



# Healthcare & Waste

Plastic, Medicine, and Waste Management

**5,000,000  
tons**

Annual hospital waste  
in the US

**25%**

**PLASTIC**

Percent of medical waste  
single-use plastic

**129,000,000,000**

Surgical masks used since  
2020

**3,000,000**

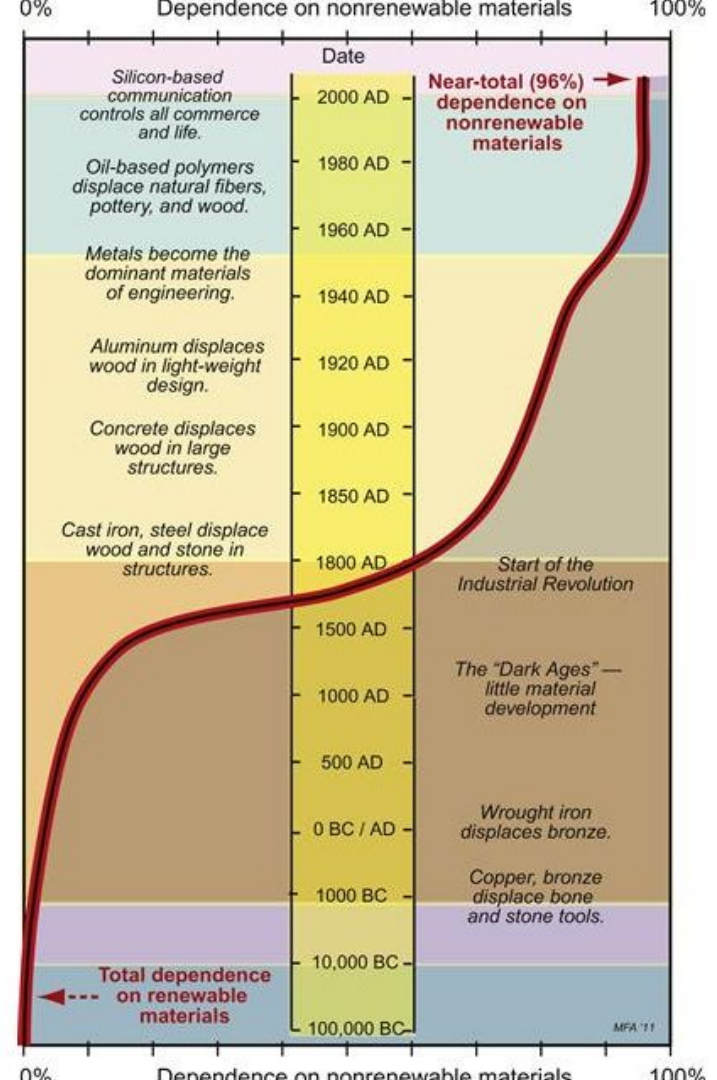
**Masks disposed every minute**

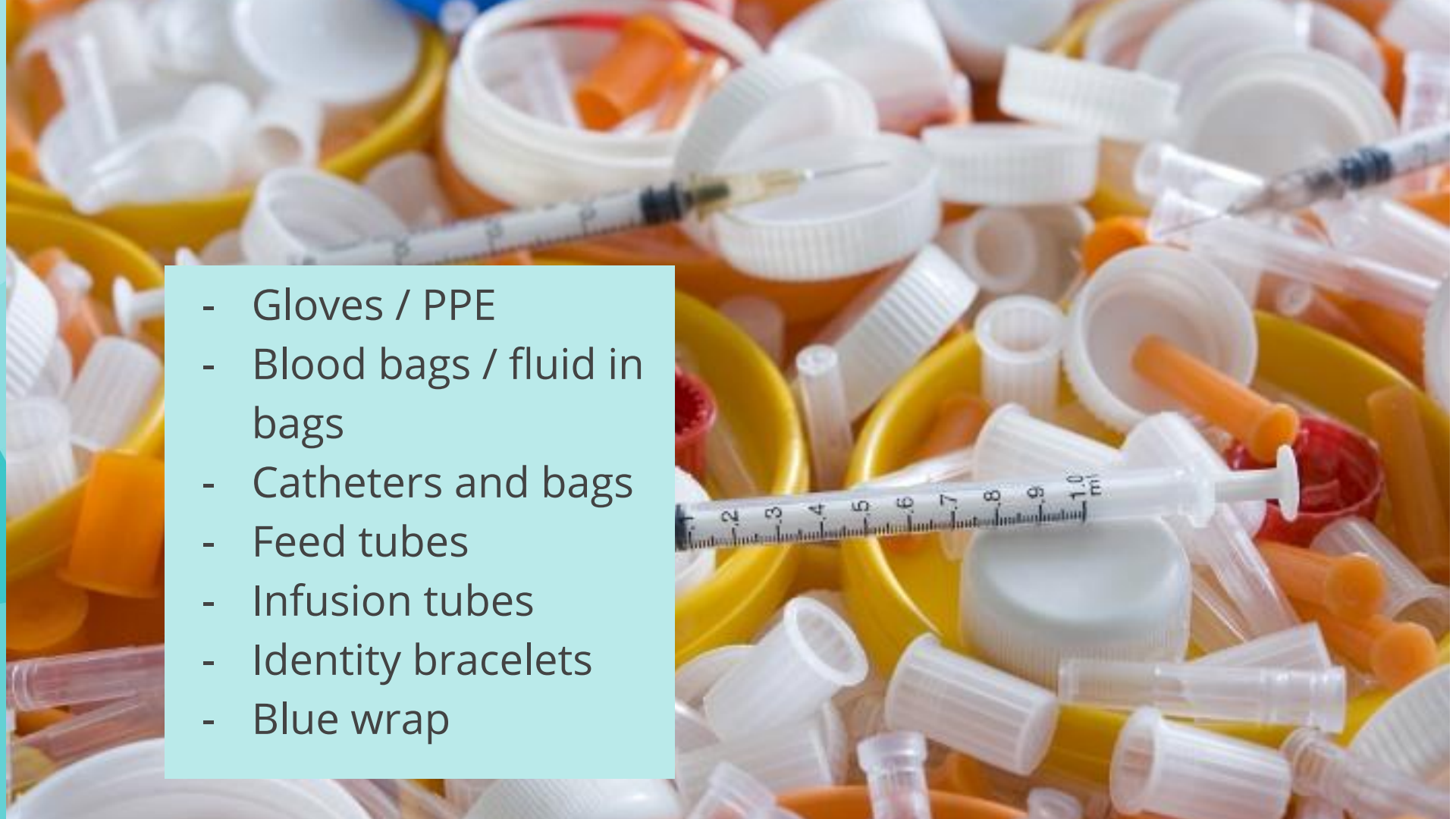
# Material history

“Scientific Revolution” beginning in **1543**:

- shift in health and medicine
- population growth
- new demands for unsustainable growth

Huge medical accomplishments, but almost complete dependence on nonrenewable materials today



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- Gloves / PPE
  - Blood bags / fluid in bags
  - Catheters and bags
  - Feed tubes
  - Infusion tubes
  - Identity bracelets
  - Blue wrap



# IMPORTANCE OF WASTE SEGREGATION

## Infectious

Contaminated by pathogens: cultures, waste from surgeries, infected patients



## Sharps

Syringes, needles, scalpels, saws and knives, broken glass, infusion sets



## Pathological

Organs, tissues, body parts, fetuses, bodily fluids



## Pharmaceutical

Expired, unused, spilled, contaminated, surplus drugs, vaccines, serums; bottles, gloves, tubes



## Chemical

Syringes, needles, broken glass



## Genotoxic / Radioactive

Anything contaminated with cytotoxic drugs or radio nuclides



## THE STORY OF PLASTIC | IV BAGS

In 1931 the Baxter Travenol Company marketed the first IV solutions in glass bottles. Plastic bottles were introduced in the late 1940s, and the first flexible plastic IV bag was released in 1970. The IV bag allowed for closed transfusions, reducing the risk of contamination.



