

Study on Improving Medical Waste Disposal Charges in the Context of the COVID-19 Pandemic

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Abstract. Regarding prevention and control measures related to the COVID-19 pandemic, if healthcare workers are on the frontlines of the battlefield, there is also another, invisible battlefield on which the virus must be prevented from prevailing – the environmentally sound disposal of related medical waste. The charging system for medical waste disposal varies around the world, and the typical case chosen for this research is China's medical waste disposal. In contrast to many Western countries that chose to adopt co-existent strategies for combating the COVID-19 pandemic, China chose to adopt a more centralized policy, including PCR testing on a community basis, a home-based quarantine method, and government-managed quarantine centers, which led to producing much more medical waste than ever before. However, China does not apply a national standard for medical waste disposal charges, and each local government has different charge systems and management regulations. There are differences in charging methods, management systems, and the nature of medical institutions in the implementation of the charging system. Given the actual situation, the paper puts forward feasible suggestions for government policy at the hospital and technology levels.

Keywords: China, COVID-19, Medical Waste, Charge System, Disposal Method.

1. Introduction

The COVID-19 pandemic is not only a public health disaster but also an environmental issue, increasing the burden of medical waste. The pandemic has necessitated the use of personal protective equipment (PPE), surgical (and protective) facemasks, gowns, and nitrile gloves, which have been used primarily against pathogens in hospitals, in domestic isolation, and individual protective measures, resulting in a rapid build-up of potentially infectious waste streams [1]. Although providing PPE to health workers is vital, ensuring its safe use, without impacting the surrounding environment, is equally important. Over the years, a growing number of countries have intensified their research on methods of sorting and safely disposing of clinical waste, but thus far, no suitable methods exist. The problem is even more acute in poor countries. Most of the waste in these countries is simply incinerated in open pits and dilapidated incinerators that do not have pollution controls. Thus, the world is facing an unprecedented challenge in the form of battling COVID-19, along with the multitude of medical waste produced since the COVID-19 pandemic began.

Medical wastes mixed with domestic wastes can lead to infections and the spread of the virus if they enter our living environment; if combined with domestic waste, medical waste can worsen land and water quality, as well as harm plants and animals. Thus, improper medical waste handling can pose a serious threat to the employees of institutions that generate medical waste, the health of the general public, and the environment. This is why government agencies around the globe have regulations and guidelines for disposing of medical waste. The World Health Organization (2022) has reported that the generation of thousands of tonnes of additional medical waste by countries responding to COVID-19 outbreaks has placed enormous pressure on medical waste management systems, threatening human and environmental health and revealing a vital call for improved waste management practices.

In contrast to the mitigation measures adopted by most western countries in the early stages of the COVID-19 pandemic and the current policy of co-existence with the virus, China's blocking measures and dynamic zero-case policy, the admission of milder patients to hospitals, and case-

tracing have been considered effective for the country, helping to curb the spread of the pandemic [2]. Before the spread of the pandemic, in some areas, the nation's 'dynamic zero-COVID' policy involved massive testing and strict quarantine measures to eliminate COVID, and Shanghai's lockdown in early 2022 proved that the policy was effective given China's situation [3].

However, generating and cleaning day by day may not be possible in some towns and communities, due to the large volume of medical waste generated. If wastes can no longer be cleared, they must be stored in a proper location in the community and marked, and measures such as rain protection, containment, and regular disinfection must be taken. The wastes must not be thrown out into the open. In the case of temporary clinical waste, a professional receiving and disposal unit should transport the waste to a clinical waste-disposal facility for safe disposal within 24 hours. The neglect of any of the above links can lead to a risk of leakage or increased expense.

In China, medical waste gathered during the pandemic has had one particularly striking feature. It is not generated only in hospitals, fever clinics, centralized facilities, and PCR testing sites. Especially at centralized quarantine sites, household waste has been categorised as medical waste. At the same time, the status quo is that the system for charging medical waste and the way it is regulated in China affect issues such as the control of medical costs in hospitals. For these reasons, this is a topic well worth studying.

