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Assessment method of health care waste generation in Latvia and Kazakhstan

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Abstract

Effective management of health care waste in medical institutions is a crucial factor for disease transmission risks, environmental pollution and, due to high utlisation costs of health care waste comparing to general waste, also economic sustainability of medical institutions. Possibilities to forecast amount of generated waste is needed for planning of waste management budgets and optimization of waste management practices. The objective of the research is to develop a health care waste generation rates prediction model for Kazakhstan hospitals. The current research describes the concept of the research and performs comparative analysis of the indicators describing health care waste management in medical institutions.

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Keywords: Health care waste, Forecasting, Generation rates, Indicators, Public hospitals

1. Introduction

In recent years generated amount of waste increases following the trends of population raise. This has the effect to the environment during transportation, treatment and disposal of waste. Among the total flow of waste, specific environmental loads are generated by the hazardous waste flow due to its properties: explosive, oxidising, flammable, irritant, toxic and ecotoxic, carcinogenic, corrosive, infectious, mutagenic, sensitizing, yielding another substance [1]. Significant part of the hazardous properties can be related to medical waste group. Environmental

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Protection Agency of US defines medical waste as "*waste materials generated at health care facilities, such as hospitals, clinics, physician's offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories*" [2]. Latvian legislation does not provide a clear definition of health care or medical waste. Despite this fact, categorization of waste generated in health care institutions is provided in the Regulations of the Cabinet of Ministers [3] and includes: (1) hazardous wastes or wastes needs to be handled as hazardous – sharps, infectious, anatomical, cytotoxic and cytostatic, pharmaceuticals, hazardous chemical waste; (2) radioactive waste; (3) household waste and (4) waste containing dangerous substances.

According to Komilis et al. [4] definitions of health care wastes varies a lot among the countries, that causes a wide range of reported health care waste generation rates – from hundred grams and up to 6 kg per bed per day [5–10]. Eurostat data for 2012 [11] shows that annually from 1 kg per capita (Denmark, Greece, Croatia, Cyprus, Lithuania, etc.) to 8 kg per capita (Spain, France, United Kingdom) of health care and biological wastes are generated (corresponds to the chapter 18 of the European Waste Catalogue) [12]; for some countries, data on generated amounts of the health care waste are not available (for example Ireland) or the defined amount of wastes is too low (for example Bulgaria, Finland) or too high (in case of Belgium). Among other issues, this might be an indication of improper waste management practice or poor data collection in the country (see Fig.1). This also discussed in several studies [6,13,14].

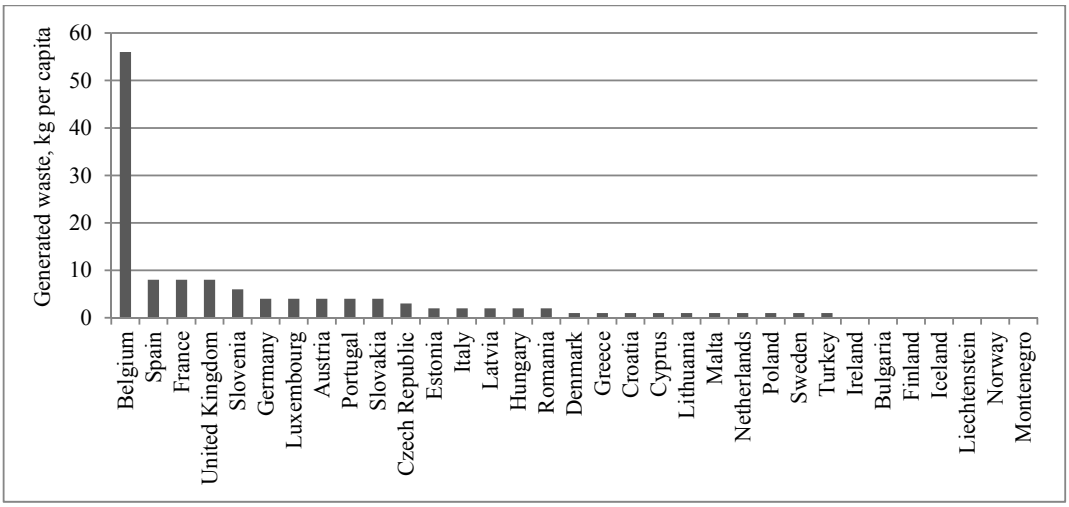

Fig. 1. Generated health care and biological wastes in Europe in 2012 [11].

