05/06/2025

Online webinar

Waste in humanitarian Operations:
Reduction and Minimisation

# Waste Management in Humanitarian Field Hospitals

## toward a more coherent approach

WORM WP 5

Solvoz, FRC, IRC

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# Quiz 1

What percentage of all COVID-19 cases were reported among health workers?

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# Answer:

# up to 14 %

Inappropriate disposal of PPE and infectious materials can expose staff to viral pathogens.

WHO News Release – “Keep health workers safe to keep patients safe,” 17 September 2020
https://www.who.int/news/item/17-09-2020-keep-health-workers-safe-to-keep-patients-safe-who

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# Quiz 2

According to World Health Organization (WHO) estimates, how many **healthcare workers** were infected in the year 2000 due to needlestick injuries?

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# Answer:

## 66,000 hepatitis B,
## 16,000 hepatitis C,
## 1,000 HIV infections

Prüss-Üstün A, Rapiti E, Hutin Y. Sharps injuries: Global burden of disease from sharps injuries to health-care workers. Geneva: World Health Organization; 2003. WHO Report

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# Quiz 3

What percentage of **healthcare cleaning workers** in British Columbia in Canada reported needlestick injuries during their work (study published in 2008)?

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# Answer:

# 32 incidents / 100 persons / year

Alamgir H, Yu S. Epidemiology of occupational injury among cleaners in the healthcare sector. Occup Med (Lond). 2008 Sep;58(6):393-9. doi: 10.1093/occmed/kqn028. Epub 2008 Mar 19. PMID: 18356143.

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# Quiz 4

What is the reported cost of
medical waste treatment & disposal in Italy in 2014?

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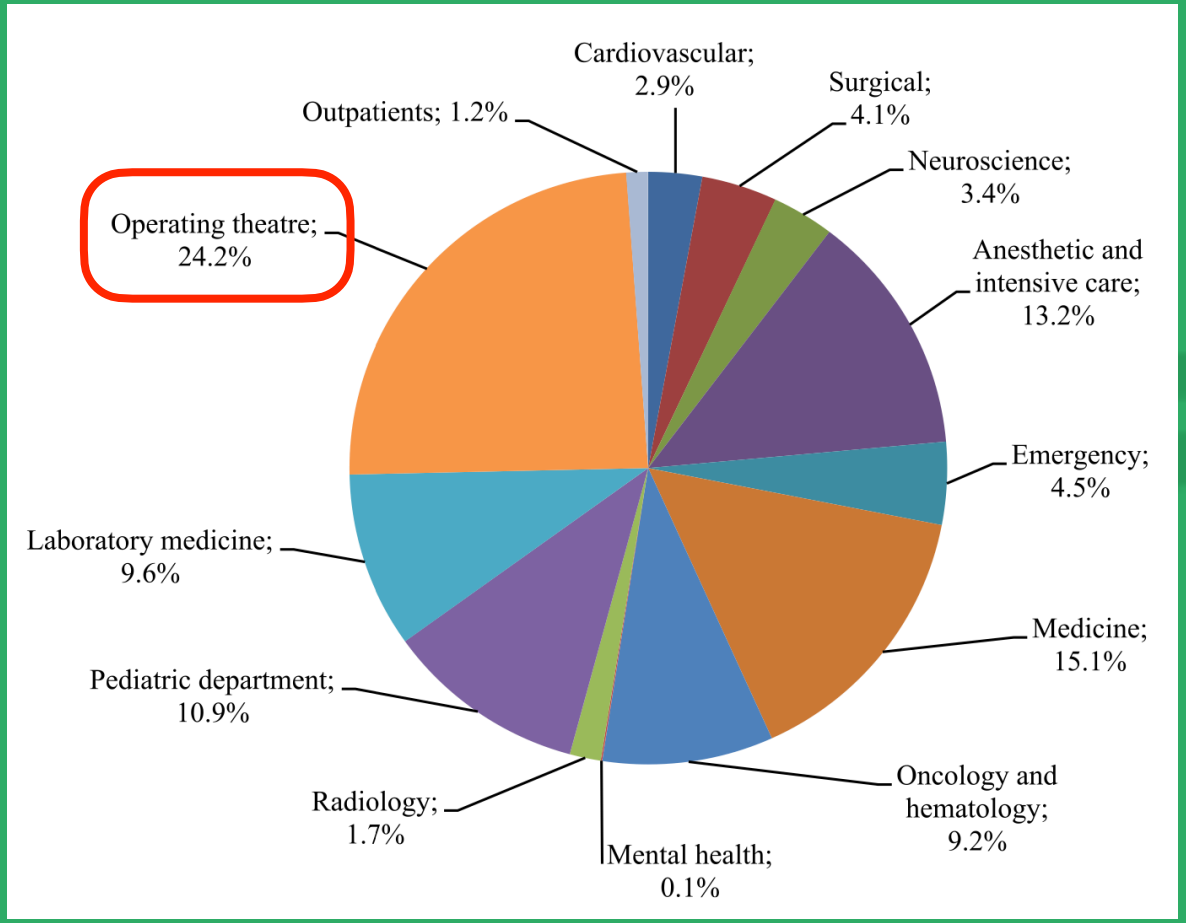
## Answer:

# $3.93 per kg
# or
# total cost of $5.08 million per year




Vaccari M, Tudor T, Perteghella A. Costs associated with the management of waste from healthcare facilities: An analysis at national and site level. Waste Manag Res. 2018 Jan;36(1):39-47. doi: 10.1177/0734242X17739968. Epub 2017 Nov 14. PMID: 29132259. Article here

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# Gasification of Humanitarian Wastes

## Lessons learned and ways forward

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# About the study

- 2 years research study – Overall feasibility study on use of waste gasification in humanitarian emergencies
- Funded by European Union through DG ECHO
- Address challenges in waste management in earliest phases of emergency response
- Waste characterization study
- Technical feasibility study
- Social impact study
- Supported by technical experts in gasification and waste systems from academia and leading engineering firms

- **Assumptions made:**
  - Camp or remote context
  - Lower income economy (not geographic specific)
  - Larger scale response (min. 40 000 affected persons)
  - First 4 months of response
  - Waste infrastructure distrupted or non-exisitant

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# Why gasification?

- Can be self-sustaining with little need for diesel or electricity.
- Thermal processes using high temperatures to break down waste
    - More complete combustion with fewer emissions
    - Elimination of pathogens
- Valuable outputs:
    - Syngas – synthetic combustible gas can be used for electricity generation
    - Char/Slag – potential use in agriculture or construction
    - Heat – potential for use in laundry or space heating

