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**NATIONAL GUIDELINES FOR  
WASTE MANAGEMENT IN THE  
HEALTH CARE INDUSTRY**



**NHMRC**

National Health and Medical Research Council

**National guidelines  
for waste management  
in the health industry**

**Endorsed March 1999**

**NHMRC**

National Health and Medical Research Council

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## PREFACE

This is the first revision of the *National Guidelines for the Management of Clinical and Related Wastes*, which was published by the National Health and Medical Research Council (NHMRC) in 1988. In this revision the national guidelines have been expanded by the addition of details of waste management such as audit, segregation and minimisation, and recommendations for the disposal of general waste.

The wider scope of the 1999 guidelines is reflected in the title, *National Guidelines for Waste Management in the Health Industry*.

Two aspects of the recommended national strategy for clinical and related wastes require special emphasis: the need for a consistent national approach, and the need for a realistic, scientific appraisal of the actual risks associated with health industry wastes.

The States and Territories should negotiate detailed and consistent definitions of the terms used in the documentation of their waste management requirements through regular consultation. This document leads the way in facilitating a consistent national approach to the management of clinical and related wastes.

While some categories of waste (such as cytotoxic and radioactive waste) can undoubtedly be hazardous in certain circumstances, the risk associated with clinical waste has often been exaggerated and has caused emotive arguments. Current epidemiological studies throughout the world have failed to establish a risk attributable to hospital waste to health-care workers, waste transport staff or the public, apart from the danger of needle-stick injuries causing infection. Nevertheless, this should not promote a false sense of security in the management of hospital waste.

Since the costs involved with waste disposal are rising, greater emphasis is now placed on financial considerations in waste management. The introduction of the practices described in these national guidelines, such as appropriate segregation and minimisation of waste, can significantly reduce the costs of waste disposal.

Economic and environmental considerations should be balanced with the need to safely manage materials which may present public and workplace risk, potential risk or public offence.

Appreciation is expressed to officers of Queensland Health, who wrote the section on radioactive waste.

The assistance provided by Dr Robert Baker of Chem Affairs, Sydney, and Professor David Moy of techSearch, Salisbury, Queensland, in finalising this revision, is acknowledged with thanks.

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# CHAPTER 1

## INTRODUCTION

### Aims

The national guidelines for health industry waste management aim to enhance and protect public health and safety; to provide a safer working environment; to minimise waste generation and the environmental impact of waste treatment and disposal and to facilitate compliance with regulatory requirements.

### Contents

The guidelines outline procedures for the classification, segregation, safe packaging (containment), labelling, storage, transport and disposal of clinical and related wastes. They are intended to assist authorities and practitioners, as well as other people involved (whether directly or indirectly), in determining an appropriate waste management strategy. The unique and specific factors applicable to each situation—the local conditions, requirements and regulations, and the type and volume of waste generated—should all be taken into account when formulating policy.

### Terminology

There has been universal difficulty within the numerous groups that work in health care establishments in reaching a satisfactory definition of clinical and related wastes. The terms *hospital waste*, *clinical waste*, *infectious waste*, *medical waste*, *biomedical waste* and *biohazardous waste* are often used synonymously, but inappropriately. The definitions of waste capable of producing human harm must be precise, but not over-inclusive.

In this document, *health industry wastes* are defined as all types of wastes (clinical, related and general) arising from medical, nursing, dental, veterinary, pharmaceutical, or similar practices, and wastes generated in hospitals or other facilities during the investigation or treatment of patients or in research projects.

### Classification

Clinical waste includes the following categories:

- discarded sharps;
- laboratory and associated waste directly involved in specimen processing;
- human tissues, including materials or solutions containing free-flowing blood; and
- animal tissue or carcasses used in research.

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Related waste includes:

- cytotoxic waste;
- pharmaceutical waste;
- chemical waste; and
- radioactive waste.

This document will consider the management of wastes that do not fall into the above categories under the heading of *general waste*. General waste is included in the guidelines to assist waste generators to develop a comprehensive waste management strategy.

## Risk assessment

General waste constitutes the bulk of waste generated by health care institutions, and is no more of a public health risk or concern than domestic or household waste. Likewise, if properly managed, the components of the clinical and the related waste streams present no actual risks to workers, whether clinicians or waste contractors.

Community perceptions—that any hospital waste is somehow dangerous—indicate a need for wider dissemination of the results of epidemiological health industry waste studies to date, and further study/analysis of waste stream components in the Australian setting.\*

Clinical and related wastes can present handling, storage, transport and/or disposal problems for the following reasons:

- the potential risk to personnel involved in the disposal of some of these wastes, and to the public, if it is **not** managed correctly; and
- the potential for pollution of the environment or visual offence if wastes are not disposed of properly.

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\* Key overseas references to date include:

- *The Public Health Implications of Medical Waste: A Report to Congress (1990)*, Agency for Toxic Substances and Disease Registry, Washington, Department of Health and Human Services;
- *Shaping State and Local Regulation of Medical Waste and Hazardous Materials, (1990)*, Report of the Ad Hoc Committee on Medical Waste and Hazardous Materials, Chicago, American Hospitals Association;
- *Society for Hospital Epidemiology of America, Position Paper: Medical Waste, (1992)*, Rutala, WA and Mayhall, CG, Infection Control and Hospital Epidemiology, Volume 13, pp 38–48; and
- *The Microbiological Hazards of Municipal and Clinical Wastes, (1992)*, Collins, CH and Kennedy, DA, Journal Applied Bacteriology, Volume 73, pp 1–6.

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The key to risk reduction is the development and implementation of an appropriate waste management strategy and plan. The plan must be supported by senior management and administration, both in principle, and in allocation of sufficient resources. Implementation should involve clinicians and contractors, and all endeavours must be supported by appropriate monitoring (eg waste audits) and an on-going education program.

The institution or individual generating clinical and related wastes is responsible for the safe management of such waste. Each generating organisation should have a comprehensive waste management strategy and implementation plan that encompasses the principles embodied in these national guidelines.

## **Generators**

The following premises are likely to generate clinical and related wastes:

- acupuncturists and other similar premises where alternative medicine is practised;
- ambulance and special emergency service depots;
- blood transfusion centres and blood banks;
- brothels;
- clinics used for medical, dental, veterinary or similar purposes;
- dental hospitals, surgeries and laboratories;
- funeral undertakers and morticians;
- general practitioner centres and clinics;
- health centres;
- hospitals;
- medical research establishments;
- pathology and microbiological laboratories;
- pharmaceutical manufacturing plants and hospital and community pharmacies;
- physiotherapists and podiatrists;
- residential and nursing homes, and hostels for the chronically sick;
- tattooists, body piercers; and
- veterinary hospitals, surgeries, laboratories, pet shops.

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## **Waste minimisation**

A fundamental principle of any waste management strategy is that the generation of waste be minimised. Appropriate classification and segregation will minimise costs and volume in certain waste stream categories. Volume reduction in real terms requires life-cycle-analysis of products used in clinical practice, and consideration/implementation of reuse/reusables, recycling and EPR (Extended Producer Responsibility) enabling producer initiated collection for re-manufacture.

## **Occupational health and safety**

The strategy must ensure that all waste is handled and disposed of safely. This applies particularly to hazardous waste such as discarded sharps, cytotoxic pharmaceuticals, microbiological cultures and radioactive waste. The waste management plan and procedures should be readily available to all workers involved.

## **Legislative requirements**

The recommendations in this document are not meant to override any special conditions imposed by the relevant State and Territory authorities. Rather, they provide a basis for the development of any current and future strategy for clinical and related wastes management in Australia, particularly for hospitals and similar health care establishments.

The legal authority for waste control rests mainly with the States and Territories. However, there is a need for a national, uniform strategy for clinical and related wastes management, and therefore the terminology used in this document is recommended. National standardisation will help to improve safety and optimise resources.

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## CHAPTER 2

### RECOMMENDATIONS

The following are the key recommendations. However, some States and Territories may adopt more stringent measures with respect to waste management options.

#### 2.1 Overview

- These guidelines should be used as the basis for a national uniform strategy for waste management in the health industry.
- Generators of clinical and related wastes must ensure the safe identification, packaging/containment, labelling, storage, transport, treatment and disposal of such wastes.
- A large proportion of clinical and related wastes is no more dangerous than domestic waste, and waste generators should lead the way in educating all personnel, and particularly disposal contractors, to approach waste management with this in mind.

#### 2.2 Organisational issues

- Appropriate waste management strategy and plan should be developed and implemented with the full support of senior management. (4.1)
- Generators should develop and periodically review a comprehensive waste management strategy. (4.2)
- Public health and environment protection, provision of information, education and training, performance monitoring and the incorporation of a feedback loop are essential elements that need to be included in the management strategy. (4.2)
- Statistical analysis of data collected on waste type, weight, volume, manner and frequency of removal, cost and associated injuries, should be undertaken annually. (4.2)
- A waste audit should be conducted prior to developing a waste management plan and subsequently repeated to monitor effectiveness after implementation of the plan. (4.3)
- As an integral part of the management plan, waste minimisation can be achieved through product substitution, product changes, procedural changes, giving preference, where appropriate, to reusable items. (4.4)
- Health care facilities, especially hospitals, should develop partnerships with product manufacturers (of both clinical/therapeutic and general goods) to initiate extended producer responsibility (EPR), collection programs for re-manufacture. (4.4)

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- Waste generators and handlers should practise waste segregation, with a single-stage segregation at source. (4.5)
  - Health care facilities, especially hospitals, should rigorously seek to implement recycling programs for materials where a viable market exists. (4.6.3)

