

Sustainable health-care waste management: Public policy making and governance

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Climate change has recently increased the frequency of extreme weather events, altered the distribution of disease vectors, and exacerbated air pollution hazards, disturbance, global environmental changes, all of which put pressure on already-existing health vulnerabilities. The dangers and effects of climate change on public health, and consequently on the standard of living, are now widely acknowledged to be quite significant. Especially, the outbreak of COVID-19 led to the increase of medical services and the accelerated use of health-care products (e.g. surgical masks, medical consumables), which consequently resulted in the increase of potentially hazardous medical waste.

Due to the potentially infectious properties of health-care/medical waste (HCW), its management and treatment are regulated by environmental and health bodies and the implementation of international treaties. For HCW transportation, most nations adopt the agreements concerning hazardous material transportation, such as the Agreement for the International Carriage of Dangerous Goods by Road (ADR) and other similar ones for different modes of transportation. Many nations lack the necessary regulations or fail to enforce them. To eliminate risks of transmission of infectious cases taking into account the monotonically increasing quantities of medical waste, special attention must be paid to its disinfection, segregation, storage, transportation, and final disposal. The most prevalent issues with HCW include a lack of knowledge and public awareness about the health risks associated with it, a lack of safe disposal systems, inadequate training in proper waste management, and a lack of financial and human resources for that purpose.

Sustainable management of HCW represents a top priority for environmental and public health concerns, especially in developed nations. The choice of the best technique for disposing of HCW is a complex, multi-criteria decision analysis problem that takes both qualitative and quantitative aspects into consideration. It should be noted that HCW treatment technology evaluation may be based on shaky or incomplete data. Among different dimensions and criteria, there may also be a lot of dependence and feedback. Though, the majority of HCW decision models now in use are unable to account for these intricate linkages.

This work focuses on a sustainability-based multi-perspective methodology (environment, resilience, societal aspects, economy, transportation), to identify the involved key factors and criteria, based on a multi-participatory approach. Risk assessment for management and transportation of hazardous materials is seen as a decision-making problem, and the most important risk variables for the management of medical supplies are defined.

A multi-stakeholder methodology is used for the analysis: since waste management needs to be managed in a sustainable manner, this calls for a multifaceted strategy including many stakeholders. Such a strategy helps to increase interest and knowledge at several levels (public authorities, healthcare providers, auxiliary actors, and others), spark conversation regarding the adoption of particular health policies, and pinpoint the best course of action. Understanding how diverse stakeholder networks are put together and function, as well as how to maximize their effectiveness, may frequently be challenging. The way the networks work by using social network analysis of HCW waste management stakeholders should be studied and evaluated. Medical staff (doctors, nursing professionals etc.) are in a good position to take part as full partners with other medical and public health emergency communities because they are a significant element of the healthcare system. In most cases, treatment and disposal of medical waste are handled by private companies that serve hospitals and health facilities. Such facilities must define an assessment to choose the best alternative for their waste among specialists that offer treatment processes. Governments, municipalities, and solid waste management councils are significant stakeholders, along with some international organizations listed with distinct responsibilities and impact.

Suggestions for how to make the HCW management stakeholder network more efficient can be made: Health care institutions having a great interest in waste management should be more informed and develop broader connections to one another. The networks operation will be improved by levelling disparities in perception, awareness and readiness as well as information exchange and financial access. The implementation of a clear legal framework will be a positive catalyst for accelerating the increase of roles and responsibilities within the system. Moreover, even if quick action can be made locally, universal and long-term development

requires governance, commitment and assistance with the ultimate goal of meeting national and international standards.

This is a long-term process that will be continued by incremental advancements, enlarging public awareness of the hazards associated with HCW, for promoting proper procedures to safeguard the individuals involved from risks when collecting, storing, transporting, treating/processing or disposing of HCW in environment-friendly way and beneficial for public health. Also, promoting social behaviors that reduce the amount of waste produced and developing policies and systems to ensure strict oversight and regulation for improving waste segregation, treatment and disposal practices are key components favoring a more sustainable health-care waste management.

Furthermore, for the safe management and transportation of HCW, the creation of a decision support system can be proposed to help the competent authorities to mitigate the risks imposed by accident probability and exposure and also provide efficient transportation and management of such hazardous material. Appealing fuzzy analytic methodologies will be used for attributing weights of relevant importance to the selected criteria and factors. When conflicting opinions of the importance ordering of the criteria and factors appear, the resolution will be implemented with the 'Entropy' multi-criteria decision making. Robustness of the methodology will be proven by conducting sensitivity analysis on the linguistic data collected from the involved stakeholders. The decision on the medical waste transportation can be assisted with a fuzzy cognitive mapping (FCM) approach investigating best and worst-case analysis on the inter-causalities of the key factors.

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