Learning Package

Health
Hunter New England
Local Health District

Renal: Introduction to Haemodialysis

Sites where package applies:	Clinical areas where care is provided to patients with renal disease
Description:	This learning package provides an overview of the basics of haemodialysis.
Target audience:	Registered Nurses and Enrolled Nurses working in nephrology.
Learning Outcomes: **On completion of this package you will be able to:**	• Understand the principles of dialysis • Understand the principles of vascular access for haemodialysis • Conduct a basic patient assessment prior to haemodialysis treatment • Demonstrate safe practice in the area of haemodialysis to ensure patient safety and quality care • Demonstrate a competent level of practice with the technical aspects of haemodialysis • Apply a problem solving approach to haemodialysis within a given situation • Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols
Keywords	Haemodialysis, Renal, Kidney, Dialysis
Document registration number	TBA
Replaces existing document?	Yes

Related Legislation, Australian Standard, NSW Ministry of Health Policy Directive or Guideline, National Safety and Quality Health Service Standard (NSQHSS) and/or other, HNE Health Document, Professional Guideline, Code of Practice or Ethics:

- Infection Prevention and Control Policy [PD2017_013]
- NSW Health Policy PD 2005_406 Consent to Medical Treatment http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_406.pdf
- Renal Guidelines and Procedures http://ppg.hne.health.nsw.gov.au/

My Health learning	Renal: Haemodialysis, Introduction to *(172374345)*
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Date authorised:	
Issue date	February 2021
Review date	February 2021

Renal: Introduction to Haemodialysis

Learning Package

2018

NSW GOVERNMENT
Health
Hunter New England Local Health District

Learning Package Overview

Purpose: *This package is designed to provide baseline information and to guide staff through the resources on haemodialysis. It will be useful for both Enrolled Nurses and Registered Nurses beginning to work in the area of nephrology nursing as well as those who would like to revise their knowledge on the subject*.

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Date: December 2017

Acknowledgements: This learning package is an adaptation of original work by:
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- Karen Cairney 2010 (Renal CNC/Lower Hunter & Greater Newcastle sector).
- Ginger Chu 2011 (Renal CNC/Lower Hunter & Greater Newcastle sector).

Date for Learning Package Review: 2020

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Introduction

This learning package is one of a suite of packages aimed at offering guided learning for nephrology nurses to further enhance their clinical skills and knowledge. Baseline theoretical knowledge of haemodialysis that underpins the practice of nurses caring for patients with end stage kidney disease is explored.

Disclaimer

This learning package has been prepared by health professionals employed in HNELHD in the Renal Services. While care has been taken to ensure accuracy the authors recommend that information is checked before use if utilised by another unit, context or organisation.

Program name in My Health Learning (MHL):

Renal: Haemodialysis, Introduction to (172374345)

Aim

The aim of this package is to provide baseline theoretical knowledge of haemodialysis that underpins the practice of nurses caring for patients with end stage kidney disease.

Learning Objectives

Following the completion of this learning package, the learner will be able to:

- *Understand the principles of dialysis*
- *Understand the principles of vascular access for haemodialysis*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*
- *Demonstrate a competent level of practice with the technical aspects of haemodialysis*
- *Apply a problem solving approach to haemodialysis within a given situation*
- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*

Pre-requisites

There are no prior learning requirements needed to undertake this package. It is a beginning level program targeted at nurses commencing in nephrology. A record will be documented on the participants My Health Learning record at completion.

Learning Package Outline

The package is designed to be a self-directed learning experience to guide you through the literature and clinical issues related to haemodialysis. This package is developed within an adult learning framework so not all activities need to be documented but it is expected that you will complete them to facilitate your learning.

Instructions for participants

- Completion of this package is equivalent to 8 CPD hours documented on MHL.
- Self-directed reading will be required to complete this package. Some activities will include essential reading and others have additional supplementary readings that participants can choose to read to further consolidate knowledge.
- There is a suggested reference list but it is by no means complete. Please read widely to facilitate your learning. Journal articles can be accessed through CIAP. If you have difficulty locating readings seek assistance from your NE/CNE/CNS/CNC or hospital library.

This package uses the following icons:

	**READING** This icon alerts you to undertake reading related to the subject

	**LEARNING ACTIVITY** This icon denotes a learning activity that you will need to complete

	**GUIDELINES** This icon alerts you to the presence of a guideline or procedure related to the subject

Assessment process

When completed, you can return the package to relevant NE/CNE/CNS/CNC who will discuss it with you.

Reflection tool

At the completion of the Learning Package we have added a reflection form that will assist you in reflecting on the package and how it meets your professional development needs.

Evaluation

A form is included at the end of the learning package for your completion. All feedback is appreciated and assists in development of a quality program. Please return the completed evaluation form to your relevant NE/CNE/CNC.

Kidney Disease in Australia

Chronic kidney disease (CKD) is responsible for a substantial burden of illness and premature death. 1.7 million Australians aged over 18 years have developed signs of CKD. This equates to one in every ten individuals. CKD develops over time and although disease progression can be slowed, damage it is not reversible. Screening for CKD is a recommendation by the World Health Organisation within the primary heath setting.

Risk factors for CKD are:

- Aged over 60 years
- Cardiovascular disease
- Hypertension
- Obesity
- Family history of kidney disease
- Diabetes
- Aboriginal or Torres Strait Islander origin
- Smokers

As CKD progresses the individual becomes symptomatic of renal dysfunction. The body is no longer able to maintain homeostasis and reaches what is termed end-stage kidney disease (ESKD). There is often much confusion regarding the terms CKD and ESKD, the terms are not interchangeable. An individual with CKD may be unaware and asymptomatic of their health breakdown, while ESKD requires intervention in the form of renal replacement therapy (dialysis or transplant) to maintain homeostasis.

READING

1. Kidney Health Australia: http://kidney.org.au/cms_uploads/docs/state-of-the-nation-2015-web.pdf Note: This web site has current Australian information and is worth exploring.

An Overview of Haemodialysis

- *Understand the principles of dialysis*

Haemodialysis is a lifesaving treatment for individuals with end stage kidney disease. Understanding the terminology is essential for the nurse so that they are able to make sense of the nursing literature and also improving communication between professional colleagues. The reading below explores and gives explanation of haemodialysis terminology.

READING

2. Agar, J. W., McGreggor, M. S. & Blagg, C. R. (2007). Chronic maintenance hemodialysis: Making sense of the terminology. *Hemodialysis International, 11*, 252-262. Available online through the Ovid Database.

