

# Study on the Current Situation of Medical Waste Disposal and Countermeasures in Gansu Province

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**Abstract.** In 2023, Gansu Province, a total of 23 built and put into operation of the centralized disposal unit of medical waste, 14 municipal and state-level, 9 county-level disposal units; production line a total of 39, 15 incineration type process, non-incineration type process 24; Lanzhou City, the day-to-day use of rotary kiln incineration disposal, the rest of the municipalities and states of the disposal unit are the day-to-day use of non-incineration method of disposing of medical waste, the incineration method of process production line on a regular or Regular or irregular operation of the incineration process production line to dispose of the last three types of medical waste. In view of the problems in the disposal and management of medical waste in the province, countermeasures and suggestions have been put forward, such as the preparation of the Gansu Province Medical Waste Disposal Technology and Capacity Enhancement Plan, the construction of a mechanism for dynamic monitoring and risk assessment of medical waste, the exploration of efficient operation modes, the formulation of incentivizing regulatory policies, the research and development of new and high-tech disposal technologies, and the introduction of low-temperature magnetization and cracking technical specifications.

**Keywords:** medical waste disposal; Gansu Province; environmental impact; risk assessment; policy recommendations.

## 1. Introduction

Medical waste is classified as hazardous waste, posing biological and chemical risks due to its complex characteristics. Domestically, it is divided into five categories: infectious, injurious, pathological, chemical, and pharmaceutical. The primary goal of medical waste treatment is to achieve “harmlessness, minimisation, and resourcefulness.” In recent years, with the occurrence of public health events, its production volume and societal attention have gradually increased.

Gansu Province, covering an area of 425,800 km<sup>2</sup> with a population of 24,654,800 (as of the end of 2023), consists of 14 cities and states. In 2009, Gansu was designated as one of the six national demonstration provinces for the integrated management and coordinated disposal of medical waste. In recent years, Gansu has been exploring practical approaches to integrated management and coordinated disposal in response to the growing needs of medical waste management [1]. In 2021, 2022, and 2023, the amount of medical waste collected in Gansu Province totaled 15,989.75 tonnes, 42,399.35 tonnes, and 16,956.92 tonnes, respectively. Among these, infectious medical waste accounted for 89.60%, injurious medical waste for 8.14%, and pathological, chemical, and pharmaceutical medical waste for 2.26%.

In 2023, there were 38 medical waste operating units in Gansu Province, of which 26 were centralized disposal units, with 23 in operation and 3 under construction. All of these disposal units were located at the county or district level. The remaining 12 were county-level medical waste collection and transfer stations, 10 of which were already operational, with 2 still under construction [2].

With the widespread application of new medical technologies and materials, the complexity and risks associated with medical waste disposal have further increased. As a sparsely populated and multi-ethnic province, the safe disposal of medical waste in Gansu is of particular importance. Given the current state of medical waste management in the province, it is crucial to scientifically assess and evaluate the safety, effectiveness, and environmental impact of existing treatment processes. Additionally, due to the unique geographic characteristics of Gansu, there is a pressing need for research and development of new medical waste treatment technologies tailored to the province's specific needs.

## 2. Current situation of medical waste disposal in Gansu Province

### 2.1 Disposal Scale and Categories

As of the end of 2023, Gansu Province operates 23 centralized medical waste disposal units, comprising 14 municipal and state-level units and 9 county-level units. Among these, 16 units use combined disposal processes, while 7 units use a single process. The approved disposal capacity stands at 161.40 t/d, with an emergency disposal capacity of 36.35 t/d for standby (production lines that are not in operation during normal daily processing). Thirteen cities and states have disposal capacity for all five categories of medical waste. However, Zhangye City and its state only have disposal capacity for infectious waste (841-001-01), injurious waste (841-002-01), pathological waste (841-003-01—limited to certain types, excluding human organs and infectious animal carcasses), chemical waste (841-004-01), and pharmaceutical waste (841-005-01) collection and storage. This city lacks full disposal capacity across all categories.

### 2.2 Disposal Process Selection

Currently, the primary disposal method for non-incineration medical waste in the province is rotary kiln incineration in Lanzhou City. In the other municipalities and states, non-incineration methods are predominantly used for daily disposal of medical waste, while incineration processes are operated either regularly or intermittently to manage the remaining categories of medical waste. Among the 13 municipal and state-level medical waste disposal units, 1 uses a non-incineration + incineration process configuration, while 12 use a non-incineration + incineration process configuration. There are also 2 county-level units with non-incineration + incineration process configurations, and 7 county-level units that rely solely on non-incineration processes. In total, there are 39 production lines, including 15 incineration-type processes and 24 non-incineration-type processes, as shown in Table 1.