### **2.3 Containers, storage and transport**

- All waste containers/bags should be colour-coded and identified according to the current national Standard. (5.1)
- Wherever practicable, in the containment of waste, rigid-walled containers should be used in place of waste bags to reduce risk potential to waste handlers. Such rigid containers should preferably be lined with tie-off plastic bags. (5.1)
- Sharps, including retractable items/sharps safety devices, must be placed in a container manufactured to the relevant Australian/New Zealand Standards. (5.1.1)
- Storage areas (for waste, prior to disposal) should be suitably sited, lockable, hygienic, appropriately sign-posted and kept secure at all times. (5.2)
- The institution's waste disposal strategy should include procedures for on-site and off-site transport of waste. During movement of wastes segregation must be maintained. However containers with mixed categories of waste must be managed according to the component with the highest level of risk. (5.3)

### **2.4 Treatment and disposal methods**

- Clinical waste must be disposed of by an approved method.
- Incineration should be used for disposal of recognisable anatomical parts and pharmaceuticals including cytotoxins. (3.1.3, 3.2.1–3.2.4, 6.2)
- High-temperature incineration should be used for the disposal of cytotoxic waste. The incineration temperature in the secondary burning chamber must be 1100 degrees Celsius, with a minimum residence time for volatile gases of 1.0 second. (3.2.1)
- Landfill is a viable alternative to incineration for the bulk of clinical wastes generated in geographical areas where approved incineration facilities are not readily accessible. Such landfill sites should be properly engineered (lined), secure and supervised.
- Where landfill disposal of clinical and related wastes is intended, recognisable anatomical parts, pharmaceuticals and cytotoxic waste should, where possible, be excluded at source and the landfill site should be confirmed as suitable. (6.3)

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- Treatment facilities for clinical and related wastes must be operated and maintained according to licence specifications. The relevant national, State and Territory emission standards must be met. (6, 6.2)
  - Radioactive waste must be handled, stored and disposed of in accordance with relevant legislation. (3.2.4)
  - General waste can be disposed of in the same manner as domestic waste.

## **2.5 Clinical waste disposal in the home**

Hospitals or other health care providers who make sharps available for use in the home are responsible for making an adequate disposal method available. (8)

People who use sharps not provided by a health care facility or practitioner must ensure that disposal is within a container which is rigid, puncture-resistant and sealable, or is within an approved sharps container. (8)



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## CHAPTER 3

### CATEGORISATION OF WASTES

The following categories of waste have been utilised either because of their potentially hazardous nature, the volume generated or aesthetic considerations:

- discarded sharps;
- laboratory and associated waste directly involved in specimen processing;
- human tissues, including materials or solutions containing free flowing blood or expressible blood;
- animal tissue or carcasses used in research;
- cytotoxic waste;
- pharmaceutical waste;
- chemical waste;
- radioactive waste; and
- general waste.

The categorisation of various wastes is not always clear-cut. For example, some contaminated sharps may be also radioactive. Where a container of waste includes more than one category of waste, eg cytotoxic and clinical waste, the method of disposal applicable to the most hazardous of these types of waste (eg cytotoxic) must be used for the whole container. Waste that has had contact with blood, exudates, or secretions may have infection potential, although it is not practical or necessary to treat all such waste as clinical.

Clinical or potentially zoonotic disease waste from veterinary facilities must be treated as clinical and related waste, but must be disposed of in accordance with the recommendations of the Ausvet Disaster Plan, and/or relevant State or Territory legislation.

Health care establishments should adopt the principle of standard precautions, including the use of protective apparels, where appropriate. All blood and body fluids or tissues are regarded as a potential source of infection. Direct exposure to any of these substances should be avoided regardless of whether human immunodeficiency virus (HIV) or other infection has been diagnosed in the patient source. For this reason, some States and Territories designate blood-stained bandages, dressings and other disposable items as clinical waste. However a commonsense approach should apply—hence the delineation of free-flowing or expressible (able to be squeezed from a sodden dressing or similar material) blood, rather than visible blood, in the above categorisation.

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## 3.1 Clinical waste

Clinical waste is that which has the potential to cause sharps injury, infection or public offence, and includes sharps, human tissue waste, laboratory waste, animal waste resulting from medical, dental or veterinary research or treatment that has the potential to cause disease; or any other waste, arising from any source, as specified by the establishment.

Clinical waste usually includes the following sub-categories:

- discarded sharps;
- laboratory and associated waste directly involved in specimen processing;
- human tissues, including materials or solutions that contain free-flowing or expressible blood; and
- animal carcasses that are contaminated or suspected to be contaminated by pathogenic organisms.

Institutions/clinicians may include other materials which are considered to be hazardous, with clinical waste for the purposes of treatment and disposal. In such instances, appropriate information regarding these materials should be supplied in writing to waste contractors and treatment/disposal facilities.

### 3.1.1 Sharps

Sharps are discarded objects or devices capable of cutting or penetrating the skin, eg hypodermic needles, intravenous sets ('spikes'), Pasteur pipettes, broken glass, and scalpel blades. Various hard plastic items, such as intact amniotic membrane perforators and broken plastic pipettes, also contribute to sharps.

All sharps pose a potential hazard and can cause injury through cuts or puncture wounds. Discarded sharps may be contaminated with blood, body fluid, microbiological materials, and toxic, cytotoxic or radioactive substances. There is disease potential if the sharp was used in the treatment of a patient with an infectious disease.

In general, disposable needles should not be removed from syringes or other appliances, nor should they be recapped after use unless an approved safety device is employed. The clipping, bending or breaking of needles without the aid of an approved protective device is most inadvisable because this may cause needle-stick injury. The practice of inserting intravenous spikes and needles into their attached plastic tubing is also not recommended.

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Where recapping of needles may be necessary, such as in the use of radioactive substances and for the collection of blood gases, special devices should be used to hold the cap.

Sharps must be placed in the designated and appropriately labelled sharps container directly after use. The design and construction of the container must reduce the possibility of injury to handlers during collection and transport of sharps for disposal.

Sufficient sharps containers must be provided and strategically placed so as to minimise the distance sharps are carried to the disposal point. Containers may be suitably attached to medication or procedure trolleys and should be placed in convenient positions in preparation and clean up areas in wards and in laboratories.

Placement of sharps containers should be such that they are out of reach of children—eg containers should not be placed on floors, or on the lower shelves of trolleys kept where children might gain access.

If carrying a sharp item, such as a syringe with needle, is unavoidable, then it must be carried in a container such as a kidney dish, so as to minimise the likelihood of a sharps injury.

Incineration or shredding/chemical disinfection and shredding/microwaving are acceptable methods of disposal for discarded sharps. Disposal via supervised landfill may be appropriate in some circumstances. In such instances it is essential that the disposal site is properly managed and that sharps containers are immediately covered with adequate soil or other suitable material.

Sharps that are contaminated with cytotoxic or radioactive materials must be labelled and disposed of according to the procedures set out in sections 3.2.1 and 3.2.4 respectively.

### **3.1.2 Laboratory and associated waste directly involved in specimen processing**

This category includes all specimens used for laboratory testing. It does not include urine or faecal specimens taken for bedside analysis.

Hair, nails and teeth are excluded, unless contaminated with free flowing or expressible blood.

Amalgam filled (contaminated with mercury) teeth should not be incinerated.

Cultures or suspensions of micro-organisms in tissue culture are included. It does not include cultures prepared for consumption in the food industry.

Landfill, incineration and shredding/disinfection processes are the appropriate disposal pathways for aerosol-spread culture materials.

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### **3.1.3 Human tissues**

This category includes pathological specimens, biopsy specimens and tissue taken during surgery or autopsy. This does not include corpses, for which there are separate regulatory requirements for disposal.

Human tissues include tissue, organs, limbs, free-flowing or expressible blood, and other body fluids that are removed during surgery, birth and autopsy, and exclude teeth, hair, nails, urine and faeces. Sanitary napkins, tampons and nappies are likewise not included as they are part of the general waste stream.

Foetuses knowingly obtained through medical procedures, regardless of appearance, and visually recognisable body tissues, such as limbs not requiring legal burial, should be specifically packaged, labelled and disposed of by approved incineration under supervision. In some States the approved treatment of a non-viable foetus includes memorial burial in a special area of a cemetery. In some circumstances, foetuses and placentas may be released to patients for disposal. Other body tissues, such as biopsy specimens, should be disposed of by methods acceptable to the relevant State or Territory authorities.

The management and disposal of certain types of pathological wastes needs to be conducted with public expectations and aesthetic considerations in mind. Items such as body organs, limbs, placentas and foetuses may not present any risk to waste handlers or to the community, but improper management during treatment and disposal has the potential to cause unnecessary public concern.

Incineration is the preferred treatment method for the human tissue category of waste, particularly for recognisable anatomical parts. (Note that incineration is not suitable for teeth containing amalgam fillings as the mercury constitutes a hazardous stack emission).

### **3.1.4 Animal tissue or carcasses**

This category comprises tissue, carcasses and other waste arising from animals used in laboratory investigation, or for medical or veterinary research or treatment. This includes animals used in experiments related to infection, or where it has been treated with chemicals that are known to be environmentally unsafe. This category also includes animals used for psychological testing, or animals used in educational institutions for dissection purposes.

Approved incineration or supervised landfill are appropriate disposal methods.

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### 3.1.5 Other waste designated as clinical

Clinicians may designate waste from patients known to have, or suspected of having a communicable disease, for disposal in the clinical waste stream. The extent and duration for which such waste is regarded as infective will depend on the particular infection, the state or type of the disease and, in some cases, the efficacy of any specific treatments. Known modes of transmission of the micro-organisms is a key factor in determining the infection potential of such wastes. (The reader is referred to the 1996 ANCA/NHMRC publication, *Infection control in the health care setting—guidelines for the prevention of transmission of infectious diseases* pp 58-76).

## 3.2 Related wastes

Related wastes are those within the waste stream which constitute, or are contaminated with, cytotoxic drugs, chemicals, pharmaceuticals, or radioactive materials.

### 3.2.1 Cytotoxic waste

Cytotoxic waste is material that is, or may be, contaminated with a cytotoxic drug during the preparation, transport or administration of chemotherapy. Cytotoxic drugs are toxic compounds known to have carcinogenic, mutagenic and/or teratogenic (causing foetal and/or neonatal abnormalities) potential. Direct contact with cytotoxics may cause irritation to the skin, eyes and mucous membranes, and ulceration and necrosis of tissue.

