Environmental Guidelines for Dialysis

A Practical Guide to Reduce the Environmental Burden of Dialysis

Editors
Jürgen Kastl
Jitka Pancirova
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This book is an initiative of the EDTNA/ERCA, Jitka Pancirová (Executive Director & Immediate Past President), and Fresenius Medical Care Deutschland GmbH, Jürgen Kastl (Project Director, NephroCare Coordination EMEA-LA).

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Environmental Guidelines for Dialysis
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This book is an initiative of the EDTNA/ERCA and Fresenius Medical Care. Thanks to all the authors for their contribution and their enthusiasm to participate in this project. The content created is an excellent example of a multidisciplinary, international teamwork, creating guidelines in the field of environmental protection in dialysis.

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Fresenius Medical Care
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Preface
Preface

Challenging, provoking, inspiring – all these terms fit the concept “go green” in dialysis. It is a matter of fact that the “go green” initiative in dialysis had to come. Dialysis has grown from its conception to surpass the wildest estimations of the nephrologists who established long-term treatment in the 1960’s. Yet in its current form, dialysis remains what it has been since its dawn - a technology that on one side consumes many valuable resources and on the other side produces enormous amount of waste. And as in many other walks of life, people have realised that dialysis cannot go this way for ever.

I am pleased that EDTNA/ERCA was the first of the existing renal associations to take up the challenge of ensuring the sustainability of further growth and development in dialysis and decide to investigate this issue and set up certain guidelines.

“Go Green in Dialysis” is a joint project of the EDTNA/ERCA and Fresenius Medical Care which, I believe, increases the chances of the project outcome being well received by both dialysis treatment providers and dialysis technology manufacturers. In fact, the combined effort of both sides in an initiative like this is essential for its success and wide acceptance.

The project does not aim to set any limits or restrictions on providing dialysis to all those who need it. On the contrary, it looks into how different dialysis-related procedures can be optimised to maximize utilisation of available resources and minimize the environmental burden with the aim of ensuring that dialysis provision can be maintained for those who need it now or will need it in future.

It is not, and it cannot be, a closed once-and-for-ever project. Rather it is a beginning, a first step that must be followed by further papers focussing on aspects of dialysis that are not covered in this initial work. This handbook addresses the most obvious issues - water and energy consumption, production/ incineration of waste and some areas of general household
management. Yet the most obvious does not mean the easiest! Just consider a simple question of which method of disinfection poses the bigger environmental burden. Is it heat disinfection which consumes some energy produced at an expense of fossil fuels? Or the alternative methods that load the municipal sewage system with chemicals? Even more difficult may be a decision on whether to choose disposable or re-usable items e.g. plastic cups or good old china which needs washing repeatedly. Waste disposal and possible recycling of some of the materials is also a big issue. There are some widely used techniques to assess environmental burden, such as carbon footprint, but really objective assessment of a particular procedure or issue is a difficult job. And the most important job is probably to raise awareness of the environmental problems related to dialysis because willingness to solve them can come only after we realize that they exist.

I believe that these guidelines will prove helpful for all the dialysis community in this. It may also be a good start in environmental management in hospitals and renal units attempting to implement the ISO 14001 standard.

And as a dialysis professional, I want to congratulate the authors on the work they have done and to wish this handbook every success in disseminating knowledge and raising awareness of the challenge of limiting the environmental impact of dialysis. For the benefit of all of us.

František Lopot, clinical engineer, Dialysis department, Prague – Strahov Czech Republic
Editor’s Preface
Editors’ Preface

The whole world is subject to environmental problems, and the field of renal care is no exception. For some time now, renal unit managers have been considering strategies on how to save energy, and ensure effective hazardous waste management and reasonable water consumption. The implementation of energy-saving strategies is crucial as high levels of water use, the creation of increasing quantities of hazardous waste, and high energy consumption have serious ecological and economic impacts.

“Go Green in Dialysis” is a joint project between EDTNA/ERCA and Fresenius Medical Care. The initiative was launched at the 38th international EDTNA/ERCA Conference in Hamburg in 2009.

The objectives of this 3-year project were to prepare environmental guidelines for dialysis therapies and dialysis facilities to:

- Create awareness about the environmental aspects of dialysis
- Change habits to achieve more “environmentally-friendly” dialysis
- Measure environmental changes and savings

Before the project work began, we conducted a survey to better understand current knowledge on environmental issues and expectations from this project within the dialysis community.

The survey, consisting of 10 questions, was distributed in seven languages during the Hamburg Conference. A total of 872 responses from 39 different countries were received.

Selected results are given below:
High expectation of nurse influence

88% of the respondents felt that nurses can influence the protection of the environment. This result supported our expectation that the “Go Green in Dialysis” project has a high potential for success and that we are on the right track.

Focus on areas of potential improvement

57% of respondents felt that the area of infectious waste reduction, followed by water consumption and electricity consumption show a high potential for improvement. The consumption of oil and gas for heating obviously has a low priority factor for renal units.
Environmental Guidelines for Dialysis

How to create better ecological awareness through information and education

The majority of respondents believe that training is the best way to influence their peers and to transmit ecological awareness.

Motivation to support the “Go Green in Dialysis” project

We asked the EDTNA/ERCA Conference participants how they judge their motivation to support the “Go Green in Dialysis” project. The results were very impressive: 72% considered it...
mandatory to support this project; a further 26% would support it if they had free capacity; and only 2% saw no need to support it.

We were very pleased with the encouraging feedback from the pre-project survey. The great belief in the influence nurses can have in environmental protection shows that the nursing community is the right group to run such a project.

We were also very impressed by the high motivation to support the project. The feedback to focus on training as tool for transmitting expertise confirmed our primary goal to develop “green standard” guidelines for dialysis, which can then form the basis for educational tools in dialysis care.

The EDTNA/ERCA and Fresenius Medical Care are pleased to launch the Environmental Guidelines for Dialysis at the 40th International EDTNA/ERCA Conference in Ljubljana.

Fifteen experts (nurses, environmental and quality managers, and technicians) from 10 different countries have created these guidelines over the past year. They contain all the state-of-the-art knowledge to reduce the environmental burden of dialysis.

The Environmental Guidelines for Dialysis first explain the general challenges of environmental management, followed by concrete details addressing the topics of waste, water and energy consumption.

We hope our Guidelines help you respond to the increasing challenge of how to perform environmentally friendly dialysis and provides you with the practical guidance needed to establish effective and successful strategies.

Jitka Pancirová
Prague (Czech Republic)
August 2011

Jürgen Kastl
Bad Homburg (Germany)
Notes
Introduction
1. Introduction

1.1 The Sustainability Challenge

In 1983, the United Nations (UN) convened what is now known as the Brundtland Commission to address the growing concern of the human impact on the environment and the rapid and increasing consumption of natural resources.

The Brundtland Report, Our Common Future, published in 1987, contained the key definition of sustainability:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”\(^1\).

Since then, the 1992 UN Rio Conference on Environment and Development and the 2002 Johannesburg World Summit on Sustainable Development have ensured that support for the principles of sustainable development (SD) are widely accepted throughout the world and have progressively become one of the European Union’s (EU) key strategies.

Dialysis can have a significant impact on the environment and the consumption of natural resources, and can therefore contribute to the principle of SD both positively and negatively.

Numerous global initiatives are concerned with the general principles of sustainability, e.g. the Agenda 21 by the UN\(^2\) the Johannesburg Plan of Implementation (JPOI) by the UN\(^3\), the Convention on Biological Diversity (CBD)\(^4\), the United Nations Framework Convention on Climate Changes (UNFCCC)\(^5\), the Intergovernmental Panel on Climate Change (IPCC)\(^6\) and the Basel Convention, which covers the trans-border transfer of hazardous waste\(^7\).
The best-known initiative is the Kyoto Protocol, an international and legally binding agreement to reduce greenhouse gas (GHG) emissions worldwide, which came into force on 16 February 2005 (after having been signed by country governments).

On the European level, the Directorate-General for the Environment/Community Environmental Action Plan, the EU GHG targets and the EU Emissions Trading System (ETS) provide a framework for environmental protection. Additionally, the Intergovernmental Panel on Climate Change (IPCC), the regulation on Registration, Evaluation, Authorisation of Chemicals (REACH), the regulation on Classification, Labelling and Packaging of Substances and Mixtures (CLP) and the Waste Electrical and Electronic Equipment (WEEE) Directive, focus on specific targets of environmental regulation.

The EU Landfill of Waste Directive Council Directive 99/31/EC objective is „to prevent or reduce as far as possible negative effects on the environment from the land filling of waste, by introducing stringent technical requirements for waste and landfills. The Directive is intended to prevent or reduce the adverse effects of the landfill of waste on the environment, in particular on surface water, groundwater, soil, air and human health.“

There are numerous local environmental requirements and regulations currently available. However, this guideline does not describe or cover local legislation.

The sustainability challenge that dialysis is facing these days is a significant increase in the number of dialysis patients with a consequent increase in the number of treatments. This is causing a tremendous environmental burden on the community.

Despite this challenge, the topic of sustainability has been poorly addressed. The medical outcomes have so far been the subject of regulatory action. These medical regulations are mainly the European Best Practice Guidelines and European
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Renal Best Practice (EBPG/ERBP)\textsuperscript{14} and other international standards and norms.

1.2 Dialysis and the Environment

In this first guideline, we intend to discuss a wide range of activities associated with dialysis treatment, with the aim of providing advice on best practice.

Only activities that can be directly controlled by multidisciplinary renal staff and others are explained in detail.

Since the start of dialysis therapy in the early 70’s, the number of patients needing renal replacement therapy worldwide has constantly increased. In 1980, about 158,000 patients were on regular dialysis. This had risen to more than 1 million at the beginning of the 21st Century, and it is expected to reach more than 2 million patients by 2011\textsuperscript{15}. Estimates suggest an increase to nearly 4 million dialysis patients in 2020, shown in Figure 1\textsuperscript{16}.

![Figure 1: Development of dialysis patient population world-wide (16)](image)

Modern renal care relies on the use of high-tech medical devices, drugs and disposable products. These are not only a drain on financial resources, but also on natural resources,
such as the raw materials for plastics and pharmaceuticals, and other materials. In addition, a range of environmental issues are associated with the long, complex – and sometimes global – supply chains for these products, many of which become items of waste during and after dialysis.

More and more people involved in renal care are now realizing that simply dealing with their own individual impact is not an option in the face of environmental issues throughout the lifecycle of many products and services. This lifecycle approach means that a look is needed to manufacturers to reduce their environmental attitude. Reducing packaging or providing products with a low environmental impact during use, such as low energy consumption, that can be recycled or disposed is a target.

Haemodialysis (HD) treatment can be briefly described with an input–output diagram (Figure 2). The environmental impact is not only caused by the input of supplies and energy and the creation of waste, but also by the impact of labour and transportation.

\[\text{Figure 2: Input-output diagram of the impact of haemodialysis treatment/facility maintenance on the environment}\]
Dialysis treatment, whether performed in the home, hospital, or any other clinical environment, plays a significant role in environmental pollution\textsuperscript{15}.

Dialysis treatment alone uses a significant amount of water and electricity, and generates different waste types. This represents an impact on the environment which, by the nature of the treatment, is regularly repeated and usually continues over a long period.

A recent study showed that thrice-weekly in-centre HD has a carbon footprint of 3.8 tons/year CO\textsubscript{2} Eq per patient. The majority of emissions arise from medical equipment (37\%), energy use (21\%), and patient travel (20\%). The carbon footprint of providing home HD varies with the treatment regimen\textsuperscript{15}.

Dialysis centres also use an extraordinary amount of water, and a lot of it is drained away as waste. During each dialysis session, mains or potable water is treated to remove salts and other substances to generate purified water.

This is used in conjunction with dried or fluid concentrates. However, a proportion of this water is usually lost as “rejected water”, although in reality the quality of this water is only slightly different from the original supply and is often simply discharged into the sewers.

Vast quantities of high-grade water are required for HD. The equipment used in the purification process might reject up to approximately two-thirds of the water entering the system. Therefore, up to 250 litres of “rejected water” result from the production of the dialysis fluid required for one treatment. This good quality, rejected water is lost-to-drain in the vast majority of centres worldwide.

**Ancillary equipment**

Dialysis treatment depends on a range of electronic and electrical equipment, such as dialysis machines, blood
pressure monitors, thermometers, water treatment systems, and macerators. In addition, a range of portable electronic devices ranging from patient televisions to IT equipment are also involved.

All of these items contribute significantly to energy consumption and associated carbon emissions as well as depletion of natural resources. In a typical dialysis unit, portable electronic devices and dialysis treatment can use up to 60% of the energy consumed. Electronic devices are known to contain a significant number of hazardous substances, and they are classified as subject to the Waste Electrical and Electronic Equipment (WEEE) Directive\(^\text{13}\), consequently, their disposal has to be carefully controlled.

**Facilities**

Dialysis clinics typically contain a range of heating, cooling, ventilation and lighting systems – also a major source of energy consumption. Oil or gas heating systems and air conditioning systems are also responsible for direct and indirect emissions of greenhouse gases (GHGs). Whilst older healthcare premises are often not as efficient as newly designed buildings, deficits can sometimes be offset by newly installed, more energy-efficient devices. New dialysis clinics need to be carefully designed to be as energy-efficient as possible.

**Transport**

Dialysis patients often require extensive patient transport services due to mobility problems. Patient transport ranges from local journeys with multiple patient collection points to long-distance journeys for individual patients. Any vehicle journey is likely to involve direct emissions of CO, CO\(_2\), NO\(_x\) and particulate matter, amongst other things, so in addition to GHGs, patient transport also has a negative effect on local air quality, with consequent negative effects on health. Busy
dialysis clinics can add to other local traffic issues such as congestion and noise.

**Domestic services**

Dialysis care involves a range of ancillary services delivered inside and outside dialysis units, e.g. hygiene, sanitary and laundry services. Most of these services use substances, such as disinfectants, or cleansing agents. In the case of laundry services, domestic services are responsible for significant energy and water consumption and waste water production. Because these services are not central to dialysis care and often offsite, their environmental impact may be overlooked.

**Catering**

Catering is a service often provided by offsite organisations. However, as it is something which is delivered directly to patients, a range of further issues need to be considered. Obviously, where food is concerned, hygiene and patient safety are of paramount importance. But other issues also need to be considered: the impact of transporting food, and the packaging and origin of food, to ensure that it is reliably sourced.

1.3 **Scope of these Guidelines**

As we have seen so far, renal care has a wide range of associated environmental issues. Some have direct effects, such as the waste generated and water used, and some have indirect effects, such as catering services for patients.

