Office of Technology Assessment

Congressional Board of the 101st Congress

EDWARD M. KENNEDY, Massachusetts, Chairman

CLARENCE E. MILLER, Ohio, Vice Chairman

Senate

ERNEST F. HOLLINGS
South Carolina

CLAIBORNE PELL
Rhode Island

TED STEVENS
Alaska

ORRIN G. HATCH
Utah

CHARLES E. GRASSLEY
Iowa

House

MORRIS K. UDALL
Arizona

GEORGE E. BROWN, JR.
California

JOHN D. DINGELL
Michigan

DON SUNDBUIST
Tennessee

AMQ HOUGHTON
New York

JOHN H. GIBBONS
(Nonvoting)

Advisory Council

CHASE N. PETERSON, Chairman
University of Utah

JOSHUA LEDERBERG, Vice Chairman
Rockefeller University

CHARLES A. BOWSHER
General Accounting Office

LEWIS BRANSCOMB
Harvard University

MICHEL T. HALBOUTY
Michel T. Halbouty Energy Co.

NEIL E. HARL
Iowa State University

JAMES C. HUNT
University of Tennessee

HENRY KOFFLER
University of Arizona

SALLY RIDE
California Space Institute

JOSEPH E. ROSS
Congressional Research Service

JOHN F. M. SIMS
Usibelli Coal Mine, Inc.

MARINA V. N. WHITMAN
General Motors Corp.

Director

JOHN H. GIBBONS

The Technology Assessment Board approves the release of this report. The views expressed in this report are not necessarily those of the Board, OTA Advisory Council, or individual members thereof.
Recommended Citation:


For sale by the Superintendent of Documents
(Order form can be found in the back of this report.)
Foreword

The adequate management of medical wastes first became a major focus of public attention when medical wastes with other debris washed ashore on the East Coast in the summer of 1988. In October of that year, as part of OTA's assessment of municipal solid waste management, OTA issued a background paper entitled Issues in Medical Waste Management. That study provided an overview of medical waste disposal practices and potential risks associated with them, and discussed the need for further Federal involvement in managing medical wastes.

Also in October of 1988, Congress passed the Medical Waste Tracking Act, establishing a 2-year demonstration tracking program for medical waste management and directing the Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry to complete several studies to evaluate management issues and potential risks related to medical waste disposal.

Some studies by these and other government agencies, and by private-sector interests, have been completed since that time on various aspects of medical waste management issues. The focus of concern has shifted primarily to the adequacy of handling, treatment, and disposal practices for medical wastes. Public concern remains high and much of the confusion and inconsistency associated with medical waste policy persists.

This OTA report was requested by the House Committee on Science, Space, and Technology, the House Subcommittee on Transportation and Hazardous Materials, Committee on Energy and Commerce, and the House Subcommittee on Regulation, Business Opportunities and Energy, Committee on Small Business. The report evaluates medical waste issues in the broader context of a waste management policy for the Nation. Waste reduction and recycling options for medical waste management, as well as incineration and non-incineration treatment alternatives are examined.

Applying a more comprehensive waste management approach to medical wastes, such as has evolved for municipal solid waste and hazardous waste, could help ensure environmentally sound and economically feasible waste practices. At a minimum, we realize that (as with most waste problems) there is no one management scenario to "solve" our medical waste problems; rather the most important task is to devise policies that will facilitate adoption of individually optimal solutions to specific problems.

OTA benefited from the assistance received from many organizations and individuals during the course of this study. We express our gratitude and thanks to the review panel and the many other reviewers for their input which greatly facilitated the preparation of the report. OTA, however, is solely responsible for the contents of this report.

JOHN H. GIBBONS
Director
Review Panel and Medical Waste Workshop Participants for Finding the Rx for Managing Medical Waste

Barry Rabe, Chairman
School of Public Health
University of Michigan

Richard Bernstein
General Medical Corp.

Janis Kurth
Metropolitan Hospital

Leland Cooley
Radiation Safety/Biosafety Office
University of Maryland at Baltimore

Jenny Lezak
Health Organization to Protect Our Environment

Frank Cross
Cross/Tessitore & Associates, P.A.

Daniel Liberman
Massachusetts Institute of Technology

John Cusack
Asea, Brown & Boveri

Thomas J. Murphy
Thomas J. Murphy Associates

Janet Emmerman
Waste Management, Inc., Medical Services

Edward Norman
State of North Carolina Health Department

Roger Etter
John Zink Co.