Rubber

**Transfuso-Vac  
1931**



Plastic

**Modern  
IV bag**



### Usage

The U.S. uses around 20 million IV saline bags a month.



### Recycling

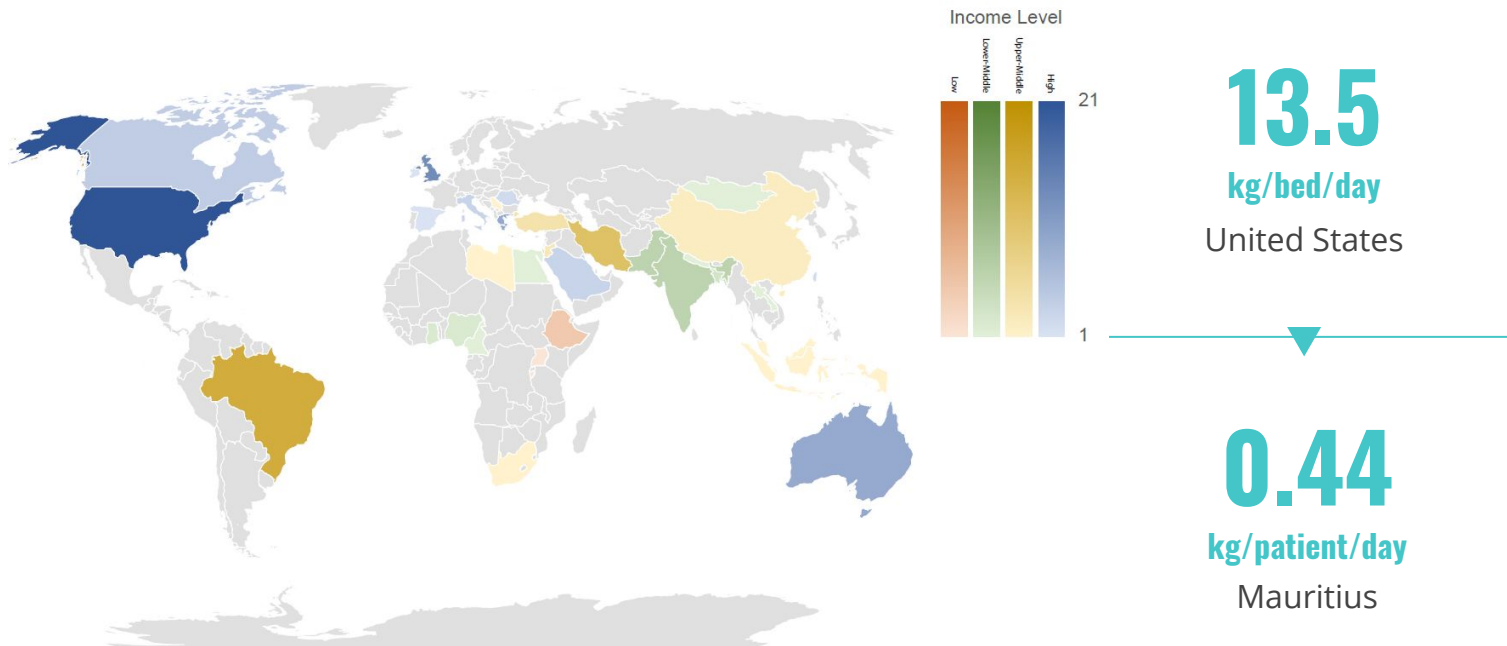
IV bags that contained regular saline or electrolyte solution can be recycled.



### Did You Know?

U.S. health-care facilities generate about 14,000 tons of waste per day; up to 25 percent is plastic.