Haemodialysis Principles

- *Understand the principles of dialysis*

Dialysis is the removal of waste products, molecules and fluid from the body across a semi-permeable membrane. Haemodialysis and peritoneal dialysis utilise the same principles, only the application is different. The principles of dialysis are:

- Diffusion
- Osmosis
- Ultrafiltration
- Solute drag
- Convection

The definitions here are summarised versions from literature compiled from the reference list.

Solutes Solvents and Solutions

These terms assist in the understanding of the principles of dialysis and in examining the mechanism by which dialysis is used to treat ESKD.

- Solutes are dissolved substances
- Solvents dissolve substances
- Solutions are the end product

Therefore solutes dissolve in a solvent to form a solution. An example is table salt (the solute) is able to be dissolved in water (the solvent) to form salty water (the solution)

Semi-permeable Membrane

A semi-permeable membrane is a membrane that is permeable to water and small ions, molecules or solutes, but is not permeable to larger molecules or plasma proteins. Think of the semipermeable membrane as a sieve. Depending on the size of the holes in the sieve, the sieve allows liquid and small items (those smaller than the holes of the sieve) to pass through, but holds back the larger items that are bigger than the holes of the sieve.

Diffusion

Diffusion is the movement of solutes across a semi-permeable membrane from an area of high solute concentration to an area of low solute concentration. Solutes continue to move until equilibrium is established. Smaller solutes move more rapidly than larger solutes or molecules. The time it takes for equilibrium to occur depends on many factors, the most significant of which are:

- Individual patient physicality
- The size of the solute
- The amount of solute on each side of the semi-permeable membrane (also known as concentration gradient)
- Permeability of the semi-permeable membrane

Osmosis

Osmosis is the movement of water from an area of high water concentration to an area of low water concentration across a semi-permeable membrane. If enough time is allowed water will reach equilibrium on either side of the semi-permeable membrane. The rate of osmosis depends on many factors the most significant of which are:

- The individual patient physicality
- Concentration differences that exist on either side of the semipermeable membrane
- Permeability of the semipermeable membrane to water

Osmotic gradients exist when the osmolality of the solution on one side of the membrane differs from the osmolality of the solution on the other side of the membrane.

Ultrafiltration

The clinical application of osmosis (shifting process of water) is ultrafiltration. In ultrafiltration the mechanism of fluid removal/shifting is manipulated by applying pressure to one side of the membrane. This pressure can be a negative or positive pressure that increases the movement of water. It can also be manipulation of the osmotic gradient that causes the movement of water.

During haemodialysis, positive and negative pressure can be applied to the fibres of the dialyser to achieve fluid movement. Both positive and negative pressures are used during haemodialysis:

- Positive pressure: A pressure resulting in fluid being pushed across the membrane. This is defined as a combination of the venous blood flow rate and venous pressure.
- Negative pressure: A pressure resulting in fluid being pulled across the membrane. This is defined as dialysate pressure created by the machine that pulls fluid across the dialyser.

Solute Drag

Fluid moves under ultrafiltration from one solution to another across a semi-permeable membrane. During this process some small to medium sized solutes and in some cases molecules are dragged with the water across the semi-permeable membrane. The amount of solutes that move this way is very small but it is important to recognise that it does happen.

Convection

The process of solute drag or solute movement of middle molecules within a solvent (plasma water) from the blood compartment to that of the dialysate compartment is known as convection. Convection is dependent upon the ease of movement the middle molecules have within the solution, to cross the semi-permeable membrane. This is dependent on the size of the molecules, the sieving coefficient of the semi-permeable membrane and the presence of hydrostatic pressure.

- The sieving coefficient is the measurement of the porosity of the membrane – the size and number of pores of the membrane within the dialyser.
- The hydrostatic pressure is dependent on:
    - Blood Flow Rate
    - Haematocrit
    - Plasma oncotic pressure
    - Site of Re-Infusion Fluid (Pre-dilution & Post-dilution in Haemodiafiltration)
    - Surface area of the dialyser

The two therapies used within the department are Haemodialysis (HD) and Haemodiafiltration (HDF). HDF is the main form of renal replacement therapy (RRT) as it combines both diffusion and convection.

Haemodialysis Machines

- *Demonstrate a competent level of practice with the technical aspects of haemodialysis*

HNELHD uses Fresenius haemodialysis machines (5008) in all facilities. Currently the home haemodialysis patients use Gambro Machines (AK95/AK98). The machines perform the same basic principles of dialysis.

This self-directed learning package will utilise haemodialysis principles and only explore equipment/supplies in relation to the Fresenius machines.

LEARNING ACTIVITY

1. If you are working in a dialysis unit please label the diagrams of the haemodialysis machine in Appendix 2.

Haemodialysis Equipment

- *Demonstrate a competent level of practice with the technical aspects of haemodialysis*

In addition to the haemodialysis machine, other specialised equipment and supplies are used to deliver haemodialysis treatments. The following reading provides an overview of the various equipment utilised.

READING

3. Please liaise with the CNE/CNC/NE to access the Renal Society of Australasia education portal: http://www.renalsociety.org/education/one-online-nephrology-education/

All haemodialysis machines have two flow pathways: the blood pathway and the dialysate pathway. These two pathways meet in the dialyser (the artificial kidney). It is important to note that each pathway remains separate as they are separated by a semipermeable membrane. It is the semipermeable membrane that allows osmosis and diffusion to occur.

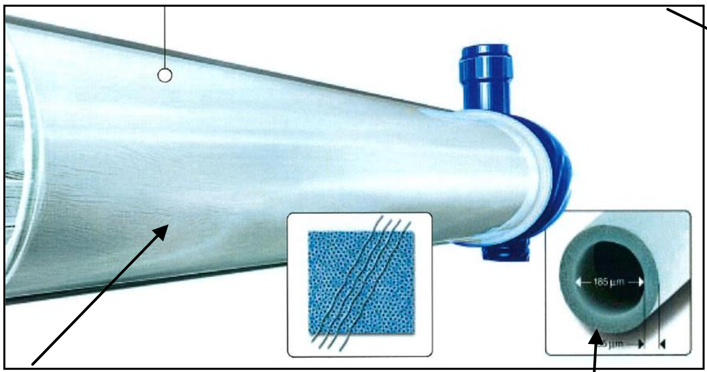
Blood pathway (Extracorporeal Circuit)

This pathway is responsible for ensuring that blood is removed via the fistula or Central Venous Dialysis Catheter (CVC) and circulated through the dialyser (artificial kidney) and then returned to the patient safely. The blood pathway components monitor and detect problems with:

- blood flow rate
- air in the blood lines
- blood leaks from the dialyser

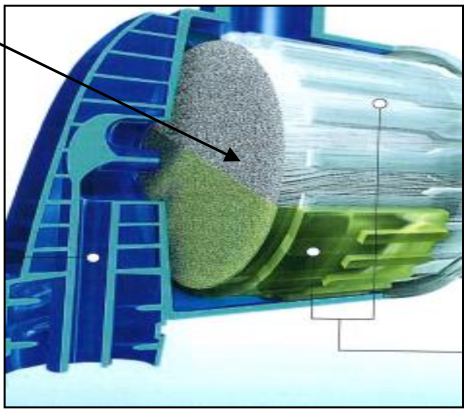
The artificial kidney is the functional unit of the haemodialysis machine, just like the nephron is the functional unit of the kidney. Dialysers are produced by a myriad of companies. The most common form of dialyser is a hollow fibre dialyser.

