



Safe management of wastes from health-care activities

Second edition

Edited by Yves Chartier, Jorge Emmanuel, Ute Pieper,
Annette Prüss, Philip Rushbrook, Ruth Stringer,
William Townend, Susan Wilburn and Raki Zghondi

Safe management of wastes from health-care activities

2nd edition



All rights reserved. Publications of the World Health Organization (WHO) are available on the WHO web site (www.who.int) or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: bookorders@who.int).

Requests for permission to reproduce or translate WHO publications –whether for sale or for non-commercial distribution– should be addressed to WHO Press through the WHO web site (www.who.int/about/licensing/copyright_form/en/index.html).

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by WHO in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by WHO to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the WHO be liable for damages arising from its use.

The named editors alone are responsible for the views expressed in this publication.

Declarations of interest

The members of the health-care waste-management working group completed the WHO standard form for declaration of interests prior to the meeting. At the start of the meeting, all participants were asked to confirm their interests, and to provide any additional information relevant to the subject matter of the meeting. It was from this working group that chapter authors and lead editors were selected.

None of the members declared current or recent (<1 year) financial interests related to commercial organizations.

Two members declared consultation contracts for work relevant to the subject matter of the meeting.

Bill Townend: Consultant for two industry nongovernment organizations, one of which – the International Solid Waste Association – is a nongovernmental organization in official relations with WHO, and provided technical and financial support for the publication.

Ute Pieper: Consultant in health-care waste management in projects financed by international agencies, development banks and bilateral government agreements.

These interests were not considered to give rise to a conflict with the aims of the meeting and the publication arising from the meeting and formed the basis of the expertise of the panel.

The following participants were adjudged to have no potentially conflicting interests in the subject matter of the meeting, based on their completed declarations: Jorge Emmanuel, Philip Rushbrook and Ruth Stringer.

Cover images (from top to bottom): tacartoons | Dreamstime.com; Jorge Emmanuel; J. Emmanuel; Sudoku1 | Dreamstime.com; J. Emmanuel; Global Methane Initiative (GMI) program; J. Emmanuel

Technical editing and design by Biotext, Australia

Printed in Malta

Contents

Foreword to the first edition	xiii
Acknowledgements	xv
Acronyms and abbreviations	xvii
1 Introduction	1
2 Definition and characterization of health-care waste	3
2.1 General definition and classification	3
2.1.1 Sharps waste	4
2.1.2 Infectious waste	4
2.2 Pathological waste	5
2.3 Pharmaceutical waste, including genotoxic waste	5
2.4 Chemical waste	6
2.5 Radioactive waste	8
2.6 Non-hazardous general waste	8
2.7 Sources of health-care waste	9
2.8 Generation of health-care waste	11
2.9 Physicochemical characteristics	15
2.10 Minimum approach to overall management of health-care waste	20
2.11 Desirable improvements to the minimum approach	21
2.12 References and further reading	21
3 Risks associated with health-care waste	25
3.1 Overview of hazards	25
3.1.1 Types of hazards	25
3.1.2 Persons at risk	25
3.1.3 Hazards from infectious waste and sharps	26
3.1.4 Hazards from chemical and pharmaceutical waste	28
3.1.5 Hazards from genotoxic waste	29
3.1.6 Hazards from radioactive waste	30
3.1.7 Hazards from health-care waste-treatment methods	30
3.2 Public sensitivity	31
3.3 Public health impact	31
3.3.1 Impacts of infectious waste and sharps	31
3.3.2 Impacts of chemical and pharmaceutical waste	34
3.3.3 Impacts of genotoxic waste	34
3.3.4 Impacts of radioactive waste	34
3.4 Survival of pathogenic microorganisms in the environment	34
3.5 The need for further research and epidemiological surveys	35
3.6 References and further reading	36
4 Legislative, regulatory and policy aspects of health-care waste	41
4.1 Importance of a national policy	41
4.2 Guiding principles	41
4.3 International agreements and conventions	42
4.3.1 The Basel Convention	42

