Methodology of Clinical Waste Management System using the GIS-technologies

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Abstract:
Around the world, countries have an environmental and social issue in common, and that is waste management. In modern Russia, many areas have a growing awareness of the impacts and implications of inappropriate disposal of wastes, particularly those wastes from healthcare facilities. Of all types of wastes, clinical waste engenders a particularly psychological reaction and poses challenges to waste managers, in logistics, economics, handling, storage, transport and eventual treatment. The human aspects of clinical waste must be considered and, as waste management is an increasingly expensive service and this study incorporates all the management elements with new technologies to reach sensible solutions.

This paper is part of a project which is considering best practice in clinical waste management, using the United Kingdom as a baseline example. Weaknesses of established standards in Russia were determined as a result of analysis and comparison of the legal framework regarding clinical waste in the UK and compared with those in Russia. This study will lead to proposals for improvement of the Russian standards.

With the use of the geographic information system ArcGIS ESRI, a centralized control system for tracking epidemiologically hazardous clinical waste disposal has been designed based on their thermal disinfection. A proposed system has come about as a result of the practical application developed under the research methodology and can be applied to any municipality.

Keywords: Clinical Waste Management, GIS-technologies, Sustainable Development, Healthcare Sector, Thermal Disinfection.

1. INTRODUCTION
In the contemporary world, ensuring the sanitary-epidemiological and ecological well-being of people is one of the priority directions in the field of human health care. In the Russian Federation the problem of optimal waste production and consumption is extremely relevant due to the large number of already accumulated and annual waste generation, for placing it together every year rejected a bit of new territory as a result of poor governance in this field. A result of this places special interest on the issue of clinical waste management because this represents an epidemiological and environmental hazard.

The purpose of this study is to develop proposals for improving the clinical waste management in Russia based on the experience of United Kingdom. In accordance with this purpose, the primary objectives of the research were to:
- analyze the existing problems of clinical waste management in Russia.
- develop a methodology of efficient clinical waste management in Russia and implement it on the example of the territory of Rostov-on-Don.
- create a database of municipal health-care network of the city of Rostov-on-Don using ArcGIS ESRI software.
- develop a system of clinical waste management for the city of Rostov-on-Don.

1.1 Literature review
Since the main objective of present study is to establish a system of clinical waste management, the analysis of the literature which is dealing with the main problems in this area was done. Additionally the use of different disinfection methods and studies in the calculation of volume of such wastes were considered.

Rahele Tabasi and Govindan Marthandan (2013) conducted an analysis of 20 existing studies in the field of generation of clinical of such researches as Taghipour and Mosaferi (2009), Yong et al. (2009), Cheng et al. (2009), Azage and Kumie (2010), Kagonji and Manyele (2011), Komilis et al. (2012) and others. They came to the conclusion that the most significant factors influencing the generation rate of clinical waste are the type of health care organization and its capacity (number of patients). This fact was used in this study in the...
determination of the generation volume of clinical waste in the health care of Rostov-on-Don.

Dasimah Omar, Siti Nurshahida Nazli, Subramaniam A / L Karuppannan (2012) in their research studies analyzed the system of clinical waste management in three hospitals by interviewing staff and patients. The study revealed breaches of the law (lack of containers, incorrect separation and storage of waste). Dispose’s practice in these hospitals occurs centrally, with the transportation of waste to the incinerator. The authors noted that it is necessary to seek to minimize clinical waste, to establish control over the collection, storage, transportation and disposal.

Hossain MS, Santhanam A, Nik Norulaini NA, Omar AK (2011) also speak about the imperfection of the legal framework, lack of awareness of staff in the treatment of medical waste. According to them, there is a lack of funding in hospitals; they need cost-effective methods of disposal of clinical waste. It is therefore the authors suggest the use of sterilization techniques SF-CO2 that clinical waste after treatment can be recycled into new materials, thus engaging them in a continuous recirculation process. The application of this technology involves the sterilization of waste at the point of collection. According to the author, this method of decontamination is cost effective and is aimed at reducing costs.