Cross section of Hi Flux Dialyser



Hi Flux Dialyser

Adapted from Fresesius Product Information



Hollow Fibre

The blood pathway is also responsible for monitoring the pressures within the blood lines. These pressures are called the arterial and venous pressures.

Dialysate pathway

This pathway monitors and detects problems with the dialysate. The dialysate comes as a concentrate and is mixed by the machine with purified water. Dialysis units have water purification systems in place; generally they are reverse osmosis units with carbon tanks/filters. The dialysate in the machine flows from the mixing unit then through the dialyser bathing the hollow fibres, flowing out of the dialyser carrying with it excess water, electrolytes and nitrogenous waste. After exiting the dialyser the dialysate is disposed of in the drain outlet.

There are a number of commercially prepared dialysate solutions available with varying concentration levels, it is about selecting the right solution for the right patient (haemodialysis prescription). Dialysate comes into two separate components "A Fluid" and the Bicarbonate component. The A Fluid contains sodium chloride, potassium chloride, calcium chloride, magnesium chloride, glucose, acetic acid. The machine used by HNE mix in a ratio of 1 part A Fluid, 1.225parts Bicarbonate and 32.775 parts purified water. Dialysate can be adjusted through machine controls that can alter: the bicarbonate and sodium concentration; temperature; and dialysate flow rate.

Anticoagulation during Haemodialysis

- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

Haemodialysis requires anticoagulation to prevent the clotting of blood in the extracorporeal circuit. Heparin Sodium is the most commonly used. Some patients will be prescribed an alternative which includes: Enoxaparin (Clexane), Danaparoid (Orgaran) and Daltaparin (Fragmin).

Heparin is used in two different ways during the haemodialysis treatment:

- When commencing dialysis as a load/bolus dose
- During dialysis as a continuous infusion

Heparin has a half-life of 90 minutes. If heparin continues to the end of treatment, there is a risk of bleeding upon the removal of needles, when dialysis is performed via a fistula or graft. Therefore a stop time, generally of one hour prior to the end of treatment is prescribed. If dialysis is performed via a central venous catheter heparin must continue to the end of treatment to decrease the risk of clotting within the catheter.

The heparin dose can vary for each individual and is prescribed according to patient requirements. This takes into account such things as patient bleeding time post needle removal and the condition of the dialyser and lines post treatment. In certain situations heparin doses may need to be adjusted or withheld completely. These include but are not limited to:

- Surgery within 24hrs of treatment
- Recent bleeding event
- Abnormal coagulation pathway
- Acute pericarditis

GUIDELINES

1. Renal: Administration of heparin during Haemodialysis HNELHD CP 16_19
2. Renal: Heparin Free Haemodialysis HNELHD CP 16_27

Side Effects

The most common side effects of heparin are bleeding and bruising. Bleeding from the needle puncture sites can occur because heparin stops the blood from clotting. If there is excessive bleeding from the needle puncture sites then the dose of heparin may need to be altered. If you note there is bleeding from cannulation sites, apply direct pressure to the puncture site for at least ten 10 minutes before rechecking. Under normal circumstances bleeding should stem within 10 minutes. Bleeding beyond this time is prolonged bleeding and requires further consultation.

Bruising occurs because the blood does not clot. Bruising occurs when blood leaks from the access into the surrounding tissues. The blood in the tissues causes the skin to have a bluish appearance. Again, if there is excessive bruising then this needs to be investigated.

Introduction to Vascular Access

- *Understand the principles of vascular access for haemodialysis*

Haemodialysis requires access to a patients' bloodstream. This access is in the form of either an arteriovenous fistula (AVF), arteriovenous graft (AVG) or a Central Venous Dialysis Catheter (CVDC). AVF/AVG is referred to as a patients' "lifeline". They are created for the treatment of ESKD and must only be used for the patient's dialysis. This is also the case for the CVDC. It is recommended that a patient reaching stage 4 of CKD should be discussing treatment options and the associated access requirements with their Nephrologist. Timely intervention can avoid unnecessary use of a temporary access and subsequent venous stenosis. For haemodialysis patients an AVF would be first choice. Complications such as thrombosis and infection are lower compared to that of an AVG and CVDC. It should also be noted that an increase in morbidity and mortality of ESKD patients maybe directly related to access failure.

Chronic Access

Arteriovenous Fistula:

- Created by the surgical anastomosis of an artery and vein. Predominately the radial artery and cephalic vein in the patients forearm.
- The blood from the artery flows into the vein. The vein subsequently thickens and dilates. This allows for cannulation with large bore needles.
- The native fistula takes six to eight weeks to mature (develop). Assessment by the Vascular Surgeon (Nephrologist for rural and regional network due to lack of surgeon) is required prior to first cannulation.
- Dialysis patients should have their access assessed by the dialysis nurse from four weeks and any indication that the vessel is lacking in maturity should be addressed at this time.
- Once access is established patients should have their AVF assessed each time they present for treatment

Arteriovenous Graft

- Created by the surgical anastomosis of an artery to an artificial vessel (graft).
- Unlike the AVF the graft requires suturing in two places, therefore there is both a venous and arterial anastomosis.
- The graft is most commonly a Polytetrafluoroethylene (PTFE) and can be placed in either a straight line or loop.
- Once post-operative swelling has resolved, the suture sites have healed and approximately fourteen days have elapsed cannulation is possible.
- The Vascular Surgeon or nephrologist is required to assess the AVG prior to first cannulation.

Central Venous Dialysis Catheter

- The insertion of a CVDC into a major vein, most commonly the internal jugular.
- CVDC placement is attended under fluoroscopy and is sutured in place.
- The catheter is double lumen, cuffed and is generally referred to as a permacath or tunneled catheter.
- This type of access is often used for patients who have had a failed AVF/AVG and remain on haemodialysis. It may also be the mode of choice for temporary access whilst an AVF/AVG is maturing.
- Permanent catheters are tunneled subcutaneously under fluoroscopy. The tip of the catheter sits in the top of the right atrium for optimal flow.
- Tissue grows into the cuff and will stabilize the catheter after approximately three months. Together with an occlusive dressing, the cuff aides in minimizing infection
- CVDC require an anticoagulant lock between treatments and regular dressing changes. (Refer to individual unit policy)
- CVDC will require surgical removal.