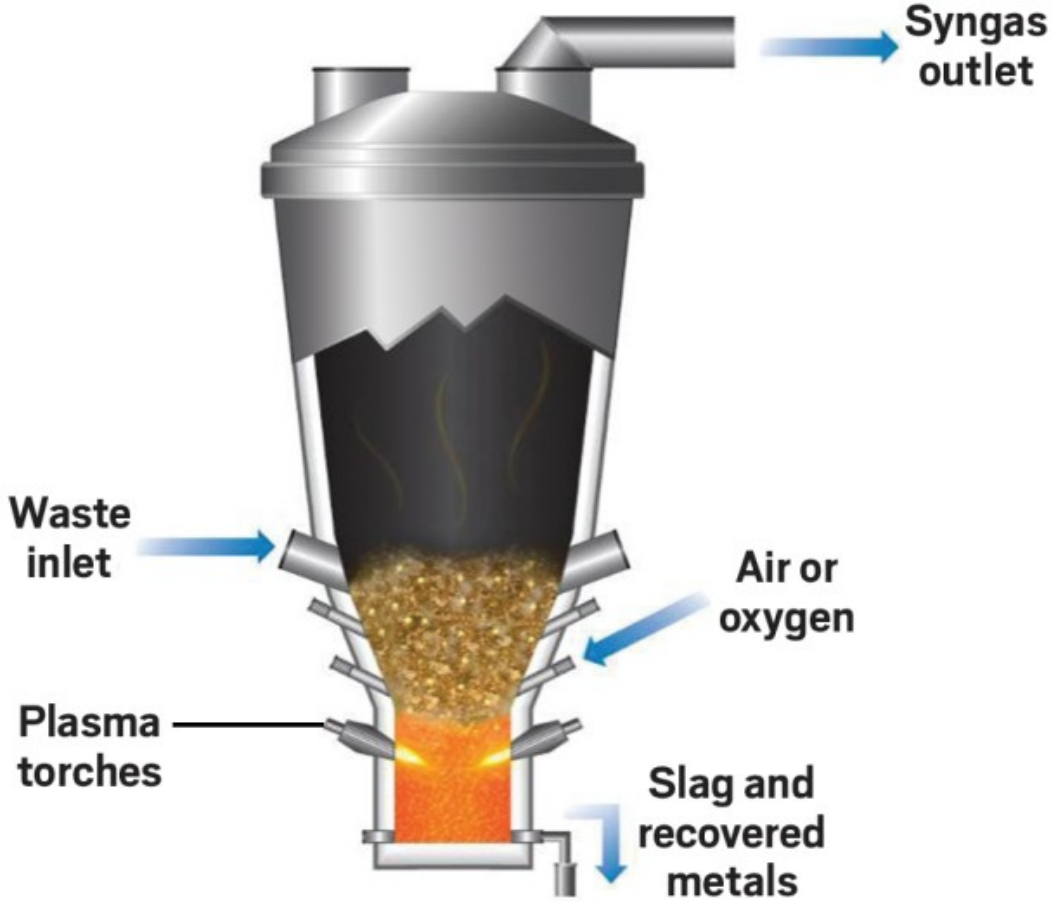


Image source: AlterNRG

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# Waste Characterization Study

Key learnings

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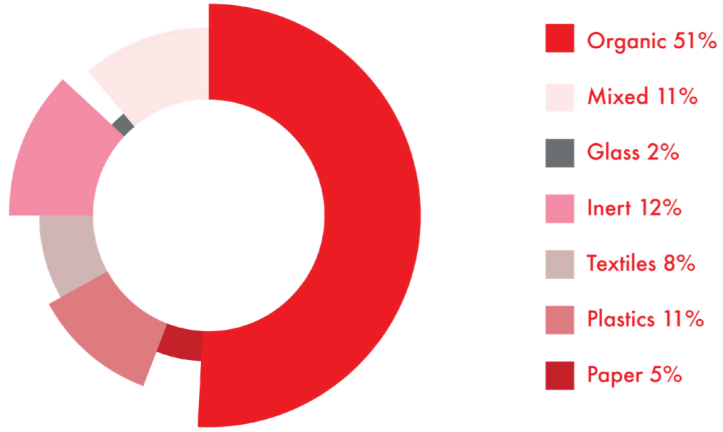
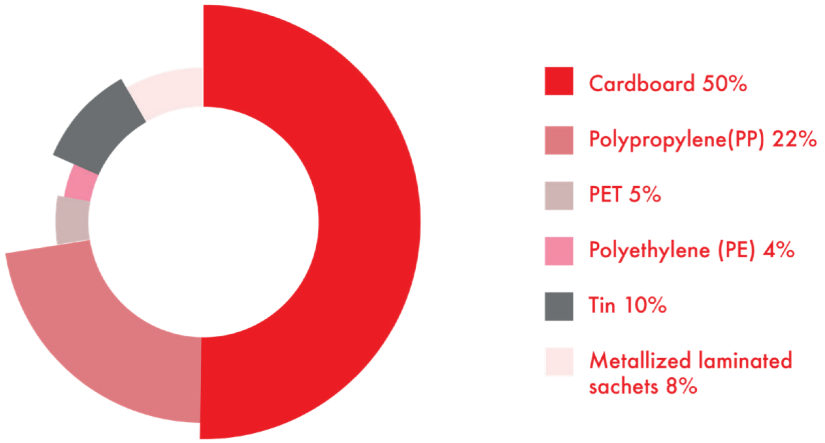
# Waste Characterization

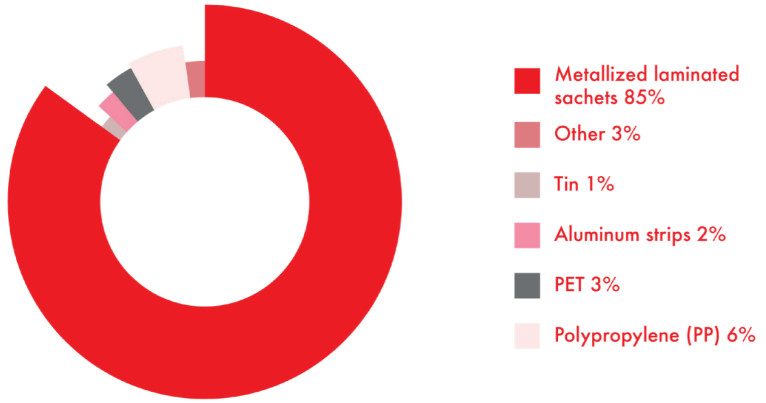
## Household waste fractions by weight




## Packaging waste fractions by weight




## Packaging waste fractions by number of pieces

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# Key take aways

- Knowledge is extremely limited and data highly contextual
  - Extremely little data exists about early response
- Knowing the waste stream is integral for finding suitable solutions
- Laminated metalized sachets are a huge problem for waste processing – most likely to end up untreated in environment
- Sorting practices must be strengthened if wishing to pursue valorization (Waste-to-X)

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# Technical Feasibility

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# Technical feasibility

- Market screening of small-scale pyrolysis/ gasification suppliers
- 21 relevant suppliers identified and screened
- 4 shortlisted relevant technologies further assessed

## Gasification and pyrolysis technologies| Shortlisted technologies

### **Chrysalis** (Earthwake)

**Input**: Plastic waste (PE+PP)

**Output**: Diesel oil product + char

**Pyrolysis** of plastic to generate oil vapours which are condensed into an oil product that can substitute diesel in motors.

**The feedstock** should be relatively clean and only contain the polymers PP and PE. Impurities and other polymers will reduce the diesel quality.

**References**: One test/demonstration facility.

### **MSW-300** (Ankur Scientific)

**Input**: Pretreated mixed waste

**Output**: Electric power + ash/char

**Gasification** of refused derived fuel (RDF) to produce a syngas which directly drives an engine for power production.

**The feedstock** is RDF. Inert materials must be removed from the waste which must then be dried, shredded and probably compressed into briquettes to provide the required uniform particle size.

**References**: One pilot plant and one demonstration plant.

### **MAGS V8** (Terragon)

**Input**: Sorted mixed waste

**Output**: Ash

**Gasification** of well-mixed waste bags into syngas which is directly combusted.

**The feedstock** of mixed waste must be free of inert materials and well distributed into plastic bags of approx. 6 kg each.

**References**: >20 marine installations on ships. (None on-shore)

### **MIHG** (Wildfire)

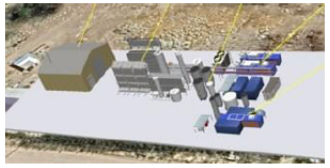
**Input**: Mixed waste

**Output**: Electric power + ash

**Gasification** of bulk mixed waste into syngas which drives an engine for power production.

**The feedstock** is mixed waste that without pre-treatment or sorting can be filled directly into large container-like reactors.

**References**: One pilot/demonstration facility.





Notes: PE: Polyethylene; PP: Polypropylene; RDF: Refuse Derived Fuel



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# Final technical evaluation matrix

| | | Waste gasification | Waste gasification | Waste gasification |
|---|---|---|---|---|
| | | **Ankur Scientific MSW-600** | **Terragon MAGS V8** | **Wildfire MIHG** |
| **Feeds** | | | | **5** Mixed waste without pretreatment |
| **Relocatable** | **4** System fits into 3-4 twenty-foot containers with limited interconnections. | Essentially con ents for a stationary system delivered loosely in >20 twenty-foot containers for local erection | **5** Compact design on skids. Module containerized into 1 twenty-foot container | **2** Adaption of stationary system delivered as >50 containerized subsystems. Supplier open to work on improving mobility. |
| **Capacity** | **3** 0.6 tpd plastic | **4** 6 tpd prepared RDF | **2** 0.4-1 tpd sorted mixed waste per module | **5** 27 tpd mixed waste |
| | | **2** | **5** | **3** |
| **Refe** | | | | **1** One pilot+test |
| **Energy outputs** | **5** Diesel oil substitute containing 60-70% of the plastic energy content | **3** Power generation with approx. 10% net efficiency | **1** No useful energy outputs apart from heat (cooling demand) | **5** Power generation with approx. 24% net efficiency |

Only takes plastics. But maybe that is ok!