Mehrdad Askarian, Mahmood Vakili, Gholamhosein Kabir (2004) indicate the presence of problems with staff training. The authors say that in Iran, 60% of hospitals have a decentralized (own) utilizer, and the remaining 40% are faced with the problems associated with the operation of the waste incineration plant. Authors also conducted a research in the area of determining the rate of generation of clinical waste and their qualitative and quantitative composition.

Shaidatul Shida Razali, Mohd Bakri Ishak (2010) noted the need to minimize waste and increase staff awareness. According to them, the rate of medical waste is 1.355 kg per 1 in the year. The authors developed a proposal to reduce operating costs in the processing of clinical waste through the creation of a competent system for their removal from the hospital to the disposal site. This could be achieved because trucks will be removing waste from large health care facilities daily, and from small - 3 times a week. Thanks to this timetable of removal, refrigeration equipment to store the collected waste is required only by small establishments.

LI Run-dong, NIE Yong-feng, Bernhard Raninger, WANG Lei (2006) describe methods used in China of disinfection of clinical waste and the rules for their use. The authors believe that a decentralized system of disinfection is economically inefficient and environmentally dangerous. In China, the most common method of disinfection is to burn at specialized plants.

Ali Ferdowsi, Masoud Ferdosi, and Mohammad Javad Mehrani (2013) in their study conducted detailed analysis of the two methods of decontamination of waste, such as incineration and autoclave. The authors note the positive and negative aspects of both methods. Description of these methods contributed to the current study notably in making a decision on the type and principle of operation of equipment for developed control system clinical waste’s utilization.

Thus, on the basis of the review of the foreign literature on the subject of the study, we can conclude that the problem of improving the system of clinical waste management is relevant to the entire world community. All authors point out the shortcomings in the management, inadequate regulatory framework and lack of awareness of staff in the treatment of clinical waste.

The present study takes into account the results of previous work and contains specific proposals to create a centralized system of health care waste management, which is based on the thermal method of disinfection. At the same time proposed equipment is not the usual "burner", also it has no harmful emissions and special operating conditions. Additionally the principle of its operation is based on the sterilization of clinical waste with steam under pressure.

1.2 Analysis of the legislation in the area of clinical waste management in Russia and the UK, the comparison of classification

According to the legislation of the Russian Federation, clinical waste - it is a waste, which is formed in organizations engaged in medical and/or pharmaceutical activity, when performing diagnosis, treatment and wellness facilities. In the Russian Federation the main document, regulating relations in the field of clinical waste, is Sanitary code 2.1.7.2790-10 "Sanitary and Epidemiological requirements for the management of clinical waste", which establishes mandatory requirements in the field of sanitary and epidemiological gathering, temporary storage, disinfection, decontamination and transportation. Also sanitary code 2.1.7.2790-10 provides rules on sanitary and anti-epidemic regime of work and allocation, equipment and operation of the site for the treatment of clinical waste.

Furthermore, there are other Russian regulations that regulate the management of clinical waste. These include:
4. Law № 570 "On organization of work on the certification of hazardous waste" from 15.08.2007
5. Sanitary code 2.1.7.1322-03 "Hygienic requirements for the placement and disposal of waste production and consumption".
6. The Federal Law № 52-FZ "On the sanitary-epidemiological welfare of the population" from 30.03.1999

In accordance with Sanitary code 2.1.7.2790-10 clinical waste according to their epidemiological, toxicological and radiation hazards, as well as negative impacts on the environment are divided into 5 classes of hazard (Table 1).