# Worldwide Healthcare Waste Generation



Number of published hospital waste audits by country, color coded by national income level (World Bank data)



## Sawalem et al. 2009

*M. Sawalem et al. / Waste M*



**Fig. 3.** On-site storage at one healthcare facility in Libya.



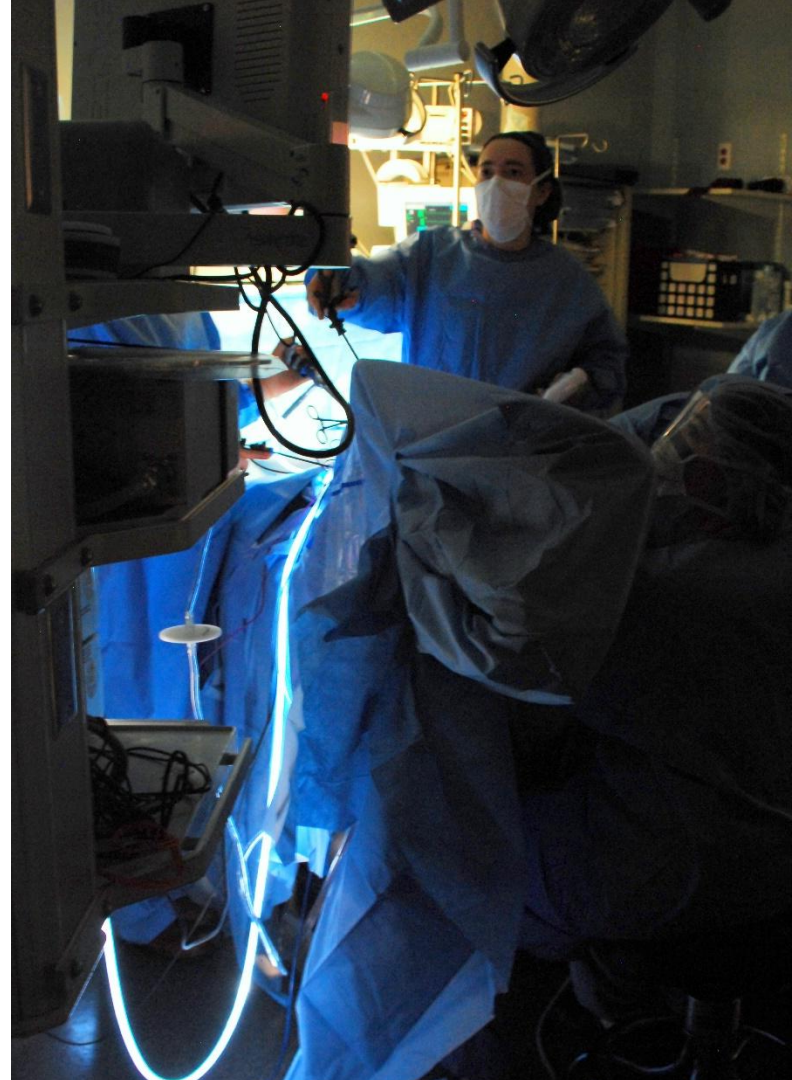
**Fig. 4.** Transportation of hospital waste in Libya.