Not mobile. Permanent installation only.

Not independently verified

Requires significant energy input (more diesel needed than incineration if no power source)

Not independently verified

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# Key take aways

- Gasification is potentially a viable solution for the future, but not ready yet
- 2-3 years time come back to re-assess
  - Look for reference cases or pilot ourselves in a controlled environment
- Need a stronger understanding of the waste stream to have a scalable/replicable solution
- Need to better connect to exisiting recyclers – **strengthen sorting practices**

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# Social impact study

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# Desk study + Field research

- Extensive interviews conducted to understand current and perceived interactions with waste
- Field visit to Maputo interview current and past disaster affected communities

# Key learnings

- There are **risks of doing harm:**
  - Need to consider and develop solutions that support exisiting recyclers and waste pickers
  - Camp management can harm livelihoods if do not account for needs of waste pickers
    - Restrictions on storing cans and bottles
    - Intimidation from authorities or management
- Those working with waste are general the most vulnerable/disinfranchised – Extra care needed to engage meaningfully and to ensure any changes do not displace these people
- Security of equipment relies heavily on acceptance and interest from the community – this is likely biggest hurdle
- Sorting at source/houeshold level is seen as a strength within the sector, people are fairly happy to comply if benefits are clear– makes humanitarian waste highly attractive
- Remuneration scheme needs to be well thought out – prioritizing volume based remuneration may result in child labour and exploitation

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# Key recommendations

- Need to map existing collection and recycling practices as early as possible
  - Aim should be to strengthen existing practices as much as possible
- Promote ”materials recovery facility” (MRF) modality as early as possible
  - True for all waste interventions, not just gasification
- Need to work more to socialize outputs (e.g. compost) and possible uses
  - Just because we make it doesn’t mean anyone wants it

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# Overall findings

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# Overall findings

- Need for stronger understanding of exisiting waste ecosystems
- Need for stronger coordination among humanitarian actors on waste management, rather than fragmented approaches
- Our waste is valuable because can be well sorted
- Do more to connect to other recylers
- Need to highlight and base solutions around the people who are doing the every important work of sorting and moving waste everyday

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# Want to learn more?

Scan this code to learn more about the project and join our mailing list!

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# Thank you

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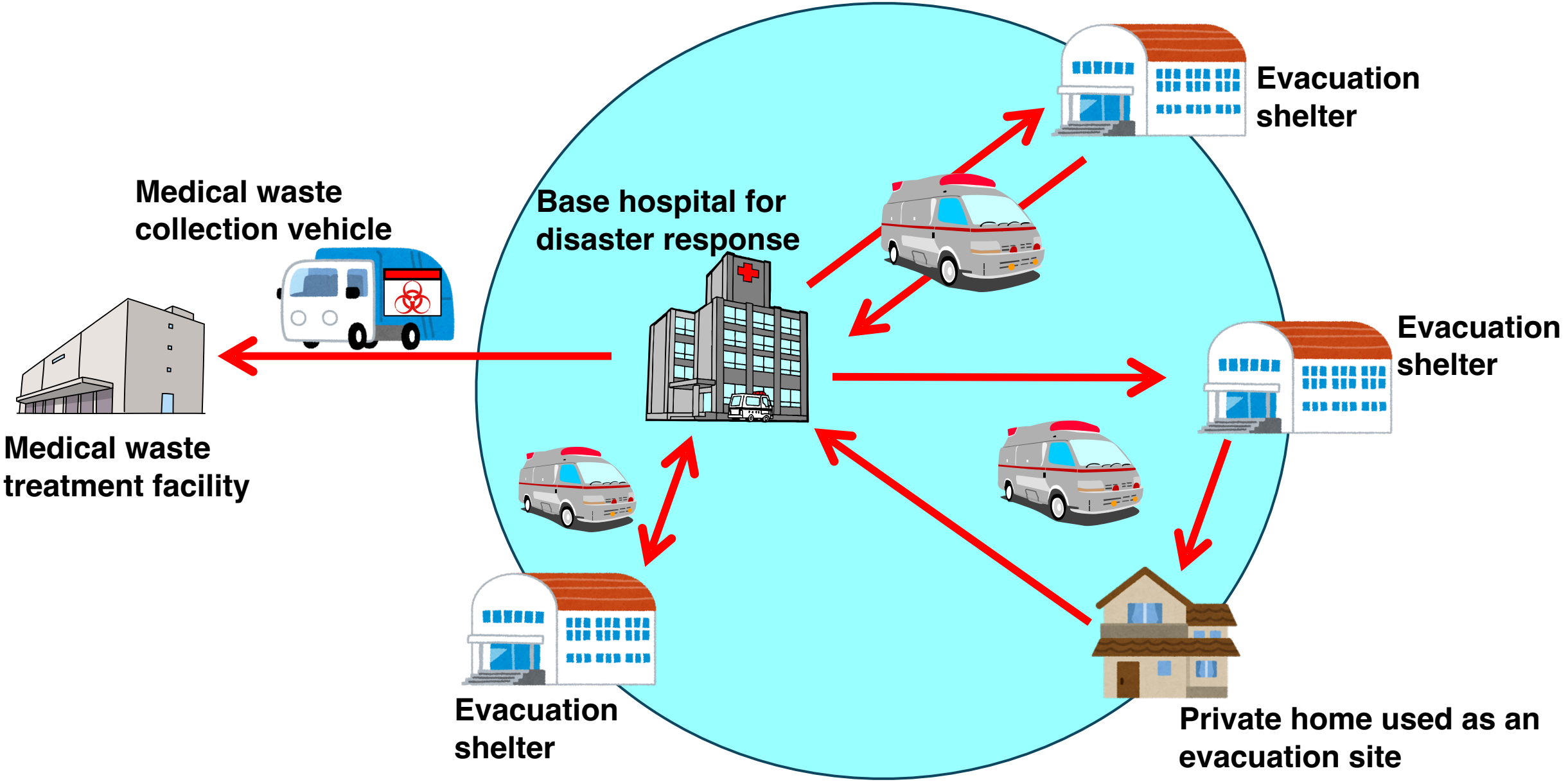
熊本赤十字病院
JAPANESE RED CROSS KUMAMOTO HOSPITAL