These Guidelines cover dialysis-centre chronic HD (cHD) treatments and specific aspects of treatment that can be influenced by clinical staff.
The Guidelines do not consider aspects associated with dialysis premises, transport, domestic services, catering, or peritoneal dialysis, which will be dealt with in a next edition of these guidelines.

Our aim in the Guidelines is to focus on the activities of people (mainly staff, but also patients) in the dialysis unit and how they can alleviate the environmental burden.

The main chapters cover environmental management, natural resources such as water and energy, and we also include a chapter on waste generation and management. Each chapter has a section marked green which includes recommendations in the form of check-lists as practical tools to assist you in your own efforts in protecting the environment.

1.4 Dialysis History

The term “haemodialysis” describes an extracorporeal blood purification procedure for filtering uremic substances from the blood of patients suffering from kidney disease. The purifying process requires the use of a semi-permeable membrane.

The purifying process later called dialysis was first described by Thomas Graham in 1854\textsuperscript{17,18}. Graham developed a bell-shaped vessel in which the wide, open end of the bell was covered by a membrane created from an ox-bladder. He filled the bell-shaped vessel with urine and suspended it inside a larger container filled with distilled water. After several hours, the bell-shaped vessel was removed. The larger container was heated so that the fluid inside boiled to dryness, and what was left was the substances that were in the urine.

The development of a functional haemodialyser was the cumulative effort of several membrane pioneers. Collodion membranes provided the first low-flux dialyser membranes, but it was not until 1914 that Abel et al. developed and tested the first efficient dialysis system at Johns Hopkins University
School of Medicine in the USA on dogs. Georg Haas, a German physician, performed the first dialysis treatments on humans in 1924. None of his patients survived because they were gravely ill\textsuperscript{18}.

In 1943, Willem Kolff from the Netherlands introduced the rotating-drum HD system using cellophane membranes and an immersion bath\textsuperscript{18,19}. The rotating-drum HD treatment was given for one week to a patient suffering from acute kidney failure and was the first patient who completely recovered from acute renal failure thanks to HD.

This was the beginning of what was to become a major medical achievement: artificial renal replacement therapy.

In 1947, the Swede Nils Alwall published a scientific work describing a modified dialyzer developed between 1942 and 1947 that could better combine the necessary processes of dialysis and ultrafiltration than the traditional Kolff kidney. The cellophane membranes used in this dialyzer could withstand higher pressure because of their positioning between two protective metal grates. All of the membranes were in a tightly closed cylinder so that the necessary pressure did not have to come along with the blood but could rather be achieved using lower pressure in the dialysate\textsuperscript{20,21}.

In 1960, Kiil\textsuperscript{18} developed the renewable plate dialyser. The system consisted of multiple polypropylene boards supporting flat cellulose membranes. It combined the necessary processes of dialysis and ultrafiltration better than the traditional Kolff kidney.

The next steps in membrane production were the Cuprophane membranes, the “parallel plate dialyser” and development of the hollow-fibre dialyser by Richard Stewart from the USA in 1964\textsuperscript{22}. Membrane biocompatibility and dialyser design were further refined by using synthetic materials\textsuperscript{23}. 
Nowadays, end stage renal failure patients undergo conventional thrice-weekly in-centre HD while nephrologists struggle to improve the quality of treatment and improve morbidity and mortality rates\textsuperscript{19}.

Alternative HD regimens, including longer or more frequent dialysis, nocturnal haemodialysis, short daily haemodialysis, home haemodialysis (HHD) and haemodiafiltration and the use of high-flux dialysers have become more widespread in recent years\textsuperscript{19}.

HHD appears to be economically more viable and sustainable than in-centre dialysis as the infrastructural maintenance and manpower costs are much lower than in dialysis centres. In times of spiralling manpower costs, nursing shortages, lack of physical space for expansion and financial pressure on dialysis providers and payers, HHD is certainly worth re-evaluation\textsuperscript{19}.

Comparing in-centre and HHD highlights that the frequency of treatments has a heavy impact on carbon emissions. For clinical reasons, more frequent dialysis is increasingly being used, which means that prevention of growing emissions will require the development of lower carbon technologies, sustainable procurement policies, and efficient waste management\textsuperscript{15}.

The cost of providing more frequent dialysis varies, depending on reimbursement policies. Increased consumable items, electricity and water bills, staffing, training and facility costs, as well as capital expenses related to home dialysis setup will need to be considered. However, with vastly improved intermediate outcomes and lower expected morbidity expected with such therapies in observational studies, the reduction in healthcare-related costs from reduced medications and less frequent hospitalizations could sway the tide in favour of more frequent dialysis from an economic point of view\textsuperscript{19}.
1.5 Summary

Dialysis is having an increasing impact on the environment, water consumption, waste water generation, energy consumption, clinical waste incineration and CO$_2$ emission.

The total number of cHD dialysis patients will probably reach 2 million by 2012. This means approx. 312 million treatments performed world-wide. This number of dialysis patients will probably double until 2020; the impact for the environment will also double, if not addressed and improved soon.

The environmental burden has become a serious issue, which we hope to improve with these guidelines.
References

7. http://www.basel.int/convention/about.html
Notes
Environmental Management
2. Environmental Management

2.1 What is Environmental Management?
An environmental management system (EMS) is a systematic approach to the identification, controlling, measuring and evaluation of an organisation’s activities and the impact it has on the environment. This may be a fully formalised approach with a documented and certified management system. An informal system (focussing on specific aspects like control of resources consumption and generation of wastes, or a series of individual tasks) can deliver over time partly comparable benefits.

2.1.1 What does environmental management achieve?
The aim of environmental management is firstly to ensure that your organisation meets its legal requirements, secondly that it protects the environment, and thirdly – and some may say most importantly – that it continuously improves your organisation’s environmental performance, thus contributing to sustainability

Other benefits can include:

- Assuring compliance to environmental legislation
- Reducing your energy use (direct and indirect CO₂ emissions)
- Increasing comfort for patients, e.g. by using natural light and proper temperature control
- Reducing the volume of waste
- Correctly controlling waste handling and reducing potential for infection
- Ensuring the efficiency of water use and the quality of water treatment
- Management of significant environmental impacts
- Provision of benchmarks for measuring improvement
2.2 Using this Guideline to Develop your own Go Green Strategy

Different strategies are possible, but each follows a broadly standardised approach. All those familiar with quality management will recognise the approach known as “PLAN”, “DO”, “CHECK”, “ACT”, or “PDCA”.

The PDCA cycle (Figure 3) is a standard tool in quality management. PDCA was made popular by E. Deming², who is considered by many to be the father of modern quality control. He, however, always referred to it as the “Shewhart cycle”³.

![Figure 3: Elements of environmental management systems according ISO 14001: 2004](image-url)
Whilst no single standard fits all situations, all standards describe a similar strategy for improving sustainability. This section describes how best to implement this approach in an organisation and provides with simple tools to help to develop an own Go Green Strategy.

Many organisations may already have quality management systems in place that follow a similar approach. Please consider how environmental management can be integrated into existing structures.

For example, can environmental protection issues be incorporated into existing review or staff meeting agendas? Can existing reporting processes be used to collect or report environmental performance data? Can existing processes or instructions be optimised to incorporate environmental legal requirements, new efficiency strategies and, ultimately, sustainability?

The remainder of these guidelines explains in detail the activities and technical elements of dialysis that can be modified to improve your environmental performance. As you will see, the purpose of the Go Green strategy is to allow you to identify and implement changes that will have the most positive impact for you.

Environmental management systems can be implemented using either the International Standardisation Organisation (ISO standard) 14001:2004 or the European Union's Environmental Management and Auditing System (EMAS). Both systems are very similar and are voluntary.

Enthusiasm for environmental activities between dialysis staff is high, as shown in the responses to surveys conducted by EDTNA/ERCA & Fresenius Medical Care⁴ and the Green Nephrology Initiative of the UK National Health Service⁵. A similar enthusiasm to support environmental protection has been reported for staff in general hospitals in Germany⁶.
2.2.1 Setting up your Go Green Team and Obtaining Commitment

For any new strategy, all parts of the organisation involved must show commitment. However, before commitment is even sought, those involved must be aware of the business needs are and why the new strategy is needed.

Often brainstorming sessions, surveys and regulatory or background research are required right at the beginning of this process.

- What objectives does your organisation wish to achieve?
- Do you have preferences with regard to the types of measure you wish to implement?
- What is the scale and scope of your new strategy?
- Over what timescale do you plan to make a difference?
- Who is likely to be involved and affected?

Once you have a business case, commitment needs to be expressed and a suitable Go Green Team from all parts of your organisation has to be put together. In Table 1, you find a Go Green strategy start-up checklist, which can be used as a guide for obtaining your organisation’s commitment at the beginning of any new programme.
<table>
<thead>
<tr>
<th>Group</th>
<th>Why do you need them?</th>
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<tr>
<td>Senior management</td>
<td>- Approval of initiatives</td>
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<td>- Allocation of resources</td>
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<td></td>
<td>- Support and provide leadership</td>
</tr>
<tr>
<td>Finance, Human resources, Procurement managers and staff</td>
<td>- Economic advantage through efficiency</td>
</tr>
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<td></td>
<td>- Associated with success</td>
</tr>
<tr>
<td></td>
<td>- Ensuring of compliance</td>
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<tr>
<td>Medical staff (e.g. nurses, physicians, nutritionists)</td>
<td>- Provide working knowledge of their roles</td>
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<td></td>
<td>- Contribute ideas</td>
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<td>- Identify and report problems</td>
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<td>- Provide support and make changes to practices</td>
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<td>- Opportunity to contribute to success</td>
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<td>- Positive environmental contribution</td>
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<td></td>
<td>- Being part of a team and helping to achieve deliverables for management</td>
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<tr>
<td></td>
<td>- Job satisfaction</td>
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<td></td>
<td>- Environmental strategy used to support the implementation of other projects and programmes</td>
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<tr>
<td></td>
<td>- Add to existing performance management processes and improve understanding of business</td>
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<td></td>
<td>- Support in developing the business case</td>
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<td>- Assist with identifying competence and delivering training</td>
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<td>- Provide useful information such as energy costs, travelianne</td>
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<td></td>
<td>- Economic advantage through efficiency</td>
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<td>- Associated with success</td>
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<td>Group</td>
<td>Why do you need them?</td>
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<tr>
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| Operational managers and Quality managers | - Lead-strategy design and implementation  
- Modifying and supporting operational changes  
- Encouragement of change amongst staff  
- Identifying and providing training  
- Tracking progress and performance  
- Complying with requirements                                                                 | - Opportunity to display success  
- Reducing costs and improving efficiency  
- Meeting of legal requirements  
- Delivery of organisations goals  
- Improvement of staff culture                                                                                                                |
| Technical staff                           | - Provide specialist knowledge and support  
- Identify potential for improving efficiency  
- Improve, monitor and maintain implemented measures to improve efficiency  
- Deliver technical training for others                                                                                                        | - Resolution of technical problems  
- Meet targets  
- Gain of support from others                                                                                                                                 |
| External parties (e.g. transport, catering, domestics, suppliers) | - Able to influence issues your organisation has no direct control over  
- Consulting, e.g. on specific legal issues                                                                                                         | - Helping to deliver shared priorities  
- Creating own benefits (e.g. economic, priority supplier, etc.)                                                                             |

*Table 1: Go Green Strategy Start-up Checklist*
2.2.2 Planning your Go Green Strategy

Planning is the first step in implementing any changes in your organisation. You need to have a clear idea about what you need to change, and how you are going to measure your success.

- What are the environmental issues that are important to your organisation?
- Which environmental issues are “significant”? Set priorities!
- How well are you currently doing and where you would like to be successful in the future?
- Do you have resources?
- What are potential indicators of success?
- Are all requirements resulting from environmental legislation known?

Your organisation’s environmental issues

Every organisation is different. The environmental issues that affect one organisation may be very different from those that affect another. All organisations should regularly review:

- Legal requirements they have to meet
- Non-financial goals of those who have an interest in your organisation. These stakeholders may be: Staff, Patients, Customers, Suppliers, Community (incl. Neighbours, Authorities, Government/Legislative, etc.)
- Your own environmental performance and that of others; i.e. how much water do you use per treatment? What is the best practice?
Assessing significance

To understand the environmental issues important to your organisation, they need to be reviewed in a straightforward, systematic manner. A simple way is to brainstorm with the group you have assembled by conceptualising your organisation. An example of a typical dialysis unit is given in Figure 4.

From this exercise, you can make a logical list of issues. A simple scoring system can then be used to assign significance.

For example:

1. Legal requirement, norms and standards
2. Organisational or stakeholder requirement or improvement needed
3. Other requirements
   (Considering 1 as the highest, three as the lowest score)
Environmental action planning

After assessing the significance of issues, the next step is to plan the action your organisation intends to undertake to monitor and improve the issues you have identified.

This could involve the following steps (example):

a. Investigating new ways of working, for example:
   • Analysis and research on different waste disposal methods
   • Evaluation of new efficient technologies or ways of working
   • Establish an “Eco-controlling”

b. Making changes to the way in which you operate, for example:
   • Changing the way you segregate your waste
   • Updating existing processes or working documentation
   • Using suppliers of products that contain less packaging
   • Implement a new, more efficient technology
   • Selecting service suppliers according their environmental compliance, e.g. certified waste service companies

c. Improving performance, for example:
   • Optimizing treatment system (WTS), which maintains a certain reject water percentage
   • Switching off lights and portable electrical devices automatically when not required
   • Planning patient transport (if applicable) so that all vehicles are never any less that half occupied
2.2.3 Implementing your Go Green Strategy

Once an organisation understands its significant environmental aspects and the actions required to monitor and control them and make improvements, the measures to achieve this need to be implemented properly so that changes can be made and maintained effectively.

Roles and responsibilities
Certain individual in particular roles are needed to offer reliable support to new initiatives. If changes are to be made, everyone who is required to play their part also needs to be identified and then made fully aware of any new responsibilities.

Often roles and responsibilities within an organisation are defined in job descriptions, manuals, procedures and other documents used to monitor and control internal processes. If a Go Green Strategy involves staff with specific roles, ideally existing documentation should be amended and training provided as usual.

Training
Obviously, gaining agreement from staff to undertake a new task or change the way they operate is sometimes easier said than done. This is why training is such an important tool, to firstly explain to others the need for change, and secondly train them in the details of any changes to be implemented.

Communication
Experience shows that success of any initiative that requires the involvement of a number of people usually hinges on the quality of communication. If staff are asked to change the way a process is delivered, trained how to do it, and make efforts to implement such changes, the changes are unlikely to last without adequate feedback.

