Medical Waste Treatment Technologies

Ruth Stringer
*International Science and Policy Coordinator*
*Health Care Without Harm*
*Dhaka January 2011*
Who is Health Care Without Harm?

An International network focussing on two fundamental rights:

- Right to healthcare
- Right to a healthy environment
Health Care Without Harm

• Issues
  – Medical waste
  – Mercury
  – PVC
  – Climate and health
  – Food
  – Green buildings
  – Pharmaceuticals
  – Nurses
  – Safer materials

• Offices in
  – USA
  – Europe
  – Latin America
  – South East Asia

• Key partners in
  – South Africa
  – India
  – Tanzania
  – Mexico

• Members in 53 countries
Global mercury phase-out

• HCWH and WHO partnering to eliminate mercury from healthcare
• Part of UN Environment Programme's Mercury Products Partnership.
• www.mercuryfreehealthcare.org
• HCWH and WHO are principal cooperating agencies
• 8-country project to reduce impacts from medical waste – esp dioxins and mercury
• Model hospitals in Argentina, India, Latvia, Lebanon, the Philippines, Senegal and Vietnam
• Technology development in Tanzania
Incineration

No longer a preferred treatment technology in many places
Meeting modern emission standards costs millions of dollars
Ash must be treated as hazardous waste
Small incinerators are highly polluting
Maintenance costs can be high, breakdowns common
Decline in Medical Waste Incinerators in the U.S.

<table>
<thead>
<tr>
<th>Year</th>
<th># of Medical Waste Incinerators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>6,200</td>
</tr>
<tr>
<td>1994</td>
<td>5,000</td>
</tr>
<tr>
<td>1997</td>
<td>2,400</td>
</tr>
<tr>
<td>2003</td>
<td>115</td>
</tr>
<tr>
<td>2006</td>
<td>83</td>
</tr>
<tr>
<td>2008</td>
<td>57</td>
</tr>
</tbody>
</table>

Decline in Construction of New Medical Waste Incinerators in the U.S.

EPA original projection of new medical waste incinerators (without the HMIWI rule) vs. Actual Number of new medical waste incinerators built since the HMIWI rule, as of 2008
Alternative Technology Options

- Needle Destroyers
- Autoclaves
- Advanced Steam Treatment Systems
- Microwave Units
- Dry Heat Systems
- Alkaline Hydrolysis
- Others
Non-incineration technologies

1. Low-heat thermal processes
2. Chemical processes
3. Irradiative processes
4. Biological processes
LOW-HEAT THERMAL PROCESSES

- Mostly between 93°C to about 177°C.
- Wet heat (steam) and dry heat (hot air) disinfection.

- Wet heat treatment uses steam to disinfect
- Autoclaving- the most common treatment method
- Microwave- also a steam disinfection process. Water is added to the waste. Micro-organisms are destroyed by moist heat and steam generated by microwave energy.

- Dry heat processes are less common. No water or steam is added.
- Waste is heated by conduction, natural or forced convection, and/or thermal radiation using infrared heaters.
Autoclaves of all sizes

- **Autoclaves**
  - Very small autoclaves
    - 4 L pressure cooker
      - $25 - $50
  - Small to medium-size autoclaves
    - 100 L autoclave
      - $1000 - $5000
  - Large centralized autoclaves
- Optional Shedders
  - 260 L waste autoclave
    - $25,000 - $35,000
  - 14,000 L waste autoclave
    - $200,000 - $250,000
  - 40 L sterilizer
    - $125-$600
  - $20,000 - $150,000
Advantages of autoclaves for medical waste disinfection

• Familiar technology in hospitals
• Reliable and economical
• Available in many sizes and levels of sophistication
• Can easily test them, prove they are working effectively
Rotoclave- advanced autoclave
Microwave

• Waste typically shredded then conveyed past several microwave generators to create heat and steam.

• Sizes range from doctor’s office to large hospital systems
Dry heat technology

- Small scale example:
- Desktop for small facilities
- Also melts syringes, but the residue is not recyclable.
CHEMICAL PROCESSES

- Disinfectants eg dissolved chlorine dioxide, bleach (sodium hypochlorite), peracetic acid, or dry inorganic chemicals.
- Chemical mixture often proprietary/secret.
- Usually often involve shredding, grinding, or mixing.
- May go through a dewatering section to remove and recycle the disinfectant.
- One developing technology uses ozone to treat medical waste and others utilise catalytic oxidation.
- Specific deactivation/neutralisation reactions used for individual chemicals
Encapsulation

• Encapsulation is a chemical process that solidifies sharps, blood, or other body fluids within a solid matrix prior to disposal.

• Even concrete can be used to dispose of small quantities of pharmaceutical waste in remote areas.
Tissue digestors

- Use high temperature sodium hydroxide to break down tissues and chemicals
- Destroys prions, EU approved for carcass disposal
- Creates a caustic slurry rich in fatty acids and amino acids
- Bones are friable
- Sizes from 5kg to thousands of kg
IRRADIATIVE PROCESSES

Involve electron beams, Cobalt-60, or UV irradiation. Need shielding to prevent occupational exposures.

Electron beam irradiation uses high-energy electrons to destroy micro-organisms in the waste by though chemical dissociation and rupture of cell walls.

Germicidal ultraviolet radiation (UV-C) has been used as a supplement to other treatment technologies.

Irradiation does not alter the waste physically and would probably require a grinder or shredder to render the waste unrecognisable.
BIOLOGICAL PROCESSES

• Technologies employ enzymes to destroy organic matter. Few non-incineration technologies have been based on biological processes.

• Natural biological processes can also be used, particularly for rural areas and small health centres.
Rural / low tech biological technologies
MECHANICAL PROCESSES

Shredding, grinding, hammermill processing, mixing, agitation, liquidsolid separation, conveying (using augers, rams, or conveyor belts), and compaction all supplement other treatment processes.

Main purposes:
Renders the waste unrecognisable
Destroy needles and syringes
In thermal- or chemical-based processes, shredders etc mixers can improve the rate of heat transfer or expose more surfaces to chemical disinfectants.

Mechanical processes often need a lot of maintenance
Needle cutters and burners

- Mechanical or electrical
- Prevent NSI during waste disposal
- The best models prevent syringe reuse
Effluent decontamination systems

- Use temperatures over 100°C for over an hour to kill pathogens.
- Heating can be provided by steam, electricity, gas, or a combination.
- Heat exchangers increase efficiency.
- Continuous or batch systems available.
- Some batch systems can include a tissue digestion stage to destroy organics as well.
- Conventional ETPs, reed bed systems also effective where space is available.
Technology selection factors

- Regulatory acceptance
- Throughput capacity
- Types of waste treated
- Microbial inactivation efficacy
- Environmental emissions and waste residues
- Space requirements
- Utility and other installation requirements
- Waste reduction
- Occupational safety and health

- Noise
- Odour
- Automation
- Reliability
- Level of commercialisation
- Background of the technology manufacturer or vendor
- Community and staff acceptance
- Cost
Technology supplier inventory

- 130 suppliers in 13 countries
- New version in preparation - around 300 suppliers
- More information at www.noharm.org
  ruth@hcwh.org
Thank you

More information from

www.noharm.org
ruth@hcwh.org