If waste consists of a mixture of cytotoxic and other waste it must be incinerated at the temperature recommended for cytotoxic waste.

Cytotoxic waste must be incinerated in an approved incineration facility. The incineration temperature in the secondary burning chamber must be 1100 degrees Celsius, with a minimum residence time for the emission gases of 1.0 second.

Consult State or Territory authorities regarding licensing and other requirements for incineration facilities.

In remote or isolated areas of Australia where small amounts of cytotoxic waste are generated, the waste should be stored and returned to a centralised collection point for disposal by incineration. However, if it is impracticable or unsafe to do so, landfill may be the preferred option, subject to approval of the relevant State or Territory authority.

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The disposal of cytotoxic drugs and their metabolic by-products to sewer via the urine and faeces of patients undergoing therapy is unavoidable, and is not prohibited or restricted.

### **3.2.2 Pharmaceutical waste**

Pharmaceutical waste, excluding cytotoxics, may arise from:

- pharmaceuticals that have passed their recommended shelf life;
- pharmaceuticals discarded due to off-specification batches or contaminated packaging;
- pharmaceuticals returned by patients or discarded by the public;
- pharmaceuticals that are no longer required by the establishment; and
- waste generated during the manufacture and administration of pharmaceuticals.

Non-hazardous materials such as normal saline or dextrin need not be considered as pharmaceutical wastes.

Excess stock of pharmaceuticals, either current or expired, may be returned to a relevant authority or collection centre for appropriate disposal or distribution. The disposal method depends on the chemical composition of the material. This must be checked with the manufacturer. The components must be interpreted/classified according to the known toxicity of the pharmaceutical involved, and the degree of contamination. If in doubt, consult the pharmacist.

Whilst the disposal of drugs and their metabolic by-products to sewer via the urine and faeces of patients undergoing treatment is unavoidable, the following general principles should be observed:

- Pharmaceutical waste should be placed in non-reactive containers.
- Wherever possible, this waste should be incinerated. It should not be sent for landfill.
- Where practicable, non-flammable liquids (eg antibiotic solutions) should be absorbed by surplus absorbent such as sawdust enclosed in either a wet bag or a plastic bag, and then incinerated.
- Pharmaceutical waste can be disposed of as clinical waste if both are incinerated. Such waste should not be discharged into sewerage systems, although in some States and Territories discharge of small quantities of pharmaceutical waste is permitted (check with your local authority). Where incineration is not possible, seek advice from the relevant State or Territory authorities, including the sewerage authority, before developing a disposal policy.

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### 3.2.3 Chemical waste

Chemical waste is generated by the use of chemicals in medical, veterinary and laboratory procedures. (One component of chemical waste already discussed is pharmaceutical and cytotoxic waste.) Chemical wastes in this category include, but are not limited to, mercury, cyanide, azide, formalin, and gluteraldehyde, for which there are special disposal requirements.

Mercury is widely used in the preparation of restorative teeth amalgams. Dental amalgam waste, even if it is designated as clinical waste, must not be incinerated because of the resultant toxic emissions and heavy metal ash residues. Its disposal is subject to local regulations.

Dental practitioners must install amalgam separators, capable of 95 per cent separation, so as to treat all wastewater streams containing amalgam residues, including cuspidor waste, from all dental chairs at the premises. This is in conformance with ISO/CD 11-143.

Amalgam waste and other chemicals, such as esters of acrylic acid used in denture preparation, must not be discarded via domestic waste disposal systems. Amalgam waste, in dental facilities, must be stored under radiographic fixer, until collected by the relevant disposal authority.

Reclamation and recycling of chemical waste should be considered where practicable, as in recovery of silver from X-ray processing wastes.

For details of chemical waste disposal procedures, refer to publications such as the NHMRC *Guidelines for laboratory personnel working with carcinogenic or highly toxic chemicals* (1990). Irrespective of the chemical waste generated, however, good housekeeping and appropriate laboratory procedures need to be observed.

To prevent contamination of soil and waterways, the disposal of chemical waste into the sewerage system must be avoided. Chemicals may cause corrosion to sewerage pipes, and some chemicals disposed of in this way can cause an explosion. Hazardous chemical waste must be collected by an authorised carrier. Consult the relevant State or Territory authorities for advice.

### 3.2.4 Radioactive waste

Radioactive waste is material contaminated with radio-isotopes, which arises from the medical or research use of radionuclides. It is produced, for example, during nuclear medicine, radio-immuno assay and bacteriological procedures, and may be in a solid, liquid or gaseous form.

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All procedures that involve radioactive substances are subject to legislative control under radiation control legislation. Statutory authorities in each State or Territory administer this, using legal instruments that include licensing and registration systems. Such licences address the radiological aspects of these procedures, including the handling, storage and disposal of radioactive waste.

The statutory authority may require the appointment of a radiation safety officer with specified responsibilities, which will include ensuring that all work practices related to radioactive material comply with legislative requirements, and providing limited radiological expertise to the workplace.

However, the statutory authority must be consulted where the level of radiological knowledge required is beyond that of the radiation safety officer, or where a proposed work practice differs from the conditions specified by the relevant licence.

Most radionuclides used in medicine have short half-lives. They are usually kept in an approved storage area and allowed to decay until they may be disposed of as non-radioactive waste, with minimal radiological impact to the population and the environment. The relevant State or Territory authorities must be consulted for disposal procedure.

All storage areas for radioactive waste must be approved by the relevant statutory authority. Approval criteria will include, but not be limited to, radiation shielding, placement of appropriate signs, and restriction of access to the store by unauthorised personnel.

The overriding principle in the handling of radioactive waste or other radioactive material is that any radiation doses received by personnel are as low as reasonably achievable and below the relevant dose limits in the *Recommendations for limiting exposure to ionizing radiation* (NHMRC, 1995).

### **3.3 General waste**

General waste is any waste not classified as being within any of the categories of the clinical and related waste streams. General waste represents the significant majority of all health industry wastes. As it is much more economical to dispose of general wastes than of clinical and related wastes, appropriate segregation practices should be maintained.

This category/stream includes incontinence pads, drained dialysis wastes, sanitary wastes and disposable nappies; and a wide range of office wastes. Intravenous drip equipment that has not been contaminated with pharmaceuticals, hazardous chemical additives, such as cytotoxic or radioactive

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drugs, and nasogastric feeding tubing may be suitable for inclusion in this category. All sharps must be removed (by cutting off with scissors) from intravenous drip sets, if disposal is intended as general waste. In this circumstance great care must be taken to avoid sharps injuries.

Since many of the components of this stream are suitable for recycling, whenever possible correct separation of the waste occurs at the point of generation, for example the ward or departmental level in a hospital.

Wherever possible, paper bags (due to their biodegradability) or reusable bins without liners should be used instead of plastic bags. The size and strength of the bags used depends upon the type of waste (eg paper, board, cards, books or microfiche) and the volume and/or weight of the materials involved. Appropriately labelled paper bags or removable bins can also be used for waste which is to be compacted prior to landfill disposal.

Manual handling of bags should be limited where possible. Containerised handling of general waste can be safer and economically more advantageous than bagging. Where practicable, reuse or recycling of general waste should be considered for the various components of the waste stream. Compost other general waste, such as food and garden waste, wherever possible. Mulching and vermiculture (worm farming) should also be implemented, where possible.

### **3.3.1 Disposable napkins**

There is no evidence that, under normal circumstances, the disposal of soiled babies' napkins, incontinence pads and sanitary pads/tampons poses risks of infection.

Health care establishments should examine their use of disposable napkins and incontinence pads. In some situations it may be appropriate to use reusable products. A decision to use reusable products should not be based on waste minimisation alone, but also on the relative merits of reusable and disposable products with respect to clinical treatment. Where disposable items are used, emphasis should be placed upon the use of biodegradable items.

Sanitary napkins and tampons should not be placed directly into the sewerage system. The most practical way of disposing of sanitary napkins and tampons is for the user to place them immediately in a suitable container in the toilet area.

Large quantities of disposable napkins (that is, where they are the major component of a load of waste and can be easily identified as such) may cause offence to the public and waste disposal personnel. This should be a consideration when formulating procedures for their disposal.

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### 3.3.2 Plastics

The proliferation of plastic waste has been mainly due to the progressive increase in the use of disposable medical items. Other uses of plastics (such as for drug and food containers/packaging, instrument and utensil wrappings, and bed liners) have also contributed to increased quantities of plastic waste. Some of this waste may need to be treated as clinical and related waste if it is contaminated with hazardous materials.

Where practicable, plastic should be recycled (see 4.6.3). Properly segregated, non-contaminated plastic materials can be disposed of to landfill.

It is likely that the volume of plastic waste generated in health care establishments will increase. The huge volume currently generated requires careful consideration of waste avoidance, segregation and recycling so that waste minimisation can be optimised.

The incineration of some types of plastics produces hazardous air emissions. For example, the combustion of chlorinated plastics such as PVC (polyvinyl chloride) produces hydrogen chloride, while the combustion of nitrogen containing plastics, such as urea formaldehyde plastic, produces oxides of nitrogen.

Replacement of these items with those manufactured from less toxic materials should be considered wherever possible. This requires the development of partnerships between generators and manufacturers. The relevant air quality standards need to be observed, and the relevant State or Territory authorities consulted.

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## CHAPTER 4

### ORGANISATIONAL ISSUES

Generators must develop and periodically review a comprehensive waste management strategy, unless specifically exempted. Patient and health provider education is the key to successful management.

#### 4.1 Waste management strategy

All generators of clinical and related wastes are responsible for the safe transport and disposal of these wastes in an environmentally sound manner that minimises risk to the community and staff involved in its management. A waste management strategy should be developed to ensure that the requirements of this guideline and all relevant regulatory requirements are fulfilled.