Communication can be a task on your organisation’s Action Plan. Effective examples include:

- Updates during existing regular meetings
The types of information that it is important to communicate regularly include:

- Progress of any tasks, changes or new processes
- Results of measured environmental performance including trends
- Any unexpected outcomes such as negative findings and positive environmental changes discovered while implementing other tasks
- Definition of corrective and/or preventive actions

2.2.4 Making Sure your Go Green Strategy is on Track

The most important part of any Go Green Strategy is making sure that any changes, tasks or projects you have implemented to control the environmental issues are on track or are being performed as planned.

Secondly, if your organisation has been measuring specific environmental performance or has targets to meet, you must establish whether they are being met and what difference the programme has made.

Effective checking, monitoring and measurement can be a task on your organisation’s Action Plan. Effective examples include:

- Audits and inspections
- Record-keeping
• Monitoring, e.g. regular reading of water, electric and gas meters (“you can not manage what you do not measure”)

2.2.5 Reviewing your Go Green Strategy

After having run a Go Green Strategy for a period, you should review the strategy. Have you achieved the goals you set in the planning phase? If yes, you might need only some fine-tuning. If the review shows that your objectives have not been addressed or are not being achieved, you will need to adjust your Go Green Strategy based on the lessons learned.

Get feed-back from the staff, e.g. implement a scheme for employee’s improvement proposals.

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References


Natural Resources
- Water
3. Natural Resources – Water

3.1 Dialysis Fluid Production and related Saving Strategies

3.1.1 Water Treatment System

An HD session consumes a large amount of purified water to prepare the dialysis fluid, maintain a favourable gradient, diffuse the patients’ waste products out, and correct their electrolytes. However, the water treatment system may use up to approximately two-thirds the volume of pure water actually required. The water discarded in the purification process is often dumped into the drainage system: this can be reduced. To achieve this, the design and operation of the WTS need to be carefully considered and reviewed in order to optimise the process and minimise water and energy waste.

The amount of water needed for dialysis highly depends on the proportion of water rejected by the purification process. There are significant differences of the amount of consumed water in dialysis reported between European countries¹.

3.1.2 Process Description

Water purification for dialysis encompasses a series of technical subunits. All together, water purification is a complex process for which a renal unit should best have its own dedicated trained team member to maintain the supply and keep detailed records of all water treatment quality parameters; both actual data and trends are important. This team member is also the best person to be the renal unit’s “green manager” for monitoring optimal water consumption practices.

The water purification equipment must be compliant with the ISO 26722: 2009 Standard: “Water treatment equipment for haemodialysis applications and related therapies”.

For more detailed technical information on this water purification process, consult a textbook such as: “Water treatment for
contemporary haemodialysis” by Gianni Capelli and Paola Inguaggiato⁵ or download from the web: “Essentials of water treatment” by Suhail Ahmad⁶.

### 3.1.3 Reverse Osmosis Water Distribution and Disinfection

Reverse osmosis (RO) water is provided via a distribution line using a booster pump and is pressure regulated. New systems usually function using direct feed with a return loop, whereas older systems operate on indirect feed, using an RO water storage tank.


Every renal unit must define and apply its own RO water distribution and disinfection policy accordingly and keep detailed quality monitoring records.

According to this standard, the system must be operated and monitored using a validated plan. As a result, together with ensuring consistently adequate water and dialysis fluid quality, it is possible to adjust disinfecting activities to the real needs of the system ensuring the water supply to the minimal waste of energy, water and chemicals.

### 3.2 Concentrate Preparation and Delivery

The availability in renal units of adequate amounts of dialysis concentrates requires an additional effort in terms of work and resources. Considering that up to five litres of acid concentrate are usually needed for each dialysis session, it is of special importance to pay attention to the way this concentrate is managed.

In recent years, the preferred configuration uses a dry bicarbonate bag or cartridge directly connected to the machine and the delivery of the acid concentrate in liquid form.
3.2.1 Process Description

Only a few different options are available for making the concentrate available at onsite at the dialysis station: the classic solution provides a canister or a bag of concentrate directly connected to the machine or a system where the concentrate is centrally distributed (CDS) or even prepared before the use.

This central delivery system (CDS) can be very effective in saving natural resources since it can:

- Avoid the need for disposal of any residual concentrate at the end of the session
- Avoid the use and disposal of plastic containers for concentrates
- Drastically reduce CO₂ emissions by avoiding transportation of the concentrate canisters

A central delivery system (CDS) can also drastically reduce the transfer of (heavy) materials inside the centre, meaning more efficient working procedures, less stress and workload for the staff and, last but not least, energy savings.

The use of the best systems presently available on the market allow the required quality standards for dialysis concentrate to be achieved at the expense of a very limited investment and effort by the dialysis centre. Different formulations are also available, which allows appropriate individualization of treatment.

The quality standards for concentrates used for dialysis are described in the European Pharmacopoeia and in ISO 13958: 2009 “Concentrates for haemodialysis and related therapies”.

The system is based on two basic elements:

- A preparation subsystem, which allows the preparation of the concentrate in accordance with the quality requirements as stipulated in the applicable regulations (e.g. European Pharmacopoeia or ISO standards as given above)
• A distribution subsystem, which allows distribution of the concentrate to the dialysis machines

Central delivery system (CDS) Critical Points:
A few specific points must be considered when designing and operating a central concentrate delivery system:

• Adequate quality of the components used to prepare the concentrate
• Adequate operation, monitoring and documentation of the preparation process
• Adequate design and operation of the distribution system

The systems for the preparation of the concentrate at the dialysis centre and for its centralized distribution is based on the availability at the centre of dialysis water that complies with requirements, as stated, for example, in ISO13959: 2009 (see above). Different regulations may apply in different countries.

The quality of the dry concentrate or highly concentrated medium must be certified and ensured.

The preparation procedure should ensure proper quality control of the prepared concentrate. QC might take the form of an automatic system (made available by some manufacturers) or a manual system based on techniques recommended by the system manufacturer or supplier, or a combination of both. The checks might involve measurements of pH, temperature and conductivity.

Both the preparation device and the distribution system must be adequately designed to ensure:

• Compatibility of materials, i.e. absence of physical or chemical interactions between all system components that come into contact with the concentrate solutions
• All piping should be designed and operated to minimize microbial contamination (usually not a problem for acid concentrates)
• When system disinfection is performed, the process must remove any residual disinfectant before the system is used again to prepare or distribute the
concentrate (disinfection is usually not needed for acid concentrates)

- The concentrate mixing device or system must be equipped with safety mechanisms to prevent inadvertent operation and all fixtures and fittings that prevent this must be adequately labelled
- Storage tanks must be vented through a hydrophobic air filter (e.g. 0.45 μm). Alternatively, soft containers, such as bags, may be used
- Electrical devices, e.g. distribution pumps, must meet the requirements of International Electrotechnical Commission (IEC) 60601-1 with respect to electrical safety

The operation of the central delivery system (CDS) requires electrical energy to circulate and deliver concentrates and water to dilute the components, powder or highly concentrated media if the concentrate is prepared at the dialysis unit itself.

For these reasons, the following additional points should be considered when planning and operating a central delivery system (CDS) to ensure that a real environmental advantage is achieved:

- The size of the unit and the number of patients to be treated
- When distributing acid concentrate, the system does not usually require disinfection because of the bacteriostatic nature of the concentrate. Disinfection would be required (see also ISO 13959: 2009 quoted above) for bicarbonate concentrate. The associated effort, resources, general consumption and consumption of chemicals suggest that it is better to avoid central distribution of bicarbonate and use it in dry form directly at the machine
- The use of an ultrafilter at the input of the distribution line to the machine also reduces the risk of contamination and, in addition to increased safety, reduces the need for ad-hoc disinfection
3.2.2 Energy Consumption Aspects

Centralized preparation and delivery of concentrates allows the reduction of dialysis-related energy and waste both inside and outside the dialysis centre.

The basic idea is to transport to the centre and to the dialysis machine only what is really needed, thus avoiding any waste energy and unused concentrate.

Outside the dialysis centre: The concentrate is an aqueous solution of salts and possibly of glucose. The transportation of the “active” part of the concentrate only (and not the diluting water) is an obvious saving in terms of energy and emitted CO$_2$.

Inside the dialysis centre: The management of concentrate canisters assumes a considerable amount of effort inside the dialysis centre. The activities involved range from the need to store large amounts of canisters or bags to the need to transport these canisters to the dialysis machine and back for disposal. This activity, besides the effort in terms of staff involvement, can also involve significant energy consumption to move avoidable amounts of heavy materials inside the centre.

If available, the higher concentrated formulation (e.g. 1:45) should be preferred.

Plastic canisters for concentrates are also an important environmental factor; for more details, see Chapter “6 Waste Management in Dialysis Clinics”.

3.3 Dialysis Fluid

3.3.1 Process Description

Quality of Dialysis Fluid from Water Treatment Systems (WTS) to the Patient

The fact that HD patients are exposed to nearly 400 litres of dialysis fluid per week stresses the importance of its continuous quality management (see for example ISO 23500: 2011: “Guidance for the preparation and quality management of fluids for haemodialysis and related therapies”). Current scientific evidence demonstrates the benefits of ultrapure
dialysis fluid for the outcome of HD\textsuperscript{10}. The careful quality control of water and dialysis fluid is also a condition for the implementation of on-line haemodiafiltration, which several authors consider to be the most effective means of removing impurities from the blood\textsuperscript{11,12}.

**Dialysis fluid at the point of care**

The electrolyte concentrate solution (or powder) is mixed in the dialysis machine with the dialysis water to produce the dialysis fluid at the point of care. The dialysis machine guarantees that the electrolyte composition, pH, temperature and flow rate comply with that medically required as set by the operator.

**Online substitution fluid**

Substitution fluid (i.e. fluid for infusion) are used in convective therapies, such as haemodiafiltration and haemofiltration. They may be produced online from dialysate by processes such as ultrafiltration of dialysate fluid with the help of bacteria- and endotoxin adsorbing membranes. Dialysate for infusion must be sterile and pyrogen-free (see e.g. ISO 11663: 2009 “Quality of dialysis fluid for haemodialysis and related therapies”). Compliance with this requirement cannot be demonstrated by culturing bacteria in the usual clinical environment. Substitution fluid should therefore be produced by a device or process that has been validated by the manufacturer to produce fluids meeting the above recommendations for a specified time or number of treatments when supplied with dialysate of a specified quality (see e.g. ISO 23500: 2011: “Guidance for the preparation and quality management of fluids for haemodialysis and related therapies”)\textsuperscript{13}.

### 3.3.2 Energy Consumption Aspects of Dialysate Fluid

**Heating of Dialysate**

Apart from machines that operate with a batch of pre-warmed dialysate fluid, all HD machines are equipped with a system that guarantees a desired dialysate temperature. Even if a dialysis fluid temperature of 37°C is higher than the average physiological core temperature, the excess is accepted as
broad compensation for unavoidable heat losses in the venous part of the extracorporeal circulation.

Since the first reports by Maggiore et al.\textsuperscript{14} in the early 1980s, many studies have confirmed that a low dialysate temperature in the range of 34 to 35.5°C may improve intradialytic haemodynamic stability when compared to dialysate temperature set at 37°C or higher\textsuperscript{15}. A lower dialysate temperature improves cardiac contractility\textsuperscript{16} and increases venous tone. For example, in a prospective study in 11 patients, dialysis fluid set at 35.5°C significantly increased the intradialytic and postdialytic blood pressure and significantly reduced the number of nursing interventions and the necessary volume of saline to be infused for intradialytic hypotension\textsuperscript{17}. Fine et al. also observed that patients with low body temperatures had the highest benefit from cooled dialysate\textsuperscript{18}.

**Energy quantity to heat dialysis fluid - dialysis fluid flow rate**

In current dialysis practice, a dialysis fluid flow rates between 500 mL/min and 800 mL/min (at a blood flow rate > 350 mL/min) are commonly used, even though optimal solute clearance is already achieved at much lower dialysis fluid flow rates. Even when the dialysis fluid flow rate equals the blood flow rate, almost 90% of the maximum small solute clearance is achieved. Thus, higher dialysis fluid flow rates do not significantly contribute to an increase in clearance.

The dialysis dose delivered to a patient is influenced by a number of factors: predominantly by the blood flow rate, the selected dialyser, the treatment time, the treatment mode, and the dialysis fluid flow rate.

**Improvement strategies and recommendations – Dialysis fluid production**

- Before buying an RO system, perform a chemical analysis of the raw water. A good raw water quality may require a smaller dimensioned system and vice versa.

- Rationalize your RO water treatment system:
An oversized water softener consumes more water for filter backwashing and salt for resin regeneration. An oversized RO system easily results in an excess of treated water and an increase in reject water drained away. If two RO units are used in series, the reject water of the second RO should be diverted to the inlet of the first RO unit avoiding extra reject water being drained off. ROs that reducing reject water from 75% to 20% are now available; they achieve this by recirculating reject water at high speed over the RO membranes, avoiding membrane plugging or foiling, and thus save vast amounts of reject water.

- **Rationalize your RO water consumption:**
  Do not switch the RO system on earlier than necessary. As soon as machine disinfection after the last dialysis session is complete, immediately switch the RO into stand-by or analogous economy mode, avoiding more water consumption than is actually required.
  The RO water distribution configuration should be optimised to avoid any high quality water being dumped to the drain: in direct water distribution systems, a flow regulator should be used, in which the excess RO water is recirculated to the RO booster pump inlet, which automatically decreases the amount of RO rejection to the drain. Alternatively, if the water distribution is indirect, using a RO water storage tank and level detectors, the RO system should be switched on and off according to RO water consumption.

- **Rationalize your dialysate consumption:**
  Dialysate flow rates should be rationalised and should not waste dialysis fluid. Their flow rate should be reduced to a minimum in the waiting time between preparation and patient connection. The use of high dialysis fluid flow rates (800 mL/min) should be reviewed as this brings no real benefit for the patient and can be replaced by an autoflow regulator, maintaining dialysis fluid flow at 1.2 times blood flow.

- **Recycle your RO reject water:**
  RO reject water is legally not accepted as drinking water, though it might meet potable water criteria. RO reject water contains salt, in proportion to water hardness, inversely increased by the % rejected by
RO. Calcium in drinking water is better for your health than sodium, but people with a water softener at home often use their softened water as drinking water and this is legally accepted.

- Why should RO reject water, in contrast with the general opinion and practice, not be “interesting and attractive” water?