To resolve the above-mentioned issues, a case analysis method was adopted to explore how the province of Guangdong chose to increase its medical waste charges in early 2022, while the national guideline was to reduce these charges. In China, the local government has the final decision to formulate the guideline for medical waste disposal upon following the national rules.

With the unprecedented threat of the mutant strain emerging in the context of a global pandemic, Guangdong Province has undertaken a series of rigorous interventions, including mass testing, active case elimination, community management, travel restrictions, and enclosure of affected areas to try to contain the spread of the disease [4]. Prompted by a series of policies by provincial party committees and governments, medical waste generation in Guangdong has also reached a record high.

2. Practices of Charging Systems for Medical Waste Disposal in the Context of COVID-19

2.1. Models of Charging for Medical Waste before the Pandemic

Most provinces in China had fee-management measures in place for medical waste disposal before the COVID-19 pandemic, and cities that had established centralized facilities for medical waste disposal put in place a fee-collection system.

Generally, in China, medical waste disposal fees are subject to a government-guided pricing-management model, whereby the pricing authorities in each province formulate the medical waste charging models and methods, while the specific rates are formulated by the municipal People's Government pricing authorities, which are divided into districts in consultation with relevant departments. Regarding pricing, the government's administrative pricing department formulates a single pricing rate, a maximum pricing rate, and a downward range or a base price and downward price range, and the operator formulates specific prices within the range prescribed by the government based on market supply and demand and production costs.

The main costs of medical waste disposal are related to transportation, materials, power, maintenance, facility and equipment depreciation, labour and welfare, and insurance (liability insurance against environmental pollution, damage to third-party property, and damage to people, as well as operators' occupational accident insurance for losses incurred during the entire process of medical wastes disposal, including treatment, as noted below). Scopes of disposal costs in the charging documents for medical waste disposal are similar across regions [5]. The two basic local methods of charging are based on the number of hospital beds and weight, including charging based upon the number of outpatient visits or medical waste generation, business area, or medical institutional practices, such as establishing a flat fee, or via additional billing.

Because there was no national charging standard for medical waste disposal in China, local governments may formulate their regulations and charges. Let us take one of the megacities, Guangzhou, as an example; in medical institutions with beds, 2.3 yuan were charged per occupied bed. There was a clinical waste disposal charge per bed of up to 0.63 kg per day and a disposal charge of 3.65 yuan per kg of excess clinical waste per bed per day. Hospital outpatients' medical waste was not charged for individually. Institutions were allowed to pay fully based on total weight and charged at a rate of 3.65 yuan/kg. Medical institutions without beds (outpatient facilities) were charged by weight. Given the age-related maintenance costs of equipment, increased energy consumption, and price increases, the original charging standard was considered too low as compared with those of smaller cities in the same province. Many practitioners believed that lower costs would limit disposers' commitment to facility upgrades and affect day-to-day operating costs. It could also have affected the safety and environmental protection of medical institutions to some extent and have been detrimental to the safe disposal of medical waste by medical-waste-disposal companies.

2.2. Models of Charging for Medical Waste during the Pandemic

The waste disposal system in many Western countries has undergone a transition from incineration to landfill to compost over the past decades [6]. These methods have some disadvantages, however: harmful gases are released during combustion; Easily, they cause air pollution. One of the concerns raised by the covid-19 pandemic, which has exacerbated waste generation and increased the proportion of infectious waste, is that people littering masks and gloves could become contagious. In the meantime, since the outbreak of Covid-19, the cost of the disposal for hazardous medical waste was higher than that for non-hazardous waste. Therefore, health facilities, transit stations, and waste-disposal facilities took pricing decisions seriously.

Medical waste supply chain managers always focus on environmental issues. Transfer stations seek ways of reducing carbon dioxide transport and transferring waste to treatment facilities; treatment facilities are also looking for new technologies with which to reduce the adverse environmental impacts of hazardous wastes. The price of services and the scale of environmental investments are therefore the hot topics of the present study. Researchers argued that medical waste institutions are willing to pay more for a disposal company that invests in environmental efforts [7].