GUIDELINES

3. Renal: Cannulation of an Arteriovenous Fistula/Graft GandP 15_09

Acute Access

Percutaneous Access

- On occasion a vascath (short, rigid and non-cuffed catheter), will be placed in a patient who requires urgent dialysis.
- This is a short term (maximum 7 days), temporary access for haemodialysis.
- The catheter has a double lumen and is most commonly placed in the internal jugular.
- This type of temporary access is generally avoided due to increased risk of infection, stenosis and subsequent complications for later placement of permanent access.
- These catheters are always locked with an anticoagulant between treatments.
- They require re-dressing as required and are sutured during the entirety of their placement.

Access Maturation

The newly created AVF should be assessed using the look, listen and feel approach. This requires the staff to:

Look for the development of the vessel. The walls should be visible, gentle tourniquet pressure may be required.
Listen for a sound known as a bruit. This is heard most strongly at the site of the anastomosis. It should be evenly heard and lessen along the length of the vessel moving away from the anastomosis.
Feel a sensation known as a thrill, most strongly felt over the anastomosis. This sensation should also lessen along the vessel.

Patients who are undertaking haemodialysis should have their new AVF/AVG assessed each time they present for treatment.
The “rule of six” should be used as a guide. The vessel should be no less than 0.6mm below the skin surface. The vessel should be approximately 0.6mm in diameter. The flow through the vessel should be no less than 600mL/min.

Patient Education for Care of AVF/AVG and CVDC

Patient education for the care of their access should begin before it has been created. It should then be reinforced post operatively and continue for the life of the vessel. The education should include the following:

AVF/AVG

- No watch, jewellery, or tight clothing on the fistula arm
- Do not carry heavy shopping bags or handbags on the fistula arm.
- No hospital ID bands on the fistula arm
- No blood pressures to be taken on the fistula arm
- No venipuncture, PICC or IVC placement in the vessels in the fistula arm
- Avoid sleeping on the fistula arm as this may occlude blood flow
- Exercise to strengthen the fistula should not begin until two weeks post-

operative and the surgical incision has healed.

- Band-Aids on cannulation sites should be removed four hours after application.
- If bleeding occurs post discharge, gentle even pressure should be applied for a minimum of ten minutes. If bleeding persists present to the nearest emergency department.
- Thrill should be checked several times a day. If changes are noted urgent review is required. If thrill is no longer felt, admission via the emergency department is required immediately.

CVDC

- After placement of CVDC the area must be kept dry.
- The CVDC is only to be used for dialysis, other than in an emergency situation.
- The CVDC dressing must be reviewed and redressed according to policy.
- Sutures to CVDC remain insitu until their removal is required according to policy.
- If any signs of infection are noted escalate immediately according to policy.
- If dislodgement occurs apply firm pressure to area just above the clavicle and call for emergency assistance.

AVF/AVG Cannulation

Staff that are new to haemodialysis are required to learn the skill of cannulation. This is a skill that requires an underpinning of knowledge, the ability to practice safely and the time to develop. Watching skilled staff, asking questions and keeping abreast of best practice through current literature is required. Practicing correct technique on a simulation arm (if available), may also assist in the learning process. It takes time to develop confidence and experience with the support of other team members. There is a direct correlation between the technique and experience of the dialysis nurse managing the vascular access and its survival.

Areas to address:

- Fistula assessment prior to cannulation must be attended each visit. Adequate blood flow through the fistula should be evident with the presence of the bruit and thrill. If swelling, bruising or infection is evident appropriate history and intervention should be attended.
- Cannulation of an AVF/AVG requires the placement of two fistula needles. The size of the vessel and unit protocol will determine the needle gauge.
- The fistula needles allow the patient’s blood to be removed for fluid and waste product removal (arterial), and then returned (venous).
- Placement of the venous needle must always be antegrade. The arterial needle may be either retrograde or antegrade, however antegrade is preferred practice.
- The angle of insertion for an AVF is approximately 25°. The angle for an AVG is approximately 45°. Once flashback (blood in the tubing) is noted, the needle is flattened out and advanced along the vessel.

- Correct placement is determined by a normal saline flush, patient comfort and is then taped according to unit policy (e.g. chevron loop).
- Best practice for cannulation technique is rope ladder puncture. This technique uses the entire length of the vessel resulting in uniform use and development of the access. This also promotes longevity of the access.

READING

3. Ball, L.K. (2005) Improving Arteriovenous Cannulation Skills, Nephrology Nursing Journal, 32 (6), 1-8 *(This is a seminal article in the development of dialysis access cannulation)*
4. Parisotto, M. T., Schoder, V. U., Miriunis, C., Grassmann, A. H., Scatizzi, L. P.Kaufmann, P., ... & Marcelli, D. (2014). Cannulation technique influences arteriovenous fistula and graft survival. Kidney international, 86(4), 790-797.

GUIDELINES

4. Explore the guidelines on vascular access from this link: http://www.cari.org.au

LEARNING ACTIVITY

Consider the following questions in relation to the care of an AVF:

2. Is the access to be used for any other purpose other than dialysis? Why?

3. On assessment of the patient's fistula a thrill and bruit were not present. What would be your course of action? Why?

4. During the cannulation procedure an infiltration occurs. What is the procedure that follows? Why?

5. A patient presents to the unit with a red and painful access (AVF/AVG/CVDC). What is the course of action for each access? Would you proceed with dialysis? Why?

Patient Assessment

- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Understand the principles of vascular access for haemodialysis*

Patient assessment is an important aspect of care delivery for the haemodialysis patient. Patients need to be assessed pre, intra and post treatment. Prior to the commencement of the haemodialysis treatment you are required to undertake a patient assessment that will inform the treatment process. Assessment should include: a history and physical assessment. Eliciting information from the patient or their significant other on their general wellbeing since the previous treatment will inform the haemodialysis nurse of any treatment related issues/adverse events that need to be taken into consideration for the forthcoming treatment. Assessment is continued throughout dialysis and post dialysis treatment.

Physical assessment parameters should include weight, postural blood pressure, heart rate, respiration, temperature, oxygen saturation, vascular access assessment, and a fluid assessment. A fluid assessment includes: inspecting extremities for peripheral oedema, listening to lung and heart sounds and a patient history.