# Medical waste management in emergencies: Case in Japan

Akinori KURODA
Kumamoto Red Cross Hospital

熊本赤十字病院
JAPANESE RED CROSS KUMAMOTO HOSPITAL

# During disasters, waste generated from mobile clinics is collected and consolidated.



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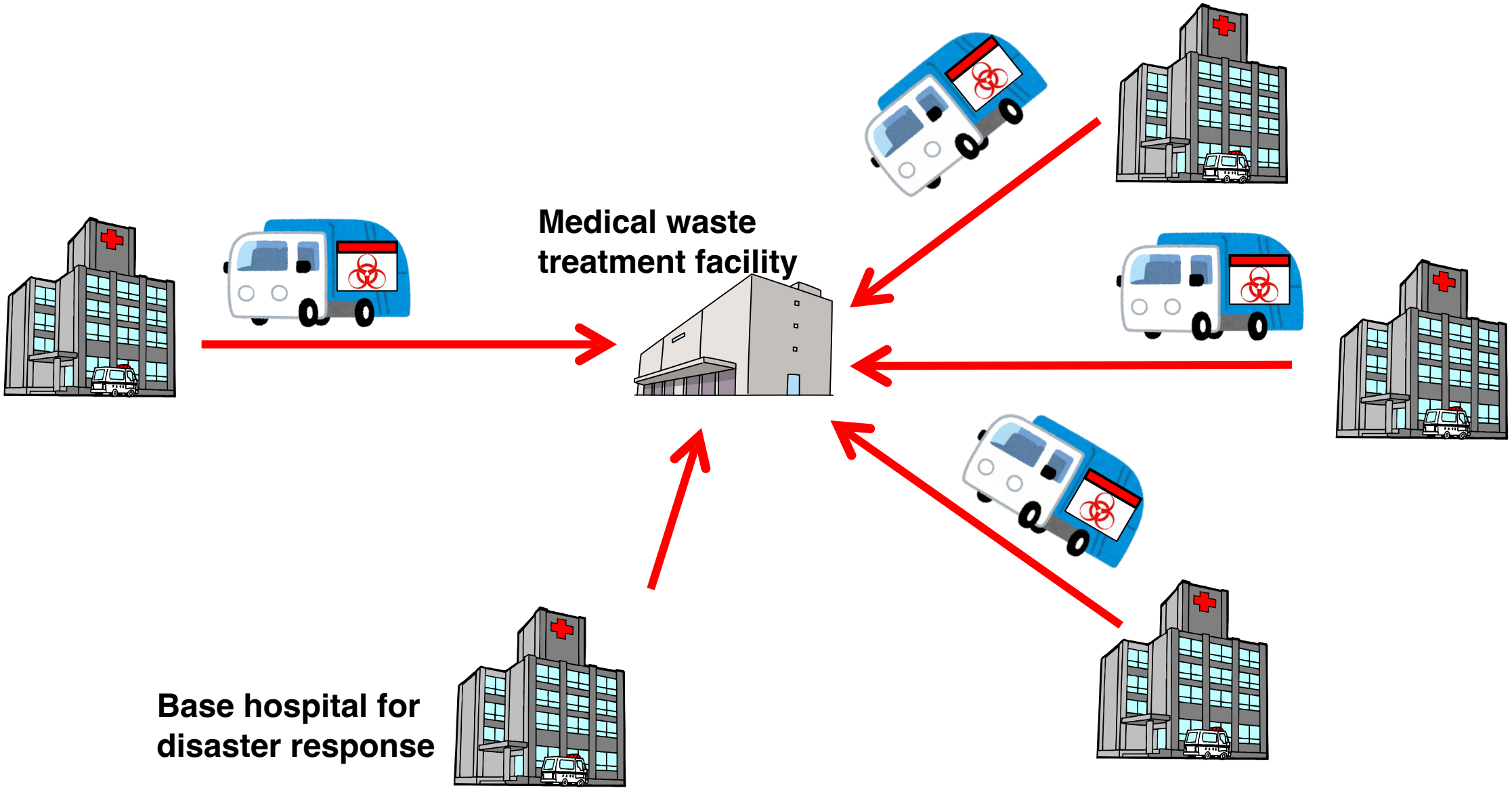
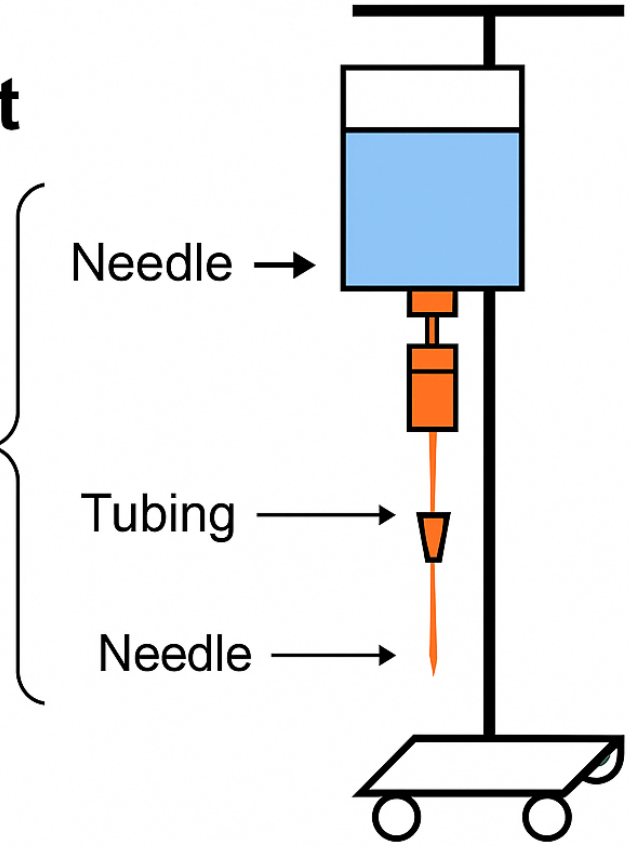


# IV Drip Set




Infection Waste

In the case of types using an air needle,
used air needles are treated as infectio waste.

Used IV bags are classified as non-infectious waste,
unless visibly contaminated with blood or bodily fluids

## Waste Management Chart

Place needles and other sharps in a white plastic container with a biohazard mark. Do not mix them with any other waste!

Medical Waste | General Waste | Recyclable Waste

**Infectious Waste**

—Sharps—
Injection needles (including unused ones)
Syringes with attached needles
Broken glass fragments (e.g., ampoules)
Cytotoxic IV bags (with tubing)
Catheters Guidewires
Infusion tubing Scalpels Razors

—Liquid or Semi-liquid Items—
Test tubes Culture media
Tissue specimens Petri dishes
Blood product containers (including glass bottles)
Drainage packs (containing large amounts of blood or body fluids)

—Solid Items—
Drainage packs Urine collection cups
Plastic gloves Urine collection bags
Plastic aprons Plastic gowns
Dialyzers Masks
Cytotoxic IV bags (without tubing)
Non-woven gowns
Bandages Absorbent cotton
Gauze Fabric lint Sheets
Diapers (related to C. difficile, O-157, norovirus, rotavirus, etc.)
※ Items not suspected of infection should be disposed of as general waste
Syringe barrels (without needles)
※ Including those not contaminated with blood or body fluids

Plastic container | Cardboard box

**Plastic Waste**

Note: Exclude beverage PET bottles!
Infusion bags
Enteral nutrition packs
Plastic containers
Disinfectant containers
Liquid medicine bottles
Bottle caps
Blister packs for tablets

Blue plastic bag

**Glass Waste**

Glass vials
IV solution bottles
Medication bottles
*(excluding those used for blood products or cytotoxic agents)*
Plaster waste
*(e.g., orthopedic casts)*

Clear plastic bag

**Burnable Waste**

Paper waste
Disposable diapers
*(non-infectious only)*
Wood waste
Leather materials
Food waste
Bandages
*(non-infectious only)*
Linen items
*(non-infectious only)*
Other plastic items
*(e.g., CDs, hangers, lighters, etc.)*

Clear plastic bag

**Recyclable Waste**

Empty cans
Empty glass bottles
PET bottles
Used paper
Plastic containers and packaging

Metal hangers
Umbrellas
Spray cans
*(must be emptied before disposal)*

Newspapers
Flyers *(advertising leaflets)*
Magazines
Cardboard

2024.02.01

(Prepared by Facilities Division, Kumamoto Red Cross Hospital)

Reference: Manual for the Management of Infectious Waste Based on the Waste Management and Public Cleansing Law, Ministry of the Environment, Japan

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| | Label | Example of Sorted Waste |
|---|---|---|
| Sharps | Designated Box  |  |
| Infectious Waste |   |  |
| Infectious Waste |   |  |
| General Waste | No Label |  |

| | | Contents | Collection Frequency |
|---|---|---|---|
| | | njection needles,<br>ls,<br>ials, etc. | When the container is approximately 80% full,<br>or at least once per week |
| Red | Infectious waste | es and IV sets (excluding needles),<br>catheters,<br>urine collection bags,<br>PPE (isolation gowns, aprons, rubber gloves, masks, etc.) | When the container is two-thirds full,<br>or at least once per day |
| Yellow | Infectious waste | Human tissue parts,<br>placentas,<br>POP (plaster of Paris),<br>gauze,<br>cloth, and paper contaminated with body fluids | When the container is two-thirds full,<br>or at least once daily |
| Transparent | General waste | Food scraps,<br>paper,<br>plastic bags,<br>plastics, cans,<br>IV bottles, etc. | At least once per day |

