

# Environmental Impact of Single-Use Medical Devices

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### Introduction

The healthcare sector produces a significant amount of waste contributing to landfills and pollution through incineration. A large portion of this waste is made up of single-use products and devices (SUDs) like gloves, wipes, catheters, and syringes. The COVID-19 pandemic has also contributed to a significant rise in the use of single-use face masks.

Current disposal methods include reprocessing of the device, recycling parts of the device, incineration, and landfilling [8]. All methods provide either provide minimal economic and environmental benefits or cause harm to exposed communities through environmental damage and health complications.



Figure 1: Various mass-produced single-use medical devices. Photo: Chevron Phillips Chemical Company [6]

### Environmental Impact

The healthcare industry is responsible for roughly 5% of greenhouse gas emissions, making it the fifth-largest emitter worldwide. United States Healthcare facilities account for nearly a quarter of those greenhouse gas emissions. Medical devices alone account for nearly 50% of emissions in the U.S. [1]. Current estimates suggest that nearly half of the world's population faces threats from environmental pollution and human health due to the unsafe disposal of healthcare waste [4].

Advancements in plastic and electronic production have led to widespread adoption of single-use devices and have further increased healthcare waste.

#### Production

- Petroleum-based plastics are used extensively in many SUDs
- Designed with little consideration for reuse or recycling

#### Transport

- Produce carbon emissions

#### Incineration

- Devices that contact biological components must be incinerated or disinfected prior to disposal [3]
- Produces dioxins, one of "the most toxic chemicals known to humankind" [2]
- Linked to cancer, immune system disorders, diabetes, birth defects, and disrupted sexual development
- Responsible for 10% of mercury emissions, and other toxic pollutants [2]

#### Landfill

- Toxic ash from incinerators disposed of in landfills may leach into groundwater

### Sensitive Unit

The end of life of medical products and devices is the least refined and therefore most sensitive of the LCA units. Currently, most medical waste is incinerated and landfilled which releases pollutants and carcinogenic dioxins in the air, harming the environment and public health [2].

Landfilling of electronic medical devices or e-waste releases harmful toxins and heavy metals like mercury, arsenic, and lead. These toxins should be filtered out of the landfill's water pools before it is released into the public water system. However, 80% of e-waste is shipped to developing countries in Asia where the infrastructure and regulations for such practices may not exist [9]. This also poses a threat to public health in vulnerable communities.



Figure 3: A woman holds onto the pipe of a blood bag, with the blood still visible, at a dumping ground in Parairchawk of Sylhet, Bangladesh, where medical waste is mixed with other wastes. Photo: Sheikh Nasir [7].

Many devices are made of high-quality materials that can be reused or recycled. This is typically done with large electronic equipment like MRI machines [5]. However, small electronic devices and instruments are not recycled because it is more cost-effective to buy new units.

Reprocessing of used medical devices is unpopular because of hygiene concerns and regulations. Potential candidates for reprocessing are low in complexity so they can be taken apart and are made of few materials for ease of sanitation [5]. It is also only cost-effective for highly-priced devices. Additionally, the reprocessing of some devices uses more energy than manufacturing, and sanitization agents can also release harmful toxins. Therefore, this method is sometimes found to be counterproductive.