An organisation's strategy and implementation plan will depend on its location, size, specialty and access to disposal services. Even within one organisation different procedures may be necessary to cope with the varying volume of waste generated in particular areas. Nevertheless, procedures should be uniform, wherever possible, within and between organisations. This will reduce the possibility of confusion and possible accidents when staff move between services.

The strategy should:

- clearly outline management commitment to the principles of responsible waste management;
- clearly outline management commitment in terms of resource allocation;
- highlight the accountabilities and responsibilities of management, staff and contractors;
- clearly define the various categories of the waste stream;
- clearly articulate appropriate disposal procedures; and
- provide adequate and on-going education.

A fundamental principle of any waste management strategy and management plan is that the generation of waste be minimised. The management plan must ensure that all waste is disposed of safely. This applies particularly to hazardous waste such as cytotoxic, clinical, chemical and radioactive wastes. The waste management plan and procedures should be readily available to all workers involved.

#### 4.2 Waste management plan

All generators of clinical and related wastes are responsible for the safe management of such waste. Each generating organisation should have a comprehensive waste management plan as part of an overall environmental

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management strategy. The larger the organisation, the more comprehensive this plan should be. There should be a designated individual and/or waste management committee responsible for its implementation.

It is recommended that large organisations consider the development of such a plan within the framework of an overall environmental management system (EMS). One tool available to assist in the development of an EMS is the Australian/New Zealand Standard ISO 14001. While the development of an EMS will take significant involvement of staff resources such an approach is invaluable in identifying opportunities for improvement, minimising any potential liabilities and consolidating the management of environmental issues into the organisation's management operations.

In some jurisdictions, there are licensing requirements for those who generate clinical and related wastes. All generators of clinical and related wastes must develop a waste management plan, unless exempted by State or Territory authorities.

Generic waste management plans have been developed by some States (eg NSW Health 1998), which could be used with suitable amendment.

In developing a waste management plan, the facility should:

- take account of the need for ensuring a high standard of patient care and worker safety;
- conduct a comprehensive baseline waste audit, with follow-up monitoring;
- consider the minimisation of waste through a purchasing policy that includes product substitution, product changes, procedural changes and replacing disposable items with reusable items;
- examine the procedures for waste segregation;
- consider the options of recycling and reuse and EPR programs;
- note the waste storage requirements;
- evaluate the disposal options;
- comply with waste transport requirements;
- establish procedures and staff training programs for effective waste management that ensure compliance with relevant published guidelines and statutes;
- develop appropriate risk management strategies that document both contingency plans and emergency procedures, including those for spills;
- specify goals and possible savings targets within set timeframes;
- investigate and initiate the means of achieving the goals and targets;

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- develop strategies for promoting the waste management plan within the organisation;
  - ensure that a feedback loop is incorporated in the plan;
  - ensure its regular update;
  - collate and review annually statistics on waste type, weight, volume, manner and frequency of removal, cost and injuries; and
  - take waste management issues into account when renovating old or planning new health care establishments.

### **4.3 Waste audit**

A waste management baseline audit should be conducted before developing or updating a waste management plan. The purpose of the audit is to determine current performance in terms of safety, efficiency, environmental impact assessment, costs and regulatory compliance.

The following information should be collated and assessed in accordance with any relevant guidelines:

- types, volume and/or weight, quantities and composition of waste generated;
- hazard assessment of waste;
- incidence and severity of waste handling injuries;
- incidence and nature of spills and leakages;
- sources of solid and liquid waste;
- in-house procedures or processes producing waste;
- points of generation, collection and storage sites;
- contents of waste containers;
- loading, transport and disposal methods;
- transportation records and waste dockets;
- documented contracts for waste collection, removal and disposal;
- costs of disposable versus reusable items; and
- costs of waste packaging, internal and external transport, treatment and disposal.

For the waste audit to be successful, all levels of management, including senior and middle management, must provide full support and commitment.

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The audit team should:

- be multi-disciplinary, with at least one representative from each major area of the organisation;
- have authorised access to all departments and staff;
- examine the current waste management system in detail; and
- preferably, have waste management/audit expertise.

Before any attempt is made to introduce a new or modified system, existing waste management procedures should be assessed to determine whether they are working effectively. Regular audits should be undertaken to monitor implementation of the waste management plan and evaluate its success.

#### **4.4 Waste minimisation**

Whenever goods are manufactured or purchased for use in health care and similar establishments, considerations should include total cost, appropriateness for the intended purpose and contribution to waste either due to packaging or ultimate disposal.

The use of disposable items should include an estimate of their ultimate disposal cost, both financially and environmentally, compared to the use of reusable or recyclable items.

All health care establishments are, therefore, encouraged to develop and implement a product purchasing policy for clinical and non-clinical products. The policy should include a 'cradle to grave' assessment with preference, where clinically appropriate, given to products that are:

- reusable, including those that are recycled by the manufacturer or able to be recycled by the user;
- derived from renewable resources; and
- made from, and packaged in, recyclable materials.

Waste minimisation can be achieved through:

- product substitution;
- product changes;
- procedural changes;
- giving preference to reusable items; and
- encouraging extended producer responsibility.

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#### **4.4.1 Product substitution**

Products should be assessed before purchase in terms of their potential to generate problematic waste, result in toxic emissions, or be detrimental to the operation and maintenance of treatment facilities.

Product assessment can be achieved through:

- evaluating product material safety data sheets;
- liaising with manufacturers and suppliers to determine the composition of the product and potential waste output;
- seeking technical waste disposal advice from consultants or relevant; and
- considering the percentage of recycled materials used or recyclable components.

Product selection and purchasing criteria should incorporate controls to ensure that less toxic/hazardous products are selected, without compromising product performance. Products such as polyvinyl chloride (PVC) plastic compounds should be progressively replaced by products made from ethylene vinyl acetate copolymers. Organic pigments should replace heavy metals pigments, commonly used for colouring waste bags and sharps containers.

Product substitution can often lead to cost-effective solutions. The types of substitutes to be considered include biodegradable cleaning compounds and safer chemicals.

#### **4.4.2 Product changes**

Management should liaise and work with manufacturers/suppliers to change or modify products to incorporate both product performance and waste disposal requirements. Where substitution cannot be achieved due to a limited range of products, management should approach manufacturers/suppliers to determine whether it is possible to change the product. There are many examples of product changes that set precedents, eg change from solvent-based products to water-based or from lead-based paints to less hazardous alternatives. Manufacturers/suppliers have readily accepted these types of product changes without significant economic costs.

Meeting industry requirements gives manufacturers and suppliers a significant commercial advantage and is therefore in their interest.

#### **4.4.3 Procedural changes**

Simple changes to patient care procedures can be made to minimise the wastes generated, for example:

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- where it is not necessary to use dressing packs for minor procedures eg removal of sutures, practitioners should use alternative equipment so the minimum amount of materials is used;
  - when preparing for dressings, clean and sterile procedures, practitioners should critically assess materials required. When 'setting up', unwanted extra materials should be removed for re-sterilisation or reuse. This should occur before commencing the procedure, so as to minimise the potential for contamination;
  - small, colour-coded containers should be accessible at the site of the procedure so that recyclable materials can be segregated; and
  - facilities should review frequency of waste collection, size and location of containers and bags.

#### **4.4.4 Reusable items**

Reusable items should be preferred to disposable items whenever it is clinically appropriate, environmentally sound and practical to do so. When assessing the suitability of a product for reuse, life cycle assessment can assist in determining the overall cost (beyond the purchase price) of the disposable versus a reusable product.

Life cycle assessment evaluates the total environmental impact of the production, distribution, use, transportation and disposal of a product.

When reusable items are used in place of disposable items, quality assurance and high standards of care must be maintained.

#### **4.4.5 Extended producer responsibility**

The responsibility for waste minimisation is increasingly borne by producers, and is legislated for in some European and US locations. Recovery of goods for re-manufacture has, to date, centred on white goods and information technology equipment such as computers, phones and photocopiers.

Extended producer responsibility (EPR) programs should be instituted for a range of health care products and equipment.

### **4.5 Waste segregation**

Waste segregation refers to the process of separating wastes at the point of generation (also known as separation at source), and keeping them apart during handling, accumulation, interim storage and transportation.

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The underlying principles in any waste segregation program are:

- to reduce the volume of hazardous waste destined for special treatment or expensive off-site disposal;
- to maintain safety standards during handling, transportation and treatment;
- to eliminate the need for waste segregation to occur at disposal sites; and
- to facilitate the recycling process.

Both generators and waste disposal contractors should practise waste segregation. Where a container of waste includes more than one category of waste, for example cytotoxic and clinical waste, the method of disposal applicable to the most hazardous component of these types of waste must be used for the whole container.

The segregation requirements depend on the disposal methods chosen. In some instances different types of waste destined for the same disposal method may not need to be segregated. Other treatment technologies may require a higher level of segregation, eg microwave and chemical disinfection. A single-stage segregation, where the waste stays in the same bag or container for storage, transport and disposal, is preferable.

Effective waste segregation has a number of benefits. It ensures proper disposal pathways for each category of waste, helps protect personnel, reduces costs and facilitates staff training.

A segregation program should be simple, time-efficient and allow segregation to occur at the point of generation—separation at source. Segregation procedures should be developed as a joint exercise between staff who produce waste and those responsible for the provision of support services.

Effective segregation can be best achieved through:

- providing education and training programs for all personnel who generate waste;
- providing material safety data sheets for identification of material composition;
- establishing identifiable colour coding, labelling and containment;
- incorporating quick and efficient waste disposal methods into patient care procedures (this may require the redesign or reorganisation of procedure trolleys and working environments and, in some cases, changes to clinical practice);
- using methods that ensure the easy, safe and proper segregation of clinical and related wastes at the earliest possible stage, preferably at the point of generation;

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- providing a suitable storage area at the point of waste generation;
  - developing systems with realistic goals and targets; and
  - an effective dialogue between waste generators and waste handlers/disposal contractors that ensures mutual awareness of the facility's segregation protocols.