<table>
<thead>
<tr>
<th>Class A</th>
<th>Class Б</th>
<th>Class В</th>
<th>Class Г</th>
<th>Class Д</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemiologically non-hazardous waste, which composition is close to the municipal solid waste</td>
<td>Epidemiologically hazardous waste</td>
<td>Extremely epidemiologically hazardous waste</td>
<td>Toxicologically hazardous waste</td>
<td>Radioactive waste</td>
</tr>
<tr>
<td>Wastes that don’t have contact with body fluids of patients and infectious patients. Stationery, packaging, furniture, inventory, which lost their consumer properties, etc. Food waste from central kitchens, as well as all parts of the organization, carrying out medical and / or pharmaceutical activity, except for infectious diseases, including phthisiological.</td>
<td>Infected and potentially infected waste, materials and tools, items, contaminated with blood and / or body fluids. Pathological waste, organic waste from surgery. Food waste from infectious department. Waste from microbiological, clinic- diagnostic laboratories, pharmaceutical, immunobiological productions, working with microorganisms 3-4 pathogenicity groups. Unusable live vaccines.</td>
<td>Materials that were in contact with infectious diseases from patients that could lead to emergency situations in the field of sanitary and epidemiological safety of the population. Waste laboratories, pharmaceutical and immunobiological productions, working with microorganisms 1-2 pathogenicity groups. Waste from treatment and diagnostic departments of hospitals contaminated sputum of patients, waste microbiological laboratories carrying out work with tuberculosis pathogens.</td>
<td>Medicines (including cytostatic agents), diagnostics, disinfectants, which can’t be used. Mercury-containing items, appliances and equipment. Waste from raw materials and production of pharmaceutical industries. Waste from the exploitation of equipment, vehicles, lighting, and others.</td>
<td>All types of waste in any state of aggregation, in which the content of radionuclides exceeds the allowable levels, established by radiation safety standards.</td>
</tr>
</tbody>
</table>

There are different requirements to clinical waste of the health facility (HCF), depending on their class, in the subject of their collection, temporary storage and transportation. Waste management for classes Г and Д is regulated by standards for toxic and radioactive waste. In this paper we consider in detail the problems associated with disinfection of waste classes Б and В.

In accordance with the approved classification Group Б includes a wide range of clinical waste from items contaminated with body fluids and infectious waste food outlets and to pathological and operating organic waste. Class Б waste subject to mandatory decontamination, but sanitary code 2.1.7.2790-10 allow burial in cemeteries and pathological operating waste without prior decontamination. Thus, there is a problem of separation unexamined clinical waste into classes in terms of requirements for recycling. A good example of maturity in the field of clinical waste management is a system of England.

In England and Wales, the main regulatory document regulating the treatment of clinical waste, is the Health Technical Memorandum 07-01 «Safe management of healthcare waste». HTM 07-01 includes all the necessary compliance rules for the handling of clinical waste, compliance with which is mandatory for the institutions in
which they are formed. In addition, HTM 07-01 describes the current system of audit in the treatment of clinical waste.

It is also possible to select the following guidance documents:
1. Clinical waste (EPR 5.07).

In accordance with HTM 07-01 in England and Wales clinical waste are divided into more classes (groups), each of which has its own code identifier. In order not to cause all of the classification, the difference in the fission of such wastes of Russia and UK presented in Table 2.

Table 2. Comparison of clinical waste classifications in Russian Federation and England