Currently, in Japan, more than 95% of medical waste is entrusted to external sources by hospitals, and its commissioning and disposal must be detailed in written form. Waste-disposal enterprises are subject to a registration and management system, the specific conditions of each waste disposal enterprise must be provided to the discharge unit, and the business license status of the enterprise must be reported, including the type of treatment, daily handling volume, equipment, and methods. Waste from unregistered companies goes untreated. In addition, the government has strict rules regarding medical waste treatment.

In China, the black-market medical waste industry chain, which uses recycled medical waste as raw material, can earn between three and five times more than a normal raw material purchase, regardless of the cost of disinfecting and sterilising it, according to numerous local news reports. There have been, however, many positive changes in medical waste management since the COVID epidemic. The Chinese government has established the principles of 'closed loop management, targeted treatment, and full traceability' for medical wastes.

In February 2022, the Guangzhou Development and Reform Commission announced that, following a price cost monitoring exercise, it had adjusted the medical waste disposal fee to 4.61 yuan/kg, representing an increase from the previous standard charge of 3.65 yuan/kg, following the principle of compensating for the costs of collecting, transporting, storage, and disposal of medical waste and making a reasonable profit. In medical institutions with beds, the charge for each bed rose from 2.3 yuan per bed to 2.9 yuan. Other details were not changed.

In northern cities such as Qingdao, the largest city in Shandong in terms of the economy, in the government's new announcement, clinical waste collection points have been established in places where there is a relatively high concentration of small medical institutions. Apart from the medical

waste generated by the medical waste-collection point itself, medical waste collected by small institutions is subject to a fee of 5 yuan/kg for disposal at the medical waste-collection unit. Clinical waste-disposal units are no longer allowed to charge medical waste disposal fees to small medical institutions that have contracted with clinical waste-collection points. Such a change will be significant for small clinics whose incomes were affected by the national imposition of social distancing, lockdowns, and large-scale PCR testing policies, and they are now expected to pay less than before.

The loading rate for existing medical waste treatment facilities in Xi'an city, in western China, is, on average, 1%. Every piece of medical waste has been disposed of safely, and epidemic medical waste 'generating and discharging day by day' has been achieved. Under the plan, Xi'an Medical Waste Management will be constructed and operational by the end of August 2022, with a total investment of approximately 300 MMB. This project includes an incinerator, boiler, neutralizer reactor, and duster, as well as an electrolytic gas incineration system. The total medical waste disposal capacity, given four microwave waste disposal lines with a capacity of 10 tonnes/day, can be as high as 180 tonnes/day. Although Xi'an has been investing in building up new facilities, the government did not change its guided price.

3. Major Problems with Charges in the Medical Waste Disposal System in the Context of the COVID-19 Pandemic

3.1. Inconsistencies between the Measurement of Fees and Costs

Current calculations of medical waste disposal costs in most provinces in China are based on direct and indirect costs per tonne of medical waste; however, in the collection of medical waste-disposal fees, the main medical institutions producing large quantities of medical waste are charged fees calculated based on a bed-to-day ratio. Because of the different units of calculation, it is difficult to understand the implementation of a fee system based on costs. Clinical waste disposal costs are charged by the tonne, and accordingly, the scale of treatment at the central clinical waste-disposal centre is expressed in terms of 'tonnes/day'. Nevertheless, based on operational experience, there is some contradiction between the adoption of quality units for different types of clinical waste and the actual amount of clinical waste disposed of. This is due to the low density and quality of most medical waste, but also its large quantity. For example, an engineer at the Henan Solid Waste Management Centre, said that a high-temperature steaming process intended for 3 t/d, which the centre is designed to handle at full capacity, actually handles just over 2 t/d, which is below the designed tonnage [8].

Guangdong Living Environment Harmless Treatment Centre Co., Ltd., a state-owned enterprise of Guangdong Environmental Protection Group Co., Ltd., owns the Guangzhou Medical Waste Treatment Station. The company is now responsible for Guangzhou, Chaozhou, Shanwei, and other health institutions generated medical waste and centralized harmless disposal work. There is no doubt that it is a for-profit enterprise, and most of the largest hospitals in Guangdong province are located in Guangzhou, which means that the firm handles most of the medical waste.

