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Managing Healthcare Waste in Developing Nations: A Growing Public Health Challenge

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Healthcare waste (HCW), or medical waste, encompasses all waste generated by healthcare activities, from hospitals and clinics to laboratories and home care [1]. While approximately 85% of HCW is general, non-hazardous waste, the remaining 15% is classified as hazardous. This hazardous fraction includes infectious materials, sharps, pharmaceutical waste, chemical waste, and radioactive waste. Improper management poses severe risks to human health and the environment [1]. A critical issue in low-income countries is the lack of waste segregation. This leads to contamination of general waste, with hazardous waste in some facilities like those in Ethiopia reaching 62.74%, well above World Health Organization (WHO) standards [2]. HCW makes up about 1–2% of urban waste globally [1]. Waste generation is projected to grow by 73%, reaching 3.8 billion tonnes by 2050, significantly affecting low- and middle-income countries [3]. The economic cost could rise from USD 361 billion in 2020 to USD 640.3 billion by 2050. However, a shift to circular economy practices could yield a net benefit of USD 108.5 billion annually [3].

Why the Crisis is Deepening in Developing Countries

➤ Inadequate Infrastructure and Technology Access

Many developing countries lack the infrastructure and technology required for safe HCW management. Hospitals often do not have incinerators or autoclaves, leading to unsafe practices such as open burning or unregulated landfilling [1,4]. Table 1 presents a summary of hazardous waste generation rates (kg/bed/day) for various countries and income categories. Though low-income countries generate less hazardous waste up to 0.2 kg/bed/day compared to 0.5 kg in high-income countries, the poor segregation practices recorded in these low-income countries make much of this waste remains untreated [1].

Country	Hazardous Waste Generation Rate (kg/bed/day)
High-income countries	Up to 0.5
Low-income countries	Up to 0.2
India	0.8–2.31
China	0.6–4.03
Ethiopia	1.1–1.8
Kazakhstan	5.34–5.4

Table 1: Hazardous Waste Generation Rate (kg/bed/day) in Various Nations

➤ **Inadequate Infrastructure and Technology Access**

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➤ **Severe Financial Constraints**

Healthcare systems in low-income countries prioritize clinical care over waste treatment. Public hospitals operate under strict budgets, and international funds are limited. The Global Fund allocated just 0.3% to HCW management (HCWM), and many COVID-19 responses spent less than 1% on waste management [6,4].

➤ **Low Awareness and Unsafe Practices**

Healthcare workers often lack awareness of HCW risks. In Ethiopia, 60.3% of staff experienced needlestick injuries, and across 22 developing nations, only 41% of workers received training [7,8]. Manual sorting without personal protective equipment (PPE) is widespread, increasing exposure to infections.

➤ **Weak Regulatory Frameworks**

Enforcement of regulations is weak. For instance, Bangladesh's 2008 HCWM rules included provisions for a central authority which was never established [9]. In India, rural regions show poor compliance, and waste disposal is often outsourced to unlicensed contractors [10].

Informal waste workers operate without legal protections or PPE, leading to respiratory illnesses, infections, and reproductive disorders [3]. These workers are usually marginalized and excluded from formal waste management systems.

➤ **Worsening Conditions such as Population Growth and Pandemics**

Urbanization, population growth, and pandemics are rapidly increasing waste volumes. Waste generation in low-income countries is projected to triple by 2050 [3]. COVID-19 drastically increased plastic waste, further straining weak HCWM systems [11].

Pathways to Progress Towards Sustainable Healthcare Waste Management

Improper HCWM leads to disease spread such as human immuno-deficiency virus (HIV), Hepatitis, tuberculosis (TB), and cholera. Annually, 16 billion injections are administered, many without proper disposal. Poor HCWM contributes to 5.2 million deaths per year [12].

Environmental damage includes soil and water contamination from pharmaceuticals, open burning emissions (e.g., dioxins, furans), and microplastics. Sri Lanka emits 17.070 g TEQ (Toxic Equivalent Quantity) annually from small facilities and 179 kg of mercury per year [13,14]. Table 2 outlines key strategies and practical steps recommended for achieving sustainable HCWM, with regional examples and global best practices.

Step	Description	Examples / Remarks
Segregation at Source	Use color-coded bins to separate waste types (e.g., yellow for biohazards, brown for radioactive, black for general).	Reduces hazardous volume; implementation still inconsistent despite growing awareness [15].
Onsite Treatment Solutions	Employ autoclaves, microwaves, and Sterilwave systems for decentralized treatment.	Suitable for low-resource areas; Sri Lanka's incinerators often remain inefficient [16].
Training & Capacity Building	Continuous training for HCW handlers enhances safety and compliance.	WHO and United Nations Development Programme (UNDP) have run effective programs in South Asia [5].
Public-Private Partnerships (PPP)	PPPs can improve infrastructure and innovation.	Sri Lanka set national benchmarks; Nepal's World Bank-funded PPPs expanded waste coverage to 70% [17,18].
Stronger Policies & Monitoring	Enforceable waste policies and tracking systems are essential.	India (2024 rules) uses audits/digital tracking; Bangladesh lags in enforcement [3,9].

Circular Economy Models	Convert waste to resources through recycling and energy recovery.	Tribhuvan Hospital (Nepal) reduced costs via recycling; aligns with United Nation's Environment Programme (UNEP) 2024 recommendations [14,19].
Innovation & Best Practices	New technologies like solar-powered autoclaves and Sterilwave improve efficiency.	Developed by MIT/IIT and others for rural/urban needs [20].
Community Involvement	Engage local communities and cooperatives in HCWM activities.	Nepal & Sri Lanka initiatives support hygiene and livelihoods; e.g., biogas use at Tribhuvan Hospital [14].
Global Support	International agencies offer funding, tools, and training.	WHO, UNDP, UNEP, World Bank invested \$5.13 billion in solid waste projects (2003–2021) [3].

Table 2: Key Steps for Sustainable Healthcare Waste Management (HCWM)

Final Note

Effective healthcare waste management is no longer optional, it is essential for protecting public health, the environment, and future generations. With coordinated efforts across policy, technology, education, and community engagement, countries like Sri Lanka and its neighbors can transition toward safer, more sustainable HCWM systems. Global support and regional innovation must continue to drive this progress.

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