Claude D. Rounds
Albany Medical Center

Martin S. Favero
Centers for Disease Control

James Sharp
Stericycle

Randell Forshey
San-i-pak Pacific, Inc.

Robert Spurgin, OTA Contractor
Spurgin & Associates

Barbara Fry
State of California

Martha Trusler
Methodist Health Systems

Air Resources Board

Wayne Turnberg
Department of Ecology

Allen Hershkowitz
State of Washington

Natural Resources Defense Council

Michelle Wilson
U.S. Environmental Protection Agency

Ode Keil
Joint Commission on Accreditation of Healthcare Organizations

NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the workshop participants, advisory panel members, and reviewers. These participants do not, however, necessarily approve, disapprove, or endorse this special report. OTA assumes full responsibility for the special report and the accuracy of its contents.
OTA Medical Waste Management Project Staff

John Andelin, Assistant Director, OTA
Science, Information, and Natural Resources Division

Robert Niblock, Oceans and Environment Program Manager

Kathryn Wagner, Project Director

Contractors

Robert Gutman, Esq.

Robert Spurgin, Spurgin & Associates

Administrative Staff

Kathleen Beil  Sally Van Aller
Reviewers and Contributors

Robert Ashworth
Browning-Ferris Industries

Charlotte Baker
University of California

Robert G. Barton
Energy & Environmental Research Corp.

John N. Basic, Sr.
Basic Environmental Engineering

William F. Bina
Naval Medical Command

Jack D. Brady
Anderson 2000, Inc.

Theodore G. Brna
U.S. Environmental Protection Agency

Joy Buck
City Hospital, Inc.

Robert E. Campbell
Johnson & Johnson

Sherry Clay
Texas Department of Health

Peter S. Daley
Chemical Waste Management, Inc.

Milton Dezube
American Hospital Association

Henry L. Diamond, Esq.
Beveridge & Diamond, P.C.

Lawrence Doucet
Doucet & Mainka

Dennis Downing
Cornell University

Al Dozier
Advanced Concepts, Inc.

Kenneth L. DuFour
Medical Disposal Systems

George Estel
New York State Department of Health

Jacquelyn Flora
Browning-Ferris Industries

Robin Gillespie
Service Employees International Union

Martin E. Gilligan, Jr.
Donlee Technologies, Inc.

Rebecca Goldberg
Environmental Defense Fund

Mary Greene
U.S. Environmental Protection Agency

Roger Greene
State of Rhode Island

Dieter Groschel
University of Virginia Medical Center

Robert Gutman, Esq.

Shan Haley
American Hospital Association

John Hall
San-i-pak Pacific, Inc.