Body Fluid

The human body is made up of approximately 60% water. Normally this water is stored in the vessels (e.g. in the blood), in the tissues (e.g. as oedema) and in the cells. For the body to maintain a stable health state, the amount of fluid entering the body must equal the amount of fluid excreted.

Fluid intake = Fluid output (including insensible losses)

The main way the body eliminates excess fluid is via the kidneys. In addition, small amounts of fluid (insensible loss) are lost by breathing, sweating and bowel motions.

For people with ESKD, fluid removal is dependent on insensible lose (approximately 500mL per day), any remaining residual renal function and dialysis.

Normal urinary output is 1mL/minute, or 1500 to 2000mL per 24 hours. In patients who do not pass urine (or minimal volumes only) a fluid restriction is applied. This is generally 500mL per day plus previous days urine output. The 500mL is to cover insensible loss. For the dialysis dependant inpatient an accurate fluid balance chart and daily weight are required.

Fluid Calculation

- Oral intake: The fluid amount awarded to the food and fluid ingested during treatment
- Wash on/off: The fluid amount of online fluid/normal saline required at commencement/completion of dialysis to start and complete treatment

Haemodialysis and Fluid Removal: All patients on dialysis are given an Ideal Body Weight (IBW), which estimates the amount of fluid they would have in their body if their kidneys were functioning normally. This weight is determined by the patient's Nephrologist and assessed each treatment by the dialysis nurse. It takes into consideration several physiological parameters including blood pressure, body surface area, jugular venous pressure (JVP), presence or absence of oedema, skin turgor and mucous membranes. During dialysis all excess fluid should be removed so that at completion of dialysis the patient will have achieved their IBW. This removal should not exceed limits determined by unit policy, unless previously discussed and agreed by the Nephrologist or Nurse Practitioner (NP).

How to Calculate Fluid Removal

A patient's IBW determines the target. This is achieved with careful calculation, taking into consideration all of the variables. Subtract their IBW from today's weight. Then add the variables to calculate the total fluid loss required. The following example is of this calculation:

<table>
<tr><th colspan="3">Calculating Fluid Removal</th></tr>
<tr><td>Today's Weight</td><td>kg</td><td></td></tr>
<tr><td>IBW</td><td>kg</td><td></td></tr>
<tr><td>Difference</td><td>kg</td><td rowspan="4">Add these together to give the total amount of fluid you need to remove</td></tr>
<tr><td>Drink</td><td>200 mL</td></tr>
<tr><td>Prime/Washback</td><td>500 mL</td></tr>
<tr><td>TOTAL TO REMOVE</td><td>mL</td></tr>
</table>

If the patient's weight today was 72.5kg, and their IBW is 70kg and they were going to have two drinks on dialysis. The total target fluid removal would be as follows.

Calculating Fluid Removal		
Today's Weight	72.5 kg	
Dry Weight	70.0 kg	
Difference	2.5 kg	**Add these togther to give the total amount of fluid you need to remove**
Drink	**400 mL**	
Prime/Washback	**500 mL**	
TOTAL TO REMOVE	**3400 mL**	

GUIDELINES

5. Renal: Ideal body weight assessment for Haemodialysis Patients HNELHD CG 16_29
6. Renal: Patient Assessment for a Haemodialysis Treatment GandP 16_07

LEARNING ACTIVITY

Calculate the total fluid to be removed for the following examples

If the patient's weight today was 68kg, and their IBW is 65kg and they planned to have one drink while on dialysis. Answer ______________________mL

2. If the patient's weight today was 77kg and their IBW is 76kg and they planned to have two drinks while on dialysis. Answer ______________________mL

3. If the patient's weight today was 66kg and their IBW is 60kg and they planned to have one drink. Answer ________________ mL

For Haemodialysis Nurses: What special precautions should you take in this case?

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4. If the patient's weight was 62kg today and their IBW is 65kg and they planned to have two drinks while on dialysis. Answer ______________________mL

5. For haemodialysis Nurses: What special precautions should you take in this case?

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	____ ____ *<u>Note</u>:* *Your calculations must be double checked with another nephrology nurse prior to you commencing fluid removal for haemodialysis*

Machine Set-Up

- *Demonstrate a competent level of practice with the technical aspects of haemodialysis*
- *Apply a problem solving approach to haemodialysis within a given situation*
- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*

Setting up a machine familiarises you with the basics of the machine and allows you to develop skills and confidence in the use of the machine.

The following points provide you with an overview of the process order for setting up a dialysis machine and will be discussed in a little more detail further into this self-directed learning package.

- Cleaning status (cleaning of the dialysate fluid pathway), both heat and cold disinfection. This is checked prior to set up.
- Connecting dialysate and bicarbonate to achieve correct conductivity. At this time the machine will be conducting its testing procedure (T1 Test)

- Lining the haemodialysis machine which involves: placing the blood lines and dialyser on the machine; preparing and connecting the heparin infusion (if required).
- Once the conductivity has reached the desired level and the T1 Test has passed, connect the dialysate lines to the dialyser to prime the dialysate compartment.
- Commence priming of the blood lines.

Disinfection (cleaning of the dialysate fluid pathway)
The dialysate fluid pathway is made up of the tubing inside the dialysis machine. It carries the dialysate, which is a mixture of purified water from the water treatment plant (reverse osmosis system) and “A fluid” and the bicarbonate component, through the machine to the dialyser and then down the drain.

This pathway needs to be cleaned and maintained according to departmental guidelines and procedures. Bleach (cold disinfection) is attended once a week to prevent bacterial growth (dialysate is a good medium for bacterial growth). Citrate is used as part of the heat disinfection process to prevent calcification of the tubing from dialysate exposure. Calcium in the dialysate cause crystal formation, and must be regularly removed to maintain patency of the fluid pathway.

For 5008 machines, diasafe filters used to purify the online fluid, are changed once every 100 treatments, 11 bleach (cold disinfection) treatments or every twelve weeks. For the AK95/AK98 filters are changed by the technical service. For both machines where applicable, the filters are changed prior to water testing (refer to the Water Treatment SDLP).

Connecting Dialysate and Bicarbonate
The “A Fluid” is part of the haemodialysis prescription. It is ordered based on the biochemistry results of the patient. The prescribed solution must be used. Failure to use the correct solution may result in an adverse outcome for the patient. Potassium chloride is one of the variables that determines which fluid needs to be used. If a potassium level alteration is required, potassium chloride needs to be added to the solution. This must be double checked with a second nurse and “A Fluid” labelled accordingly.

Bicarbonate is supplied in 900gm bags. The variance of delivery is controlled by the delivery system on the machine when programmed and is part of the patient prescription. The default delivery is 35mmol/L during a haemodialysis treatment.