## **4.6 Recycling and reuse**

Product recycling and reuse can minimise the volume of costly waste disposal streams, though a high standard of patient care and worker safety may preclude reuse of some items. Health care establishments should critically examine current waste streams and determine what products can be separated out at the point of generation to be effectively recycled, for example:

- glass;
- plastics;
- aluminium cans;
- paper and cardboard; and
- ferrous and non-ferrous metals.

Recycling programs should be based upon the identification of markets for the materials under consideration. The materials should be able to be easily separated from the waste stream and be in sufficient volume to justify the expense and effort involved. Due to the requirement for work practice changes and the need to avoid contamination of the products, it is advisable to introduce recycling for one product at a time. Local and State or Territory authorities should be consulted, as they generally have expertise and experience in recycling and reuse.

Before beginning any reclamation/recycling program, it is advisable to review the possible uses for these products. Where materials for recycling are to be sent off-site, merchants should be contacted to ascertain what their requirements are, whether they will provide storage containers, and the manner and frequency of collections.

### **4.6.1 Glass**

A large quantity of glass waste is generated from cafeterias. Other points of generation include pharmacy, pathology, milk formula rooms, kitchens, diet kitchens and intensive care units.

All glass containers for recycling should be emptied of their contents, rinsed where necessary, and free of contaminants such as lids. Similarly ceramics and

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pyrex contaminate the waste stream and therefore must not be included in glass recycling as they render the entire batch of glass unsuitable for recycling.

#### **4.6.2 Paper and cardboard**

Wherever possible, cardboard packaging materials and paper should be removed from the waste stream, compacted and baled for recycling. Service departments (eg supply, pharmacy) can remove much of the packaging material before products are forwarded to wards or clinical areas. Flattening of cardboard boxes by staff will make their collection, storage and removal much easier.

In the case of waste paper, care must be taken to ensure the security of confidential information such as patient records and reports. Confidential papers should be shredded before being placed in the recycling stream, or managed separately as confidential wastes and shredded and recycled off-site.

#### **4.6.3 Plastic**

Large quantities of single forms of plastic and some types of mixed plastic used in health care facilities can be recycled. Australians currently recycle some 35 per cent of the plastics they use domestically and the rate for industry is higher still. The proportion of high-density polyethylene (HDPE) products being recycled is some 55 per cent.

Health care facilities, especially hospitals, should rigorously seek to implement plastics recycling programs, especially for HDPE products. The widely used one-litre saline bottle, for example, is a high-quality HDPE product which is sterile, and thus poses no risk to handlers. Furthermore, there are established recycling markets for HDPE plastics in several States.

The recycling and reclamation of plastics is best achieved when the plastic containers have been silk-screen labelled.

The major obstacles to recycling plastics are public perceptions, particularly among recyclers, that products coming from health care facilities are potentially hazardous; and lack of adequate storage space.

Not all plastics are recyclable and the recycling of some plastic products used in health care facilities presents problems. Plastic containers that have been used for the storage of certain poisonous or toxic materials may be unsuitable for recycling or constitute a prescribed waste under the relevant State or Territory legislation, and should be disposed of accordingly.

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## 4.7 Waste tracking

Waste tracking is the documentation of the movement of waste from the generating facility to the point of final disposal. There are a number of benefits, which include:

- ensuring appropriate disposal of clinical and related wastes;
- facilitating the auditing and monitoring of waste segregation programs;
- providing for the maintenance of records on the quantities and type of waste generated and disposed of;
- assisting to minimise risk and associated liability should in-transit spillage or loss occur; and
- helping to pin-point areas of education needs with respect to waste management.

Relevant State or Territory authorities should be contacted concerning specific waste tracking requirements. Waste tracking should also comply with the National Environment Protection Council's *Movement of controlled waste between States and Territories: National Environment Protection Measure (1998)*.

## CHAPTER 5




### WASTE CONTAINERS, STORAGE AND TRANSPORT

#### 5.1 Containers

The key principle of successful and safe waste containment is correct source separation/segregation. Sturdy (rigid walled) containers should be used, preferably lined with tie-off plastic bags, and handled mechanically.

Where unlined rigid plastic bins are used these should be emptied mechanically and, when cleaned, precautions should be taken to avoid aerosol generation and exposure.

All waste containers/bags must be colour-coded and identified as follows:

Waste category	Colour code for container	Marking	Sign	Transport labelling in accordance with AS 1216
Clinical	Yellow	Black biological hazard		Class 6.2, if appropriate
Cytotoxic	Purple	White telophase		(Not specified)
Radioactive	Red	Black ionizing radiation		Class 7
All other wastes	(Not specified)	(Not specified)	As specified by relevant regulations	(Not specified)

Source: *Australian/New Zealand Standard: Management of clinical and related wastes* (AS/NZS 3816: 1998), p. 7.

##### 5.1.1 Sharps containers

Sharps, including retractable items/sharps safety devices, must be placed in a container manufactured to the relevant Australian Standards.

No one container is suitable for the safe disposal of sharps in all medical/laboratory situations. It will often be necessary to supply a variety of different sharps containers of varying volume. Although sharps may be directly disposed of into mobile garbage bins in some States and Territories, this section deals with small portable sharps containers.

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Containers should be selected according to the following criteria:

- the opening must be wide enough to allow disposable materials to be dropped into the container by a single hand operation. Depending on the bulk of the disposable material for which the particular container is designed, the aperture should, under normal conditions of use, inhibit removal of the contents;
- if retractable lids are incorporated, they should be designed so that there is never a need to push material into the container by hand;
- containers should be designed to minimise the possibility of the external surface being contaminated when disposing of a used item;
- the container walls must be impermeable to fluids and non-readily penetrable. Cardboard containers are not acceptable;
- after being sealed, all types of containers must be leak-proof;
- the container must be capable of being securely sealed and remaining sealed during transport;
- the container must be safe and easy to handle;
- the container should be predominantly yellow. Sharps contaminated by cytotoxics should be placed in a purple sharps container with the cytotoxic waste symbol; and
- the container should be clearly labelled with the words 'Danger: Contaminated Sharps' and should contain the biohazard symbol on the label. Labelling should be in accordance with the appropriate Australian Standard.

Manufactured reusable containers must meet the manufacture requirements as specified by the Standards Australia publication *Reusable containers for the collection of sharp items used in human and animal medical applications* (1994).

Non-reusable containers must meet the manufacture requirements as specified by the Standards Australia publication *Non-reusable containers for the collection of sharp medical items used in health care areas* (1992).

### 5.1.2 Plastic bags

Plastic bags for the collection and storage of clinical and related wastes other than sharps should:

- have sufficient strength to safely contain the waste class they are designated to hold;
- be suitable for the purpose if used for moist heat sterilisation;
- not be filled to more than two-thirds of their capacity;

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- allow for secure final closure when the bag is filled to a maximum of two-thirds of its capacity or 6kg, whichever is the lesser; and
  - not be secured with staples or any other closure devices with sharp protuberances.

### 5.1.3 Rigid-walled containers

Reusable rigid-walled containers, eg mobile garbage bins, should be resistant to leakage, impact rupture and corrosion. These containers should be inspected after each use to make sure that they are clean, intact and without leaks. Any containers found to be defective should be repaired before use or taken out of service. Rigid-walled containers should have interiors of smooth impervious construction to contain any spills and so that they can be readily inspected, cleaned and sanitised.

Containers for chemical wastes should be compatible with the chemical and labelled to identify the contents and source.

## 5.2 Storage

Storage facilities for waste should be suitably sited, lockable, hygienic and appropriately sign-posted. They must be kept secure at all times. Health care and similar establishments are responsible for providing:

- designated storage areas with adequate lighting, ventilation and provision for the containment of spills within the storage area;
- waste security and restriction of access to authorised persons; and
- storage areas designed so that routine cleaning, maintenance to hygienic standards, and post-spill decontamination are all easy to undertake.

For small waste generators, the requirement for a designated storage area may be achieved by the use of a suitable rigid-walled container in accordance with the standards outlined in 5.1.3. The container should be kept in a secure area. The same area can also be used for storage of cytotoxic waste, although clinical and cytotoxic waste must not be physically mixed in the same container. Measures should be taken to prevent obnoxious odours or nuisance.

Storage areas for clinical and related waste should be clearly labelled with the biohazard symbol and the words 'Clinical and Related Waste'. Appropriate labelling for any other forms of waste stored in the area should be included.

Compaction can be an efficient way of storing general waste for disposal by landfill. Clinical and related wastes must not be fed into a compactor, mulcher or

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grinder prior to disposal, unless the treatment system has been approved by the relevant State or Territory authorities.

State or Territory guidelines must be consulted regarding requirements for clinical and related waste storage. A licence from environmental authorities may be required to store hazardous wastes.

### **5.3 Transport**

The institution's waste disposal strategy should include procedures for on-site and off-site transport of wastes. During movement of wastes segregation must be maintained and the batch of waste managed according to the component with the highest level of risk.

#### **5.3.1 On-site transport**

On-site transport of waste is usually from the initial storage point to an assembly storage or treatment area by means of trolleys or handcarts, which should have a solid base and bunding to contain spills. Trolleys used for the movement of clinical and related wastes should be designed to prevent leakage, be easily cleaned and minimise manual handling.

Wherever possible, the transport of clinical and related wastes should be separate from general traffic. Waste collection rounds should be performed so as to minimise housekeeping hazards associated with the storage of waste at 'user' sites.

Chutes must not be used for the transport of clinical and related wastes. Waste disposal chutes should not be incorporated in the design of new hospitals.

#### **5.3.2 Off-site transport**

Relevant State or Territory authorities must be contacted for special requirements for the transport of clinical and related wastes. Reference should be made to local regulations in conjunction with the *Australian code for the transport of dangerous goods by road and rail* (Federal Office of Road Safety 1998).

