an entity is displayed as a rectangle, inside which its name and attributes are listed in bold. The connection is fixed by a line above which its name is placed, and the form of connection with the entity determines the cardinality of the connection: "crow's foot" stands for M, and the absence is 1 (Fig. 1).

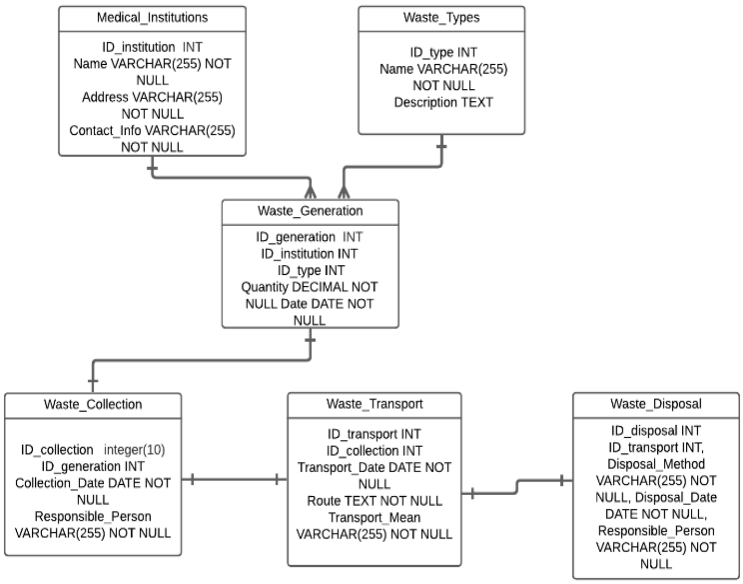

Fig. 1. ER diagram

MySQL is one of the most common relational databases and is suitable for implementing a medical waste database.

1. Key tables:

```sql
CREATE TABLE MedicalInstitutions (
    ID_institution INT PRIMARY KEY AUTO_INCREMENT,
    Name VARCHAR(255) NOT NULL,
    Address VARCHAR(255) NOT NULL,
    ContactInfo VARCHAR(255)
);
CREATE TABLE WasteTypes (
    ID_type INT PRIMARY KEY AUTO_INCREMENT,
    Name VARCHAR(255) NOT NULL,
    Description TEXT
);

CREATE TABLE WasteGeneration (
    ID_generation INT PRIMARY KEY AUTO_INCREMENT,
    ID_institution INT,
    ID_type INT,
    Quantity DECIMAL(10, 2) NOT NULL,
    Date DATE NOT NULL,
    FOREIGN KEY (ID_institution) REFERENCES MedicalInstitutions(ID_institution),
    FOREIGN KEY (ID_type) REFERENCES WasteTypes(ID_type)
);
```

2. Filling in tables

```sql
INSERT INTO MedicalInstitutions (Name, Address, ContactInfo) VALUES ('Hospital A', '123 Main St', '123-456-7890');
INSERT INTO WasteTypes (Name, Description) VALUES ('Infectious Waste', 'Waste that poses a risk of infection.');
INSERT INTO WasteGeneration (ID_institution, ID_type, Quantity, Date) VALUES (1, 1, 150.00, '2024-09-01');
```

3. Requests for data extraction

```sql
SELECT MI.Name AS Institution, WT.Name AS WasteType, WG.Quantity, WG.Date
FROM WasteGeneration WG
JOIN MedicalInstitutions MI ON WG.ID_institution = MI.ID_institution
JOIN WasteTypes WT ON WG.ID_type = WT.ID_type;```
```

Discussion of scientific results. Designing a database for medical waste is a multistep process that requires careful planning and implementation. The database structure, logical and physical models, as well as implementation examples are key aspects that ensure effective waste data management. This approach allows not only to improve the accounting and control of medical waste, but also contributes to improving the safety and sustainability of the health system as a whole.

Software solutions for waste data management. The development and implementation of specialized software solutions for waste data management is one of the most important steps towards effective management of medical waste. Such programs may include the following functions:

1. Waste registration and classification: The software should provide the ability to register all types of medical waste, classify and account for them by volume and origin. This may include creating templates for data entry, which allows medical institutions to easily and quickly capture information about waste.

2. Monitoring and tracking: Waste management systems can use tracking technologies such as barcodes or RFID tags to monitor the movement of waste from the place of its formation to disposal. This significantly reduces the risk of leaks or improper waste management

3. Process automation: Software solutions allow you to automate routine processes such as scheduling waste collection schedules, processing accompanying documents and reporting. This helps to reduce administrative costs and improve work efficiency.

4. Analysis and Reporting: Built-in analytical tools can provide real-time analysis of medical waste data. This allows you to make informed decisions about how to optimize collection and disposal processes, as well as identify bottlenecks and opportunities for improvement.

5. Integration with other systems: Effective software solutions should be integrated with other information systems, such as medical facility management systems, to ensure data exchange and obtain a more complete picture of waste management.

Conclusion. As a result of the study of the mechanism for collecting data on medical waste, several key conclusions were made. The introduction of generally accepted standards for all medical institutions will simplify the process of collecting and processing information about medical waste. The use of specialized software solutions for accounting for medical waste will significantly reduce the likelihood of errors and increase the speed of information processing. Such systems may include functions for automatic registration of volumes and types of waste at the stage of their formation and transportation.Thus, the implementation of the proposed conclusions and recommendations will make it possible to create an effective mechanism for managing data on medical waste. This, in turn, will lead to safer and more sustainable management of medical waste, which is an important task for ensuring public health and environmental protection in the future.