Table 1: Statistical Table of Technology Adoption and Disposal Scale of Medical Waste Disposal Units in Gansu Province in 2023

Process Classification		Adoption Quantity (Number of Firms)	Disposal Scale (t/d)	Proportion of the Entire Province (%)	Subtotal (%)
Incineration Process	Rotary Kiln Incineration	1	14.65	9.08	33.24
	Pyrolysis Incineration	7	34.80	21.56	
	Low-Temperature Magnetization Pyrolysis	7	4.20	2.60	
Non-Incineration Process	High-Temperature Steam Sterilization	14	59.45	36.96	66.76
	Microwave Disinfection	10	48.30	29.80	

Total Quantity		39	161.40	100.00	100.00
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### 2.3 Operation and Management Modes of Disposal Units

The operation and management modes of the 23 centralized medical waste disposal units established and operated in Gansu Province mainly include the enterprise-based operation mode, government operation mode, and PPP (Public-Private Partnership) operation mode. Among these, 11 units operate under the enterprise-based model, accounting for 47.83%; 10 units follow the government operation model, accounting for 43.48%; and 2 units are managed under the PPP model, accounting for 8.69%.

Among the 23 medical waste disposal units, 4 are managed by the Housing and Urban-Rural Development Bureau, accounting for 17.40%; 3 are managed by the Sanitation Bureau, accounting for 13.05%; 4 are overseen by the Ecology and Environment Bureau, accounting for 17.40%; 2 are managed by the Health Commission, accounting for 8.67%; 2 are under the Law Enforcement Bureau, accounting for 8.67%; and 1 is managed by the Financial Services Bureau, accounting for 4.35%. Additionally, there are 2 state-owned enterprises, accounting for 8.67%, and 5 private enterprises, accounting for 21.79%.

## 3. Issues and Challenges in Medical Waste Disposal in Gansu Province

### 3.1 Imbalance in Medical Waste Generation and Treatment Capacity Across Different Regions.

Lanzhou, with its strong medical waste disposal infrastructure and technological reserves, is relatively capable of effectively addressing waste disposal and emergency management needs. However, for some remote and economically underdeveloped areas, particularly in regions like Qingyang and Longnan, issues such as outdated facilities, a shortage of talent, lack of environmental awareness, and inadequate supervision lead to serious medical waste disposal risks and environmental pollution problems. These areas struggle to respond to emergency needs during sudden large-scale public health events.

### 3.2 Significant Gap in Treatment Capacity and Technological Level Compared to Eastern Coastal Developed Areas.

Due to its inland location and relatively underdeveloped economy, Gansu Province faces limitations in terms of talent, technology, and funding. As a result, the medical waste disposal capacity in the province is significantly behind that of developed areas in eastern coastal regions. This gap is particularly evident in centralized disposal capacity and technology, where noticeable shortcomings are apparent. The primary environmental impacts and risks in Gansu's medical waste disposal include potential hazards from infectious medical waste, leakage of harmful chemicals, and the safe disposal of radioactive medical materials. These issues are directly related to hospital infection management, disease transmission risks, environmental pollution, and ecological balance.

### 3.3 Problems with Non-Incineration Technologies.

In Gansu Province, except for Lanzhou, the average daily medical waste generation in other cities and regions is below 5 tons. In some areas, such as Gannan, the daily waste generation is only about 1 ton, which makes it difficult to meet the requirements for continuous and stable operation of incineration equipment. This is the main reason why many regions choose non-incineration technologies.

The province adopts a diversified approach combining physical, chemical, and biological methods for non-incineration medical waste disposal. This choice is based on local conditions, management levels, operating costs, and public environmental awareness. The number of devices and chemicals used for solidifying, disinfecting, and decomposing medical waste has reached 24,

with most preferring environmentally friendly chemical disinfectants and mechanical shredding methods to reduce the risk of secondary environmental pollution [3]. However, the following issues are evident:

(1) The widespread use of non-incineration technologies, while reducing the environmental pollution issues associated with incineration, has limited capability in handling specific medical waste types. It cannot meet the diverse and complex medical waste treatment needs, such as the safe disposal of sharp objects and laboratory chemical waste, which remain difficult to address with targeted and efficient technologies.

(2) The operation and maintenance costs of non-incineration equipment are relatively high, especially for county-level medical waste disposal facilities. Additionally, the slow update of disposal technologies results in low operational efficiency, making it difficult to meet the rapidly increasing demand for medical waste disposal.

(3) Non-incineration technologies cannot handle the three remaining categories of medical waste and must be used in conjunction with incineration technologies. Seven cities and regions have adopted low-temperature magnetization technologies to complement incineration, with a disposal scale of only 0.5–1 ton per day.

(4) Some treated waste still has a high infection risk. Research has shown that certain pathogens have strong resistance to thermal disinfection

### 3.4 Problems with Incineration Technology

Although incineration technology has the ability to dispose of all five types of medical waste and has advantages such as high harmlessness and significant volume reduction, it also has drawbacks such as high operating costs, high technical requirements, a lack of specialized technical personnel, and difficulties in meeting emission standards. Issues in its practical application include:

(1) Incineration is based on the actual collection volume of the three remaining categories of medical waste, and the equipment operates either regularly or irregularly, with a low daily usage rate.