Finnish Red Cross

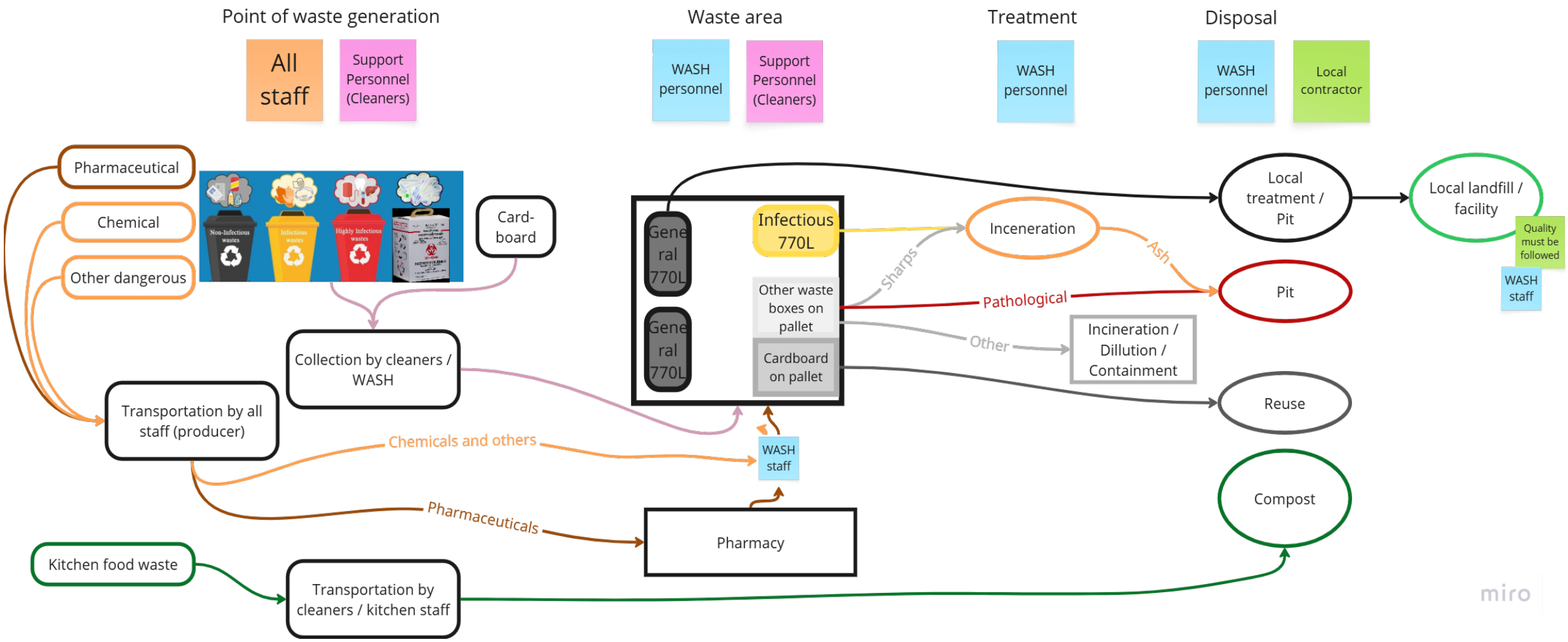
# Waste Management in Finnish Red Cross Emergency Hospital

Paula Peltola / Technical Planning Officer / Finnish Red Cross

5.6.2025 WORM Webinar

Waste Management in Humanitarian Field Hospitals: Towards a More Coherent Approach

# Waste Management Process Chain

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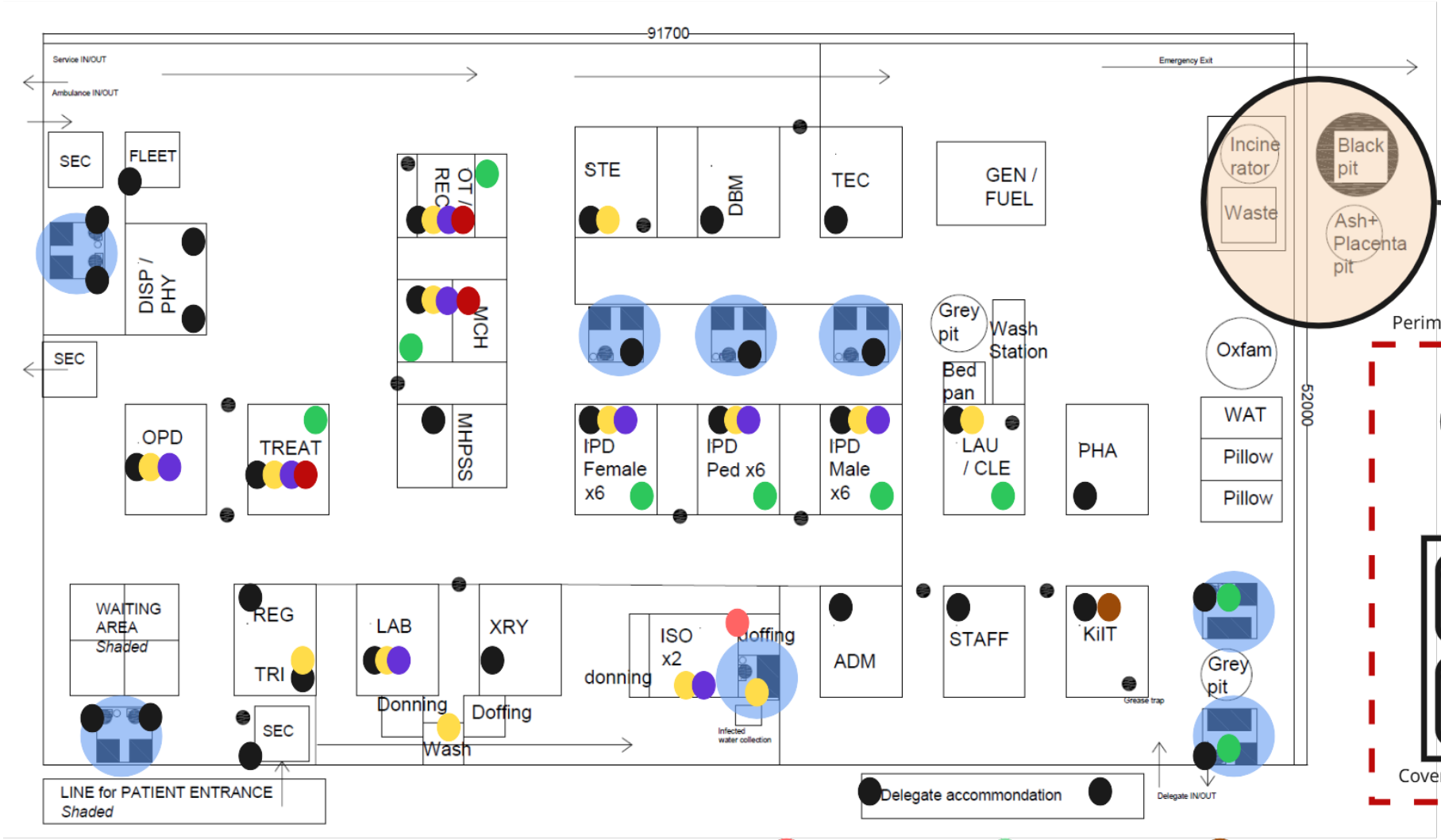
# Waste Management/Segregation Layout