<table>
<thead>
<tr>
<th>Clinical waste in Russian Federation</th>
<th>Clinical waste in England</th>
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</thead>
<tbody>
<tr>
<td>Class A</td>
<td></td>
</tr>
<tr>
<td>20 Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions</td>
<td>20 01 99 Other fractions not otherwise specified (used for offensive waste)</td>
</tr>
<tr>
<td>20 03 01 Mixed municipal waste</td>
<td></td>
</tr>
<tr>
<td>Class B</td>
<td></td>
</tr>
<tr>
<td>18 01 Waste from natal care, diagnosis, treatment or prevention of disease in humans</td>
<td>18 01 01 Sharps except 18 01 03</td>
</tr>
<tr>
<td>18 01 02 Body parts and organs including blood bags and blood preserves (except 18 01 03)</td>
<td>18 01 04 Waste whose collection and disposal is not subject to special requirements in order to prevent infection, e.g. dressings, plaster casts, linen, disposable clothing</td>
</tr>
<tr>
<td>Class В</td>
<td></td>
</tr>
<tr>
<td>18 01 03 Waste whose collection and disposal is subject to special requirements in order to prevent infection</td>
<td>18 02 01 Sharps except 18 02 02</td>
</tr>
<tr>
<td>18 02 03 Waste whose collection and disposal is not subject to special requirements in order to prevent infection</td>
<td></td>
</tr>
<tr>
<td>Class B</td>
<td></td>
</tr>
<tr>
<td>18 01 03 Waste whose collection and disposal is subject to special requirements in order to prevent infection</td>
<td>18 02 02 Waste whose collection and disposal is subject to special requirements in order to prevent infection</td>
</tr>
<tr>
<td>Class Г</td>
<td></td>
</tr>
<tr>
<td>18 01 06 Chemicals consisting of or containing dangerous substances</td>
<td>18 01 06 Chemicals consisting of or containing dangerous substances</td>
</tr>
<tr>
<td>18 01 07 Chemicals other than those listed in 18 01 06</td>
<td>18 01 07 Chemicals other than those listed in 18 01 06</td>
</tr>
<tr>
<td>18 01 08 Cytotoxic and cytostatic medicines</td>
<td>18 01 08 Cytotoxic and cytostatic medicines</td>
</tr>
<tr>
<td>18 01 09 Medicines other than those mentioned in 18 01 08</td>
<td>18 01 09 Medicines other than those mentioned in 18 01 08</td>
</tr>
<tr>
<td>18 01 10 Amalgam waste from dental care</td>
<td>18 01 10 Amalgam waste from dental care</td>
</tr>
<tr>
<td>18 02 05 Chemicals consisting of or containing dangerous substances</td>
<td>18 02 05 Chemicals consisting of or containing dangerous substances</td>
</tr>
<tr>
<td>18 02 06 Chemicals other than those listed in 18 02 05</td>
<td>18 02 06 Chemicals other than those listed in 18 02 05</td>
</tr>
<tr>
<td>18 02 07 Cytotoxic and cytostatic medicines</td>
<td>18 02 07 Cytotoxic and cytostatic medicines</td>
</tr>
<tr>
<td>18 02 08 Medicines other than those mentioned in 18 02 07</td>
<td>18 02 08 Medicines other than those mentioned in 18 02 07</td>
</tr>
<tr>
<td>20 01 31 Cytotoxic and cytostatic medicines</td>
<td>20 01 31 Cytotoxic and cytostatic medicines</td>
</tr>
<tr>
<td>20 01 32 Medicines other than those mentioned in 20 01 31</td>
<td>20 01 32 Medicines other than those mentioned in 20 01 31</td>
</tr>
<tr>
<td>Class Д</td>
<td>Do not included in the classification of clinical waste in England</td>
</tr>
</tbody>
</table>

Thus, we can conclude that it is necessary to revise the existing classification of clinical waste in Russia with experience of UK for the improving of the quality of regulations in this area.

The UK experience suggests that the waste, which is not subject to special requirements (eg 18 01 04, 18 02 03),
can be disposed of at the landfill separately from municipal solid waste. They can also be decontaminated and treated at the incinerator with energy recovery. Waste, which require specific, alternative methods are disposed, preferably by burning, including at waste incineration plants. Thus the combustion products may be used as an energy source or recycled at the site. [16]

2. METHOD

This research is aimed at developing a methodology of creating a system of clinical waste management in Russia, as well as its practical application for the territory of megacity Rostov-on-Don. The study was based on the systematic approach, which consists of a comprehensive analysis of the component parts of the process of disposal of clinical waste, and the environmental safety is a priority.

This methodology included the following:

1. Firstly, the existing practice of clinical waste management was identified. Interviews were held with health care workers about the existing problems. Interview group included representatives of the regional and city hospitals, of the treatment and rehabilitation institute "Palace of health", of the Ministry of Health and of the processing plant of clinical waste. The collected information about the waste management practices showed the relations in the field of the clinical waste management.

2. Secondly, the program for minimization, prevention the formation and competent division of clinical waste has been designed. It was considered that the reduction of waste generation in health care settings is possible due to introduction of more advanced technologies.

3. The third step reviewed and analyzed the current classification and the legislative framework in the field of clinical waste. As a result, it was concluded that the Russian regulatory system relating to the clinical waste, it is necessary to revise and modernize. Analysis of the UK experience in the treatment of clinical waste has shown that it is necessary to consider the possibility of processing clinical waste and their further use as secondary material resources, or in the form of energy.