Machine Testing Procedure (T1 Test)
This test is an automated test that verifies the operating and safety systems. It is a mandatory test that is initiated after powering on the machine and completion of a cleaning program.

There are two types of safety alarms on dialysis machines. One set for the blood pathway and one set for the fluid pathway. The blood pathway alarms consist of the: venous pressure alarm; arterial pressure alarm; blood leak detector; air detector alarm. The dialysate pathway alarms consist of the: conductivity and temperature alarms.

Lining the Machine

The blood lines and the dialyser make up the pathway the blood will travel through during dialysis. They allow the blood to be pumped from the patient through the dialyser and back to the patient.

LEARNING ACTIVITY

6. Ask a staff member to demonstrate lining the machine for you. Practice lining a machine with supervision. As you become more comfortable, line the machine on your own and ask another nurse to check you have completed this correctly.

Heparin Infusion

Heparin as previously explained is used during dialysis to prevent the blood from clotting outside of the patient's body. The heparin infusion is located before (pre) the blood pump.

Priming the Blood Lines and Dialyser

Before commencing dialysis you will need to prime the lines to remove the air and sterilising agents.

- 5008 will use online fluid (produced by the machine) to prime the blood lines and dialyser. Online fluid will be used for fluid replacement and for wash back at the end of the haemodialysis treatment to reinfuse (return) the patient's blood. Normal saline is an option if required.
- AK95/AK98 will use normal saline to prime the blood lines and dialyser. Normal saline will be used for fluid replacement and for wash back at the end of the haemodialysis treatment to reinfuse (return) the patient's blood. You will need to use a 1000mL bag of normal saline. There will be solution left in the bag at the end of the prime.

GUIDELINES

7. Renal: Machine preparation for a haemodialysis or haemodiafiltration treatment HNELHD CP 16_33

Commencing a Dialysis Treatment

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

Commencement of a haemodialysis treatment involves the connection of the blood lines on the machine to the fistula needles/central venous catheter. It also involves the running of blood into these lines. It is important to use a no-touch technique when connecting the lines to the fistula needles/central venous catheter as this will reduce the risk associated with contamination which may result in systemic infection. Always check the patient's assessment and weight are recorded before commencing haemodialysis. Please refer to the guideline and procedure for a step-by-step instruction on the commencement of haemodialysis.

Occasionally you may experience problems during dialysis commencement. These problems include air in the bloodlines and or clamps on the bloodlines or cannulas. However, your clinical mentor will demonstrate the correct procedure and educate you in problem solving as required. You are aiming to commence dialysis independently. Your mentor will assess your technique as you are learning.

GUIDELINES

8. Renal: Commencement of Haemodialysis using Central Venous Dialysis Catheters (Permacath/Vascath) with a Luer Access Device HNELHD CP 16_30Renal: Machine preparation for a haemodialysis or haemodiafiltration treatment HNELHD CP 16_33

Completing a Haemodialysis Treatment

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

Completion of a haemodialysis treatment involves returning the blood in the blood lines to the patient via the patient's vascular access and disconnecting the blood lines from the patient. Completing a treatment also involves the removal of used blood lines, dialyser and dialysate from the machine. This is often referred to colloquially as "stripping the machine" and then commencing the cleaning and disinfection processes.
If the patient has a fistula or graft the fistula needles are removed and direct pressure is applied immediately to the puncture sites. One needle is removed at a time and stasis achieved before removing the second needle. If a patient is unable to perform this task effectively it is the nurse's responsibility to attend to this aspect of care.

It is important to eliminate post dialysis complications such as bleeding and bruising by ensuring direct pressure to the puncture sites. If a patient is holding their own sites they need to be observed to ensure correct technique is used.

Nurses are responsible for cleaning the haemodialysis machine, and to empty and clean the contaminated waste bin. Depending on the acuity of your patient you will also be responsible for cleaning the chair/bed.

GUIDELINES

9. Renal: Completion of Haemodialysis - Disconnection of Central Venous Dialysis Catheter (Permacath/Vascath) with Luer Access Device HNELHD 16_29
10. Renal: Completion of Haemodialysis or Haemodiafiltration via an Arteriovenous Fistula or Graft (AVF/AVG) HNELHD CP 16_16

Intradialytic Haemodialysis Problem Solving

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*
- *Apply a problem solving approach to haemodialysis within a given situation*

Intradialytic (during dialysis) alarms and complications can occur at any stage during the treatment. The nurse is responsible for responding to alarms and managing complications as they arise. Problem solving skills are required to resolve alarms and complications quickly and safely. You need to use all alarms and complications as learning opportunities.

- Hypotension requiring either normal saline or online fluid replacement
- Arterial and venous pressure alarms
- Air detector alarms
- Conductivity alarms
- Blood leak alarms
- Power failure
- Water failure
- Blood pressure alarms

Your clinical mentor will demonstrate the correct procedure for the problems listed. Your mentor will assess your technique as you are learning.

Responding to Hypotension

- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

Patients on haemodialysis are at risk of hypotension. Hypotension is a physiological response to fluid shifts associated with the removal of fluid on haemodialysis. Responding quickly and appropriately to hypotension is vital, as untreated hypotension can result in a medical emergency and possible patient death.

Hypotension is managed by minimising the ultrafiltration rate, decreasing the blood flow rate and fluid volume replacement (normal saline or online fluid bolus), laying the patient supine or in trendelenburg position. The fluid replacement is usually given in 150mL (5008) or 200mL (AK98) boluses of online fluid or normal saline. Patients experiencing hypotension may complain of various symptoms. For example:

- Cramps
- Feeling unwell or feeling “low/flat”
- Dizziness, seeing dots, ringing in the ears
- Tunnelled vision

READING

5. Daugirdas, J. T. (2015). Measuring intradialytic hypotension to improve quality of care. Journal of the American Society of Nephrology, 26(3), 512-514.

LEARNING ACTIVITY

7. How might you avoid hypotensive episodes and the need to give fluid replacement in the future?

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GUIDELINES

8. Renal: Management of Intradialytic Hypotension HNELHD GandP 16_08

Arterial, Venous & Transmembrane Pressures

- *Apply a problem solving approach to haemodialysis within a given situation*

Blood is pumped from the vascular access into the arterial blood line. The arterial pressure measures the resistance or how easy it is to withdraw the blood from the vascular access. The arterial pressure is a negative pressure. If arterial blood flow is inadequate &/or needle placement is poor within the vascular access, the arterial pressure reading will have a greater negative value.

The venous pressure is the pressure required or the resistance met when the blood is returned to the body. The venous pressure is measured at the transducer located pre venous bubble trap. The venous pressure is a positive pressure. Any obstruction before the bubble trap will cause a low venous pressure, any obstruction after the bubble trap will cause a high venous pressure.