RO reject water is online-monitored softened water and has not been in contact with patients in any way. It has had chlorine, chloramines and other organic compounds filtered out. Hard water inhibits soap lathering and cleaning capabilities. The following illustrates this well: when tap water is hard and a softener is used, soap products need to be reduced in proportion to the water hardness, otherwise they produce excess foam. Softened water feels smoother on your skin when taking a shower: less shampoo, shower gel, soap and detergents are used. Anti-lime-scale tablets are no longer needed. The lifespan of appliances such as water heaters, washing machines and dishwashers can be increased by as much as 30%, and repair costs are also reduced. In addition, when hard water is heated, the minerals in the water precipitate out and form scale in water heaters. These build up and increase water-heating costs. Thus, soft water is more comfortable and saves money; this is why people install water softeners in their homes.

In renal units, however, this otherwise much appreciated commodity is usually drained off unused into the sewerage system. It could at least be used to flush toilets, which would still be “under-using” it as a valuable commodity, but this would be better than sending it directly down the drain. This means that reducing RO reject water is important and makes sense because it cannot be fully reused.

- What technical equipment is needed to reuse RO reject water?

Connor et al.\textsuperscript{9} reported on using RO reject water in the UK for more than 10 years and describe their system as follows. The RO reject water is directed to a recovery tank in the basement. From there, it is pumped up to a grey water tank on the roof, which then supplies
the water to the hospital toilets. Float switches divert this RO reject water to the drain if the grey water tank becomes full, and diverter valves direct the RO reject water directly to the drain from the RO system during monthly chemical disinfections. The authors report that this system is associated with a potential annual saving of over € 12,000 and an overall carbon saving of 0.76 tonnes CO$_2$ for this unit.

- **Reuse of spent dialysate:**

  Tarrass et al from Morocco$^7$ concluded that waste dialysate can be used for irrigation in arid countries with water shortages. Effluent dialysate is therefore treated with ultrafiltration and RO techniques in the same way as other types of waste water; this cheaper than desalinating seawater.

**Improvement strategies and recommendations – Concentrate preparation and delivery**

When planning the CDS, the dialysis centre designer should bear in mind the following:

- **Amount of treatments to be performed by the unit and the number of different formulations required**
- **Composition and total consumption of concentrates and the way the material is transported to the centre.** Usually the marginal impact from production and management (e.g. quality control) of the additional dialysis-grade water and from the preparation of the concentrates are largely compensated for by the positive effects.
- **Efforts, also in terms of energy, needed for the in-house movement of the canisters.** The energy consumed by the pumps is usually negligible in the context of energy wasted elsewhere.

Operators of dialysis machines should consider the following:

- **Dialysis fluid flow to be properly set in accordance with the blood flow (see section above).** A ratio of 1.2 is usually adequate for treatment and prevents waste water and concentrates.
- When not performing dialysis, the machine should be set in standby mode
- Recycle concentrate canisters and bicarbonate bags and cartridges; most countries do not require them to be disposed of as infectious waste.

**Improvement strategies and recommendations: Dialysis fluid**

**Adapt heating to the patient**

The rationale of temperature control is to prevent heat accumulation that might increase body temperature during HD. As dialysate temperature should be individualized and chosen with regard to actual patient temperature, blood flow and treatment mode, such as HD or haemodiafiltration. In addition, the temperature may also need to be adjusted throughout treatment in accordance with the needs of the patient.

**Feedback control of patient temperature**

Devices for the monitoring of the blood temperature are available. This kind of module for the regulation of the thermal energy balance is a component from a overall concept of “Physiological Dialysis”. Numerous studies have confirmed that a controlled negative thermal balance in patients with unstable circulation has a positive effect upon intradialytic vascular stability.

Using the control function, non-physiological – and so far unnoticed – changes in body temperature leading to cardiovascular reactions can be avoided during treatment.

In addition to non-invasive measurement, the device should permit – within tight physiological limits:

- The regulation and stabilisation of the intradialytic body temperature
- The regulation of the intradialytic extracorporeal thermal energy balance

For regulation of the body temperature, the device should determine the arterial and venous fistula temperature by
means of a temperature-compensated sensor and, by take into account the current recirculation value, should calculate the body core temperature. Based on the targeted control of the dialysate temperature, the venous temperature is initially set at the prescribed body temperature (for example ± 0°C/h) and continuously monitored. In this way, the processor-controlled regulation permits a rapid reaction to unwanted body temperature changes to ensure stabilisation of the circulatory system within physiological limits.

Using such devices, we might save room heating or cooling energy.

Adapt the quantity to the modality, based on patient needs

Although the dialysis fluid flow rate is the factor that has the least influence in determining the dose of dialysis, it is nevertheless the most significant factor in economic and environmental terms.

By using a function integrated into dialysis machines, it should be possible to reduce dialysis fluid consumption significantly and thus cost in terms of:

- Energy/electricity consumption
- Water
- Waste water without affecting to prescribed Kt/V.

More than just a simple mixture of water with acid and bicarbonate concentrates, dialysis fluid is required to have a very high chemical purity and microbiological quality – an important feature with respect to patient safety. Moreover, energy is needed to heat the dialysis fluid to the appropriate temperature required by the patient.

Dialysis fluids, therefore, are highly valuable entities and need to be used economically. The activation of the system able to adapt dialysis flow to patient need leads to a reduced dialysis fluid flow rate and thus enables savings in dialysis fluid consumption. It should be noted, however, that the potential savings on dialysis fluid and energy (required to heat the dialysis fluid) are dependent upon individual treatment conditions that may vary from one unit to another and according to dialysis practices in different countries.
References


Natural Resources
- Energy
4. Natural Resources – Energy

4.1 Dialysis Treatment Rooms

Dialysis units require a significant amount of energy. Overall consumption is influenced by many factors, mainly by the quality and characteristics of the building, the type of used technologies, treatment modalities and by the habits of the clinical staff.

Beside the energy needed for the dialysis machines, WTS, lighting, elevator (if used), ICT and other treatment-associated tasks, a dialysis unit also needs energy for heating, ventilation and cooling.

The dialysis machine itself requires approx. 2.5 – 3.5 kWh electricity per treatment, which is just a small proportion of the overall energy used.

Requirements according to the climate differ within Europe. In many places, the outdoor temperature varies widely throughout the year and from day to day. The Köppen-Geiger Classification\(^1\) describes different climate zones, which require different approaches for dialysis centres. In hot countries, a heat protection, avoidance of heat production and air conditioning has highest priority, while in cold countries, an efficient heating and maintaining the temperature is in focus.

The ideal temperature in the treatment room, however, should be held constant during treatment. Maintaining a constant temperature is often achieved by warming or cooling the ambient air. Warming often uses all heat sources in the room, and cooling usually works against all active heat sources.
Sources of heat:

1. Radiators and heating system
2. The dialysis machine (warm dialysate, electrical activity and (if used) hot disinfection)
3. Sun through windows
4. Heat disinfection (if used)
5. Drainage pipes
6. All staff
7. All patients
8. Other electrical equipment (Lighting, medical equipment, TV, computers)

Requirements for staff and patients do not match. Patients are often sensitive to cold air in the treatment area. They usually
sit or lie passively during treatment so do not generate much body heat from muscle work.

Modern dialysis machines are equipped with a heat exchanger, which is heating up the incoming dialysis fluid with the help of the outgoing waste dialysis fluid. These heat exchangers are reducing the energy needed to heat dialysis fluid significantly.

Furthermore, the dialysate temperature can be used to cool the patient a little, to achieve better cardiovascular stability during treatment. Patients therefore normally prefer a slightly warmer ambient temperature to the staff and are more sensitive, especially to cool draughts. The staff are usually on the move most of the time, and therefore prefer slightly cooler air. In addition, sensitivity to the ambient air increases as humidity increases. The temperature of storage rooms must be controlled and is topic of local regulations in Europe.

There are several strategies for reducing heat and regulating temperature in enclosed spaces. These are summarised below.

4.1.1 Insulation

Shading systems help to avoid solar heat in the scenario of hot climate zones. At the design stage, plans can include roofs with wide eaves to prevent direct sunshine entering windows; this can also be achieved with awnings. The aim should be to minimise direct sunshine and maximise daylight entry.

Window seals should be checked for leaks once a year.

If the outdoor and indoor temperatures differ widely, double or triple glazing is useful.
Non-deliberate sources of heat should be insulated so they do not affect the ambient temperature, e.g. warm water pipes should be insulated. Insulation is a “green” investment: once paid for, it no longer costs anything but its effects last for years.

4.1.2 Dialysis treatment

The selection of devices can influence the energy consumption of a dialysis clinic. Especially functions, which reduce the energy consumption, should be used e.g. stand-by, Eco-flow, flow-rate of dialysate (see chapter 3), etc. In addition, a proper shift planning may help for efficient energy consumption. If possible, energy saving medical devices should be used. All devices should be clearly marked if they can be switched to “stand-by” or “off” after the treatment, nights or during weekends.

4.1.3 Evacuation at the Source of Heat

If unwanted heated air is evacuated where it is generated, it will not affect the room temperature. In rooms with slow air movement, heated air always moves upwards. If for practical reasons air evacuation is not possible at the source, it could be evacuated in the roof over the heat source, and the need for cooling is reduced. This requires conditions with slow laminar airflow in the patient area. This method could also provide relief from smells in treatment area.

If possible, at defined heat sources, install a ventilation outflow over the heat source, e.g. above each dialysis station. The evacuated air should be balanced by inflow of fresh air. The air inflow should not be directed towards patient stations, but should preferably be drawn into areas where the staff move. The inflow area has to be big enough to avoid slow airflow in the room.
4.1.4 Regulation and Compensation

If possible, the heat and cooling system should be integrated. If there are separate systems for heating and cooling, their settings must match. These systems could work against each other, using energy to produce heat while cooling the same room. The sum of the effects will be less effective and at the same time will waste energy. Air-conditioning could be designed to cool the fresh air in the areas used mainly by staff, and only secondarily by the patients.

Best practice would be “chilled beam” systems (passive coolers with no fans but relatively large surface areas) installed in the ceiling in non-patient areas, e.g. corridors, together with the evacuation of heat at strategic sources; this enables laminar slow flow of convected air slightly cooler in non-patient areas and slightly warmer air between dialysis machines. A well-balanced system should be both more convenient and energy effective than air-conditioning using fans.

The design of the heat and cooling system and its operation may differ very much, depending on the climate zone. The staff should be trained to use the heating and cooling system properly.

4.1.5 Manual Ventilation Strategy

Avoid opening windows and running air-conditioning or heating systems at the same time if ventilation via windows has to be used. Automatic switch-off systems connecting windows with the power of the ventilation are available. While heating or cooling systems are on, ventilate vigorously in short bursts rather than gently for long periods.
4.1.6 Water Pipes

If a central heating system is also used to heat tap water, a ring pipe is recommended. Otherwise, the warm water will generate heat that will increase the room temperature. This can also encourage *Legionella* organisms to grow in the system. In addition, running taps to obtain warm water (or cool water) is wasteful. Moreover, flushing the system to reduce *Legionella* will consume even more water, also wasting the energy used to heat it.

4.1.7 Painting

Dark colours, especially black surfaces, absorb heat energy. Light colours, especially white surfaces, reflect natural light and absorb less heat energy. To avoid heat from the sun and provide natural light, it is recommended to use light colours in rooms. Especially the window frames should be white.

4.1.8 Energy Consumption. Aspects of Dialysate Production

*See chapter 3.2.2.*

4.2 Offices and Staff Rooms

Depending on how office and staff rooms are used, consider infrared detectors or motion detectors to trigger lighting. If people are in rooms for only short periods, it is a waste of energy to keep the light on for long periods.

4.2.1 Stock Areas

Depending on how office and staff rooms are used, consider infrared detectors or motion detectors to trigger lighting.
4.2.2 Technical Areas

Depending on how office and staff rooms are used, consider infrared detectors or motion detectors to trigger lighting. Ventilation should be planned to evacuate air above dialysis machines, especially if heat disinfection is planned.

4.3 Lighting

Illumination is extremely important to guarantee patient and staff comfort, but it is also important to increase work efficiency and reduce errors.

The illumination of a building accounts for an important part of the energy required by the building. It has been estimated that the energy consumption for illumination can be between 12% and 15% of the total energy used. There are also recent data from German hospitals, show that 22% of all electricity is used for lighting.

4.3.1 Lighting Requirements

The illumination of each room or area of the dialysis centre should comply with the local regulations regarding the minimum safety and health requirements for the workplace. The European norm: EN 12464-1, “Light and lighting – Lighting of work places, Part 1: Indoor work places”, can be used as a reference.

Research (admittedly quite old, but still routinely cited) suggests that medication error rates increase when work environment illumination levels are relatively low or dim. A large-scale controlled study of hospital pharmacists found that medication dispensing errors occurred more frequently when work surface illumination levels were in the low to moderate range (450–1000 lux). The same pharmacists made markedly
fewer errors, however, when work surface illumination levels were increased to 1500 lux.

The finding that bright lighting reduces medication errors implies that there is cause for concern that low illumination levels are common in healthcare spaces. It is not uncommon to have staff performing paper-based reading and writing tasks in low illumination designed for computer monitor use, which is not ideal. The Illumination Engineering Society of North America recommends 500–1000 lux for work surfaces for “performance of visual tasks of medium contrast or small size”\(^4\).

The illumination requirements for the rooms where special hygienic conditions are required, such as dialysis and medical services, should also comply with specific characteristics:

- **Hygienic conditions**: dust accumulation should be avoided and cleaning fixtures should be easy and effective.
- **Glare control**: reflected glare should be controlled to avoid disturbance to patients when they are lying down, (they look directly at the ceiling).
- **The position of light sources in the dialysis rooms should**:
  * Avoid shadows of patients’ arms during connection and disconnection procedures
  * Be parallel to the wall (if rectangular)
  * About 1.20–1.50 m away from the wall
- **Artificial lighting provided in spaces occupied by patients should allow the easy identification of any changes in skin tone and colour.**
- **During connection and disconnection procedures, illumination levels for high visual requirements must be achieved.**
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- During treatment (when patients might sleep or watch TV), illumination levels for moderate or low visual requirements will usually be sufficient.

### 4.3.2 Energy-saving Strategies

It is important to bear in mind that even though the lighting in a building may have been expensive and may consume large amounts of energy, it may not necessarily provide good visual comfort conditions. There are different reasons for this type of inefficiency in the illumination process:

- Poor design, positioning and operation
- Use of inefficient technology
- Inadequate maintenance of the light sources
- Incorrect behaviour of the people in the centre

The European Norm EN15193: 2008, “Energy performance of buildings – Energy requirements for lighting” gives guidance for the estimation and measurement of the energy required to illuminate buildings. The EU program “GreenLight” gives recommendations and advice for energy savings for lighting. It is “…an on-going voluntary programme whereby private and public organisations commit towards the European Commission to reducing their lighting energy use, thus reducing polluting emissions”.