4. The fourth stage included examining the possibilities for communication of the existing system of clinical waste with the existing municipal system for the collection, transportation, processing and disposal of solid waste. It is important to note that clinical waste should not be considered separately from the city complex system of waste management. The present study examined the transport routes of vehicles that collect and remove of solid waste in the city of Rostov-on-Don. By considering the existing routes of waste tracks can be concluded that the considered network of health care institutions can be brought into a single system of export, thus refers to the removal of clinical waste, or Class A, which is not subject to special requirements for disposal, or already disinfected waste.

5. Finally, raising awareness and control in decision-making and management of clinical waste has been developed. At this stage the existing system of control over the implementation of legislation was investigated and proposals for its improvement were developed with experience of UK.

After performing these 5 stages of the methodology, we moved on to the creation of an integrated system of health care waste management, which is based on the using of advanced technologies, such as:


2. Proposals to create new products from recycled clinical waste with the aim of involving them in the production process of the closed cycle.

Thus, the analysis of the legislation of Russia and the UK, the Reviews of documentation and interviews with key personnel involved in the management of clinical waste have provided the initial information for analysis. Site visits to view present practice have been informative. The establishment of procedures for the appropriate handling, routing and disposal will be a valuable outcome of this work, and this will inform a future strategy for sustainable waste management that could be offered for replication throughout the country.

3. RESULTS

Currently in Russia the most widely used method for chemical disinfection of clinical waste in the field of formation is with the application registered disinfectants [16]. However, this method has a number of significant disadvantages: it is costly, worsens the conditions of workers, moreover, destruction of pathogens is not always guaranteed due to incomplete impregnation of waste disinfectant solution. Around the world to this type of waste used methods of thermal sterilization and disinfection. Thus, centralized incineration remains the most used method of waste treatment health in the European Union. But the process of incineration is not the best solution. Installations for the incineration of waste – “incinerators” were widely distributed in the world 10-15 years ago,
but since then a lot has changed. As it turned out, the burning is not as harmless as it seems at first glance, and for all virtues have a number of drawbacks. For example, the formation of dioxins, which cause a number of diseases, includes cancer, immune system damage, and disruption of reproductive and other body systems. In addition, they are a source of heavy metals such as lead, cadmium, arsenic, chromium, and halogenated hydrocarbons, acid vapors and other harmful substances. Nevertheless, manufacturers often claim incinerator air emissions are "under control", but the facts indicate that it is not.

As a result of the aforementioned, this study proposes the establishment of a centralized system of health care waste management classes B and B, using the method of thermal disinfection. For this purpose it was decided to use the equipment, which the principle of work consists of sterilization of classes B and B of clinical waste and steaming under pressure with first creating a vacuum in the chamber and the subsequent mechanical deconstruction by compressing into briquette. This method provides a complete disinfection of waste with their shredding and deprivation of the structural properties. With this steam sterilization under vacuum provided the penetration of steam into all cavities of materials that provides uniform destruction of pathogenic bacteria. The process is environmentally friendly and has no tailpipe emissions, pollution the air, water or land. Modern sterilizers allow to decontaminate solid clinical waste of non-biological and biological nature, such as:

- plastic products (syringes, probes, filters, deflyuzory, catheters, tanks, etc.)
- glass (bottles, vials, tubes, ampoules, pipettes etc.)
- small metal tool, including needle syringes, lancets, scalpels, razors;
- products from latex, cellulose, rubber, paper, cardboard, wood and fabrics;
- bandaging material;
- postoperative anatomical parts;
- biological material and culture.

In the selection of the technology for a specific region the first step is to determine the system of disposal of clinical waste. There are two systems: a decentralized, i.e. installation of low-power systems in individual hospitals, and centralized - based on placement of more productive plants in the basic health-care facilities or through the construction of a large incinerator in the centers of processing. Of course this choice depends on the type of health care facility (for example, institutions of tuberculosis profile can only be a decentralized system), qualitative and quantitative composition clinical waste, the characteristics of transport routes and the results of the mapping of the region, preferably with using geoinformation technologies. Sanitary code 2.1.7.2790-10 supports active introduction of clinical waste management in the regions based on a decentralized, centralized or mixed principle of thermal destruction of waste classes B and C. In this case, waste of Class B must be collected and transported in sealed condition, "dry", ie without chemical disinfection, to the site of their thermal disinfection, provided that the accumulation of waste will be no more than 24 hours. With more time clinical waste in hospitals requires refrigeration. Waste Class B shall be subjected to thermal treatment at the site of their formation, ie installation should be placed locally. Thus, for this type of establishments is necessary to use the principle of a decentralized disinfecting medical waste.