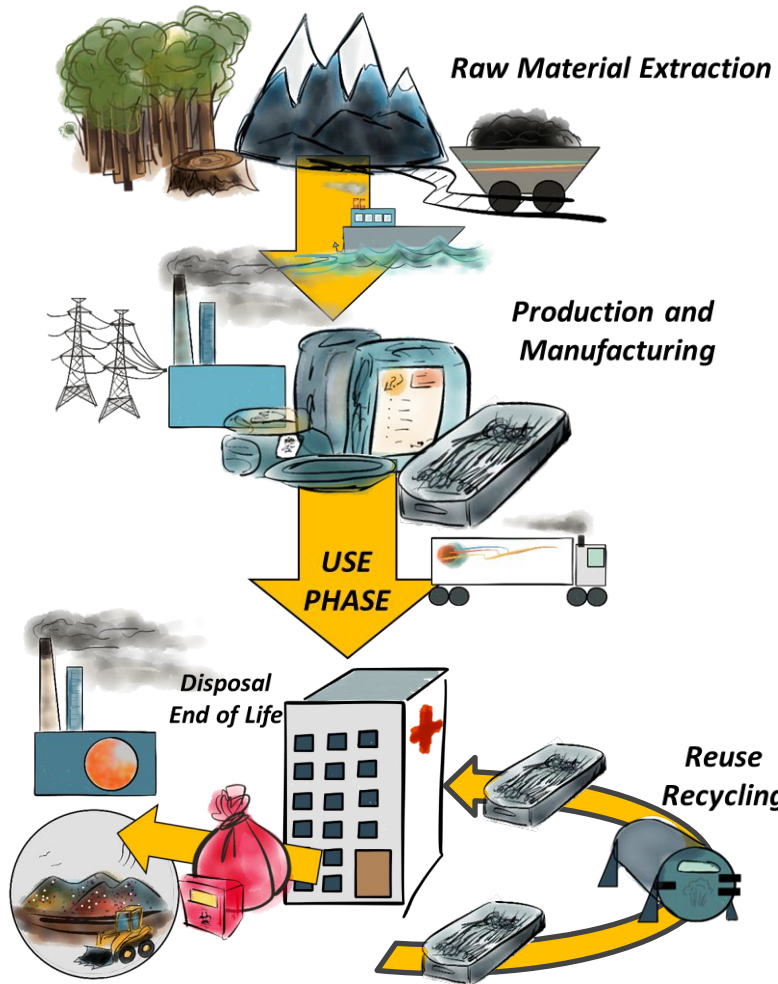
# PLASTIC