Susan Harwood
U.S. Department of Labor

Steven A. Hickerson
EMCOTEX

Travis Honeycutt
Isolyser

Wally Jordan
Waste Tech

Edwina Juillet
Martha Jefferson Hospital

Larry King
Poly-Flex

Jonathan Kiser
National Solid Waste Management Association

Carolyn Konheim
Konheim & Ketcham

Judy Kowalski
New Mexico Energy, Minerals
and Natural Resources Department

Jack Lauber
New York State Department of
Environmental Conservation

C.C. Lee
U.S. Environmental Protection Agency

Howard Levenson
Office of Technology Assessment

Maureen Litchveld
Agency for Toxic Substances and Disease Registry

Edward Londres
New Jersey Department of Environmental
Protection

Hugo Lopez
Beth Israel Hospital
Robert Lord
Nassau-Suffolk Hospital Council, Inc.
Rodney W. Lowman
The Council for Solid Waste Solutions
Donald C. Malins
Pacific Northwest Research Foundation
Ted Malloy
Stanford University
John Manuel
Ontario Ministry of the Environment
Gretchen McCabe
Human Affairs Research Center
Battelle
Jean-Ann McGrane
New York City Health & Hospitals Corp.
Jim McLainey
American Hospital Association
Allan McLean
The University of Chicago Medical Center
John McVicar
Centers for Disease Control
Tom Merski
University of Pittsburgh
Thomas W. Moody
State of Florida Department
Environmental Regulation
Pat Moore
U.S. General Accounting Office
Sue Moreland
University of Tennessee
Phil Morris
South Carolina Department of
Health and Environmental Control
Regina Morris
New York Department of Sanitation
Lisa Neonen
The RACOURSE Network
Jerry Ness
Northwestern Memorial Hospital
Ross Patten
BFI Waste Systems
Robert Peters
National Solid Waste Management Association
Jacqueline Polder
Centers for Disease Control
Sven E. Rodenbeck
Agency for Toxic Substances and Disease Registry
Claude Rounds
Albany Medical Center
William Rutala
University of North Carolina
School of Medicine
Jacqueline W. Sales
Hazmed
W. Thomas Schipper
Kaiser Permanente
Steve Schuler
Joy Energy
Harvy Schultz
NY City Department of
Environmental Protection
Robert Sheehan
Medi-Gen
Robert Spurgin
Spurgin & Associates
Jeffrey Steiner
Mayo Clinic
Tom Stewart
State University of New York
Christopher B. Strasser
The Allentown Hospital—Lehigh Valley Hospital Center
Pam Sulmer
State of Minnesota
Attorney General’s Office
Kevin Tonat
National Institutes of Health
Jim Tripodes
University of California
Jacqueline Warren
Natural Resources Defense Council
Joe Wilson
Medical Safetec
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction, Major Findings, and Policy Issues</td>
<td>1</td>
</tr>
<tr>
<td>SUMMARY OF FINDINGS</td>
<td>4</td>
</tr>
<tr>
<td>POLICY ISSUES FOR FEDERAL ACTION</td>
<td>6</td>
</tr>
<tr>
<td>Chapter 1. Characterizing Medical Wastes and Applying a Comprehensive Management Strategy</td>
<td>9</td>
</tr>
<tr>
<td>MEDICAL WASTE IN A COMPREHENSIVE WASTE MANAGEMENT STRATEGY</td>
<td>9</td>
</tr>
<tr>
<td>WASTE CHARACTERISTICS AND TYPES—TREATMENT IMPLICATIONS</td>
<td>11</td>
</tr>
<tr>
<td>Chemical Characteristics</td>
<td>13</td>
</tr>
<tr>
<td>Biological Characteristics</td>
<td>15</td>
</tr>
<tr>
<td>Physical Characteristics</td>
<td>17</td>
</tr>
<tr>
<td>Chapter 2. Before Treatment: Waste Reduction and Recycling</td>
<td>19</td>
</tr>
<tr>
<td>BEFORE-TREATMENT APPROACHES</td>
<td>19</td>
</tr>
<tr>
<td>WASTE REDUCTION</td>
<td>19</td>
</tr>
<tr>
<td>RECYCLING AND SOURCE SEPARATION PRACTICES</td>
<td>23</td>
</tr>
<tr>
<td>Chapter 3. Non-incineration Treatment Technologies and Trends</td>
<td>27</td>
</tr>
<tr>
<td>AUTOCLAVING</td>
<td>28</td>
</tr>
<tr>
<td>Capacity and Sizing Issues</td>
<td>29</td>
</tr>
<tr>
<td>Suitability for Different Medical Wastes and Associated Risks</td>
<td>31</td>
</tr>
<tr>
<td>Costs and Volume Reduction Issues</td>
<td>31</td>
</tr>
<tr>
<td>AUTOCLAVING AND COMPACTION</td>
<td>32</td>
</tr>
<tr>
<td>MECHANICAL/CHEMICAL DISINFECTION</td>
<td>33</td>
</tr>
<tr>
<td>MICROWAVE</td>
<td>36</td>
</tr>
<tr>
<td>IRRADIATION</td>
<td>36</td>
</tr>
<tr>
<td>OTHER POTENTIAL TREATMENT TECHNOLOGIES</td>
<td>38</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>39</td>
</tr>
<tr>
<td>Chapter 4. Incineration Treatment Issues and Trends</td>
<td>41</td>
</tr>
<tr>
<td>REGULATORY TRENDS AND MEDICAL WASTE INCINERATION</td>
<td>42</td>
</tr>
<tr>
<td>CAPACITY, COSTS, AND RISKS</td>
<td>46</td>
</tr>
<tr>
<td>Capacity</td>
<td>46</td>
</tr>
<tr>
<td>Costs</td>
<td>47</td>
</tr>
<tr>
<td>Risks</td>
<td>47</td>
</tr>
<tr>
<td>TRENDS IN AIR POLLUTION CONTROL SYSTEMS</td>
<td>51</td>
</tr>
<tr>
<td>OPERATOR TRAINING</td>
<td>53</td>
</tr>
<tr>
<td>OFF-SITE INCINERATION</td>
<td>54</td>
</tr>
<tr>
<td>Off-Site v. On-Site Treatment</td>
<td>54</td>
</tr>
<tr>
<td>Co-Incineration or Co-Firing of Wastes</td>
<td>54</td>
</tr>
<tr>
<td>Regional Incineration</td>
<td>55</td>
</tr>
<tr>
<td>SUMMARY</td>
<td>57</td>
</tr>
<tr>
<td>Chapter 5. Special Treatment Issues</td>
<td>59</td>
</tr>
<tr>
<td>SHARPS MANAGEMENT</td>
<td>59</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>59</td>
</tr>
<tr>
<td>Mechanical/Chemical</td>
<td>60</td>
</tr>
<tr>
<td>Encapsulation</td>
<td>60</td>
</tr>
<tr>
<td>Mail Shipment for Disposal</td>
<td>60</td>
</tr>
<tr>
<td>SMALL GENERATOR MANAGEMENT</td>
<td>61</td>
</tr>
<tr>
<td>OTHER TREATMENT TECHNIQUES: SEWER USE AND SHREDDING</td>
<td>62</td>
</tr>
<tr>
<td>Sewer Use</td>
<td>62</td>
</tr>
<tr>
<td>Shredding</td>
<td>62</td>
</tr>
<tr>
<td>Chapter 6. Comparisons of Treatment Alternatives</td>
<td>65</td>
</tr>
<tr>
<td>CAPABILITIES AND RISKS</td>
<td>65</td>
</tr>
<tr>
<td>COSTS</td>
<td>66</td>
</tr>
<tr>
<td>Appendix A. The Medical Waste Tracking Act</td>
<td>69</td>
</tr>
</tbody>
</table>
Contents—Continued