Rostov-on-Don is the political and economic “capital” of the Southern Federal District of Russia and is a large industrial, cultural and scientific center, growing rapidly and placing pressures on the healthcare facilities system. Current clinical waste management practice in Rostov-on-Don provides separation and neutralization of clinical waste at source, partial incineration and disposal to landfills. A teaching system on accurate waste separation is in place, but is in need of updating. Future innovations must be harmless to future generations’ health and environment, cost-effective and take into account the characteristic features, potential and limitations of the current system.

4. DISCUSSION

For Rostov-on-Don, it was decided to develop a centralized system that consists of placing powerful installations in the basic settings. This decision is caused by the fact that the placement of units in each health facility will require significant investment, and in most cases, will not wash equipment operating at full capacity due to the small volume of waste to be disinfected. In this study, using a geoinformation system ArcGIS ESRI for the city of Rostov-on-Don has developed a comprehensive system of health care waste management for classes B and B (which must be decontaminated). As a result of the use of geoinformation technologies a visual representation of the information has been provided, allowing taking into account the features of placing health care facilities and transporting infrastructure.

When creating a centralized system for the disposal of clinical waste classes B and B, the first stage was created a database, containing information about all the objects of the municipal health-care network, namely: name, address, year of construction, the planned and actual output, number of floors, square, etc. All objects were plotted on an electronic map of the city (Figure 1).
Based on information about the power of health care institutions, calculations of quantitative and qualitative composition of generating of clinical waste have performed, with a help of "Practical Guidance on waste management of health facilities" [17]. Calculations are necessary in order to determine the capacity of the units on the thermal disinfection as necessary to satisfy the requirements of the network of health facilities.

Unfortunately, in Russia at the moment there are no official documents regulating the standards of generation of clinical waste in hospitals. According to various authors standards of education the total clinical waste are:

- Permanent medioprophilactic institutions - from 1.1 to 1.3 kg per bed per day;
- Outpatients' clinic - 145 grams per visit;
- In sanatorium and boarding house - 460 grams per bed per day.

Approximate rate of waste generation of waste of Class B:

- For Permanent medioprophilactic institutions - 156 grams per bed per night;
- For outpatient clinics - from 12 to 25 grams per visit.

Approximate rate of waste generation of waste Class B:

- For Permanent TB dispensary and mycological medical institutions - 910 grams per bed per night;
- For TB dispensary - 107 grams per visit.

In this research work standard of generation of clinical waste was determined in accordance with the above rates, with rounding. In order to determine the standard of generation of clinical waste per year, we assume that inpatient facilities and health centers operate year round seven days a week, and Outpatients' clinic and dental work in two shifts, five days a week, taking into account the duty on non-festive Saturdays at 1 shift.

Volume of the total amount of medical waste in hospitals is determined by the Equation (1), the amount of waste classes Б and В - according to the Equation (2).

\[ V_{\text{mo}} = K_{\text{LPU}} \cdot M_{\text{LPU}} \]  
(1)

where \( V_{\text{mo}} \) - the total amount of generation of clinical waste in hospitals, kg / year,

\( K_{\text{LPU}} \) - the coefficient of generation of clinical waste, depending on the type of health facility.

For inpatient \( K_{\text{LPU}} = 475 \) kg per year per 1 bed for outpatient health care facilities \( K_{\text{LPU}} = 78.59 \) kg per year per 1 n / cm;
\[ V_\text{U} (B, C) = K_\text{U} (\text{MPI, BV}) \cdot M_\text{LPU} \]

where \( V_\text{U} (B, C) \) - the volume of clinical waste generation of classes Б and В in hospitals, kg / year,

\( K_\text{U} (\text{MPI, BV}) \) - the coefficient of generation of clinical waste classes Б and В, depending on the type of health facility. For inpatient \( K_\text{U} (\text{MPI, BV}) = 57 \text{ GFP year} \cdot 1 \text{ bed for outpatient health care facilities} \ K_\text{U} (\text{MPI, BV}) = 10.8 \text{ kg per year per} \cdot 1 \text{ n / cm}, \text{ for dentists} \ K_\text{U} (\text{MPI, BV}) = 35.4 \text{ kg per year per} \cdot 1 \text{ n / cm}. 