Vehicles used for transporting clinical and related wastes should be reserved for this purpose wherever possible. They must be easy to load, unload, and clean, and should be equipped with spillage collection sumps or other suitable spill controls. The driver's cabin should be physically separated from the waste. The design of the vehicle should afford the driver, and the general public, protection from the waste in the event of an accident. Vehicles should also have provision for holders to display prominently the necessary warning placards (symbols) specified by the transportation code.

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Any vehicle washings must be disposed of in accordance with State or Territory requirements. The drivers should be trained in these procedures. Only in special circumstances, such as transporting small amounts of clinical waste to a central disposal facility, should conventional vehicles be used. In such instances the waste should be clearly labelled and identified, and special containers used wherever possible, and the waste carried in a compartment separate from the driver's. Alternatively, agencies can be established to provide a collection service to small institutions such as medical or dental surgeries.

Containers for the off-site transport of clinical and related wastes should be:

- of suitable design, construction, materials and strength for the intended service;
- in good serviceable condition, with their interiors clean and free from defects and protrusions likely to cause damage to packages or bulk containers during transit;
- constructed of a durable non-reactive material;
- capable of retaining liquids from the wastes; and
- equipped with a feature to secure them during transport.

Generators of clinical and related wastes should ensure that their contracted transporters have appropriate public liability insurance.

## **5.4 Spill management**

Health care and similar establishments can be held responsible for small clinical and related waste spills that may occur both on-site and during transportation. Facilities must develop a spill management plan with well-defined policies and procedures for handling spills safely.

Personnel who may be involved in spill management must receive education and training in emergency procedures and handling requirements. They should be fully aware of how, when and which emergency services to call for advice and assistance.

Spill kits must be easily accessible. Vehicles carrying clinical and related waste should carry spill kits. A typical spill kit should contain all items necessary to clean up spills of clinical and related waste. Typical contents include absorbents, disinfectants, buckets, shovel, gloves, disposable overalls, facemask/shield, torch, disposable containers, and plastic waste bags with appropriate labelling.

Washings from spills should not be disposed of via the stormwater drainage system.

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**Cytotoxic spills:** Adequate supplies of absorbent and cleansing materials should be readily available in the area of constitution or administration of cytotoxics to cater for accidental spills. Suitable materials include commercially available absorption granules and 'cytotoxic spill' kits. The resultant waste should be treated as cytotoxic.

In the case of gross spills of any type of clinical and related waste, containment should be the principal objective. Procedures must specify spill management procedures and under what conditions emergency services such as the Fire Brigade should become involved.

A suitable emergency procedure guide with appropriate documentation must be carried with all off-site movements of clinical and related wastes.

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## CHAPTER 6

### TREATMENT AND DISPOSAL METHODS

There are a range of methods available in Australia to treat and dispose of clinical and related wastes. The methods used depend on specific factors applicable to the institution, relevant legislation, and environmental aspects affecting the local community.

The bulk of waste falls into the category of general waste, much of which can be recycled or reused (see 4.6). With correct segregation, less than 5 per cent of the waste is likely to be classified as clinical waste.

Clinical waste must be managed by approved treatment methods. Once treated by a process acceptable to the relevant State or Territory authorities, it may be reclassified accordingly before recycling or disposal.

The waste treatment options currently available have various capabilities and limitations. As technology changes, health care establishments should evaluate treatment alternatives for their safety, effectiveness, environmental impact, costs, and compliance with relevant State or Territory licensing requirements.

Large volumes of liquids (such as 24-hour urine collections) should generally be disposed of into an appropriate sluice. Precautions must be taken to avoid the hazards of splashing. Empty disposable containers may be disposed of as general waste, whereas non-disposable containers must be rendered safe for the intended reuse.

Body fluids, particularly blood and fluids visibly contaminated with blood, should be treated with caution. Bulk blood and suctioned fluids may be disposed of into the sewer, but care should be taken to avoid splashing, which may cause health risks. A suitably experienced and trained person should carry out this procedure. The disposal of large volumes of blood into the sewer is subject to approval from the local sewerage authority.

There are special circumstances when a known infected material requires extra precautions, such as specific handling procedures required before waste removal from a microbiological laboratory. Moreover, community expectations for responsible clinical waste management require treatment of the waste before landfill disposal. Pathogenic microbiological cultures transmissible by the aerosol route should be rendered sterile by an approved treatment method before they leave the control of laboratory personnel.

For special precautions regarding disposal pathways of waste from cases of viral haemorrhagic fever and other quarantinable diseases, eg Ebola or Lassa fever, refer to the relevant State or Territory legislation. In addition, AS/NZS 2243—*Safety in Laboratories* details risk groupings of micro-organisms by type and Section 5 provides advice on degrees of hazard associated with various micro-organisms.

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Any treatment option for clinical and related wastes should:

- render sharps incapable of causing penetration injury;
- render the waste unrecognisable;
- achieve a significant volume reduction;
- result in residues being suitable for approved landfill disposal without harmful leaching to the environment;
- result in minimum levels of hazardous or toxic by-products, including organochlorines, as approved by the relevant authority;
- reduce the potential for the transmission of infection;
- be verifiable for the treated wastes;
- have automatic controls and built-in fail-safe mechanisms;
- have continuous automatic monitoring and recording;
- ensure that the waste cannot bypass the treatment process;
- meet occupational health and safety standards;
- have fail-safe alternative treatment and disposal in case of emergency;
- provide pre-treatment refrigerated storage facilities as licensed; and, where feasible, implement materials and energy recovery strategies; and
- in the case of autoclaves, be tested at least annually to ensure that optimal performance is maintained.

Waste treatment and disposal methods currently approved in Australia include:

- autoclaving;
- chemical disinfection
  - grinding/shredding (sodium hypochlorite)
  - grinding/shredding (hydrogen peroxide and lime);
- landfill;
- microwave;
- regulated incineration;
- encapsulation; and
- sewerage (as determined by relevant authorities).

Details on some of the treatment options follow.

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## 6.1 Autoclaving

Autoclaving involves the heating of infectious waste by steam under pressure. The effectiveness of autoclaving depends on the temperature, pressure, exposure time and the ability of steam to penetrate the container. Confirmation that the required temperature has been reached is imperative.

Noise emissions can be of concern with an autoclave and should be considered in design and siting of the equipment. The energy costs for steam production could be high. Trained staff are required to ensure proper operation. Autoclaving can produce offensive odours, which require proper ventilation to satisfy the relevant State or Territory air emission standards. Autoclaving does not change the physical form of visually offensive waste.

Condensate and blow-down liquids may contain sufficient contaminants for the effluent to be classified as hazardous. Excessive liquid contained by autoclaved waste can make the surrounding working area constantly wet. This seepage problem persists all the way to the final site of disposal.

Autoclaving can be used for the bulk of clinical and related wastes. Care must be taken to exclude body parts, pharmaceuticals, including cytotoxics, and radioactive wastes.

Autoclaved waste can be disposed of by landfill, provided that approval has been obtained from the relevant State or Territory authorities.

## 6.2 Incineration

Incineration is a term used commonly to describe all systems of burning, although only one standard is considered to be effective. In these national guidelines 'incineration' is used to describe the process of combustion carried out in a multiple-chambered incinerator that has mechanisms for closely monitoring and controlling the combustion parameters.

Combustible waste can be incinerated provided that an appropriate incinerator is used. Incinerator residues can generally be disposed of in landfills. However, if the residues contain considerable heavy metal contaminants, the relevant State or Territory disposal codes of practice or legislation must be followed. Where incineration is used, the following issues should be addressed.

**Emission standards:** Depending on the types of waste incinerated, gaseous emissions may involve toxic gases such as hydrogen chloride, nitrogen oxides, sulphur oxides, dioxins and furans. Regular maintenance of any incinerator is therefore essential to efficient operation. This will ensure that the appropriate

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emission requirements are met as well as minimise the long-term total running costs.

**Ash disposal:** A well-designed and -operated incinerator will destroy any infectious and toxic waste by exposing it to a sufficiently high temperature for a sufficient time, with sufficient oxygen to burn organic matter, leaving a biologically inert ash with no combustible residue. There should be no recognisable plastic, paper or fabric in the ash.

Care should be exercised in the removal and disposal of incinerator ash:

- it should be wetted for a sufficient time before handling to minimise the potential for generating airborne dust and any fire risk;
- the amount of water used in wetting the ash must be controlled, because excessive water in the ash may enhance leachate generation in landfill;
- all personnel handling the ash should wear face masks fitted with dust filters, heavy gloves and protective clothing as a safety precaution;
- the removal of incinerator ash should be mechanised, and be designed to facilitate continuous or semi-continuous operation of the incinerator; and
- the ash should be stored in enclosed containers and transported to an approved landfill site for supervised burial.

Flyash collected from particulate control devices may have high concentrations of heavy metals. It may need special disposal treatment.

The fire box, or domestic incinerator, is a single chamber in which combustion is usually incomplete and involves uncontrolled temperatures. It is therefore unsuitable for the incineration of clinical and related wastes and its use is no longer permitted.

Approved incineration is suitable for all types of clinical and related wastes, excluding radioactive wastes.

### 6.3 Landfill

Landfill is a traditional disposal method for waste. Some landfill sites used in the past are unsatisfactory for disposal of clinical or other wastes because leaching can contaminate ground water or public access is not controlled. If clinical and related wastes have been carefully segregated, most of the material can be safely landfilled.

Clinical and related wastes constitute a very small proportion of the total waste stream directed to landfill (less than 1 per cent) and, when managed correctly, are no more dangerous in the landfill environment than domestic waste.

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Where clinical and related wastes are disposed of by landfill, the site must be confirmed as suitable. A physically contained (engineered) site is preferable where movement of leachate is controlled.

Public access to the point of disposal of clinical and related wastes should be restricted during the active disposal period. The owner of the waste or their agent, who is trained to deal with the waste, must deposit the material at the lower edge of the working face of the landfill or in an excavation, and supervise immediate covering of the waste to a depth of one metre. (This does not apply to the general waste component of the waste stream). Soil or other solid waste may be used as cover. The recommended depth of one metre aims to prevent scavenging and accidental recovery of the waste.