Boxes

<table>
<thead>
<tr>
<th>Box</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Management of Medical Low-Level Radioactive Waste (LLW)</td>
<td>16</td>
</tr>
<tr>
<td>B. Disposables: Infection Control and Waste Management Implications</td>
<td>20</td>
</tr>
<tr>
<td>C. California and Its Dioxin Control Measure: A Case Study of One State’s Approach to Regulation of Air Toxics and Medical Waste Incinerators</td>
<td>43</td>
</tr>
<tr>
<td>D. The Medical Waste Tracking Program</td>
<td>70</td>
</tr>
</tbody>
</table>

Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Schematic of One Hospital’s Proposed Segregation Categories and Comprehensive Medical Waste Management Approach</td>
<td>23</td>
</tr>
<tr>
<td>2. Autoclave</td>
<td>29</td>
</tr>
<tr>
<td>3. Typical Sterilization Destruction Curve</td>
<td>30</td>
</tr>
<tr>
<td>4. Autoclave and Compaction Unit</td>
<td>33</td>
</tr>
<tr>
<td>5. Mechanical/Chemical Disinfection Unit</td>
<td>35</td>
</tr>
<tr>
<td>6. Mobile Microwave Medical Waste Disinfection Unit</td>
<td>37</td>
</tr>
<tr>
<td>7. Irradiation Unit</td>
<td>38</td>
</tr>
<tr>
<td>8. Controlled Air Incinerator</td>
<td>45</td>
</tr>
<tr>
<td>9. Comparison of PCDD/PCDF Concentration in Medical and Municipal Wastes</td>
<td>49</td>
</tr>
<tr>
<td>10. Comparison of PCDD/PCDF Emissions From a Variety of Incinerators</td>
<td>49</td>
</tr>
<tr>
<td>11. Comparisons of Cadmium Emissions From a Variety of Incinerators</td>
<td>50</td>
</tr>
</tbody>
</table>

Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Major Federal Agencies Addressing Medical Waste Issues</td>
<td>3</td>
</tr>
<tr>
<td>2. Types of Wastes Designated as Infectious by Various Entities</td>
<td>12</td>
</tr>
<tr>
<td>3. Percentages of Waste Types Produced at Different Medical/Health-Care Facilities in the State of Washington</td>
<td>14</td>
</tr>
<tr>
<td>4. Characteristics of Medical Waste</td>
<td>17</td>
</tr>
<tr>
<td>5. Comparison of the Composition of Medical and Municipal Waste</td>
<td>17</td>
</tr>
<tr>
<td>6. Emissions of Dioxins and Cadmium From Medical Waste Incinerators in California</td>
<td>48</td>
</tr>
<tr>
<td>7. Performance Data of Medical Waste Incinerators With Pollution Control Equipment</td>
<td>52</td>
</tr>
<tr>
<td>8. Comparison of Treatment Technologies</td>
<td>66</td>
</tr>
</tbody>
</table>