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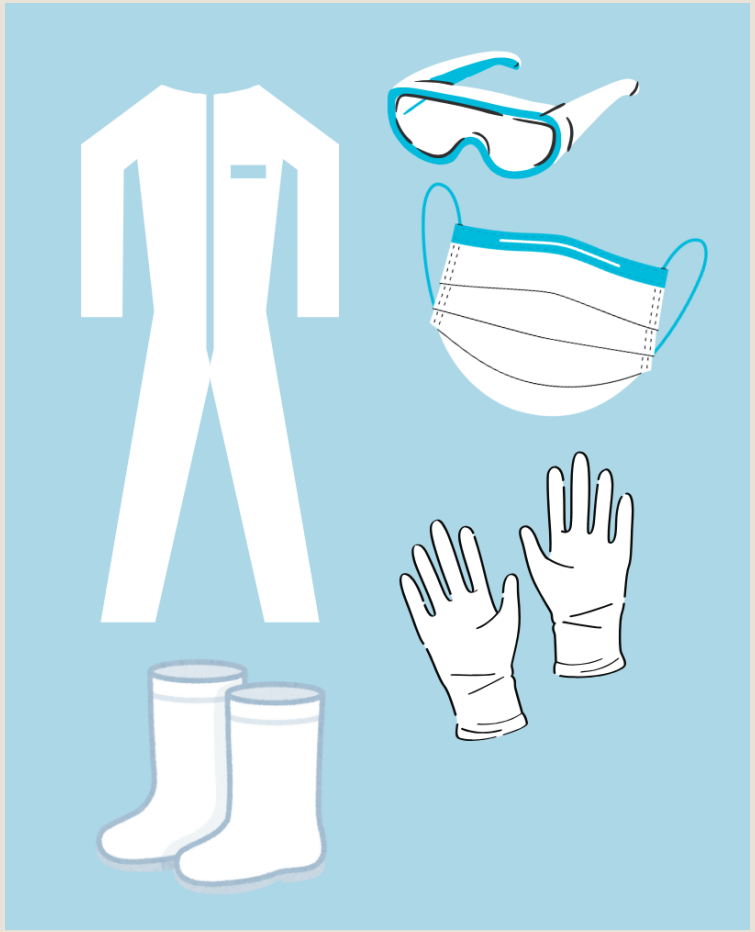
# Integral parts of waste management process

## PPE



## Training and guidance

- All staff
- Cleaning Team
- Waste Management Team


## Monitoring

- IPC Monitoring Tool
- Clear responsibilities
- Reacting to deviations
- Active communication

# Integral Waste Management Strategy for Humanitarian Field Hospital Interventions

Yumiko Soulier, Ph.D
Yumiko@solvoz.com

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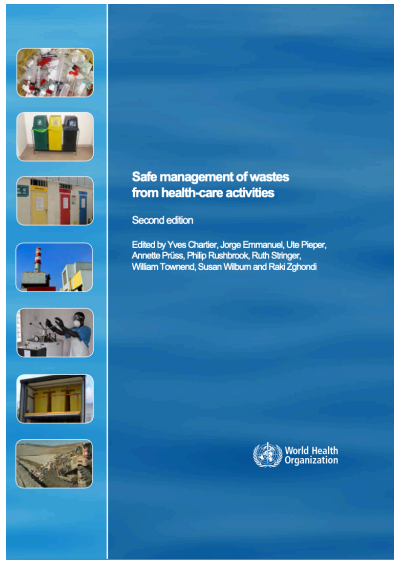
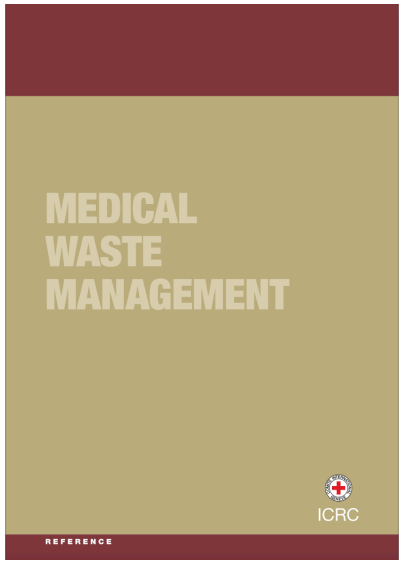
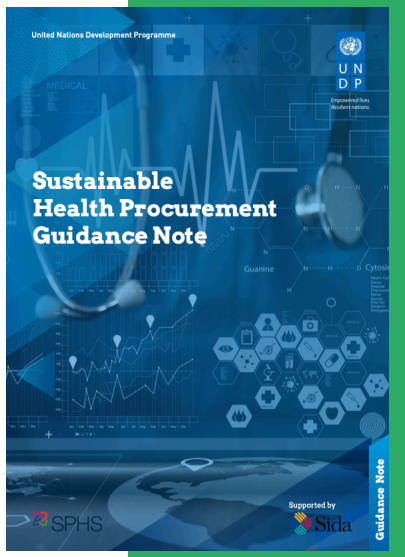
# Existing guideline documents



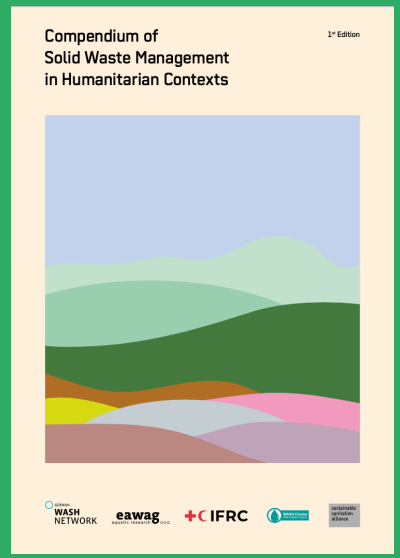









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# Challenges in MWM at EMTs/Field Hospitals

- Limited Resources: Lack of infrastructure for proper waste disposal.
- Training Gaps: Continuous staff education in waste management is needed.
- Local Compliance: Aligning with national waste management policies in emergencies.
- Environmental Impact: Managing waste in fragile settings with minimal environmental harm.

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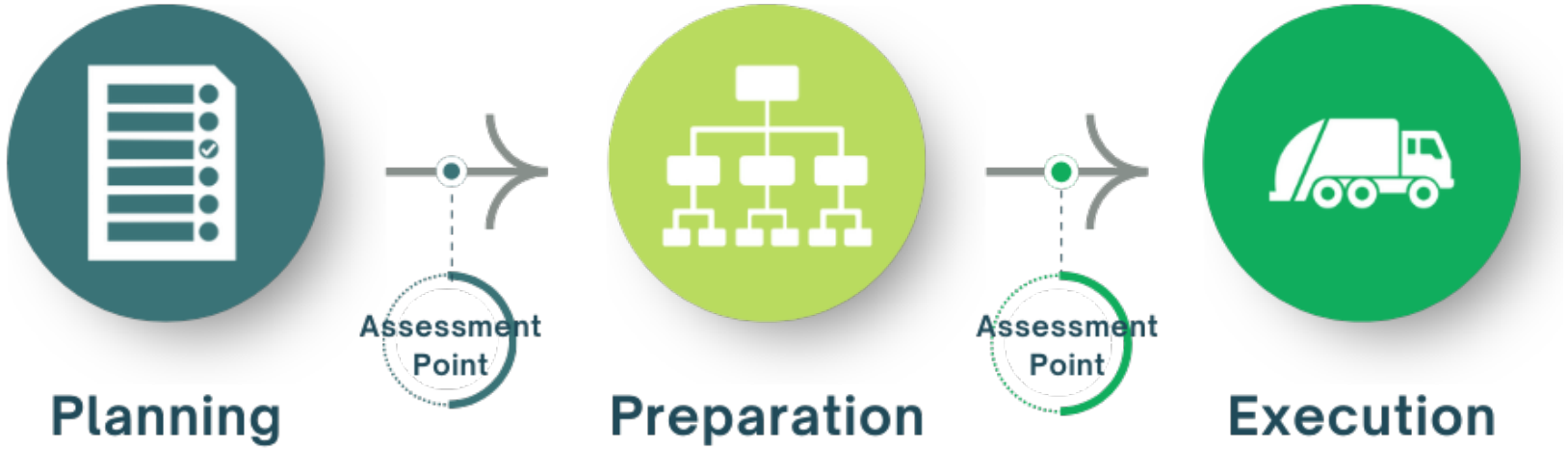
# Challenges in MWM at EMTs/Field Hospitals

| Challenges | Enabling conditions |
|---|---|
| Limited Resources | • Improve the preparedness (WM design & on-site solutions)<br>• Greater budget allocation |
| Training Gaps | • Improve communication and visualisation materials<br>• Harmonized practices and shared responsibilities |
| Local Compliance | • Stakeholder assessment and engagement framework<br>• National policy database<br>• Coordination body |
| Environmental Impact | • Identification of environmental impact & harm<br>• Solutions to avoid such harm<br>• Knowledge of alternative methods<br>• Greater budget allocation |