According to the World Health Organisation, up to 80% of the total waste generated in the health care facilities relates to non-hazardous general waste, and only remaining 20% are considered to be hazardous health care waste [15]. Besides disease transmission risks, effects to public health and environmental pollution, improper management of hazardous health care waste is connected with economic sustainability of a medical institution – treatment ad utilization of health care waste is up to 8 times more expensive than general non-hazardous waste [16]. Provision of a sound waste management planning and monitoring systems in hospitals is a prerequisite issue for effective reduction of health care waste associated risks [10].

The work aims to define the mathematical relationships between general and health care waste generation rates in regional multi-profile hospitals. Such mathematical equations are useful tool for multi-profile hospitals due to several reasons:

- it will lead to improvement of the existing health care waste management practices suggesting an additional verification method of waste generation scheme implemented in hospitals – amounts of waste defined by weighting or other method might be checked with the proposed mathematical equation;

- defined relationships and quantitative indicators might be used for forecasting of next years waste generation rates when planning a hospital's waste management budget.

The current paper describes the concept of the research and provides the comparative analysis of the waste generation rates in Latvian and Kazakhstan medical institutions.

2. Research methodology

The overall objective of the research is to develop a mathematical model for prediction of health care waste generation rates if the limited amount of data is available in the target country. The algorithm of the research is given in Fig. 2.

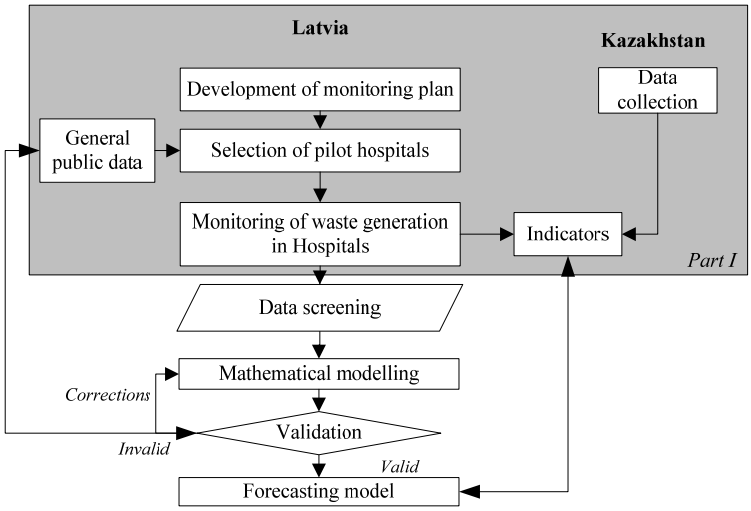

Fig. 2. Algorithm of the study.

Kazakhstan is selected as a target country to use the prediction model. Prediction model is based on a detailed data collected during the waste generation monitoring in hospitals of Latvia. Two regional multi-profile hospitals in Latvia were selected for a case study. Cheng et al. [17] statistically justified that the type of medical institution affects the production of infectious and general waste, thus the purpose of the selection process of case hospitals were based on similarity criteria – hospitals with similar treatment services and number of patients were selected from the online list of the Ministry of Health. Initial waste management plans and also waste segregation systems exist (classified in 5 flows: general non-infectious waste, sharps, pathological waste, chemical waste, infectious waste) in the both hospitals. However quantification of health care waste management is performed only at the total basis – a company collecting infectious health care waste provides monthly data on collected infectious health care waste amounts. General waste is also quantified only on the basis of invoices provided by the municipal waste managing company.

For the current study needs a one month waste generation monitoring plan was developed and implemented in each Latvian hospital (see a research algorithm in Fig.2): each class of generated waste in each hospital department for infectious wastes (sharps and infectious non-sharp) and general waste in the medical establishment calculated. Statistical data analysis is applied to define the mathematical relationships between the parameters of waste generation in hospitals. The following methods relate to the most commonly used for analysis of health care waste generation: questionnaires, direct measurements and weighting during site visits (incl. classification and analysis of segregation practice), definition of indicators and linear regression analysis of gathered data [7,10,18–20]. However Jahandideh et al. [21] defined the non-linear nature between the parameters on the rate of medical waste generation and use of combined method (neural networks and multiple linear regression) for prediction of waste generation

rates in medical institutions. The hospitals' public data on waste generation amounts were used to validate a model. Finally the prediction model is used for definition of health care waste (general non-infectious waste, sharps, pathological waste, chemical waste, infectious waste) production rates in medical institutions of Kazakhstan.