Factors influencing Arterial and Venous Pressures

- Individual vascular access characteristic
- The position of the needle or the patency/placement of the central venous catheter.
- The speed of the blood pump
- The size of the cannula (if applicable)
- Availability of blood flow
- Kinking or occlusion of blood lines
- Clotting of bloodlines &/or the dialyser

As a general guide arterial pressure should be around –150mmHg (negative pressure) and venous pressure 150mmHg (positive pressure) when blood flow rate is at 300mL per minute. Pressures greater than this may indicate there is a problem with the established haemodialysis AVF/AVG or CVDC.

When a transducer becomes wet with fluid, the reading becomes inaccurate. Without accurate readings the patient's access could be compromised.

Transmembrane pressure (TMP)

The pressure calculated by the machine for fluid removal. The TMP is calculated by the venous pressure minus the dialysate pressure and is expressed in mmHg.

The machine may adjust the TMP during the dialysis treatment as fluid is removed and in response to changes in the venous pressure, blood flow rate and amount of fluid removal required.

Power Failure

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols*
- *Apply a problem solving approach to haemodialysis within a given situation*

The machine requires a constant power supply of electricity to function. If this supply is interrupted the machine will alarm and require confirmation that battery backup is in use. Once confirmed dialysis will continue.

Investigation as to the reason for power loss is required immediately as battery life is limited. There are certain steps that need to be undertaken and you will need to consult with your mentor to ensure the safety of the patient.

LEARNING ACTIVITY

8. What are the potential causes of a power failure?

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Ask your clinical mentor/CNE to simulate the management of a power failure using the above guideline and procedure

GUIDELINES

14. Renal: Management of Haemodialysis Equipment in the Situation of a Power Failure HNELHD GandP 16_10

Water Failure

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols*
- *Apply a problem solving approach to haemodialysis within a given situation*

The haemodialysis machine requires a constant water supply to function. If the water supply is interrupted the machine will alarm and indicate there is a water supply problem. The machine will continue to alarm and switch automatically into dialysate bypass. When the machine is in dialysate bypass no dialysate will be pumped through the dialyser. In the event of a water supply alarm the conductivity alarm will also sound. The 5008 will require normal saline attachment as the ability to deliver online fluid is lost and with it fluid resuscitation if required.

Investigation as to the reason for water loss is required immediately with consultation with the dialysis technical service if applicable. There are certain steps that need to be undertaken and you will need to consult with your mentor to ensure the safety of the patient.

LEARNING ACTIVITY

9. What are the potential causes of a water failure?

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10. Where is the reverse osmosis unit located within your facility?

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11. How is this reset in the event of a power or water failure supply?

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12. Undertake the management of a water failure with your clinical mentor/CNE using the above guideline and procedure

READING

6. Explore the information on water quality from this link.

https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0007/306088/water-for-dialysis-2016.pdf

Recirculation of Blood

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

The situations where you are may be required to recirculate the patient's blood are:

- A fistula needle is clotted or blown and you need to re-cannulate
- There is air in the venous line
- The patient needs to go to the toilet

When implementing this procedure the patient's blood can only be recirculated for an absolute maximum of 20 minutes. During recirculation the machine must be in dialysate bypass so that no dialysate is flowing through the dialyser.

GUIDELINES

16. Renal: Recirculating of Blood in Extracorporeal Circuit HNELHD GandP 16_05

	LEARNING ACTIVITY 13. Ask your clinical mentor/CNE to undertake the recirculation of blood using the above guideline and procedure.

Blood Leak Testing

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

The blood leak detector alarm informs you that blood is leaking out of the hollow fibres inside the dialyser. In the event of a positive blood leak DO NOT return the patient's blood, this treatment is aborted and the machine needs a bleach disinfection. If appropriate the treatment should be resumed on another machine with a fresh set up. Patient assessment and reassurance should be attended throughout this event.

<u>There are two types of blood leak alarms</u>:
Minor: The blood leak detector detects very small amounts of blood that you cannot visually see by looking at the dialysate. The dialysate must be checked immediately with a haemastix. If negative then the alarm can be cleared and the treatment can be resumed. If positive the treatment is aborted.
Major: Blood is visualised within the dialysate tubbing. Treatment is aborted immediately.

	GUIDELINES 17. Renal: Management of Blood Leak Alarm on Haemodialysis HNELHD CP 16_28

	LEARNING ACTIVITY 14. Ask your clinical mentor/CNE to undertake a simulation of a minor and major blood leak using the above guideline and procedure

Returning Blood via a Single Needle

- *Practice within the legal and ethical standards of nursing based on professional codes of practice and Nephrology Unit protocols.*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

It may be necessary to return blood to the patient via a single needle or catheter lumen. This may occur as a result of:

- a blown needle that cannot be re-cannulated
- a clotted needle where the patient cannot be re-cannulated
- if the patient has an arteriovenous graft and the pressure is too great to allow wash back by gravity (AK95/98)
- if the patient has a positive pressure in their arteriovenous fistula and the pressure is too great to allow wash back by gravity (AK95/98)
- clotted lumen of a central venous catheter

Where possible, if the treatment time has not been completed re-cannulation of the fistula or graft should occur rather than terminating the treatment early. It may be necessary to recirculate during this time however, for the 5008 "click-clack" may be appropriate to use whilst waiting to re-cannulate.

GUIDELINES

18. Renal: Unplanned Dialysis Treatment using Single Needle (Click-Clack) HNELHD CP 16_34

LEARNING ACTIVITY

15. Demonstrate the procedure for return of blood via a single needle using the above guidelines and procedures with your clinical mentor/CNE

Cannulation and Blood Collection

- *Understand the principles of vascular access for haemodialysis*
- *Conduct a basic patient assessment prior to haemodialysis treatment*
- *Demonstrate safe practice in haemodialysis to ensure patient safety and quality care*

Cannulation for haemodialysis is one of the last skills that new staff learn during their two week orientation program. Cannulation is a skill that takes time to develop. You are encouraged to practice on a simulation arm (if available), prior to cannulating an actual patient. You must have an experienced nurse who is proficient at cannulation with you when you are learning. At no time will an inexperienced nurse cannulate a new vascular access.

Where possible, blood collection for haemodialysis patients should occur at the commencement of treatment. This eliminates the need for unnecessary venepuncture on non-dialysis days. Before commencing dialysis cannulation or accessing central venous catheters check the request form and then prepare equipment with the tray set-up for dialysis.