Adequate design means planning the proper illumination level in accordance with the requirements mentioned in the above section, using the proper sources. Efficient approaches also include avoiding excessive lighting in areas without specific needs (e.g. corridors).

An additional important aspect is the mixing of natural and artificial light: the proper mixing of the two sources, when possible, guarantees that the required levels of illumination are achieved and has a beneficial effect on patients and operators.
Daylight integration can also be automatically achieved with photocells.

This goal can also be achieved by the use of daylight guiding systems that can bring the natural light into areas far from windows or external openings.

Additional ways of saving energy with illumination are:

- The modulation of the lighting level to comply with the requirements of the activities performed. An example is the dimming of the illumination level in the dialysis ward, and using a higher level only when medical activities must be performed.
- Individual dimming: concentration of the illumination only on the area where it is really needed.
- Use of presence sensors to avoid the illumination of empty areas.

The use of proper technology is also a very effective way to avoid energy waste. The use of high efficiency T8 lamps (usually rated at 32 W) instead of the T12 lamps (rated at 40 W) can easily achieve a 20% energy reduction at the same illumination level.

A further possible solution is the use of LED technology. This promising technique allows energy savings of greater than 50% to be achieved (in some cases up to 90% less than with older technologies) compared to current standard illumination and has the additional advantage that the lamps have a much longer service life.

### 4.4 Information and Communications Technology

The development of information and communication technology (ICT) also has an affect on the working field of dialysis. The documentation of treatments and workflows including logistics
and purchasing is moving from a paper-based systems towards paper-free systems.

For a long period, ICT was regarded as a “clean” technology bringing lots of advantages and improvements for workflows in healthcare.

However, the continuous use of ICT installations has led to significant energy consumption and electronic waste. Currently, estimated 2% of total CO₂ emissions worldwide are caused by the production, usage and disposal of IT systems². The environment should not be forgotten when choosing hardware. Energy consumption, the use of hazard-free materials, and the correct disposal of electronic devices must also be borne in mind when planning and buying systems, and should be reviewed regularly to enable switching to a more energy efficient technology if appropriate.

Despite consuming resources themselves, ICT installations can also be an additional tool in the reduction of the environmental impact of our activities.

Savings can be achieved by selecting low-consumption devices and using standby settings or complete switch off when not in use. A typical sight when entering offices or dialysis wards are the PC monitors showing the screen saver.

PCs consume between 60 and 250 W per hour whether actively being used or in screensaver mode. This value can be reduced to 1-6 W in sleep or standby mode. The proper power management of LCD monitors can also achieve similar consistent reductions.

ICT can also help in achieving lower environmental impact if extensively used in the optimisation of daily working procedures and the reduction of travel, by using video conferences and other distance communication tools in larger organisations.
Development of an e-learning platform can also make an additional contribution to the reduction of the CO$_2$ footprint.

**Improvement strategies and tips:**

**Dialysis Treatment Rooms**

Use dialysis machines with heat exchangers as these use significant less energy for dialysis fluid heating.

Reduce the dialysis machine flow to a minimum in the waiting time between preparation and patient connection, as this is not only effecting water but also energy consumption (for pumping and heating).

**Offices and Staff Rooms**

When designing a dialysis clinic or unit, consider evacuated heat as an energy source.

If using heat exchangers or heat pumps, energy from evacuated warm air should be re-used, especially in a cold climate. If the cooling is distributed to chilled beams using water, free cooling, using cooling towers for example, could be effective in providing cooling.

Electric devices for offices and staff rooms, including coffee machines, refrigerators and washing machines should be selected and purchased based on the energy efficiency class.

**Lighting**

As a general rule, the proper design of a lighting system should include the following aspects:

- Use of both natural and artificial illumination
- Task- versus general-lighting
- Automatic switch controls
1. The use of natural light is a straightforward way to save lighting energy and it also improves the well-being of the people living and working in a building.

Natural light can be used effectively in different ways. In all cases, it must also be considered that the correct illumination level in a room – depending on the kind of activities performed – is usually achieved by the optimal mixing of natural and artificial illumination.

2. The use of task lighting is a further way to reduce energy waste, especially in large areas where different activities are performed. It is typical to have higher lighting levels in the nurses’ station where documentation or medications are prepared, while a lower level may be used in the patient area, when a high level is not required for connection and disconnection or other medical operations.

3. Another important aspect is the control of light, either by dimming or by switching lights off when different illumination levels are needed.

The proper use of lighting controls:

- Saves energy
- Extends the service life of lamps and related devices (e.g. electronic dimming ballasts)

In addition, lighting control may have a positive impact on the energy required by heat, ventilation and air-conditioning systems (HVAC) by reducing a building's cooling needs.

The most common types of automatic electric lighting controls include occupancy sensors, daylight sensors, timer switches, and a variety of manual and automatic dimming devices.

If lighting levels cannot be controlled automatically, the best strategy is to raise staff and patient awareness to the value of judicious use of energy for lighting. Further strategies to
save energy are training and clear instructions on which lights and devices can be switched off during the night and at weekends.

**Information and Communications Technology (ICT)**

Use ICT sensibly:

- Switch off or set to standby the system when not in use. The screen saver was invented in the past for old-style CRT monitors and is purely aesthetic for modern monitors.
- Select the most environmentally friendly ICT devices in terms of power consumption and disposal strategy. A computer may contain many dangerous materials, such as cadmium, lead, mercury and arsenic.

Exploit the “green potential” of ICT

- Use video conferencing and e-learning to avoid travel unless urgently required
- Select ICT devices, which are energy efficient, e.g. Energy Star\(^8\), TCO\(^9\), or similar
- Go paperless
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References


Notes
Hygiene and Housekeeping
5. Hygiene and Housekeeping

5.1 Hygiene, Sanitation, Cleaning and Disinfection

Hygiene and environmental asepsis are always important issues when dealing with patients undergoing surgical procedures, and this especially applies to HD.

The risk of infection during HD is very high due to the prolonged treatment involving removal and return of purified blood; microorganisms can enter the bloodstream via the extracorporeal circuit. Overall, dialysis-related bloodstream infections are the second leading cause of death in patients undergoing HD.

Research shows that bloodstream infections can occur because of dialyser contamination due to membrane rupture, inadequate disinfection of devices, contamination of priming fluids, contamination of multi-dose vial medications during repeated use, and inadequate hand hygiene by dialysis staff1. It is therefore essential to emphasize the importance of hygiene by regular training. Proper adherence to infection control guidelines is also essential to minimize infections in healthcare settings.

As mentioned in Chapter 1 in the introduction, the medical outcome always takes precedence over ecological impact. However, this should not prevent us from being as environmentally friendly as possible with regard to hygiene and housekeeping procedures. Before going into the environmental aspects, here a recap on hygiene basics in dialysis care.

Hygiene, sanitation, cleaning and disinfection are key words for a healthy and impeccably clean working environment in every healthcare facility.
Hygiene is the branch of medicine that deals with the prevention of disease transmission and examines the adverse and beneficial effects on human health and the measures to maintain and improve healthy living conditions. These include the provision of clean drinking water, safe food, adequate water for personal hygiene, with the aim of reducing microbiological, biological, chemical and physical risk factors to a level that is acceptable to human health\textsuperscript{2}.

Sanitation is a way of life, which is reflected in a clean apartment, clean workplace, orderly and clean surroundings, ordered people, and the communities in which we live (definition of the National Foundation for Sanitation, USA)\textsuperscript{3}.

Cleaning is the removal of visible and invisible contamination from surfaces. With proper cleaning, we can remove up to 80% microbiological contaminants from surfaces. Cleanliness must comply with both visual and microbiological criteria. When cleaning, we should pay attention to choosing the right resources and tools for cleaning and appropriate cleaning procedures.

The primary objectives of regular cleaning are to prevent the creation of conditions conducive to the development of microorganisms in the environment, the removal of biofilms and to maintain material in good order. It also has an aesthetic objective to create a “user-friendly” feeling.

Characteristics of good cleaning agents are economical, effective against impurities, non-toxic, non-corrosive, user-friendly (simple dosage, stability during storage), and biodegradable according OECD guideline for testing chemicals\textsuperscript{4}.

Disinfection is the process by which, through physical or chemical means, we hinder growth and destroy harmful microorganisms, except bacterial spores. The purpose of disinfection is to reduce the number of microorganisms (99%)
in working areas and on equipment and accessories which could not be removed by regular cleaning procedures.

In situations where disinfection is necessary, the hygiene nurse at the centre is responsible for setting up detailed plans for cleaning and disinfection in a Hygiene Table. As for cleaning, when performing disinfection, the disinfectants must always be used in accordance with the manufacturer’s recommendations and instructions for use.

Disinfection is a separate procedure from cleaning. All areas designated for disinfection must be thoroughly cleaned and dried before disinfection. The effectiveness of many chemical disinfectants is greatly reduced if the surface is not pre-cleaned and they still bear organic residues.

When disinfecting with chemicals, always follow the manufacturer’s instructions implicitly with regard to contact time, concentration, and safety information, and always use the proper protective equipment when preparing them.

Disinfection is obligatory in areas with large numbers of users (public institutions), dangerous places (switches, handles), and special facilities (operating rooms). In case of outbreaks of diseases and epidemics, this also applies to places with large numbers of sick people (health centres, hospitals, nursing homes, dialysis centres).

The characteristics of a good disinfectant are: Instant effect on different kinds of microorganisms, not harmful to health, no residue, no damage to the materials being disinfected, user-friendly, environment-friendly (biodegradable), and economical.

**Renal Unit's Hygiene Table**

The prerequisite for effective cleaning and disinfection of work surfaces and devices in a dialysis centre is an established hygiene table, which defines the scope of cleaning and
disinfection, the type and concentrations of detergents and disinfectants, contact time, frequency and displays the appropriate danger symbols. A safety data sheet must be available for all agents used in the dialysis centre. Safe storage at the proper temperature and in an appropriate area must also be guaranteed.

In some cases, it is useful to determine water hardness as this affects the efficiency of agents used in dilution.

Cleaning products must be used correctly for maximum effect. They should be environmentally friendly and meet high market demands. Proper preparation and correct dosage together with continuous training of staff for the proper and safe usage of detergents, other agents and technology, assist in achieving thoroughly and continuously clean working surroundings, are better for the environment, and help to save costs.

All cleaning and disinfection procedures should be recorded on appropriate record forms with information on who performed the measure, at what time and on what date, which agents were used, and in what concentration.

In dialysis centres, clean and unclean areas and paths must be defined to prevent cross-contamination.

Hygiene measurements must be carried out on all areas in the centre: rooms, building and close surroundings. Working processes are necessary to maintain clean equipment and accessories. This includes the cleanliness of sanitary facilities, functional equipment on washing stations for proper hand hygiene, maintenance of water supply installation (taps, drains), air conditioning units, proper hygiene in food handling and clean means of transport (e.g. wheelchair). Facilities for staff and patients to maintain personal hygiene, including a supply of clean working clothes, as well as areas for the segregation, collection and proper disposal of waste, should all be subject to regular cleaning and disinfection.
5.2 Green Cleaning

Before developing all necessary procedures and a detailed Hygiene Table for a dialysis unit, we should also think about environment and how we can “green up” our housekeeping.

So the question is: What is “green cleaning”? Green cleaning means using cleaning methods with environmentally friendly ingredients and chemicals to preserve human health and guarantee environmental quality. Green cleaning techniques and products avoid toxic cleaning products that contain toxic chemicals, some of which emit volatile organic compounds causing respiratory and dermatological problems, amongst other adverse effects. “Green cleaning” can also describe the way residential and industrial cleaning products are manufactured, packed and distributed. If the manufacturing process is environmentally-friendly and the products are biodegradable, then the term “green” or “eco-friendly” may apply.

A wide range of green cleaning agents are available for use in dialysis centre kitchens. Phosphates, chlorine, artificial fragrances and artificial colours should be avoided. Recycled packaging should be used for cleaning products. Whatever choices we make about our cleaning supplies, a huge variety of environmentally friendly products are available for those interested in green cleaning.

Ways to clean the dialysis centres with detergents that contain fewer toxins and more environmental friendly ingredients should be sought, and it may also be possible to save money while doing so.

Products for green cleaning should be compostable and biodegradable. This is better for the environment at the time of disposal.
5.3 Catering

Plastic plates, cups and cutlery for single use can be used for serving food to patients. This saves water and electricity, and avoids effluent chemicals in detergents. However, plastic can be a huge problem and burden for the environment if not properly collected and disposed of. Only recyclable or biodegradable plastic materials should be used.

If glass or crockery and traditional cutlery are used, energy and water can be saved using ecological dishwashers together with environmentally friendly organic detergents that do not contain synthetic solutions of chlorine compounds and other halogen compounds, inorganic acids, or petroleum products.

“Green” detergent is made from plant-based materials and all components of non-mineral origin are fully degradable and meet the required 301 F OECD method (OECD Guideline for Testing of Chemicals). If a program that pre-washes is selected and the dishwasher is full, 35% less water is used than washing by hand.

5.4 Hygiene related to Patients and Staff

Hand hygiene is widely acknowledged to be the most important procedure to reduce cross-contamination. However, evidence suggests that many healthcare professionals do not decontaminate their hands as often as needed or the technique used is not correct.

For this reason, the promotion of hand hygiene education and auditing of compliance must be mandatory for all healthcare professionals.

There is clear evidence in the literature demonstrating the presence of nosocomial pathogens on the hands of healthcare professionals. Such contamination may occur during contact with infected wounds, mucous or secretions, but also following...
contact with intact skin or contaminated objects in the patient’s environment.

The hands of a healthcare professional may be contaminated during “clean activities” such as taking a patient’s pulse, lifting a patient, or shaking the patient’s hand\textsuperscript{10}. Correct hand hygiene reduces the rate of healthcare-associated infections with decreased transmission of nosocomial pathogens\textsuperscript{11,12}.

For all the above-mentioned reasons, strictly following the hygiene standard precautions for clinical staff and patients is an essential part of patient care in dialysis centres. However, incorrect use or misuse of PPE (such as gloves, masks, aprons) or hygiene procedures can lead to very high water consumption or increased waste.

**Conclusion and Recommendations for Hygiene and Housekeeping**

Environmentally aware waste management should be implemented in daily clinical work. Environmental awareness should be made visible for all clinical staff.

In dialysis, clinic products should be used that are safer for users and less stressful to the environment.

Evaluate the environmental burden of products needed for hygiene and housekeeping. This should cover the factors “safe for the environment”, but bear in mind that the medical outcome in dialysis has the highest priority.

Work closely with your purchasing department to select environmentally friendly products that fulfilling the required medical needs.