After the outbreak of COVID-19, the Guangdong provincial government demanded that, by the end of 2023, the capacity of cities at or above the local level to use and dispose of medical waste would match the type and quantity of hazardous waste produced. With this in mind, they declared that the layout of the facilities used for hazardous waste must be reasonable and that the capacity for the use and disposal of hazardous wastes must meet the actual needs. By 2023, the government expects Guangzhou's centralized disposal capacity for medical waste to process 148 tonnes per day. A report from the People's Government of Guangdong province on the implementation of public health reforms noted that, in Guangdong province, 22 medical waste disposal facilities have been built, so the approved disposal capacity has expanded to 619.9 tonnes per day. The reserve emergency capacity is 1,600 tonnes per day, and pandemic-related medical waste was expected to receive 'daily disposal', instead of piling up in the station. There will still be a great demand for financing to build new facilities.

Although new facilities are being built, the problems of measuring the costs and fees associated with medical waste persist, and no new documents have been issued in reply.

3.2. Differences between Medical Institutions

In 2022, the Guangzhou medical waste disposal fee began including a per outpatient fee. This billing method has resulted in large differences between different types of outpatient services, with some specialised hospitals having fewer patients but higher fees. At the same time, some clinics charge low fees but generate large amounts of medical waste, exposing a large difference in disposal costs. Regarding charging rates, the same bed rate is applied to large hospitals, ignoring the differences among medical institutions. For example, psychiatric hospitals and sanatoriums, which produce less medical waste, are charged at the same rate as general medical institutions, and medical institutions with strong medical capacity apply the same standards as district and county medical institutions, resulting in the unfair assessment of medical waste-disposal costs. These problems were not taken into account in the outpatient approach and have even led to an additional burden on many hospitals.

Because many clinics in villages and towns do not have government subsidies, they must pay for medical waste disposal themselves. In addition to the purchase price of infusion tubes, needles, and other medical supplies, village health clinic and clinic managers are inevitably afraid of problems. The only thing many believe must be adjusted is the fee for such facilities, with the patient or government taking some of the burden if conditions allow it. However, this claim and its practicality are questionable.

4. Suggestions

4.1. Improve Government's Macro-control

Currently, medical waste disposal is self-regulated in large cities, and while the cities' overall charging models are the same, rates vary. For instance, a networked hospital, such as one with headquarters in Guangzhou and branches in Foshan and Heyuan, with general departments and internal auditors based in Guangzhou, will face various methods and fees for inspection and supervision. In addition, the number of outpatient surgeries at major hospitals has plummeted since the pandemic began, and revenues have not yet recovered to pre-pandemic levels. The government should consider transferring the medical waste disposal fees collected by medical institutions directly from the state treasury to the centralised medical waste disposal centres, not withholding them from medical institutions. At the same time, concerning the relevant comprehensive social security system, such as health insurance, medical waste disposal costs should be incorporated into the social healthcare system, ensuring that medical waste is disposed of centrally.

In addition to the above, pricing is not disclosed. The government should consider introducing public scrutiny to balance the interests of companies, patients, and hospitals via cost accounting and pricing hearings, and it should set reasonable rates for medical waste disposal. Implementing a dynamic accounting mechanism for medical waste disposal fees could guarantee the coverage of operational costs and a reasonable profit and return on investment for disposal companies while also promptly strengthening subsidies.

4.2. Inter-management in Medical Institutions

Prior to the pandemic, medical waste management is highly influenced by economic environment and managerial quality [9]. Thus, in Gansu Province, the local government must provide financial and administrative oversight to improve treatment practices, develop internal policies, strengthen management, and reduce medical waste.

As the lead department in medical waste management in medical institutions, the logistics management department is responsible for formulating and implementing medical waste-management systems, guiding and inspecting medical waste collection, transportation, temporary storage, and the management and implementation of occupational safety protection measures; organizing the

emergency management of medical waste loss, leakage, proliferation, and accidents; managing medical waste records; and addressing other problems in medical waste management in a timely fashion.