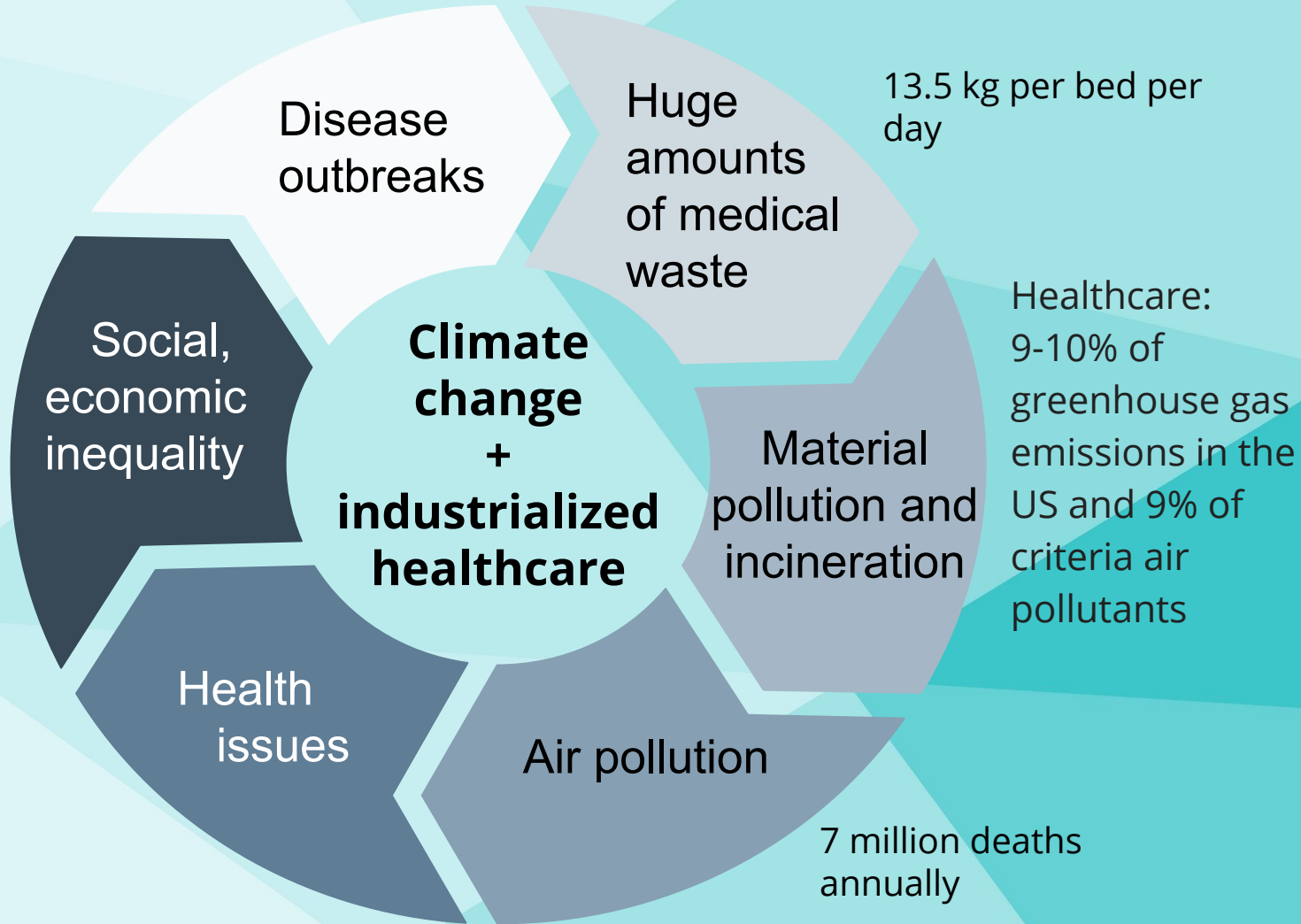
Operating rooms: up to 75% of hospital waste