Labels like the “Nordic Swan label”\textsuperscript{5} are used to designate environmentally friendly products, but unfortunately these labels are seen only rarely on healthcare products.
When buying products, try to select those with the following criteria:

- High proportion of regenerative raw materials
- Low GHG and ozone degradation potential
- Human toxicity effects
- Ecotoxicity effects
- Potential hazardous effects during application and at the place of use
- Recyclable

Consider also the following aspects:

- Ensure that all disinfectant containers have a metered dosing device to avoid overuse that would be environmentally unfriendly
- Automixing devices with a calibration function (water and disinfectant) are recommended and can be used instead of a dosage device
- If you are unsure which types of disinfection procedure are more environmentally friendly, e.g. chemical versus thermal methods, calculate the CO$_2$ footprint for both procedures
- Educate your staff when necessary to wash their hands and when necessary to disinfect them. Perform hand-washing audits regularly.
- Perform hygiene focus audits annually. Are the procedures defined in the previous year still environmentally friendly? Are there new eco-products your clinic can use, or new procedures available to make further savings?
- Evaluate the use of single-use mops. Do you need them for all clinical and non-clinical premises?
- Review the hygiene plan for “infectious” treatment rooms. Properly defined clinical nursing standards
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are more effective and environmentally friendly than overuse of other materials and disinfectants.

Hygiene related to patients and staff: Optimising water and consumption of disposables

It is therefore recommended that hands be washed:

- at the right moment
- for the right time
- with the right technique

Wash your hands only when necessary; disinfect your hands routinely using alcohol-based disinfectants!

Do not leave the water running while you are soaping your hands; this saves about 2 litres of water per hand wash!

Ensure that the tap is turned off completely when you finish washing. Dripping taps also waste water!

Teach patients the right procedure for hand washing and how to maintain hygiene of the vascular access arm. Make them aware of the importance of water consumption.

Use and do not misuse gloves:

Used appropriately, the right gloves, gowns and masks help reduce cross-contamination among patients. If gloves or other PPE are misused, however, this has a negative impact on the environment.

When wearing PPE and uniform remember:

Before any procedure do a risk assessment; this will help you to choose the appropriate glove:

Gloves should be worn if there is a risk of exposure to:

1. blood or body fluids
2. non-intact skin
3. mucous membranes
4. hazardous or dangerous substances
When doing a risk assessment of the individual procedure think about:

1. the nature of the task
2. the contamination risk
3. requirement for sterile or non-sterile gloves
4. requirement for any other PPE

Before a procedure ask to yourself: “Do I need to wear gloves? If so which is the most appropriate: sterile or non-sterile?”

Buy gloves and all other PPE only with essential packaging to minimise waste.

Always think about the disposable you are going to use: “To misuse them is to waste money and damage the environment.”
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References


2. Program for prevention and management of hospital infections, Ministry of health, Slovenia.


4. OECD Guidelines for testing of chemicals. National Foundation for Sanitation. USA. http://www.oecd.org/department/0,3355,en_2649_34377_1_1_1_1_1,00.html


Waste Management in Dialysis Units
6. Waste Management in Dialysis Units

6.1 The History of Waste in Dialysis

Since dialysis treatment was first performed in humans in 1924 by Georg Haas, a continuous stream of changes have improved the effectiveness of treatment. The impetus for these improvements has come from the fields of medicine, engineering, physics, chemistry and microbiology, often working in concert. During this process, HD has also developed into a life-saving therapy that produces massive amounts of waste.

First, the dialysers themselves evolved from a bulky cluster of collodion tubing into a complex, neat and small filter consisting of hollow fibres. For a time, these artificial kidneys were re-used for a few treatments by each patient. This is no longer the case in most countries worldwide, however, since severe morbidity and even mortality is associated with using reprocessed dialysers.

Second, vascular access has evolved from the Quinton, Dillard and Scribner’s shunt to the present fistula, a delicate arterio-venous anastomosis, which is cannulated with single-use needles of steel and PVC.

Third, developments in the areas of microbiology and hygiene forced great improvements in aseptic techniques. In fact, aseptic requirements have become more and more stringent, and the risk of infection has increased, mainly due increasing antibiotic resistance. The consequence is that swabs, dressings, syringes, needles, adhesives and many other materials now have to be produced as sterile, disposable, pre-packaged products.

In addition to the statements above, developments in the technology have also resulted in an increase in single-use
products such as bicarbonate cartridges and other concentrate containers, filters, all with individual packaging requiring disposal.

In summary, because controlling waste is a relatively recent development, few records exist that account objectively for the amount of waste produced by dialysis in the early days. Nevertheless, we can definitely assume that the development of dialysis has led to increases in:

- the quantity of waste produced
- the types of waste generated
- the legal requirements relating to waste disposal

### 6.2 Concepts and Aims

In line with EU directives, our main goal is to minimise the negative effects of the generation and management of waste on human health and the environment. We aim to reduce the use of resources, and shall favour the practical application of the waste hierarchy¹:

1. Prevention
2. Re-use
3. Recycling
4. Energy recovery
5. Disposal

The prevention of waste is any measure that is designed to reduce both the generation of waste and the impact of waste:

- Reduce the use of resources and reduce the production of waste
- Choose materials for which disposal is harmless or that have minimal environmental impact
The following 3 means are defined as priority measures by the waste framework directive of the EU (Directive 2008/98/EC):

- **Reduce**, re-use and recycle are the most cost effective methods for waste prevention and reduction.
- **Re-use** means to expand the lifecycle of a product, by extending its use to similar or alternative purposes. Re-using contributes to the reduction in the use of resources and to minimising waste generation. (Please keep in mind, that re-use in the medical area is highly regulated and restricted due the potential associated risks. We refer here to the standard guidelines which do not propose any re-use of dialysers, a procedure which was commonly used for dialysis in the past).
- **Recycling** is dependent on adequate segregation, which assures that different materials have different disposal bins to allow specific treatments or processing that transform old into new.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Action plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce the production of waste</td>
<td>Segregation at the place of generation</td>
</tr>
<tr>
<td></td>
<td>Revise procedures for priming, connection and disconnection (e.g. online priming)</td>
</tr>
<tr>
<td></td>
<td>Routine audits on waste segregation</td>
</tr>
<tr>
<td></td>
<td>Waste education and awareness programmes</td>
</tr>
<tr>
<td>View waste as a resource issue</td>
<td>Re-use and recycle, if applicable</td>
</tr>
<tr>
<td>Minimise the adverse effects of waste disposal on human health and the environment.</td>
<td>Find, purchase and use alternative eco-friendly materials to replace dangerous materials</td>
</tr>
<tr>
<td></td>
<td>Choose eco-friendly disposal routes</td>
</tr>
</tbody>
</table>
6.3 Types and Classification of Waste


According to Directive 2008/98/EC, waste is: “Any substance or object which the holder discards or intends or is required to discard”.

A large percentage of the waste generated by HD has at least one property that renders it hazardous – it is a potential source of infection. According to Annex III of the Directive, it is infectious because it is composed of: “Substances and preparations containing viable microorganisms or their toxins which are known or reliably believed to cause disease in man or other living organisms”.

For methodological purposes, we shall consider that hazardous waste is in most European countries a synonym for contaminated waste and, therefore, we shall subdivide the waste generated by dialysis into contaminated and non-contaminated waste. The key factor in the reduction of contaminated waste is the appropriate segregation of contaminated and non-contaminated waste.

HD generates large amounts of non-contaminated waste compounds, such as paper sheets, plastic bags, and packaging materials, including cardboard containers, wooden pallets (if not re-used), and wrappings.

Organisation of take-back, re-use, recovery and recycling of all packaging waste is the responsibility of the producer, as regulated by the EU. However, much of this, along with waste
Environmental Guidelines for Dialysis

from non-clinical uses, is often discarded in the domestic waste system.

6.3.1 Classification of Waste

Classification and segregation is intended to separate different waste materials according to the threat they pose and the type of material, assuring minimum environmental impact and enhancing the possibilities for re-use and recycling, when feasible. As a consequence, we shall focus on these aspects with regard to the types of waste generated by dialysis.

Within the EU, the waste classification is regulated by the European waste catalogue (2000/532/EC), which should be therefore considered.

6.4 Contaminated Waste

Contaminated medical disposables is waste generated by medical activity that contains or has come into contact with blood or other biological fluids, as well as viruses, parasites, and microorganisms and toxins. This type of waste represents a real risk for general human health and the environment.

Please note that the transportation of contaminated waste could fall under the regulations of transportation of dangerous goods. Depending on local regulations, contaminated waste could be classified as infectious good (UN code 3291 – Waste or resumable material derived from medical treatment of an animal or human, or from biomedical research, which includes the production and testing of biological products). This may cause specific obligations for the dialysis clinic.

These types of waste are further classified as:

- Non-sharp contaminated waste, e.g. syringes, gloves, gauze, infusion sets, drapes, blood lines, and dialysers
• Sharp contaminated waste, e.g. waste that can cause physical injury by pricking or cutting, such as any type of needle, cannula or blade and broken glassware or plastics

Table 2 lists items typically used in providing dialysis therapy which are considered to be contaminated. The quantities used can vary depending upon circumstances at the time, for example, if needles, bloodlines or dialysers need to be replaced during the treatment session. Differences in operational procedures at dialysis centres may also result in differences in quantities and types of contaminated waste.
<table>
<thead>
<tr>
<th>Contaminated waste (AVF)</th>
<th>Material</th>
<th>Quantity per treatment</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fistula needles</td>
<td>Steel and PVC</td>
<td>1 for single needle 2 for double needle</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Glass containers from pharmaceutical preparations (drugs and anticoagulants)</td>
<td>Glass</td>
<td>1 vial of heparin for 8 treatments</td>
<td>0%</td>
<td>0%</td>
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<td>Hypodermic needles</td>
<td>Steel</td>
<td>1 for each administration of medicines and blood sampling</td>
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<td>0%</td>
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<td>Dialyser</td>
<td>Plastics, Polymers, PVC</td>
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<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Blood tubing sets</td>
<td>Plastics, PVC</td>
<td>1</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Syringes 10 mL</td>
<td>Plastics, PVC</td>
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<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Contaminated waste (AVF)</td>
<td>Material</td>
<td>Quantity per treatment</td>
<td>Potential for reuse (estimated)</td>
<td>Potential for recycling (estimated)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------</td>
<td>------------------------</td>
<td>--------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Syringes 30 mL</td>
<td>Plastics, PVC</td>
<td>1</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Syringes 5 mL</td>
<td>Plastics, PVC</td>
<td>1 for each administration of medicines (e.g. EPO, iron)</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Adhesives*</td>
<td>Paper or plastic</td>
<td>6 strips of adhesive, minimum</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Gauze*</td>
<td>Cloth</td>
<td>6</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Gloves*</td>
<td>Latex or latex-free</td>
<td>5 pairs</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Disposable aprons*</td>
<td>Plastics</td>
<td>2</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Disposable clothing*</td>
<td>Non-woven fabric</td>
<td>2</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

* = Contaminated objects and those containing blood

Table 2: Items considered to be contaminated used in dialysis after vascular access via AVF or graft (will vary according to local practices).
<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity per treatment</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass containers from pharmaceutical preparations (drugs and anticoagulants)</td>
<td>1 vial of heparin for 8 treatments</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Hypodermic needles</td>
<td>1 for each administration of medicines and blood sampling</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Dialyser</td>
<td>1</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Blood tubing sets</td>
<td>1</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Syringes 10 mL</td>
<td>4</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Syringes 30 mL</td>
<td>1</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Syringes 5 mL (for anticoagulant removal)</td>
<td>2 + 1 for each administration of medicines (e.g. EPO, iron)</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Syringes 2.5 mL</td>
<td>2</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Drapes</td>
<td>4</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Contaminated waste (CVC)</td>
<td>Material</td>
<td>Quantity per treatment</td>
<td>Potential for re-use (estimated)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------</td>
<td>------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>CVC pouch</td>
<td>Plastic or non-woven fabric</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>CVC exit site dressing</td>
<td>Non-woven fabric</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Adhesives*</td>
<td>Paper or plastic</td>
<td>8 strip of adhesive</td>
<td>0%</td>
</tr>
<tr>
<td>Gauze*</td>
<td>Cloth</td>
<td>16</td>
<td>0%</td>
</tr>
<tr>
<td>Disinfectant wipes*</td>
<td>Paper or cloth</td>
<td>6</td>
<td>0%</td>
</tr>
<tr>
<td>Gloves*</td>
<td>Latex or latex-free</td>
<td>6 pairs</td>
<td>0%</td>
</tr>
<tr>
<td>Face masks*</td>
<td>Non-woven fabric</td>
<td>4</td>
<td>0%</td>
</tr>
<tr>
<td>Luer lock caps*</td>
<td>Plastics</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>Disposable aprons*</td>
<td>Plastics</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>Disposable clothing*</td>
<td>Non-woven fabric</td>
<td>2</td>
<td>0%</td>
</tr>
</tbody>
</table>

* = Contaminated objects and those containing blood

*Table 3: Items considered to be contaminated used in dialysis following procedures for vascular access via central venous catheters (CVC) (will vary according to local practices)*
Comments:

It must be borne in mind that CVCs are used for dialysis in about 30% of patients. Samples for laboratory testing in dialysis centres are drawn about once per month (will vary according to local practices) using multiple luer lock adapters. Blood glucose tests are performed for about 30% of patients with diabetes using in most cases 1 mL syringes with needles. Diapers are rarely used.

6.4.1 Segregation and Separation

Dialysis clinics generating contaminated waste are obliged to reduce the quantity of contaminated waste by segregating contaminated, non-contaminated and domestic waste at the point of origin. If this process of separation by categories is not correctly performed when waste is created, all waste generated is considered to be contaminated.

The problems of dealing with healthcare waste are further complicated by the negative influence of so-called “over-classification”, which is the practice of dumping non-clinical materials, such as packaging or unused disposables, or even food waste, into clinical waste bags for disposal. This artificially inflates the quantity of contaminated waste generated by hospitals.

It is very important to note that hospital management establishes a defined list of the materials considered as contaminated waste according to local legislation (the contracted waste service supplier may provide support). Table 4 lists items typically used in providing dialysis therapy that are not considered as contaminated. Again, the quantities used can vary depending upon circumstances at the time. All persons responsible must be made familiar with the content of this list.
Proper implementation of waste segregation can significantly reduce the volume of infectious waste. An excellent example of infectious waste reduction was given at the 2009 EDTNA/ERCA Conference, where one participant reported a reduction from 1.44 kg per treatment to 0.89 kg per treatment thanks to rigorous implementation of waste segregation³.

Single-use bags are used for collection and are disposed of along with the content. Bags for uncontaminated, domestic and contaminated waste are colour-coded for easy recognition and those for contaminated waste carry the “biohazard” symbol (Figure 6).