References

1. O Kontseptsii po perekhodu Respubliki Kazakhstan k «zelenoy ekonomike» Ukaz Prezidenta Respubliki Kazakhstan [On the Concept for the transition of the Republic of Kazakhstan to a “green economy” Decree of the President of the Republic of Kazakhstan] dated May 30, 2013 No. 577, [in Russian].
2. Ishchenko V.A. Osobennosti obrashcheniya s otkhodami v meditsinskikh uchrezhdeniyakh [Peculiarities of waste management in medical institutions] // Tverdyye bytovyye otkhody Uchrediteli: Otraslevyye vedomosti. [Municipal solid waste Founders: Industry News.], 2022. No. 1. P. 22-30, [in Russian].
3. Askarova U.B., Mustafaeva R.M. Problemy utilizatsii tverdykh bytovykh i promyshlennykh otkhodov v Kazakhstane [Problems of disposal of solid municipal and industrial waste in Kazakhstan] //Актуальные проблемы гуманитарных и естественных наук [Current issues in the humanities and natural sciences], 2014. No. 8-2. P. 12-14, [in Russian].
4. Order of the Minister of Health of the Republic of Kazakhstan dated August 11, 2020 No. KR DSM-96/2020 «Ob utverzhdenii Sanitarnykh pravil «Sanitarno-epidemiologicheskiye trebovaniya k ob"yektam zdravookhraneniya» [On approval of the Sanitary Rules "Sanitary and Epidemiological Requirements for Healthcare Facilities] (as amended on April 22, 2023), [in Russian].
5. Order of the Minister of Health of the Republic of Kazakhstan dated November 30, 2020 No. KR DSM-219/2020 «Ob utverzhdenii pravil predostavleniya informatsii po meditsinskim otkhodam» [On approval of the rules for providing information on medical waste], [in Russian].
6. Zhuravlov P.V.et al. Tverdyye bytovyye, meditsinskiye otkhody i COVID-19 (obzor literatury) [Municipal solid waste, medical waste and COVID-19 (literature review)] // Zdorov'ye naseleniya i sreda obitaniya [Population health and habitat], 2022. Vol. 30. No. 1. P. 71-78, [in Russian].
7. Ali M. et al. Hospital waste management in developing countries: A mini review // Waste Management & Research, 2017. Vol. 35. No. 6. P. 581-592.
8. Windfeld E.S., Brooks M.S.L. Medical waste management – A review // Journal of environmental management, 2015. Vol. 163. P. 98-108.
9. Connolly, T. Bazy dannykh. Proyektirovaniye, realizatsiya i soprovozhdeniye. Teoriya i praktika [Databases. Design, implementation and support. Theory and practice]. – Moscow: Vil'yams I.D., 2017. – 1440 p., [in Russian].
10. Lukin, V.N. Vvedeniye v proyektirovaniye baz dannykh [Introduction to Database Design]. – Moscow: University book, 2015. – 144 p., [in Russian].

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МЕДИЦИНАЛЫҚ ҚАЛДЫҚТАРДЫ БАСҚАРУ ПРИНЦИПТЕРІ МЕН ӘДІСТЕРІНЕ ШОЛУ ЖӘНЕ ОЛАРДЫ ДЕРЕКТЕР ҚОРЫН ЖОБАЛАУДА ҚОЛДАНУ

Аңдатпа. Мақалада медициналық қалдықтармен жұмыс істеу проблемасы және олардың пайда болуына, жиналуына, тасымалдануына және кәдеге жаратылуына байланысты деректерді жинау механизмін әзірлеу үшін ғылыми-әдістемелік база құру қажеттілігі қарастырылады. Цифрлық технологияларды енгізу және медициналық қалдықтармен жұмыс істеудің барлық кезеңдері бойынша деректерді интеграциялау тиімді басқару жүйесін құруға мүмкіндік береді. Жүйелік, процестік және тәуекелге бағытталған тәсілдерге, сондай-ақ әртүрлі кезеңдердегі деректерді жинау әдістеріне назар аударылады. Мақалада цифрлық шешімдерді енгізу және медициналық қалдықтарды басқару процестерін автоматтандыру мәселелері мен перспективаларына назар аударылады. Мақалада мәліметтер базасының құрылымы, негізгі параметрлер мен қатынастар, логикалық және физикалық құрылымға баса назар аудара отырып, деректерді модельдеу қарастырылады.

Тірек сөздер: медициналық қалдықтар, әдістер, мәліметтер базасы, тасымалдау, кәдеге жарату.

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ОБЗОР ПРИНЦИПОВ И МЕТОДОВ ОБРАЩЕНИЕ МЕДИЦИНСКИМИ ОТХОДАМИ И ИХ ПРИМЕНЕНИЕ ДЛЯ ПРОЕКТИРОВАНИЯ БАЗЫ ДАННЫХ

Аннотация. В статье рассматривается проблема обращения с медицинскими отходами и необходимость создания научно-методологической базы для разработки механизма сбора данных, связанных с их образованием, сбором, транспортировкой и утилизацией. Введение цифровых технологий и интеграция данных по всем этапам обращения с медицинскими отходами позволит создать эффективную систему управления. Основное внимание уделяется системному, процессному и риск-ориентированному подходам, а также методам сбора данных на различных этапах. В статье фокусируется на проблемах и перспективах внедрения цифровых решений и автоматизации процессов обращения с медицинскими отходами. В статье рассмотривается структура базы данных, ключевые параметры и взаимосвязи, а также моделирование данных с акцентом на логическую и физическую структуру.

Ключевые слова: медицинский отход, методы, база данных, транспортировка, утилизация.