The landfill site operator should sign appropriate documentation completed by the transporter. The transporter should hold proof of proper disposal.

Where landfill disposal of clinical and related wastes is intended, recognisable anatomical parts, pharmaceuticals and cytotoxic waste should be excluded at source. Landfilling of liquid wastes is not permitted. Consult State or Territory regulations for approved landfill disposal of clinical and related waste residues.

## **6.4 Sewerage**

Disposal of certain liquid wastes to sewer may be acceptable because the associated potential hazards are reduced through dilutions and dispersals within the sewerage system. Disposal to sewer must meet occupational health and safety guidelines.

Bulk blood and suctioned fluids may be disposed of into the sewer, but care should be taken to avoid splashing, which may pose health risks. A suitably experienced and trained person should carry out this procedure. The disposal of large volumes of blood into the sewer is subject to approval from the local sewerage authority.

Approval should be obtained from the relevant authorities before any discharge of large amounts of fluid waste into the sewerage system (see 6).

Sewerage is not a suitable disposal method for solid clinical and related wastes, pharmaceuticals including cytotoxics, or radioactive wastes.

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## 6.5 Microwave

The microwave process usually involves the grinding and shredding of waste materials to optimise radiation exposure. Water is sprayed onto the waste, which is then moved by an auger through microwaves generated by a series of microwave power packs. Volatile materials and water are driven off by heat generated during the process. The resulting waste is a relatively dry granular material suited to landfill.

Microwaving is suitable for the bulk of clinical and related wastes, excluding body parts, pharmaceuticals including cytotoxics, and radioactive wastes.

## 6.6 Chemical disinfection

Chemical disinfection, which includes physical maceration (shredding or grinding) is a suitable treatment for small amounts of clinical and related wastes. This treatment usually involves an initial grinding/shredding of the waste, which is then soaked in a liquid disinfectant. Agents used include sodium hypochlorite, and hydrogen peroxide and lime.

Subject to the approval of the relevant State or Territory authorities, the spent liquid can be discharged to sewers and the solid residue can be disposed of in a landfill.

Chemical disinfection is not a suitable treatment method for human body parts, pharmaceuticals including cytotoxics, or radioactive wastes.

## 6.7 Other treatment options

Other technologies include:

- plasma arc torch;
- continuous-feed autoclave;
- pyrolysis and electro-oxidation;
- dry heat sterilisation involving quartz infrared treatment; and
- radiation.

As technologies are continually being updated and developed, institutions should be open-minded with respect to their waste disposal options.

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## CHAPTER 7

### OCCUPATIONAL HEALTH AND SAFETY

Health care establishments need to observe all public and occupational health requirements. They must comply with standards set for the ambient environment, as well as for effluent and emission limits that are prescribed under the relevant State or Territory regulations.

Employees and contractors must comply with instructions given for the protection of their own and others' health and safety. This includes the correct use of safety and protective equipment. They should avail themselves of the relevant information and training programs.

Employers and contractors are responsible for providing appropriate information, education and training, and ensuring that a safe work environment is developed and maintained.

#### 7.1 Information

In large facilities it is advisable that an occupational health and safety committee member is appointed to the waste management committee. In smaller organisations the individual/s responsible for OH&S and waste management should liaise closely. To ensure that information about OH&S issues within waste management is consistent and adequate, it should be disseminated by one source only.

All personnel who handle clinical and related waste must be provided with information about:

- occupational hazards of unprotected exposure;
- policies and procedures for specific waste handling and prevention of injury and disease;
- personal protective equipment;
- immunisation programs;
- access to medical care and counselling services and rights to privacy; and
- availability and access to first aid resources.

#### 7.2 Education and training

The purpose of education and training is to minimise the risk of injury associated with waste handling and facilitate efficient waste management.

Employers and contractors must provide education and training to the following personnel:

- waste generators;
- waste handlers, collectors and transporters;

- 
- key managers instrumental in the implementation of the waste management plan; and
  - operators responsible for treatment and disposal methods.

Education and training programs should be interactive and include:

- approved work practices;
- regulatory requirements and methods of compliance;
- the use of required personal protective equipment;
- waste minimisation, segregation, labelling, containment and disposal strategies;
- first aid and medical management (which encompasses information on where and how to seek further attention) for needlestick and other injuries related to waste handling; and
- hand-washing procedures.

Education and training should be provided:

- at the induction of new employees;
- on an on-going basis;
- with the introduction of new equipment; and
- at times of technological change.

Education and training programs must be incorporated with a feedback loop to ensure their relevance and acceptance by staff. They should be reviewed periodically and updated when necessary.

### **7.3 Occupational health and safety committee**

The workplace occupational health and safety (OHS) committee is responsible for reviewing:

- the provision and installation of facilities and protective equipment;
- work practices;
- incidents and accidents;
- provision and status of information, education and training; and
- relevant records.

The committee should ensure that advice given meets the relevant regulatory requirements.

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## 7.4 Standard operating procedures

Health care establishments must ensure that safe work practices are developed and maintained.

Approved work practices should be documented and promoted. Multilingual translations should be provided to personnel who may not be proficient in English.

Standard operating procedures should:

- specify the health care establishment's waste management plan;
- specify approved waste handling procedures requiring waste generators to segregate waste into the appropriate waste container;
- detail appropriate training required for waste generators, and handlers;
- specify personal protective equipment required for waste handling tasks;
- identify key managers instrumental in the implementation of the waste management plan;
- outline spill management strategy;
- specify appropriately trained personnel for spill management on-site;
- identify first aid resources and specify the protocol for needlestick injury treatment;
- encourage waste minimisation;
- be documented in manuals which must be readily accessible to all staff; and
- be reviewed and updated regularly.

## 7.5 Monitoring performance

Monitoring should include incident and accident reporting and recording.

Incident and accident reporting is an essential management information system for identifying the factors that cause waste handling injuries. It is useful in determining the effectiveness of the waste management plan in reducing the incidence and severity of these injuries.

Incident and accident reporting and recording should facilitate cost estimations of associated financial loss and enable management to make decisions about investing in injury prevention based upon accurate data.

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## CHAPTER 8

### CLINICAL WASTE DISPOSAL IN THE HOME

Many patients who are treated in the home require administration of drugs. The sharps generated through home health care must be disposed of responsibly so that injury to the family and the general community is prevented.

In the home environment the only category of clinical and related wastes requiring special treatment is sharps or other devices used to penetrate the skin. All other wastes can be disposed of through the domestic waste stream.

Hospitals or other health care providers that make sharps available for use in the home are responsible for making an adequate method of disposal available.

Patients who use sharps not provided by a health care facility must ensure that they are disposed of safely in a rigid, puncture-resistant and sealable container, or an approved sharps container. The container should be returned to an official disposal point (eg a hospital), or disposed of according to the relevant local authority regulations.

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## GLOSSARY

- Animal tissue or carcasses used in research** This category comprises tissue, carcasses and other waste arising from animals used in laboratory investigation, or for medical or veterinary research or treatment. This includes animal tissue where it is contaminated with infectious organisms, or where it has been treated with chemicals which are known to be environmentally unsafe.
- Chemical waste** Chemical waste is generated by the use of chemicals in medical, veterinary and laboratory procedures. Chemical wastes in this category include, but are not limited to, mercury, cyanide, azide, formalin, and gluteraldehyde.
- Clinical waste** Clinical waste is that which has the potential to cause sharps injury, infection or offence, and includes sharps, human tissue waste, laboratory waste, animal waste resulting from medical, dental or veterinary research or treatment that has the potential to cause disease; or any other waste, arising from any source, as specified by the establishment.
- Clinical waste usually includes the following sub-categories:
- discarded sharps;
  - laboratory and associated waste directly involved in specimen processing;
  - human tissues, including materials or solutions that contain free-flowing or expressible blood; and
  - animal carcasses that are contaminated or suspected to be contaminated by pathogenic organisms.
- Cytotoxic waste** Cytotoxic waste is material that is, or may be, contaminated with a cytotoxic drug during the preparation, transport or administration of chemotherapy.
- Cytotoxics** Drugs which are toxic compounds known to have carcinogenic, mutagenic and/or teratogenic (causing foetal and/or neonatal abnormalities) potential.
- Extended producer responsibility** Refers to producer initiated and operated collection programs whereby goods are recovered for re-manufacture/re-modelling and resale.

<b>Flyash</b>	Finely divided particulate matter, which may contain heavy metals, emergent post combustion, particularly in flue gases.
<b>Free-flowing or expressible blood</b>	Refers to blood which is flowing, dripping, oozing or able to be squeezed from, a sodden material, such as a dressing or bandage. Lightly blood-stained materials are thus excluded from this categorisation.
<b>General waste</b>	General waste is any waste not classified as being within any of the categories of the clinical and related waste streams.
<b>Generators</b>	Organisations and their associated personnel (including, for example, owners, staff and board members) as follows: <ul style="list-style-type: none"> <li>• acupuncturists and other similar premises where alternative medicine is practised;</li> <li>• ambulance and special emergency service depots;</li> <li>• blood transfusion centres and blood banks;</li> <li>• brothels;</li> <li>• clinics used for medical, dental, veterinary or similar purposes;</li> <li>• dental hospitals, surgeries and laboratories;</li> <li>• funeral undertakers and morticians;</li> <li>• general practitioner centres and clinics;</li> <li>• health centres;</li> <li>• hospitals;</li> <li>• medical research establishments;</li> <li>• pathology and microbiological laboratories;</li> <li>• pharmaceutical manufacturing plants and hospital and community pharmacies;</li> <li>• physiotherapists and podiatrists;</li> <li>• residential and nursing homes, and hostels for the chronically sick;</li> <li>• tattooists, body piercers; and</li> <li>• veterinary hospitals, surgeries, laboratories and pet shops.</li> </ul>