# Integral waste management

- Integration throughout intervention

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# Challenges in MWM at EMTs/Field Hospitals

| Challenges | Enabling conditions | IWM phase |
|---|---|---|
| ▶ Limited Resources | • Improve the preparedness (WM design & on-site solutions)<br>• Greater budget allocation | —> Planning<br>—> Advocacy & Sharing |
| ▶ Training Gaps | • Improve communication and visualisation materials<br>• Harmonized practices and shared responsibilities | —> Preparation<br>—> Planning |
| ▶ Local Compliance | • Stakeholder assessment and engagement<br>• National policy database<br>• Coordination body | —> Planning<br>—> Planning<br>—> Planning |
| ▶ Environmental Impact | • Identification of environmental impact & harm<br>• Solutions to avoid such harm<br>• Knowledge of alternative methods<br>• Greater budget allocation | —> Planning<br>—> Planning<br>—> Planning<br>—> Advocacy & Sharing |

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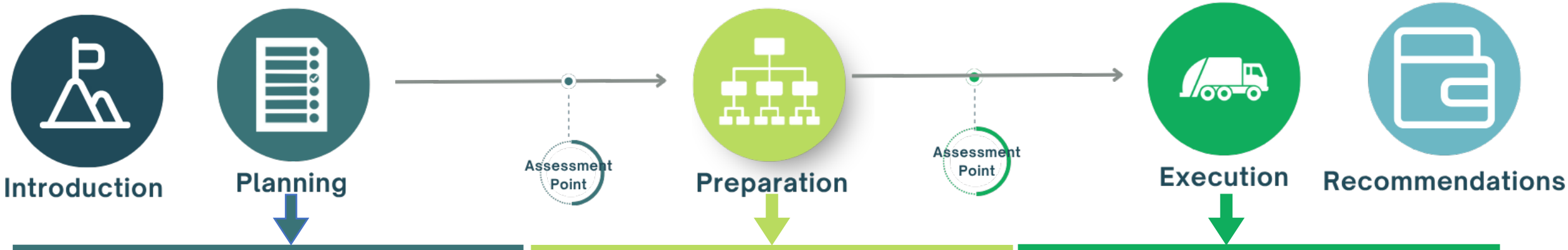
# Integral waste management guideline structure




Annex 1: Green procurement

Annex 2: Prevention of dioxin formation

Annex 4: WM options by waste streams

Annex 5: Regulatory framework and AI-based database assessment

Annex 6: Stakeholder assessment questionnaire

Annex 12: WM kit content and specifications

Annex 7: WM zone preparation

Annex 8: Segregation posters

Annex 9: Personal protection posters

Annex 10: Waste collection & transport guidelines

Annex 11: Handling and disposal of body fluids from containers guideline and poster

Annex 13: Waste bin placement recommendations

Annex 3: WM labels and recording log sheets

worm

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# Integral waste management guideline structure

Planning

Annex 1: Green procurement

Annex 2: Prevention of dioxin formation

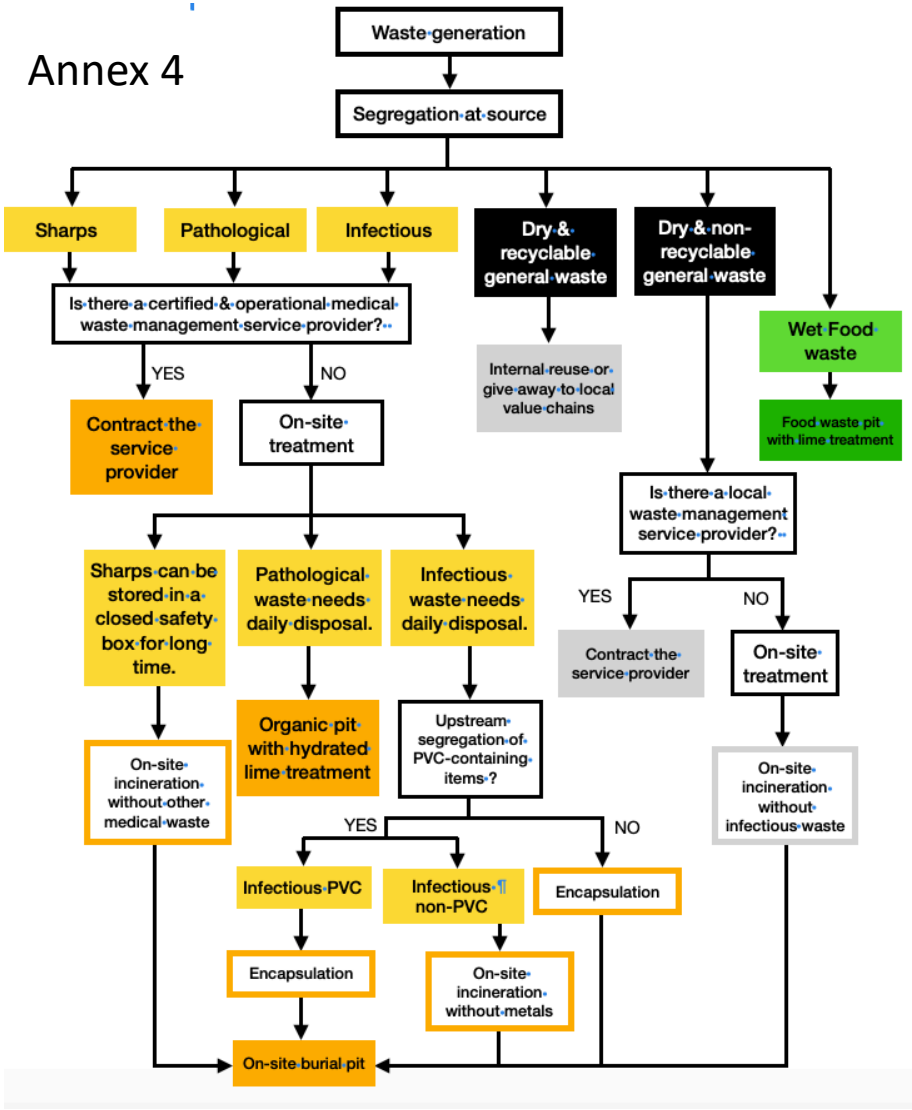
**Annex 4: WM options by waste streams**

**Annex 5: Regulatory framework and AI-based database assessment**

Annex 6: Stakeholder assessment questionnaire

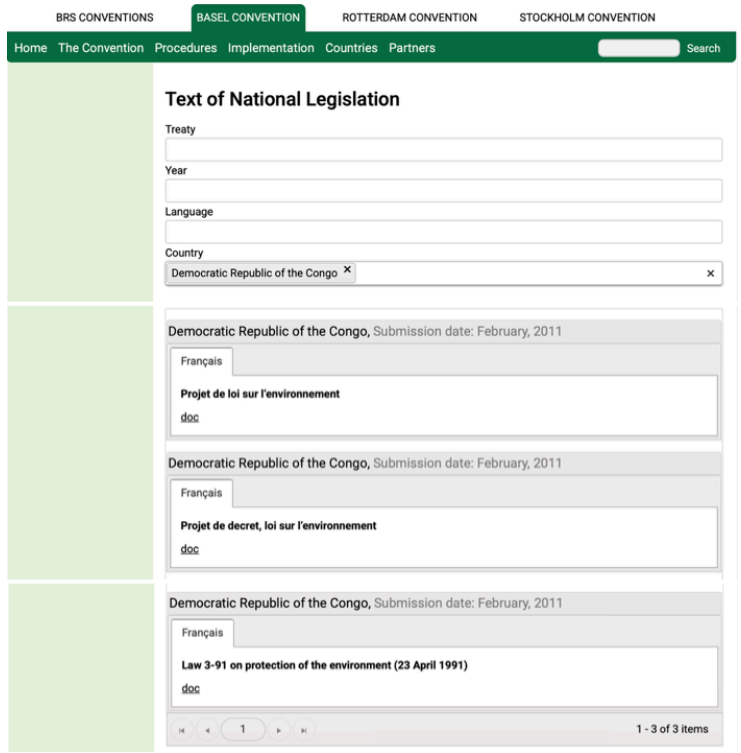
Annex 12: WM kit content and specifications