	4.3.2	The Bamako Convention	43
	4.3.3	The Stockholm Convention.....	43
	4.3.4	The environment and sustainable development conferences	43
	4.3.5	United Nations Committee of Experts on the Transport of Dangerous Goods	44
	4.3.6	United Nations Economic Commission for Europe	44
	4.3.7	Aarhus Convention of the United Nations Economic Commission for Europe	45
4.4		Available guidance	45
	4.4.1	World Health Organization Guidance	45
	4.4.2	The International Solid Waste Association	46
	4.4.3	ISWA policy document on health-care waste management	47
4.5		National legislation	47
4.6		Technical guidelines	48
4.7		Minimum approach to developing health-care waste-management policy	48
4.8		Desirable improvements to the minimum approach	48
4.9		References and further reading	49
5		Health-care waste-management planning.....	51
	5.1	The need for planning	51
	5.2	National plans	52
	5.2.1	Purpose of a national health-care waste-management plan	52
	5.2.2	Action plan for developing a national programme	52
	5.3	Waste-management plan for a health-care facility	56
	5.3.1	Assignment of responsibilities.....	56
	5.3.2	Management structure, liaison arrangements and duties.....	57
	5.3.3	Assessment of waste generation	61
	5.3.4	Development of a hospital waste-management plan	62
	5.3.5	Implementation of the waste-management plan	64
	5.4	Minimum approach to planning	65
	5.5	Desirable improvements to the minimum approach	65
	5.6	References and further reading	65
6		Health-care waste minimization, reuse and recycling.....	67
	6.1	The waste-management hierarchy	67
	6.2	Waste minimization	68
	6.3	Environmentally preferable purchasing	68
	6.4	Green procurement.....	69
	6.4.1	Recycling symbols for plastics	69
	6.5	Safe reuse.....	70
	6.6	Recycling and recovery.....	71
	6.7	Environmental management systems	73
	6.8	Minimum approach to waste minimization.....	74
	6.9	Desirable improvements to the minimum approach	74
	6.10	References and further reading	75
7		Segregation, storage and transport of health-care waste	77
	7.1	Guiding principles	78
	7.2	Segregation systems.....	78
	7.2.1	Waste containers, colour codes and labels.....	78
	7.2.2	Beyond basic segregation	82

	7.2.3	Waste containers: specifications and siting	83
	7.2.4	Setting and maintaining segregation standards	85
7.3		Collection within the health-care facility	86
7.4		Interim storage in medical departments	86
7.5		Onsite transport of waste	87
	7.5.1	General requirements	87
	7.5.2	Transport trolleys	87
	7.5.3	Routing	88
7.6		Central storage inside health-care facilities	89
	7.6.1	General requirements	90
	7.6.2	Hazardous waste storage	91
	7.6.3	Layout of waste-storage areas	94
	7.6.4	Documentation of the operation of storage places	95
7.7		Offsite transport of waste	95
	7.7.1	Logistic staff	95
	7.7.2	Vehicle requirements	96
	7.7.3	Labelling of the transport vehicle	97
	7.7.4	Cleaning of container and vehicle	99
	7.7.5	Transport documentation	99
7.8		Minimum approach to segregation, storage and transport	102
7.9		Desirable improvements to the minimal approach	102
7.10		References and further reading	103
8		Treatment and disposal methods	105
8.1		Selection of treatment methods	105
8.2		Overview of waste-treatment technologies	106
	8.2.1	Thermal processes	106
	8.2.2	Chemical processes	106
	8.2.3	Irradiation technologies	107
	8.2.4	Biological processes	107
	8.2.5	Mechanical processes	107
8.3		Suitability of treatment methods for infectious waste	107
8.4		Steam treatment technologies	108
	8.4.1	Autoclaves	108
	8.4.2	Integrated steam-based treatment systems	111
8.5		Microwave treatment technologies	112
8.6		Dry-heat treatment technologies	113
8.7		Chemical treatment technologies	113
	8.7.1	Internal shredding of waste	114
	8.7.2	Chemical disinfectants	114
	8.7.3	Microbial resistance	115
	8.7.4	Alkaline hydrolysis	116
8.8		Incineration	116
	8.8.1	Combustion	116
	8.8.2	Pyrolysis and gasification	117
	8.8.3	Required waste characteristics	118
	8.8.4	Energy recovery	118
	8.8.5	Types of incinerators for health-care waste	119