For the development and validation of clinical waste management strategy in the city of Rostov-on-Don the software ArcGIS and ArcView of ESRI were used. The received information about the volumes of wastes was introduced into a previously created database environment ArcGIS ESRI. Furthermore an electronic map was produced clearly showing the total quantity of waste in hospitals in Rostov-on-Don clinical waste (Figure 2).

![Figure 2. Network of health care institutions in Rostov-on-Don with the total amount of clinical waste, produced in their](image)

The placing of centralized thermal destruction of waste classes Б and В was adopted by 21 basic health care facilities with the maximum volume of waste and in close proximity to smaller institutions. In each basic health facilities it is planned to place different performance installations are able to handle the necessary volume of wastes classes Б and В surrounding health care facilities (Figure 3).

The aggregate performance of the proposed network of installations of thermal disinfection of wastes Б and В – 820,000 kg per year, and the total volume of such waste throughout the network of health facilities of Rostov-on-Don – 561,000 a year. Thus, the capacity of the proposed network will meet the needs not only of the municipal network, but also to enter into a contract to dispose of hazardous wastes from health care facilities of other affiliation.
Currently, in many countries, there is the problem of increasing the cost of waste disposal. In the UK, the cost of waste disposal is increasing. The National Health Service produces an annual average of 250,000 tonnes of waste, at a cost of over £40 million. In Russia, according to stuff of health facilities, payment for the disposal of clinical waste, especially the classes Б and В, is a particular problem because there is no corresponding item of expenditure in the budget of hospitals.

In this regard, there is a need to develop proposals to reduce or waste, or the cost of its disposal. But in the process of generation and recycling used a significant amount of resources, materials and labor staff - all this forms the “true value”, which is often not apparent. Therefore, the actual problem is the development and promotion of programs to minimize or prevent of waste generation. Clinical waste minimization can be achieved by reducing the weight and volume of packaging materials for medical devices, instruments, devices, by improving the quality produced by the domestic industry of medical products and devices, rationalizing food services (obtaining packaged products, etc.), the centralization of the preparation of disinfectants funds and a number of other preventive measures. In this case, the desire to minimize of waste generation in health care facilities should not create obstacles to the introduction of technologies and ensure a high level of patient care.

Also relevant is the question of the involvement of clinical waste in the production process of the closed type. In accordance with Russian legislation, the use of waste as secondary raw materials is allowed only with the control measures in consultation with the Center of State Sanitary and Epidemiological Surveillance. Careful separation of waste at the site of formation is creating certain preconditions for effective waste recycling. Besides the need to prevent the spread of infection starts to process waste must as far as possible, apply their processing requirements with complete loss of commodity properties, i.e. do constitute of wastes of medical institutions unrecognizable or inaccessible to living beings. The proposed network of installations of thermal disinfection of wastes Б and В in the study meet this requirement, since it provides a complete mechanical deconstruction waste.

Future developments should ensure the safety of the environment and human health, are cost effective and take into account the characteristics and possible limitations of the existing management system of clinical waste disposal.
5. CONCLUSIONS

Thus, as a result of the study were achieved the following results:

1. The existing problems in the field of clinical waste management in Russia was analyzed.
2. The methodology for establishing a system of clinical waste management in Russia.
3. The database of municipal health-care network in Rostov-on-Don in a medium of ArcGIS ESRI.
4. A centralized system of disposal of medical of waste classes B and B for the Rostov-on-Don, based on the application of modern methods of disinfection was developed.

Application of the results of this study will provide transition municipalities of the Russian Federation on a new level of sustainable development, as they are aimed at improving the quality of life and environmental protection.

Further studies will address improving governance and controls during all stages of clinical waste through the optimization the global practices in the field of auditing for Russia.

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