![Figure 6: Symbol for Biohazard](image)

Sharp contaminated waste has to be collected in impermeable containers resistant to mechanical action, with a cap that allows the insertion of the waste and prevents it from falling out when it is full (max. 75% of volume). The cap may have holes that allow detachment of syringes needles.

6.5 Non-Contaminated Waste

Items considered not contaminated are usually disposed of in the domestic waste stream (Table 4). However, the nature of dialysis therapy is such that the majority of items used have the potential to become contaminated with blood or other biological agents. This includes items used for preparation, connection and disconnection and any personal protective equipment (PPE) such as gloves and aprons.
<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity per treatment</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gloves</td>
<td>2 pairs for AVF, 3 pairs for CVC</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Face masks</td>
<td>2 for shift</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Caps</td>
<td>2 for shift</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Disposable aprons</td>
<td>2 for shift</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Disposable clothing</td>
<td>2 for shift</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Diapers</td>
<td>2 for shift</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Paper towels</td>
<td>1</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Concentrate containers and cartridges</td>
<td>1</td>
<td>90-100%</td>
<td>0%</td>
</tr>
<tr>
<td>Bicarbonate bags and cartridges</td>
<td>1</td>
<td>90-100%</td>
<td>0%</td>
</tr>
<tr>
<td>Cardboard containers</td>
<td></td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Saline containers not contaminated</td>
<td></td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Non-contaminated waste</td>
<td>Material</td>
<td>Quantity per treatment</td>
<td>Potential for re-use (estimated)</td>
</tr>
<tr>
<td>-----------------------------------------------------</td>
<td>-----------------------------------</td>
<td>------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Connection set packaging</td>
<td>Paper and plastics</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Disconnection set packaging</td>
<td>Paper and plastic</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Dialyser packs</td>
<td>Plastic</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Blood lines packs</td>
<td>Plastic</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Bicarbonate bag/cartridge protection caps</td>
<td>Plastic</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>CVC branches and tip cover packs</td>
<td>Paper and plastic</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>Syringe packs</td>
<td>Paper and plastic</td>
<td>1 for administration of medicines and/or 1 for blood glucose control</td>
<td>0%</td>
</tr>
<tr>
<td>Fistula needle packs</td>
<td>Paper and plastic</td>
<td>2</td>
<td>0%</td>
</tr>
<tr>
<td>Hypodermic needle packs</td>
<td>Paper and plastic</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Prescriptions and other paper with writing or printed on-site documentation</td>
<td>Paper</td>
<td>1</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 4: Dialysis waste considered as non-contaminated. The definition of “non-contaminated” depends on country-specific regulations.
6.5.1 Potential for Reduction

There is probably only limited scope for reducing the amount of waste generated by dialysis. However, gains can be made through:

- Revision of clinical procedures
- Staff education, information and training
- Routine monitoring
- Include reduction criteria in the purchasing process
- Periodic auditing
- Implementation of a paperless clinic concepts (see chapter 4.4 Information and Communications Technology).

6.5.1.1 Revision of Clinical Procedures

The process of reducing the quantity of contaminated waste begins with its generation. Adequate procedures for preparation, connection and disconnection with the prime focus on patient and nursing staff safety but also on the reduction of waste can markedly reduce the amount of contaminated waste, thereby diminishing the environmental impact.

All the practical possibilities of achieving this objective should be studied, considering the manufacturer’s recommendations for different expendables, dialysis machines, and those from European Best Practice Guidelines/European Renal Best Practice (EBPG/ERBP).

6.5.1.2 Staff Education and Training

The formulation of a project plan is recommended at the dialysis clinic’s management level with a SMART objective (Short, Measurable, Achievable, Realistic and Time bound). This objective (e.g. a maximum of 1.2 kg contaminated waste per treatment until end of next year) is communicated to the
entire staff. Achievement and maintenance of this target level will be a direct result of the team effort.

A crucial role in achieving this target is training, explaining in detail all the steps from generation to disposal of the waste, focusing on the processes of sorting and collecting.

In essence, this process requires a change in mentality, discarding bad habits and replacing old habits with new habits, and requires a high degree of commitment and concentration on the part of the medical staff. A concerted team effort is required, which means that the best means of stimulating and motivating the entire staff to achieve the established target has to be found.

Periodic monitoring and analysis of documented achievements is also useful as this highlights weaknesses (and strengths) so that corrective action, for example retraining or refresher courses can be taken if necessary.

6.5.1.3 Routine Monitoring

Daily monitoring during the implementation process is decisive because it identifies problems at the very beginning and corrective measures can be taken. Monitoring at intervals of 6 months or less is recommended.

6.5.1.4 Periodic Auditing

Periodic auditing is recommended in every hospital to maintain the established goal and to evaluate the status of the project. Based on the audit, corrective measures are established with the goal of changing the procedures involved so that they become part of the daily routine.

6.5.1.5 Implementation of the Paperless Clinic Concepts

See Chapter 4.4. Information and Communications Technology
6.6 Domestic Waste

For the sake of simplicity, domestic waste generated by dialysis units can be defined as waste not classified as contaminated or clinical. It is similar to that classified as Municipal Solid Waste (MSW). Please check local requirements, norms and standards before following European environmental guidelines for dialysis.

6.6.1 Description of Domestic Waste

The generation of waste is not confined solely to the dialysis room, and domestic waste generation in dialysis units occurs in several areas: the clinical area, kitchen and staff room, offices and administrative areas, domestic services, and the equipment workshop and maintenance room. As a tool for understanding the types of waste generated, and the potential for reduction, it is useful to consider each area separately.

6.6.2 Clinical Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Item/Product</th>
<th>Material</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical area</td>
<td>Wrapping and packaging</td>
<td>Paper</td>
<td>0-10%</td>
<td>90-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic</td>
<td>0-20%</td>
<td>80-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardboard</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Hand towels</td>
<td>Paper</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Soap and other dispensers</td>
<td>Plastic</td>
<td>refillable</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Equipment cleaning cloths and wipes</td>
<td>Fabric</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Packaging of cleaning agents</td>
<td>Plastic</td>
<td>Depends on packaging</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Table 5: Waste generated in clinical areas.*
Items and products used in a typical dialysis unit are shown in Tables 2, 3, 4, and 5. Figure 7 shows typical volumes and types of waste generated per dialysis patient. It is evident that most items are designed for single use and are therefore individually packed. As has been noted, the nature of dialysis therapy is such that the majority of items used have the potential to become contaminated with infectious blood or other biological agents. This potential is greater if the packaging is retained until the end of the therapy Session (the retention of packaging is generally required in case an untoward incident occurs).

In some cases, items used for the cleaning of dialysis machines and beds and chairs etc. can also be considered as potentially contaminated. The other main source of domestic waste is from personal hygiene activities, i.e. hand washing. From this, it can be surmised that there is limited scope for these items to be disposed of other than via the domestic waste stream.

If cleaning cloths etc are considered contaminated, i.e. with blood or other body fluids, then they are disposed of in clinical waste. If only “dirty”, they are disposed of in domestic waste. Hand towels used after hand washing should not be considered as contaminated, and are disposed of in domestic waste as they are not considered suitable for recycling.

![Figure 7: Volumes and types of waste generated per patient and year (7).](image-url)
Environmental Guidelines for Dialysis

6.6.2.1 Potential for Reduction

The necessity of using individually packed items precludes the possibility of major reductions in the amount of waste generated. However, some gains can be made via the means of disposal.

Where concentrate canisters are used, changing to a bulk supply of concentrates will reduce the amount of plastic containers. However, the nature of the premises and the conversion costs may prevent this option from being considered.

Reviewing operational procedures and maximising the usage of machine capabilities, such as on-line priming and washback, can provide some reduction in the amount of products used.

6.6.2.2 Segregation and Separation

In general, it is mainly the product packaging that can be separated and considered for re-use or recycling, rather than disposal as waste. The external packaging can be separated out at the point of use and put into different containers for paper and plastic, for example. Separate containers have to be placed at strategic points to achieve this.

The disposal of plastic products, such as bicarbonate cartridges and infusion bags, is a contentious issue. All have the potential to become externally contaminated during therapy. However, most are suitable for recycling. Similarly, where concentrate canisters are used, these have the potential to be re-used, or at least recycled. Emptied concentrate containers can also be returned to the supplier (this is mandatory in some countries). This route can be explored – it reduces the burden on the renal unit and encourages re-use, but increases transportation.

Palettes used in the delivery of bulk supplies should be returned to the supplier. All cardboard boxes can be recycled.
### 6.6.3 Maintenance and Workshop Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Item/Product</th>
<th>Material</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance and workshop area</td>
<td>Dialysis machine components</td>
<td>Plastic</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metal</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Packaging</td>
<td>Cardboard boxes</td>
<td></td>
<td>0-10%</td>
<td>90-100%</td>
</tr>
<tr>
<td></td>
<td>Paper</td>
<td>0-10%</td>
<td>90-100%</td>
<td></td>
</tr>
<tr>
<td>Concentrate containers</td>
<td>Plastic</td>
<td></td>
<td>0%</td>
<td>Depends on type, up to 100%</td>
</tr>
<tr>
<td>Batteries</td>
<td>Mixed</td>
<td>0%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

*Table 6: Waste generated in maintenance and workshop area, if not contaminated with blood or body fluids.*

The maintenance and repair of dialysis equipment often results in the replacement of components and parts. Dialysis disposables (concentrates etc.) are also used when carrying out testing procedures. The majority of these are supplied in individual packages (boxes and wrapping) which, as in other areas, can be recycled.

Waste electrical and electronic equipment (WEEE) marked with a specific symbol (Figure 8) and batteries are subject to specific directives in the EU, requiring separate waste streams or take-back systems.
6.6.3.1 Potential for Reduction

Without a change in supplier policies for exchange (repaired) parts, there is little scope for reducing the amount of waste generated in this area. The use of re-chargeable batteries reduces the number requiring replacement, although there is a small increase in the energy used as a result of the charging process.

6.6.3.2 Segregation and Separation

Replaced machine parts can be separated according to type and material. Many of the larger electronic components (power supplies, printed circuit boards) used to be repaired by suppliers, but this is no longer the case, and all electronic components should be disposed of under the Waste Electrical and Electronic Equipment directive regulations (WEEE).

Metal parts can be sent to a metals recovery facility, and suitable plastic parts can be segregated for appropriate disposal, except those which have not been decontaminated by cleaning and disinfection (e.g. some faults may prevent a disinfection cycle being implemented).

Cleaning materials and personal hygiene materials can be placed in domestic waste.
6.6.4 Office and Administrative Areas

<table>
<thead>
<tr>
<th>Area</th>
<th>Item/Product</th>
<th>Material</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office and administrative areas</td>
<td>Printer and photocopier paper</td>
<td>Paper</td>
<td>10–20%</td>
<td>80-100%</td>
</tr>
<tr>
<td></td>
<td>Printing ink cartridges</td>
<td>Plastic</td>
<td>100%</td>
<td>100% if not re-used</td>
</tr>
<tr>
<td></td>
<td>Photocopier toner cartridges</td>
<td>Plastic</td>
<td>100%</td>
<td>100% if not re-used</td>
</tr>
<tr>
<td></td>
<td>Wrapping and packaging</td>
<td>Paper, cardboard, plastic</td>
<td>10–20%</td>
<td>80-100%</td>
</tr>
</tbody>
</table>

Table 7: Waste in office and administrative areas.

Office or administrative areas offer the potential of zero waste sent for disposal, with all major items used either being re-used (ink and toner cartridges) or recycled (paper and packaging).

6.6.4.1 Potential for Reduction

Reduction of the volumes used can be achieved by restricting the amount of printing and copying to what is strictly essential. This will also reduce the number of ink and toner cartridges used. Where appropriate, double-sided printing and copying should be used. Paper can be re-used as note paper before subsequently being sent for recycling.

A paperless clinic concept can reduce the burden of excessive paper consumption – See Chapter 4.4. information and communication technology.
6.6.4.2 Segregation and Separation

Paper, printed materials and cardboard packaging can be separated out for recycling. Printer and toner cartridges can be sent for re-filling or recycling.

Some plastic packaging is not fully recyclable so will need to be segregated and disposed of in the domestic waste.

6.6.5 Kitchen and staff rest rooms

<table>
<thead>
<tr>
<th>Area</th>
<th>Item/Product</th>
<th>Material</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitchen and staff rest rooms</td>
<td>Foodstuffs</td>
<td>Solid and liquid</td>
<td>0%</td>
<td>0% (100% if specified and disposed as organic waste)</td>
</tr>
<tr>
<td></td>
<td>Food containers</td>
<td>Plastic</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metal</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paper/cardboard</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Liquid and drinks containers</td>
<td>Plastic</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metal</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paper/cardboard</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Dishes</td>
<td>Paper</td>
<td>0%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Cutlery</td>
<td>Plastic</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Reading materials</td>
<td>Paper</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 8: Waste generated in kitchen and staff rest rooms
In many HD units, the provision of food and drink to the patients is limited to supplying drinks (tea, fruit juices) and light snacks such as sandwiches, biscuits and fruit. Almost all of the dishes and cutlery are made from disposable paper or plastic. Many of the paper-based products may be “contaminated” with food residues, which could preclude them from recycling. However, all plastic items can be rinsed or cleaned, thus enabling them to be recycled. All drinks containers have the potential to be recycled (if not classified as infectious – depending on patient status and local regulations). See also chapter 5 Hygiene and Housekeeping.

A similar situation applies to staff areas where food and drink are consumed.

### 6.6.5.1 Potential for Reduction in Domestic Services

Apart from using larger volume containers and dispensing from such containers, there is probably little scope for reducing the amount of waste generated in these areas without a negative effect on patient services.

### 6.6.6 Domestic Services

<table>
<thead>
<tr>
<th>Area</th>
<th>Item/Product</th>
<th>Material</th>
<th>Potential for re-use (estimated)</th>
<th>Potential for recycling (estimated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All areas</td>
<td>Wrapping and packaging</td>
<td>Paper</td>
<td>0–20%</td>
<td>80-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic</td>
<td>0-20%</td>
<td>80-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardboard</td>
<td>0-20%</td>
<td>80-100%</td>
</tr>
<tr>
<td></td>
<td>Hand towels</td>
<td>Paper</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Soap and other dispensers</td>
<td>Plastic</td>
<td>100%</td>
<td>100% if not re-used</td>
</tr>
<tr>
<td></td>
<td>Cleaning cloths, wipes and mops</td>
<td>Fabric</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Cleaning agent containers</td>
<td>Plastic, metal</td>
<td>100%</td>
<td>100% if not re-used</td>
</tr>
</tbody>
</table>

*Table 9: Waste from domestic services*
Environmental Guidelines for Dialysis

Empty disinfection substances containers must are (in most cases) classified as hazardous waste and dangerous good. They must be cleaned and the hazardous symbol must be erased before potential recycling.