Legal mandates to be single-use

Just-in-time supply chains





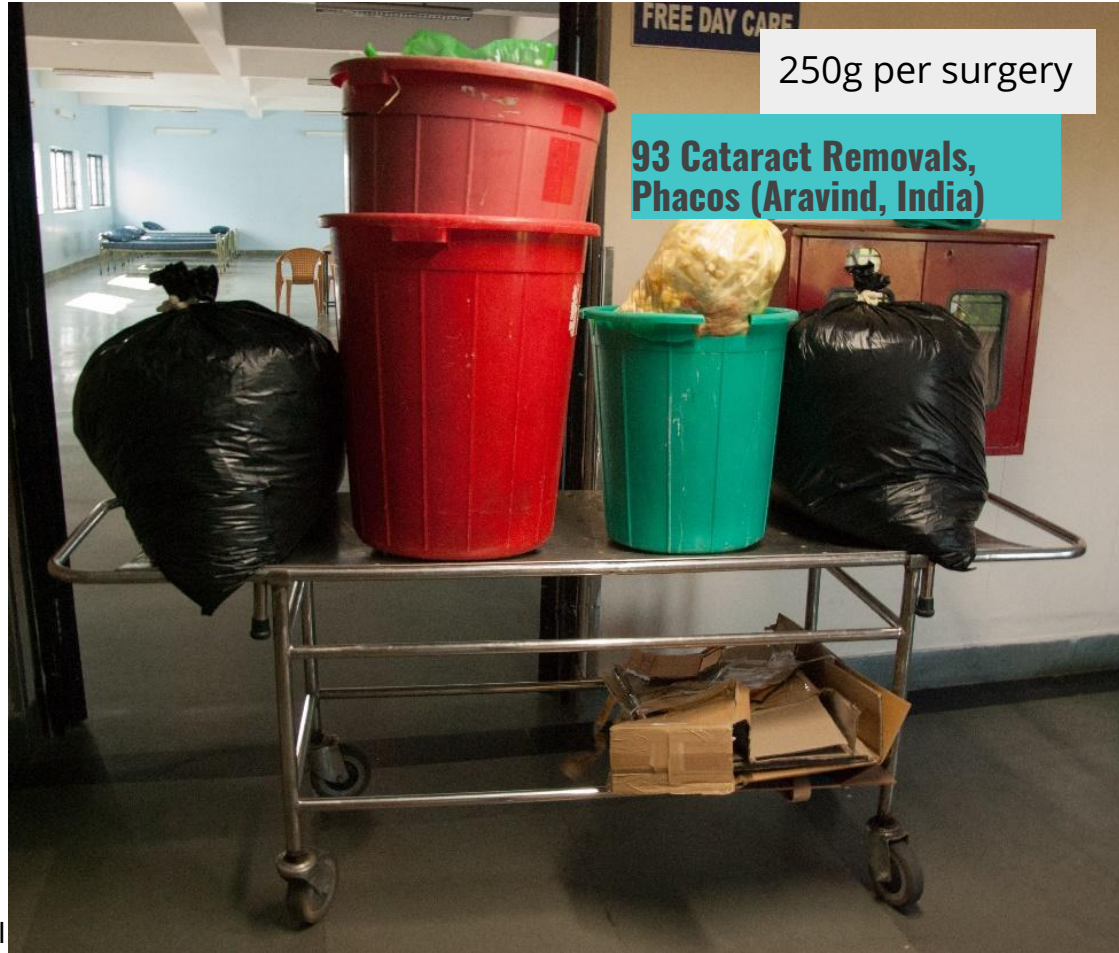


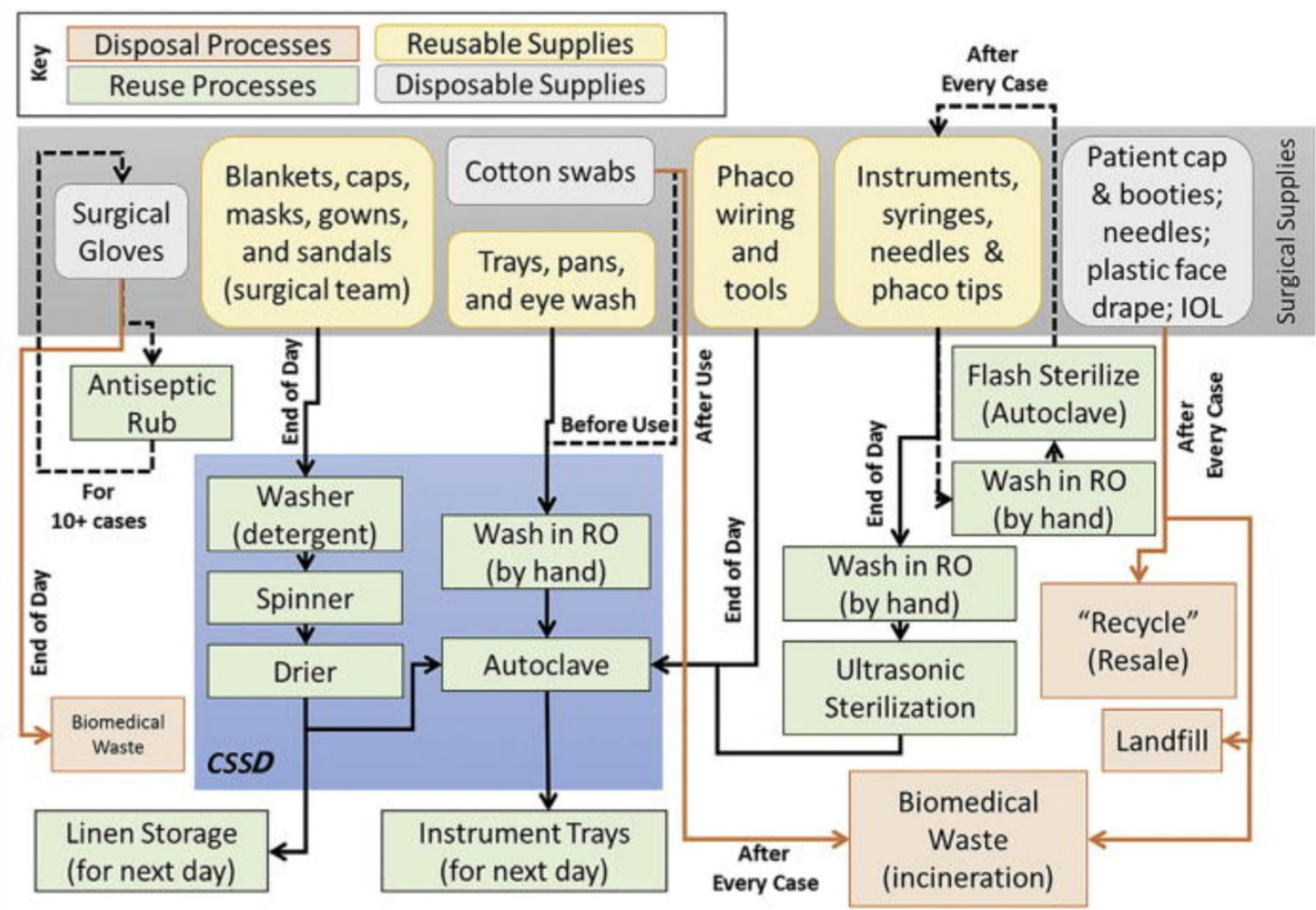
**1 Cataract Removal,  
Phaco (USA)**



**250g per surgery**

**93 Cataract Removals,  
Phacos (Aravind, India)**





Method	# Studies	Type of pathogen	Microbiological result	Integrity, fit and filtration
Benzalkonium chloride wipes [30]	1	Bacteria	Disinfection	Failed
Dry heat [35, 38–42, 61, 74, 79]	9	Viruses and Bacteria	Disinfection and failure	6 studies: all passed
Ethanol [35, 40, 48]	3	Viruses and spore-forming bacteria	Disinfection and failure	Failed
Ethylene oxide [20, 79]	2	Viruses	Sterilization and disinfection	2 studies: all passed
Gaseous hydrogen peroxide [20, 40, 42, 47–49, 51, 79, 80]	11	Viruses, bacteria, spore-forming bacteria, fungus	Sterilization, disinfection, 1 failure	9 studies: all passed
Gaseous hydrogen peroxide with peracetic acid [74, 81]	2	Viruses, bacteria and spore-forming bacteria	Sterilization	1 study: passed
Hypochlorite [30, 35]	2	Bacteria and spore-forming bacteria	Disinfection	1 study: failed