Annex 4




Annex 5

National legislation database (from Basel Convention website)

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# Integral waste management guideline structure

Preparation

Annex 6: WM zone preparation

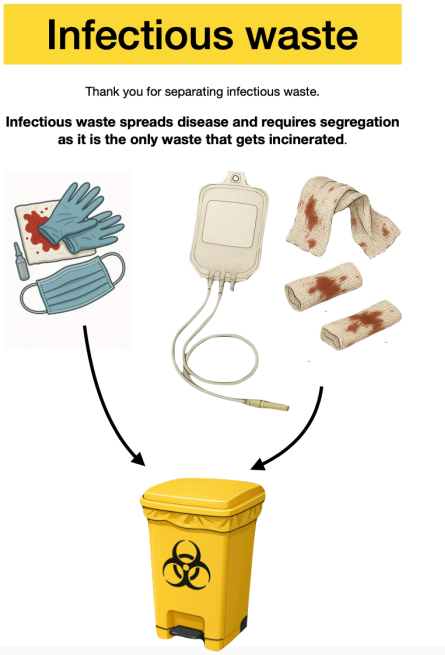
**Annex 7: Segregation posters**

Annex 8: Personal protection posters

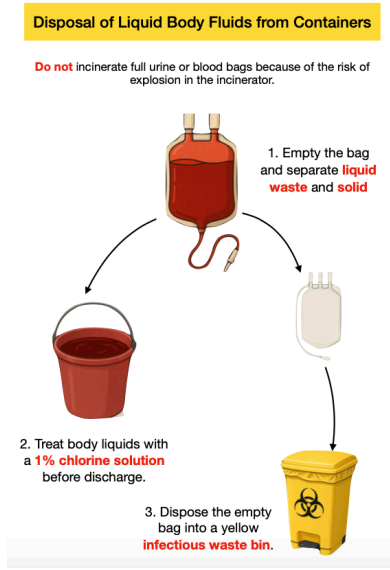
Annex 9: Waste collection & transport guidelines

**Annex 10: Handling and disposal of body fluids from containers guide and poster**

Annex 12: Waste bin placement recommendations

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# Environmental impact

| Challenges | Enabling conditions |
|---|---|
| Limited Resources | • Improve the preparedness (WM design & on-site solutions)<br>• Greater budget allocation |
| Training Gaps | • Improve communication and visualisation materials<br>• Harmonized practices and shared responsibilities |
| Local Compliance | • Stakeholder assessment and engagement<br>• National policy database<br>• Coordination body |
| **Environmental Impact** | • Identification of environmental impact & harm<br>• Solutions to avoid such harm<br>• Knowledge of alternative methods<br>• Greater budget allocation |

**Annex 1: PVC-based products - Methods to prevent dioxin formation**

Annex 3: WM options by waste streams

Annex 4: Regulatory framework and AI-based database assessment

Annex 5: Stakeholder assessment questionnaire

Annex 11: WM kit content and specifications

Solution 1:
Replace PVC-based products with alternatives (Phase-out PVC)
—> incineration sans dioxins

Solution 2:
Use of no-burn technology.

Solution 3:
Segregation of infectious PVC-based products
—> Encapsulation & on-site burial

Solution 4:
Use high-performance incinerators

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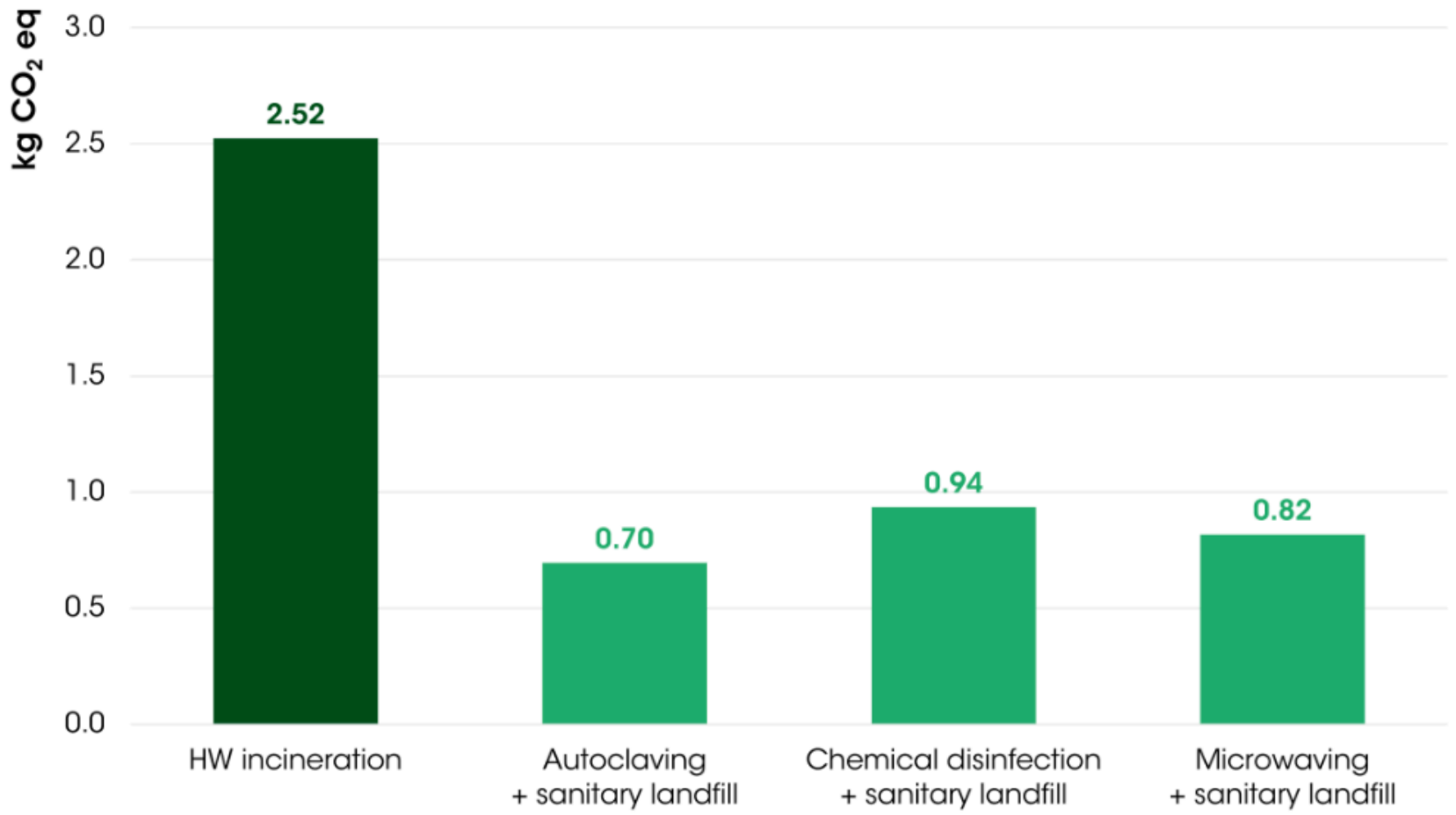
# Environmental impact

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# Life cycle cost approach for Procurement

**Figure 4. Comparing costs of two products**


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| Challenges | Enabling conditions |
| --- | --- |
| Limited Resources | • Improve the preparedness (WM design & on-site solutions)<br>• Greater budget allocation |
| Training Gaps | • Improve communication and visualisation materials<br>• Harmonized practices and shared responsibilities |
| Local Compliance | • Stakeholder assessment and engagement framework<br>• National policy database<br>• Coordination body |
| Environmental Impact | • Identification of environmental impact & harm<br>• Solutions to avoid such harm<br>• Knowledge of alternative methods<br>• Greater budget allocation |

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