	8.8.6	Environmental control of incinerators	121
	8.8.7	Dust removal.....	124
	8.9	Encapsulation and inertization	125
	8.10	Emerging technologies.....	126
	8.11	Applications of treatment and disposal methods to specific waste categories	127
	8.11.1	Sharps.....	127
	8.11.2	Anatomical waste, pathological waste, placenta waste and contaminated animal carcasses	128
	8.11.3	Pharmaceutical waste	129
	8.11.4	Cytotoxic waste	129
	8.11.5	Chemical waste	130
	8.11.6	Waste containing heavy metals.....	131
	8.12	Land disposal	133
	8.12.1	Municipal and other external disposal sites.....	134
	8.13	Minimum approach to treatment and disposal.....	136
	8.14	Desirable improvements to the minimum approach	137
	8.15	References and further reading	138
9		Collection and disposal of wastewater	147
	9.1	Characteristics of health-care wastewater	147
	9.2	Hazards of wastewater from health-care facilities.....	147
	9.2.1	Wastewater-related diseases.....	148
	9.2.2	Hazards from liquid chemicals in wastewater	149
	9.2.3	Hazards from pharmaceuticals in wastewater.....	149
	9.2.4	Hazards from radioactive substances.....	150
	9.2.5	Quantity of wastewater.....	150
	9.2.6	Quality of wastewater by hospital department	150
	9.3	Collection and pretreatment of liquid health-care waste	151
	9.3.1	Sewerage systems for health-care facilities.....	151
	9.3.2	Pretreatment of hazardous liquids	152
	9.4	Discharge into municipal sewage systems.....	153
	9.5	Onsite wastewater treatment	153
	9.5.1	Wastewater-treatment systems	153
	9.5.2	Disinfection of wastewater	155
	9.5.3	Disposal of sludge	155
	9.5.4	Emerging technologies.....	156
	9.5.5	Reuse of wastewater and sludge	156
	9.5.6	Offsite treatment and disposal in specialized facilities.....	157
	9.6	Operation and monitoring of sewerage systems.....	157
	9.6.1	Operation and maintenance of wastewater systems	157
	9.6.2	Monitoring of wastewater systems	157
	9.7	Minimum approach to wastewater management.....	158
	9.7.1	Sanitation system.....	158
	9.7.2	Minimal liquid hazardous waste-management system	158
	9.7.3	Basic wastewater-treatment systems	159
	9.8	Desirable improvements to the minimum approach	162
	9.9	References and further reading	163

10	Economics of health-care waste management	165
10.1	Guiding principles	165
10.2	Cost elements.....	166
10.2.1	Costs at a health-care facility level	166
10.2.2	Costs at a central treatment facility level	167
10.2.3	Costs at a national level.....	168
10.3	Cost estimation.....	168
10.4	Cost and financing.....	174
10.4.1	Methods of financing	174
10.4.2	Costing tools	175
10.4.3	Pricing models for a treatment provider	177
10.5	Recommendations for cost reductions.....	178
10.6	Minimum approach to health-care waste management costing	178
10.7	Desirable improvements to the minimum approach	179
10.8	References and further reading	179
11	Health and safety practices for health-care personnel and waste workers.....	181
11.1	Guiding principles	181
11.2	Occupational health risks	182
11.2.1	Health hazards	182
11.2.2	Cytotoxic safety	184
11.3	Exposure prevention and control	184
11.3.1	Hierarchy of controls (applied to bloodborne pathogens)	184
11.3.2	Dealing with spillages	185
11.3.3	Reporting accidents and incidents.....	187
11.3.4	Protective equipment	187
11.3.5	Occupational post-exposure prophylaxis.....	188
11.4	Training.....	189
11.5	Minimum approaches to health and safety practices	189
11.6	Desirable improvements to the minimum approach	189
11.7	References and further reading	190
12	Hospital hygiene and infection control	195
12.1	Guiding principles	195
12.2	Chain of infection	195
12.3	Epidemiology of nosocomial infections.....	195
12.3.1	Transition from exposure to infection	196

预览已结束，完整报告链接和二维码如下：

https://www.yunbaogao.cn/report/index/report?reportId=5_27821