Moist heat [39, 47, 57–61, 79]	8	Viruses, Bacteria, spore-forming bacteria	Sterilization, disinfection, failure	5 studies: passed
Microwave-generated moist heat [23, 24, 58–60]	5	Viruses and Bacteria	Disinfection	3 studies: passed, 1 study: mixed results
Non-antimicrobial detergent wipes [30]	1	Bacteria	Failure	Failure
Ozone [26, 62, 63]	3	Viruses and Bacteria	Sterilization, disinfection, 1 failure	3 studies: 2 failed elastic band but passed face piece, 1 study: passed
Peracetic acid dry fogging system (PAF) [20]	1	Viruses	Sterilization and disinfection	Passed
Steam [20, 35, 66]	3	Viruses, bacteria and spore-forming bacteria	Sterilization, disinfection, failure	2 studies: passed
UVA [35]	1	spore-forming bacteria	Failure	N/A
UVGI [29, 35, 40, 42, 48, 58–60, 69, 70, 72, 74, 79, 82, 83]	15	Viruses, bacteria, spore-forming bacteria, fungus	Sterilization, disinfection, failure	7 studies: 1 failure, 1 partial failure, 5 passed
UVGI + dry heat [68, 79]	2	Viruses and Bacteria	Disinfection and failure	Passed
UVGI + medium humidity heat [79]	1	Viruses	Sterilization, disinfection, failure	Passed

# RESOURCES

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