<b>Health industry wastes</b>	Defined as all types of wastes (clinical, related and general) arising from medical, nursing, dental, veterinary, pharmaceutical, or similar practices, and wastes generated in hospitals or other facilities during the investigation or treatment of patients or in research projects.
<b>Human tissues</b>	Human tissues include tissue, organs, limbs, free-flowing or expressible blood, and other body fluids that are removed during surgery, birth and autopsy, and exclude teeth, hair, nails, urine and faeces. This category also includes pathological specimens, biopsy specimens and tissue taken during surgery.
<b>Incineration</b>	Incineration is a term used commonly to describe all systems of burning, although only one standard is considered to be effective. In these national guidelines 'incineration' is used to describe the process of combustion carried out in a multiple-chambered incinerator that has mechanisms for closely monitoring and controlling the combustion parameters. The incineration temperature in the secondary burning chamber must be 1100 degrees Celsius, with a minimum residence time of 1.0 second.
<b>Laboratory and associated waste directly involved in specimen processing</b>	This category includes all specimens used for laboratory testing. Cultures or suspensions of micro-organisms in tissue culture are included. (It does <b>not</b> include urine or faecal specimens taken for bedside analysis. Hair, nails and teeth are also excluded, unless contaminated with free flowing or expressible blood. It does not include cultures prepared for consumption in the food industry.)
<b>Life cycle assessment</b>	Refers to analysis of the total environmental (and, where appropriate, social) impacts of the manufacture, use, transportation and disposal of any product, process or activity.
<b>Pharmaceutical waste</b>	Consists of pharmaceutical (drug, remedy/medicinal substance) or other chemical substances specified in the Poisons List under the <i>Poisons and Therapeutic Goods Act 1966</i> . Pharmaceutical waste, excluding cytotoxics, may arise from expired or discarded pharmaceuticals, those no longer required by patients or departments and waste materials/substances generated during the manufacture and administration of pharmaceuticals.

<b>Radioactive waste</b>	Radioactive waste is material contaminated with radio-isotopes, which arises from the medical or research use of radionuclides. It is produced, for example, during nuclear medicine, radio-immuno assay and bacteriological procedures, and may be in a solid, liquid or gaseous form.
<b>Related waste</b>	Wastes within the waste stream which constitute, or are contaminated with, cytotoxic drugs, chemicals, pharmaceuticals, or radioactive materials.
<b>Residence time</b>	The average length of time a particle of reactant spends within a process chamber or in contact with a catalyst.
<b>Safe packaging (containment)</b>	Refers to the type of container used for storage (at the point of generation), transportation and disposal of the various types of waste.
<b>Segregation at source</b>	Separation of the various waste components, at the point of generation, into their relevant waste stream categories, for subsequent containment, transportation and disposal.
<b>Sharps/discarded sharps</b>	Sharps are discarded objects or devices capable of cutting or penetrating the skin, eg hypodermic needles, intravenous sets ('spikes'), Pasteur pipettes, broken glass, and scalpel blades. Various hard plastic items, such as intact amniotic membrane perforators and broken plastic pipettes, also contribute to sharps.
<b>Shredding/chemical disinfection and shredding/microwaving</b>	Waste treatment and disposal processes which involve grinding/maceration and subsequent destruction of pathogens to a level required by state and territory authorities.
<b>Storage</b>	Holding area (or in small facilities, a container/s) for waste, prior to disposal. It should be suitably sited, lockable, hygienic, appropriately sign-posted, and kept secure at all times.
<b>Zoonotic disease waste</b>	Zoonotic agents are those organisms derived from animal sources, which are capable of infecting and transmitting disease in humans.

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## APPENDIX A

### PROGRESS REPORT

The NHMRC *Guidelines for the management of clinical and related waste (1998)* was reviewed in 1993–94, with a second stage public consultation undertaken in 1995. Results of the 1995–96 consultation were reviewed and incorporated into the draft review document, where appropriate, by December 1997.

Members of the original working panel were:

Dr Warwick Forrest (Chairperson), Environment Protection Authority, New South Wales; Dr Noel Bennett, Department of Health and Community Services, Victoria; Mr Gerry Faulkner; Health Department of Western Australia, Mr Terry Grimmond; Department of Microbiology and Infectious Disease, Flinders Medical Centre, South Australia, Mr Barry Vincent Department of Health and Community Services, Victoria; Dr Michael Whitby, Infectious Diseases and Infection Control, Princess Alexandra, Hospital, Brisbane, and Mr Tony Cheng (Secretary) Commonwealth Department of Health and Family Services, with the assistance and advice of Ms Lyn Neville of the Environment Protection Authority, New South Wales.

In view of the lengthy time involved in the review process, the draft document was sent to an external expert, Dr Robert Baker, of Chem Affairs, Sydney, in October 1998, for an update. Dr Baker's analysis involved a literature search, reappraisal of previous submissions and their incorporation into the document, checking for consistency of definitions and harmonisation of management protocols and consideration of other recently developed publications and Standards.

In December 1998 a reference group was convened by the Health Advisory Unit of the NHMRC to consider, and incorporate where appropriate, the findings of the Baker update.

The reference group consisted of four members of the 1993 working party: Dr Michael Whitby, (Chair of the new group), Dr Noel Bennett, Mr Terry Grimmond and Mr Gerry Faulkner. New members of the reference group were Dr Bill Gara, Environment Protection Authority, NSW, Mr Brendan Hewitt, Department of Human Services, South Australia, Ms Melissa Langhorne, Environmental Health Branch, NSW Health, Ms Helen Lucas (Technical Secretary) Health Advisory Unit, NHMRC and Ms Noelene O'Keefe, Environment Protection Authority, Victoria. Assistance was provided by a technical writer, Ms Virginia Wilton.

The reference group undertook incorporation of the Baker findings, but determined that changes made to the document were largely to do with congruence and accuracy (to reflect industry developments). Since the changes were not fundamental to either the principles or practices recommended in the guidelines, further public consultation was not warranted.

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In February 1999 the final draft document was sent for independent review by Professor David Moy, of techSearch, Salisbury, Queensland. In March 1999 the document was amended, where appropriate, to incorporate the reviewer findings, and was forwarded to Council (NHMRC) for endorsement.

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## APPENDIX B

### SECOND STAGE CONSULTATION—SUBMISSIONS RECEIVED

Aged Case Australia Inc, ACT  
Australian Dental Association, Victorian Branch  
Australian Hospital Association, ACT  
Australian Institute of Medical Scientists, QLD  
Australian Nursing Homes and Extended Care Association Ltd, NSW  
Australian Radiation Laboratory, Commonwealth Department of Human Services and Health  
Australian Veterinary Association Ltd, NSW  
BioQual Advisory Services, ACT  
Central Queensland Rural Division of General Practice Association Inc, QLD  
Central Sydney Area Public Health Unit, NSW  
Clinical Oncological Society of Australia Inc, NSW  
Clinical Waste Australia Pty Ltd, NSW  
Department Infectious Diseases, Infection Control and Sexual Health, Princess Alexandra Hospital, QLD  
Division of Environmental Management, Department of Environment and Land Management, QLD  
Eastern Sydney Public Health Unit, NSW  
Environment Protection Agency, (Commonwealth)  
Environment Protection Authority, VIC  
Environmental Health, Food and Nutrition, NSW Health, NSW  
Dr GM Farmer, Glen Waverley, VIC  
Faulding Pharmaceuticals, David Bull Laboratories, VIC  
Flinders Medical Centre, Flinders University  
Greenpeace Australia Ltd, VIC  
Mr G Hardwick, Hobart, TAS  
Health and Environmental Awareness Link, WA  
Health Department of Western Australia, WA (Andrew Penman)  
Health Department of Western Australia, WA (Michael Jackson)  
Illawarra Public Health Unit, Wollongong, NSW  
Integrated Sharps Disposal Systems Pty Ltd, VIC  
Mr A Jackson, Scarborough, QLD  
Kimberly-Clark Australia Pty Ltd, ACT  
R Lear, Freshwater, QLD  
The Mark-Costello Co, Australia Pty Ltd, QLD  
Medical Industry Association of Australia Inc, NSW  
Metropolitan Health, South Australian Health Commission  
Dr DA Nicholson, Sunnybank, QLD  
North Coast Public Health Unit, Lismore, NSW  
NSW Environment Protection Authority  
Nursing the Environment, Australian Nursing Federation, VIC

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Office of the National Health and Medical Research Council, ACT  
Office of Waste Management, WA  
Organisational Development, NSW Health Department  
Public and Environmental Health Branch, South Australian Health Commission  
Public Health Unit, Hunter Area Health Service, NSW  
Public Health Unit, Northern Sydney Area Health Service, NSW  
Public Health Unit, South Western Sydney Area Health Services, NSW  
Queensland Health, QLD  
Royal Australian College of Medical Administrators, VIC  
Royal Australian College of Obstetricians and Gynaecologists, VIC  
Royal College of Nursing, Australia, ACT  
Sancella Pty Ltd, VIC  
School of Aquatic Science and Natural Resource Management, Deakin  
University, VIC  
South Australian Fire Services, Fire Safety Department, SA  
Southern Sydney Area Public Health Unit, NSW

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Three notable sources of relevant information were: *Australian/New Zealand Standard: Management of clinical and related wastes* (AS/NZS 3816: 1998), Waste management guidelines for health care facilities (Environmental Health Branch, NSW Department of Health) and the Victorian EPA publication *Manual for the management and disposal of biomedical wastes in Victoria*.

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## CORRESPONDENCE

The Health Advisory Unit  
Office of the NHMRC  
MDP 50  
GPO Box 9848  
Canberra ACT 2601

*Phone:* 02 6289 1430 (24 hour answering machine, publications)

*Fax:* 02 6289 5923

*Internet:* <http://www.nhmrc.health.gov.au>

*E-Mail:* [health.advisory.ctee.nhmrc@health.gov.au](mailto:health.advisory.ctee.nhmrc@health.gov.au)

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