The current paper describes the first part of the research (the boundaries of the Part 1 is shown in Fig.2). Due to the lack of data describing waste generation in Kazakhstan hospitals, the UNDP [22] provided data on average waste generation rates (kg per bed per day) in the Kazakhstan medical institutions is used. The indicators will help to justified the model to the specific conditions of the target country.

3. Results and discussion

As stated before, a monthly monitoring (31 day) of waste generation was performed in two Latvian hospitals. To avoid any seasonal effects to the generated amount of waste, the monitoring was performed in the same time (November) at all the hospitals. Proposed indicator for evaluation of the hospitals waste management is daily generated amount of waste per one patient. But due to the reason that monitoring of generated amounts of waste was not yet implemented in Kazakhstan hospitals, to ensure coherent data analysis a daily generated amount of waste to one bed (general waste per bed per day (GW) and health care waste (HCW) per bed per day) is selected as an indicator for the study.

The following inventory data were collected during the monitoring in the Latvian hospitals: number of beds in the hospitals; number of occupied beds per day, number of patients (incl. outpatients) per day, amount of general non-infectious waste (GW) generated, amount of sharps (SW) generated, amount of pathological waste (PW) generated, amount of chemical waste (CW) generated, amount of infectious waste (IW) generated. Generation rates were inventoried for each department separately.

Data related to a preliminary analysis of health care waste generation in Kazakhstan hospitals were available only. Thus, to compare the data a comparative indicator (amount of total health care waste (HCW) was defined – it reflects sum of SW, PW, CW, IW. The results are given in Table 1.

Table 1. Summary of the average waste generation indicators in hospitals of Latvia and Kazakhstan

Indicators	Latvia	Kazakhstan*
Average total waste (GW+SW+PW+CW+IW) generation rate in kg per bed per day	1.182	5.34
Average total waste (GW+SW+PW+CW+IW) generation rate in kg per occupied bed per day	1.70	-
Average total waste (GW+SW+PW+CW+IW) generation rate in kg per total patient per day (where total patient is bedded patients plus outpatients)	0.638	-
Average GW generation rate in kg per bed per day	0.553	4.97
Average SW generation rate in kg per bed per day	0.013	-
Average PW generation rate in kg per bed per day	0.021	-
Average CW generation rate in kg per bed per day	0.446	-
Average IW generation rate in kg per bed per day	0.149	0.13
Average total HCW (SW+PW+CW+IW) generation rate in kg per bed per day	0.629	0.37

*Average data for the country is used [22]. ** Indicator defined to compare the Latvian and Kazakhstan data.

The results of the monthly monitoring performed in Latvia shows that GW varies from 0.272 kg to 0.876 kg/per bed daily and in Kazakhstan case the value is 4.97 kg per bed daily. Additional analysis is needed to clarify what is included in general waste category defined for Kazakhstan.

The amount of the HCW generated in Latvian hospitals reached 0.629 kg/bed (and 0.37 kg/bed in Kazakhstan). The higher value in the Latvian hospitals is characterized with a high share of chemical waste (laboratory stocks) in the hospitals. If the laboratory departments are excluded, then the average HCW indicator for Latvia is 0.212 kg/ bed daily. The values of the HCW are smaller than stated by Sanida et al. [13] and this might be reasoned with the following: different seasonal period of the data monitoring, different use of single use materials (for ex. linens). Two

factor linear correlation analysis was performed to define the correlation equation between HCW and number of beds is 0.76.

4. Conclusions and further work

The study is aimed to develop a mathematical model for prediction of waste generation rates in Kazakhstan. The model is based on monitoring data of waste generation in Latvian hospitals. The first part of the analysis quantifies the general, infectious, sharp, pathological and chemical waste rates in the hospitals. Further works needs to done to complete the model and validate it.

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