The management departments of medical institutions are responsible for training medical facility personnel in the theoretical knowledge and operational skills of medical waste management, as well as implementing technical guidance and supervision of medical-waste management in medical institutions. For medical waste generation units (departments), strictly complying with relevant medical waste management requirements is important. The disposal of medical waste bags and containers should be standardized, medical waste should be disposed according to classification requirements in yellow-coated medical waste containers lined with special bags for medical waste, and medical sharps should be discarded in sharp instrument cases after use.

The key for the clinical areas of major hospitals since the outbreak began has been to designate special staff to oversee them and focus on guidelines for separating and disposing medical waste from people visiting emergency areas so as to avoid mixing medical waste with domestic waste and minimize loss, leakage, proliferation, and accidents. Quantitative management and reduction of medical waste sources is also the direction in which major medical institutions are currently working.

4.3. Informatization and Big Data Technology Application

In large medical institutions, a comprehensive closed-loop information management system should be implemented. Researchers have concluded that many commissioned parties receive a financial support of disposed medical waste from the local government in the first operational year to persuade them to use advanced technology for medical waste disposal [10]. This could help control the burden of medical waste expenditures and reduce management expenses. To reduce costs, hospitals invest a great deal of money in information systems construction. All enterprises are the same; the informatization systems are not cheap, but they can reduce the burdens of management and costs in the long term. To ensure quality control, cost accounting and performance appraisals, it is beneficial to carry out classified information statistics and analysis reports regularly and to make regular visits to major hospital medical waste regulatory agencies to put forward practical suggestions to further optimize the existing charging standards and policies.

Some hospitals had purchased certain medical waste collection trucks that have automatic Wi-Fi [11]. After each bag of medical waste is weighed, weight data can be automatically fed into the system and matched to a department and time, generating traceable data for the system, which eventually directly connects with the hospital's medical waste management officer and city's medical waste disposal center.

Given the increasing number of hospitals opting to outsource cleaning services to more established cleaning or real estate companies, it is more important for hospitals to train third-party staff in the use of information technology to manage waste. Prior to arriving at work each day in clinical departments, outsourced third-party cleaners are given barcodes that are specific to certain departments; these are to be attached to the garbage cans when they are packaged. The code is scanned, the can is weighed when the receiver comes down, and the weight and traceability data are automatically uploaded to the system.

Fixed Wi-Fi scales will also be available in operating theatres and ICUs with high levels of waste ready for weighing and entry. In the background data system of the real estate company used for outsourcing, the amount of medical waste generated and the source departments can be seen in real time. Managing the information on the entire process effectively eliminates the need for third-party cleaning staff in hospitals to complete paper handovers, which were easy to damage. Additionally, the data derived from such paper handovers are not easy to use in statistics and can create pollution problems.

It is also worth mentioning that the UK and France have made the on-site disposal of medical waste possible in hospitals. In an era when hospitals around the world still take the traditional path of centralizing medical waste in waste centers, Bertin, a unit of France's CNIM Group, has developed

the most advanced medical waste-handling machine, STERILWAVE, an all-in-one machine that safely disposes of medical waste [12]. Its greatest innovation is the idea of Internet regulation. In this regard, China is in a void. Overall, immediate collective, voluntary, and effective measures for environmentally sustainable medical waste management are in demand, especially in countries currently battling the COVID-19 pandemic.

5. Conclusion

This paper presents the phenomenon of medical waste disposal in China, especially after the outbreak of COVID-19, and analyses the main problems of medical waste-disposal prices. The key issues are the weak supervision of charging policy implementation, the problem of billing methods, differences across medical institutions, a lack of dynamic pricing adjustment mechanism, and social debate on government guided pricing.

In an attempt to solve the existing problems of medical waste disposal, this paper put forward some feasible suggestions. By implementing a comprehensive closed-loop information-management system, the burden of medical waste expenditure will be controlled, management costs will be reduced, weight-based disposal will be popularized, specific monitoring mechanisms will be available in all provinces, information will be open, dynamic subsidy mechanisms will exist, and source classification management will be strengthened.

The paper puts forward theoretical solutions to existing problems in the medical waste-disposal pricing system, such as a broader macro-control from central and local governments, expanding inter-management inside institutions that generate medical waste and applying big-data technologies and other information systems to manage the source of medical waste. Nevertheless, in-depth research is still required in practice due to the existence of various professional domains.

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