GUIDELINES

19. Renal: Blood Collection via Haemodialysis Access HNELHD CP 16_18

LEARNING ACTIVITY

16. Demonstrate the procedure for cannulation using the above guidelines and procedures on a consenting patient who has a well-developed and easy to cannulate fistula.

References

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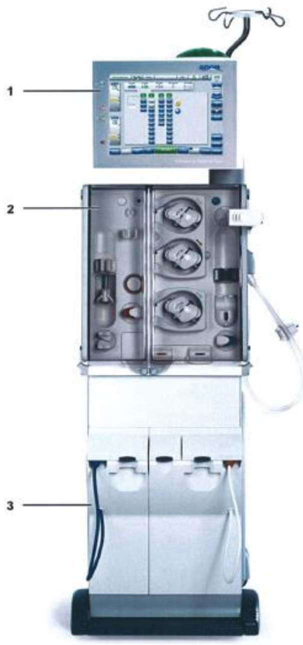
Appendix 1.

Machine Familiarisation Exercise

Please label the following diagrams

Fresenius 5008S

3.1 Front View



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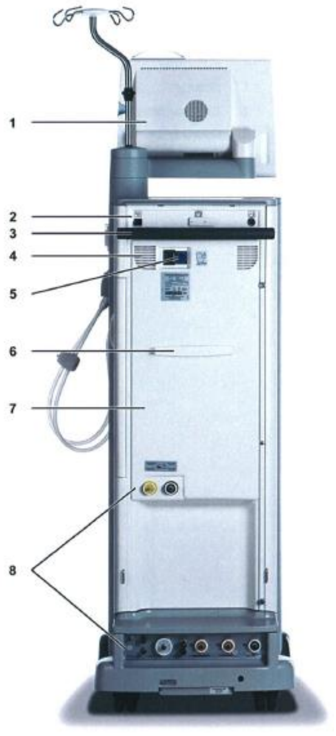
3.2 Rear View



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[**LP: 17:**]

3.3 Lateral View, Left Side

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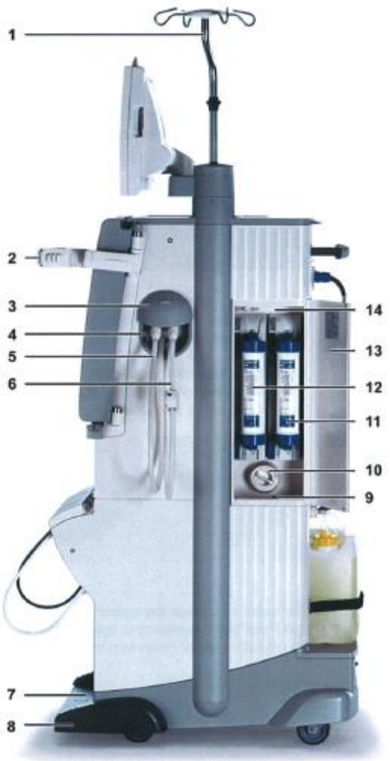
3.4 Lateral View, Right Side



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3.5 Monitor Front

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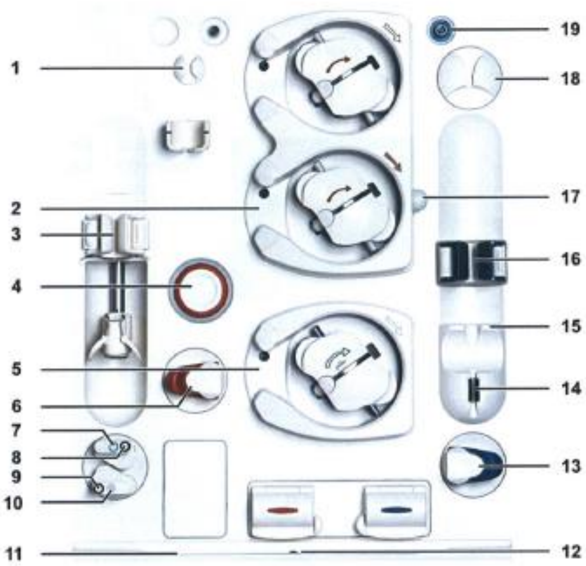
3.7 Extracorporeal Blood Circuit Module



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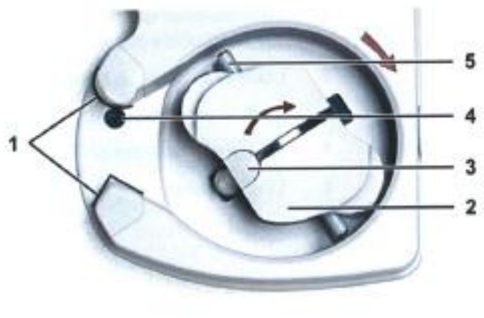
Blood pump



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Heparin pump

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Venous fill level and air monitoring function

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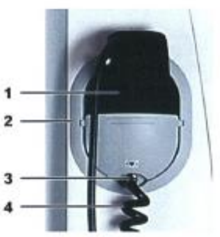

BPM (option)

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[**LP: 17:**]

3.9 Hydraulics

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[**LP: 17:**]

Learning Package: Reflection on Learning

This document guides your reflection on the extent to which the package meets your professional development needs, and how you plan to apply your learning into practice. This tool is not part of the assessment process, and has been included as a document that you may wish to include in your professional portfolio. Time taken to complete learning package____________________

What was your purpose in completing this learning package?

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Did you achieve this by completing the learning package?

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Reflecting on the content, what key learning have you obtained?

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What learning will you apply to your practice immediately? How will you do this?

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[**LP: 17:**]

What learning needs have you identified as a result of completing this learning package?

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How do you plan to address these needs?

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Signature:___________________________ Date:______________________________

[**LP: 17:**]

Learning Package Evaluation Form

Your feedback regarding this learning package is important to ensure the package meets your learning needs. Please take 5 minutes to answer the following questions to facilitate any change required for future learning packages.

1. The learning outcomes of the learning package were clearly identified	Yes	No
2. The learning outcomes of the package were appropriate	Yes	No
3. The content provided enabled me to meet the learning outcomes?	Yes	No
4.The activities motivated my interest in the topic	Yes	No
5.The activities and workbook questions supported my understanding of the topic	Yes	No
6.The package was presented in a logical manner	Yes	No
7.The assessment process related to this package was clearly outlined (if applicable)	Yes	No

8. My most relevant learning outcomes from this package were:

____

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9. The key learning points from this package I can immediately apply to practice include:

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10. The least relevant component(s) of this package were:

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11. Some suggestions I would like made to improve the package would be:

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12. Further comments:

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Thank you for your time to complete the evaluation
Please return to:

The relevant CNE/NE/CNC/NP within your area