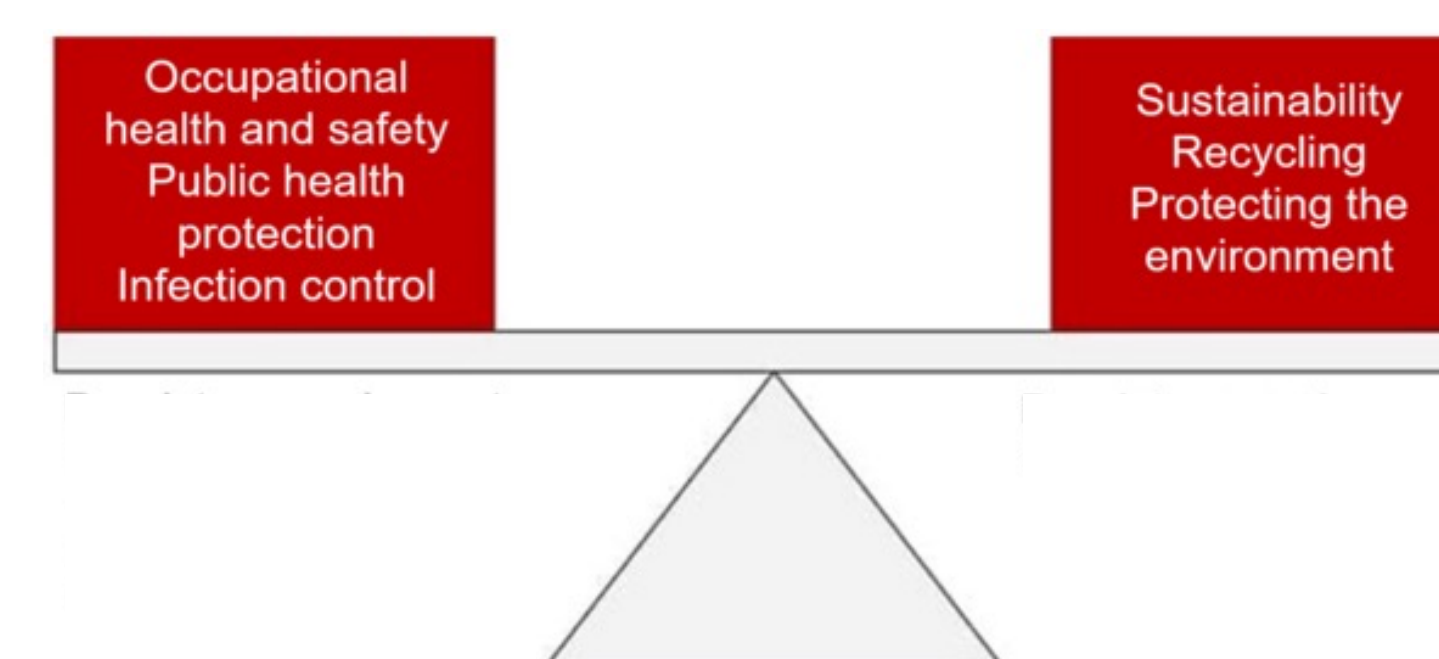


Figure 4: The recycling of medical devices conflicts with occupational health and safety [6].

### Research

#### Hypothesis

Designing single-use medical devices with more considerations for reuse and recycling will help reduce the environmental impacts caused by their disposal.

#### Protocol

- Identify parts that are not directly contaminated and can be easily sanitized in the hospital for reuse
- Simplify designs so it is easy to take apart the device
- Decrease packaging materials
- Investigate more sustainable materials like bioplastics or faster degrading plastics

#### Analysis

Collect data on emissions in the air and pollutant concentration in water over 5-10 years. Examine the development of different devices and look for changes in the amount that can be recycled.

### References

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### Process Description

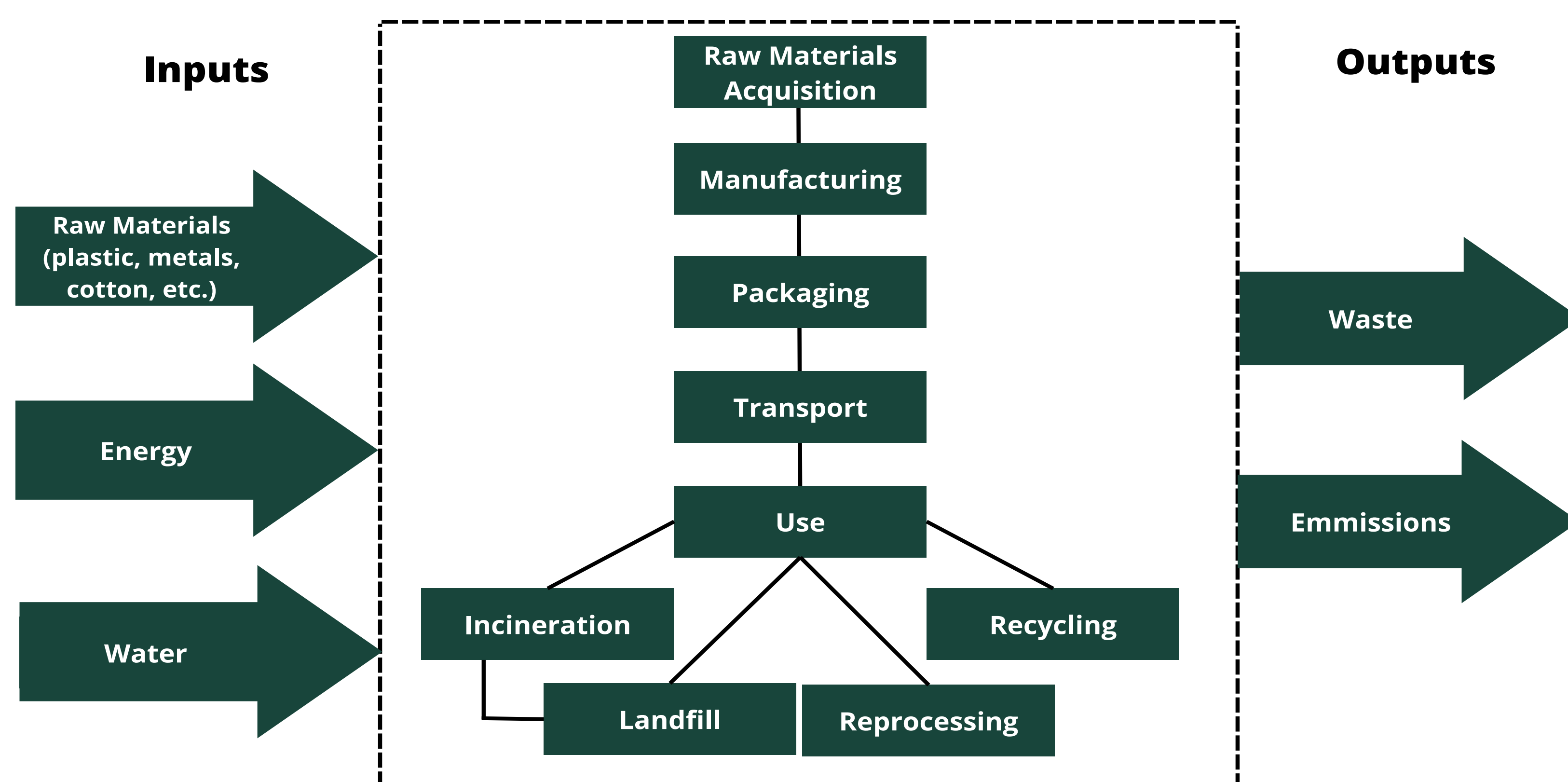


Figure 2: A cradle-to-grave life cycle analysis of a typical single-use medical device.