Routine cleaning of all areas in the dialysis unit is essential. The nature of this means that there will be little scope for re-use or recycling the cleaning products. Plastic containers would need to be rinsed before being considered for recycling, so this may restrict the amount available.

6.6.6.1 Potential for Reduction

The possibility of using refillable dispensers should be investigated.

6.7 Waste Handling

The handling of waste is usually governed by local health and safety regulations that define the appropriate administrative procedures. These include:

- Adequate waste storage facilities
- Local requirements
- Legal responsibilities

6.7.1 Adequate Storage of Waste

Adequate numbers of suitable waste containers must be provided in appropriate positions. These must be removed regularly.

Temporary bulk storage of contaminated waste is done in specially equipped spaces, functionally separated and secured by a closed system. The room must have facilities that allow appropriate cleaning, disinfection and ventilation. Domestic waste must be stored separately from clinical waste.
The storage period must be as short as possible and the storage conditions must follow local hygiene regulations.

6.7.2 Local Requirements

Ideally, contaminated waste should be moved around the hospital through dedicated areas. Outside the clinic, waste is transported according to local legislation and will have to comply with minimum requirements regarding vehicle facilities, routes of transportation etc. Waste handling contractors must be licensed and use only appropriate disposal methods.

6.7.3 Legal Responsibilities

The personnel involved in management of waste (both contaminated and domestic) must be properly trained to identify the type and quantity of waste generated and the risks the different types represent for human health and the environment. They must also be familiar with the local waste management plan, the documentation requirements, and the legislation and procedures regarding the gathering, storage, transportation and discharge of contaminated waste.

6.8 Management of Waste Generated by Dialysis

The most cost-effective and harmless method of waste management is to reduce, re-use and recycle, but most of the waste generated by dialysis results from products designed for single use. Disposal routes must be adequate for each type of waste to ensure minimum human health and environmental impacts.

6.8.1 Local Legal Requirements

Contaminated waste must be disposed of according to local legislation, mostly depending on the classification “medical disposables” or “non-medical disposables”. There are different authorised procedures for each type of waste. The methods
Environmental Guidelines for Dialysis

used must assure rapid and complete elimination of any factors with noxious potential for human health and the environment. The methods used are:

- Incineration: incinerators must fulfil regulations and standards governing gas emissions and secondary products of incineration.
- Neutralization treatments: autoclaving, chemical disinfection, microwave disinfection, encapsulation, irradiation. Contaminated waste that undergoes neutralization become domestic waste that does not need special treatment.
- Landfill disposal: domestic waste is often disposed of in a landfill site, often without being subject to any special measures.

6.8.2 Landfill

Landfill is the oldest form of waste treatment. At a landfill site, after having passed acceptance criteria, the waste is deposited along the working front, and is then spread and compacted, and with soil daily (in most cases covered). Other waste-cover materials are used, such as foam products, temporary blankets, chopped wood and bio-solid chemicals.

Landfill has serious environmental effects: contamination of groundwater, aquifers and soil by leakage of metabolites and off-gassing of methane (a GHG 21 times more potent than carbon dioxide). PVC, a material abundant in dialysis units and disposed of in landfills, is largely responsible for the production of toxic substances such as dioxins, whose “short-term exposure of humans to high levels … may result in skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function” and whose “long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions” From an environmental viewpoint, landfill is the
least desirable method of disposal, and so should only be considered as the last option\(^7\).

### 6.8.3 Incineration

Incineration is the usual method for the disposal of contaminated waste. It consists of the combustion of waste materials at high temperatures. The environmental impact of incineration can also be considerable. Combustion at temperatures such below 800\(^\circ\)C leads to the production of dioxins, furans, particulates, nitrogen oxides and sulphur dioxide. In particular, the combustion of PVC, a commonly used polymer in dialysis material, produces large amounts of dioxins and furans if incinerated at low temperatures. Incinerators should ideally operate at higher than 900\(^\circ\)C, to break down dioxins\(^8\).

Incineration produces ash, flue gas and heat. The flue gases must be cleaned of gaseous and particulate pollutants before they are released into the atmosphere. The residual resulting from incinerating waste is sterile and the volume is reduced by 70–80%. Many residual products can be used for other purposes. The heat generated by incineration can be used to generate energy, which makes incineration a waste-to-energy technology.

In many respects, after re-use and recycling, incineration with energy recovery should be considered as the gold standard for the treatment of waste.

### 6.8.4 Technologies for the Neutralisation of Contaminated Waste

Recently, because waste incineration is more expensive than landfill, technologies have been developed to reduce the volume of contaminated waste. All technologies lead only to a different waste classification, by consuming a certain amount of energy. These processes include:
Environmental Guidelines for Dialysis

- Autoclaving
- Chemical disinfection
- Microwave sterilisation

6.8.4.1 Autoclaving

Autoclave sterilization units (steam, > 120°C, and pressure) are easy to install and operate. However, this type of sterilisation has limitations for tubing systems and compressed waste as the steam must reach all surfaces properly. Autoclave systems are easy to operate, but energy consumption is high.

6.8.4.2 Chemical disinfection

Chemical substances are added to wastes to destroy or inactivate pathogenic microorganisms. Chemical disinfection is adequate for liquid waste treatment (blood, urine, excrement, residual water). Solid hospital waste, including microbiological cultures and broken glass fragments, can also be disinfected.

6.8.4.3 Microwave treatment of infectious waste

Medical waste is rarely treated with microwaves. This technology is more energy efficient than classic thermal technologies, but is often limited to the maximum temperature (100°C), which is often not accepted by health authorities for disinfection of waste. Nevertheless, microwave devices can allow onsite disinfection of infectious waste so that it can be regarded as classified household waste⁹.
Conclusion And Recommendations

Undoubtedly, the first step towards the reduction of waste is recognising that action needs to be taken. From a practical point of view, the appropriate segregation of waste into re-usable or recyclable and non-re-usable materials is the most important, and this depends on:

- the development of a local action plan
- segregation at the point of generation
- continuing educational programmes
- routine audits on waste generation and segregation
- waste service supplier selection/contracting
  (for recycling)

Residual waste should be disposed of using the least environmentally damaging method, which is that of energy recovery, usually via incineration.

ACTION PLAN:

10 Steps to Implementing a Waste Reduction Plan

Step 1 - Understand waste definitions

Review your unit’s policies, procedures and definitions for handling and disposal. Check with your regulatory authorities to make sure you understand specific regulations. Meet with your Infection Control staff to refine and clarify your facility’s guidelines. A strong partnership with Infection Control will help ensure a successful programme. Include waste reduction information and goals in your Blood-borne Pathogens Exposure Control Manual.
Step 2 - Define the problem and develop a cost/benefit analysis

First you need to understand your true waste costs and potential savings by identifying:

**How much waste are you generating?**
You need to determine how much waste you currently have and how it is being disposed of. This will help you identify the opportunities you have to reduce the volume and your disposal costs.

**What are your total disposal costs?**
Understanding the total disposal costs and the opportunities for cost savings are powerful tools in obtaining support, not only from management but also from staff.

**What are your potential savings?**
When you present the programme to management, present cost savings first, but remember to include the other benefits of a waste reduction programme such as employee morale, improved safety implications, community and public relations.

Step 3 - Create a team to develop goals and an action plan

With a good understanding of the amount of waste your unit currently generates, the cost of disposal and a cost-benefit analysis, you are ready to develop your reduction programme goals and action plan.

For optimal results, create a diverse team that includes staff from Housekeeping, Infection Control, Nursing, Safety, Facilities/Engineering, Education, Purchasing and Clinicians.

It is important that the team share a common understanding of the goals. Make goals measurable and practical. A first step is to review the processes that are generating the most waste. These areas should be targeted first.
A written action plan will help team members stay focused on the steps necessary to achieve the goals and implement the waste reduction programme.

Goals should include health and safety, cost reduction, and pollution abatement considerations.

Delegate a leader to take responsibility for meeting each of the project goals. Each area of the unit should have a designated point person with whom team members can communicate about goals and accountability for the unit’s performance and waste generation rates. The work is not difficult, but it requires perseverance, accountability and an ongoing commitment.

Step 4 - Planning for waste segregation

Proper waste segregation is critical to any waste reduction effort.

Provide the proper tools to easily implement waste segregation. Once you make it easy for staff to properly segregate waste, you will end up with less misplaced waste.

Buy new containers and signage depending upon the required changes in your unit. Size the container for the appropriate amount of waste generated.

Step 5 - Container placement and signage

Proper container placement and signage are the keys to the success of any waste segregation programme.

Proper signage and labelling provide instructions and on-the-spot education. All containers should display the correct label.

Step 6 - Worker training and education plans and policies

Training is the key to success in a waste reduction programme. Staff need clear, coherent information to understand the
reasons for proper segregation: **Environmental leadership, regulations, and cost implications.**

Training all new employees from their first day onwards as part of the orientation programme.

Include your unit’s commitment to compliance, good segregation practices, and stewardship (policy statement). Staff should understand that improper disposal of their waste has potentially serious effects. Make it clear to them that it is part of their job to manage waste safely.

Consider making “compliance with hospital waste management policies” a part of every job description.

Re-train existing staff with agreed definitions. Inform staff about the facility’s reduction goals. Improved awareness leads to good segregation practices.

**Step 7 - Sharps management**

Have you noticed a problem with needlestick or sharps injuries due to improper waste handling in your unit?

Are you spending an excessive amount on sharps containers relative to your patient activity?

More than likely you have a sharps management policy, but you will probably still find opportunities to reduce your sharps container usage.

**Step 8 - Problem identification and resolution plan**

You will encounter waste disposal issues: you will find infectious waste in the domestic waste and vice versa. Perhaps even sharps!

Have a plan of action to solve problems. If problems are not solved quickly and adequately, they will persist and increase.
Step 9 - Waste treatment and waste transfer

A great benefit of any waste reduction plan is that it reduces the amount of waste that requires disposal, which not only saves money, but also minimises environmental impact.

Understand how your waste is being treated, and consider your treatment technologies.

Given the adverse impacts of landfill on public health and the environment, explore your opportunities for minimising landfill waste.

Step 10 - Track your progress, report successes and reward staff

A successful, sustainable programme needs a leader, good tracking and reporting, and sustained vigilance!

To realise the full benefits, track and celebrate the positive changes in your waste volumes (reduced waste and increased recycling) and your cost-savings.

Let the community know about your successes and the positive effects your efforts are having on the environment and community health.

Reward staff for their efforts and encourage continued participation in your waste reduction programme. A change in work habits means a great commitment and deserves recognition.
Environmental Guidelines for Dialysis

References


Appendix and Recommended Reading
## 7.1 Table of Abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AVF</td>
<td>Arterio-venous fistula</td>
</tr>
<tr>
<td>CDS</td>
<td>Central Delivery System</td>
</tr>
<tr>
<td>cHD</td>
<td>Chronic Haemodialysis</td>
</tr>
<tr>
<td>CVC</td>
<td>Central Venous Catheter</td>
</tr>
<tr>
<td>EDTNA/ERCA</td>
<td>European Dialysis and Transplant Nurses Association/European Renal Care Association</td>
</tr>
<tr>
<td>EMAS</td>
<td>Environmental Management and Auditing System</td>
</tr>
<tr>
<td>EMS</td>
<td>Environmental Management System</td>
</tr>
<tr>
<td>EN</td>
<td>European Norm</td>
</tr>
<tr>
<td>EPBG/ERBP</td>
<td>European Best Practice Guidelines/European Renal Best Practice</td>
</tr>
<tr>
<td>EPO</td>
<td>Erythropoietin</td>
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<tr>
<td>ETS</td>
<td>Emissions Trading System</td>
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<td>EU</td>
<td>European Union</td>
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<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>HD</td>
<td>Haemodialysis</td>
</tr>
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<td>HHD</td>
<td>Home Haemodialysis</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standardisation Organisation</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
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</table>
**Kt/V**

Kt/V is a number used to quantify haemodialysis and peritoneal dialysis treatment adequacy. K - dialyser clearance of urea; t - dialysis time; V - volume of distribution of urea, approximately equal to patient’s total body water

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>LCD</td>
<td>Liquid Crystal Display</td>
</tr>
<tr>
<td>LED</td>
<td>Light-emitting diode</td>
</tr>
<tr>
<td>lux</td>
<td>SI unit of luminance and luminous emittance</td>
</tr>
<tr>
<td>MSW</td>
<td>Municipal solid waste</td>
</tr>
<tr>
<td>NOx</td>
<td>Nitrogen Oxides</td>
</tr>
<tr>
<td>PDCA</td>
<td>Plan, Do, Check, Act</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
</tr>
<tr>
<td>RO</td>
<td>Reverse Osmosis</td>
</tr>
<tr>
<td>SD</td>
<td>Sustainable Development</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNFCCC</td>
<td>United Nation Framework Convention On Climate Changes</td>
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<td>WEEE</td>
<td>Waste Electrical and Electronic Equipment Directive</td>
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<td>WTS</td>
<td>Water Treatment System</td>
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## 7.2 Tables and Figures

### Tables

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<td>Items used in dialysis following procedures for vascular access via AV fistula/graft which are considered to be contaminated</td>
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<td>Items used in dialysis following procedures for vascular access via central venous catheters (CVC) which are considered to be contaminated</td>
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<td>4</td>
<td>Dialysis waste considered to be non-contaminated. The definition of un-contaminated depends very much on country specific regulations</td>
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<td>Development of dialysis patient population world-wide</td>
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7.3 Literature/Recommended Reading

General topics about environment, climate, CO₂ footprint, etc.

- http://unfccc.int/kyoto_protocol/items/2830.php

Guidelines, programmes

- http://sustainablehealthcare.org.uk/green-nephrology-programme
- http://www.gghc.org/

Waste management

- http://www.noharm.org/
Appendix and Recommended Reading
Invest in your Future and Profession
Join the EDTNA/ERCA Community

The European Dialysis and Transplant Nurses Association/European Renal Care Association (EDTNA/ERCA) represents 3000 members from 55 countries and is one of the most important forums in Europe for the exchange of information and experience in Renal Care.

Visit our website to learn about:

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- Research and Education
- Annual Scientific Conference
- Journal of Renal Care® and Journal Club
- Interest Groups (Anaemia, Nutrition, Chronic Kidney Disease - CKD, Social Workers, Transplantation and Technicians)
- Newsletters and Publications
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