(2) Some pyrolysis processes use fixed furnace single-unit technology, which cannot achieve continuous and stable operation.

(3) Low-temperature magnetization technology lacks national technical standards.

(4) The selection of pyrolysis or low-temperature magnetization technologies shows regional distribution characteristics, with the Hexi Corridor and some neighboring areas using low-temperature magnetization technology, while other regions adopt pyrolysis technology. The selection of processes needs further investigation regarding the compatibility with local geographical conditions, engineering technology, and the needs for medical waste generation and disposal.

## 4. Summary and Recommendations

### 4.1 Summary of the Development of Medical Waste Disposal Technology in Gansu Province

The medical waste disposal technology in Gansu Province has seen significant advancements. Fifteen disposal units in thirteen cities and states now have incineration processes in place to handle all five types of medical waste. The incineration disposal processes mainly consist of one rotary kiln incineration, seven pyrolysis processes, and seven low-temperature magnetization processes. In terms of non-incineration processes, microwave disinfection has developed rapidly, gradually replacing some of the previous high-temperature steam sterilization processes. New projects now mostly select microwave disinfection. The number of microwave disinfection processes has increased from one in 2015 to eleven today, while high-temperature steam sterilization processes have remained relatively stable, with fourteen currently in operation [4].

The disposal processes have evolved from being dominated by incineration methods in the past to a current dual approach, where both incineration and non-incineration methods coexist.

Previously, only Lanzhou City could handle all five types of medical waste, but now, thirteen cities and states have the capacity to treat all five types. Additionally, fourteen cities and states now have standardized facilities for the collection and storage of all five types of medical waste, greatly alleviating the issues surrounding the safe disposal of medical waste generated by medical institutions in the province.

#### 4.2 Suggestions for Enhancing Disposal Capacity and Management Countermeasures

(1) Develop a Gansu Province Medical Waste Disposal Technology and Capacity Enhancement Plan: A reasonable allocation of disposal capacity across the province is essential. The construction of disposal capacity should align with the current status and development plans for municipal disposal centers to avoid regional overcapacity or undercapacity. The plan should consider the emergency needs of large-scale public health events. Existing centralized disposal units should be upgraded to suit local conditions and medical waste generation levels. When choosing disposal technologies, factors like applicability, reliability, investment and operating costs, processing efficiency, capacity, and simplicity of operation should be prioritized. It is also important to ensure that the chosen technologies do not lead to secondary pollution and that they can meet the requirements for pre-treatment and final disposal, particularly for medical waste from different grades.

(2) Establish a Dynamic Monitoring and Risk Assessment Mechanism for Medical Waste: The integration of an intelligent management system utilizing Internet of Things (IoT) and big data technologies will enable real-time monitoring and data analysis of the entire process of medical waste generation, collection, transportation, and treatment. This will optimize resource allocation, reduce labor costs, improve process safety and adaptability, and ensure transparency and standardization in medical waste treatment. Timely identification of potential pollution issues will allow for targeted interventions and continual optimization and risk control in the medical waste disposal process across Gansu Province.

(3) Explore Efficient Operation Models to Improve Disposal Efficiency: A deeper analysis of the current state of the medical waste disposal industry in Gansu Province is needed. Research should focus on the high-quality development of the industry, identifying the strengths and weaknesses of existing operational models. Various more efficient operation models, such as commissioning, DBO (Design-Build-Operate), and entrusted operations, should be explored. The goal is to ensure the safe and stable operation of disposal units and to foster a new model of public-private partnerships in waste treatment.

(4) Formulate Incentive Regulatory Policies and Improve the Financial Subsidy Mechanism: Policies should encourage the use of clean energy and renewable materials, raise technological standards in waste treatment processes, and motivate enterprises to invest in advanced technology and equipment, accelerating the modernization of the industry. Additionally, financial subsidies should be improved, considering the status and safety of collection points, transportation costs, and cross-regional disposal oversight to create a favorable industrial ecosystem.

(5) Conduct Technical Assessment and Summarize the Low-Temperature Magnetization Cracking Process: With the increasing adoption of low-temperature magnetization cracking processes, technical specifications should be introduced and technical assessments should be carried out to evaluate the effectiveness of this technology.

(6) Strengthen the Regional Coordinated Disposal Mechanism: Collaborative disposal between neighboring regions, disposal units, and domestic waste incineration power generation units should be enhanced. For smaller amounts of certain types of medical waste, local domestic waste incineration power generation units can be utilized, which will help reduce disposal costs significantly.

(7) Increase Investment in Human Resources and Financial Support: To bridge the gap with developed regions, more investments should be made in both human resources and financial resources. Training programs for existing professionals should be strengthened, and senior

personnel from developed areas should be introduced to improve local technological expertise. Non-incineration and incineration technologies have certain limitations, so a combination of both should be optimized. The development and application of new, efficient, and environmentally friendly disposal technologies, such as plasma pyrolysis technology, supercritical water oxidation technology, and joint treatment technologies, should be encouraged. These technologies not only improve treatment efficiency but also reduce operational costs.

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