The Association of Renal Technologists

Technologist Training Scheme Syllabus

The scheme sets out a syllabus of learning split into two parts.

Part A: sets out the underpinning knowledge for candidates to work through with their nominated mentor. The candidate's knowledge and understanding will be tested within the department by the completion of a set number of assessments covering each of the sections, which will then be submitted to the nominated assessor within the ART ED group.

Part B: sets out a range of practical competencies which candidates must acquire and then demonstrated to their mentor. These are then recorded in a logbook of activity; this is to be submitted to the ART ED group for assessment. Candidates who feel they have already acquired some relevant experience and competence in previous job roles can submit this for accreditation of prior learning. This will be assessed by the ART ED APL assessors.

Part A is also designed to provide candidates with the underpinning knowledge required to begin studies on the two renal specific modules of the BSC (Hons) in Clinical Technology provided by the University of Bradford. It is therefore recommended that the candidate completes Part A before starting the Bradford modules.

Completion of the ART scheme and Bradford renal modules will allow entry onto the Register of Clinical Technologists. In recognition of the achievement successful registrants are permitted to use the post-nomial, RCT, which signifies they are on the register and will abide by its rules and code of conduct.

Part A: Introduction to the Clinical and Technical Role of the Renal Technologist

The aim of this section is to develop an overview and an appreciation of the job role of a renal technologist and of the clinical environment they work in. This requires an understanding of the objectives and methods of renal replacement therapy, the clinical and technological aspects involved in providing it and quality systems required to manage it

The initial aim is to embed the basic principles which will enable a trainee technologist to then progress to a level where they can work safely within the renal environment. So focus initially is on basic principles and functions rather than in-depth theory, emphasising the key knowledge and understanding required to work safely within the job role. Theory can then be developed further either "in house" or through formal academic modules.

- Section 1

  This introduces the objectives of renal replacement therapy and the basic principles of the current therapies.

- Section 2

  This section is concerned with the methods employed to safely transport an adequate supply of blood from the patient, through the dialyser and then back to the patient. This includes the formation of the access site. It introduces the trainee to the complications and the risks involved in passing blood through artificial materials, as well an introduction to the performance characteristics of the dialyser.

- Section 3

  This section deals with water quality. It discusses the requirements for the incoming water quality (for which reliance is placed on the supplier). It highlights the variance in regional water quality and also covers governance issues, quality control and maintenance. Risks introduced by maintenance are highlighted, as well as contingency plans for plant failures. It also covers the basic functions of the components of a renal water plant.

- Section 4

  Section four introduces the key concepts of asset management and the particular requirements for medical equipment.

- Section 5

  Section five introduces the legislation, standards and guidance that have relevance to a renal technical department. (As standards and guidance are likely to be superseded in time, they have been grouped in the same section of the syllabus to enable them to be reviewed more conveniently. However they are best assessed individually in the context of their relevant applications)

- Section 6

  This section deals specifically with electrical safety. It covers a general awareness of how guidance and legislation are related, the different classifications of medical equipment and then develops an understanding of the particular test types and their application in routine and post repair testing.

- Section 7

  This covers the professional standards required of a Renal Technologists whilst performing their job roles.

- Section 8

  This section introduces units of measurement used in water quality testing and renal technology. Some units are covered purely as a prerequisite for further academic study.

Part A:

1 Introduction to haemodialysis

1.1 Basic Renal Anatomy and Function

Aim: To understand the basic objectives of renal replacement therapy

Underpinning knowledge

- Recall that the PH scale ranges from 0 to 14 and measures the acidity (0-6) or alkalinity (8-14) of a solution due to the number of free Hydrogen ions it contains.
- Recall that 7 on the scale indicates a neutral PH
- Recall that the normal PH range in body fluids is between 7.35 and 7.45.
- Recall that acids are molecules that will donate hydrogen Ions into a solution if conditions are suitable
- Recall that bases are molecules that will accept hydrogen Ions from a solution if conditions are suitable
- Recall that Acids and Bases can therefore control the PH of a solution.

1.1.1 Recall the following anatomical components and identify their location in the human body.

- Kidney
- Bladder
- Ureter
- Urethra

1.1.2 Recall the following basic functions of the kidney

1. Filtration of water and toxins from the blood
2. Control of electrolyte level in the blood (sodium in particular).
3. Production of bicarbonate to neutralise the acidic by-products of metabolism
4. Production of EPO to stimulate the production of red blood cells

1.1.3. Recall that the objective of dialysis is to replicate the first three renal functions stated above.

1.1.4. Recall that the body's metabolism produces acidic waste products.

1.1.5. Recall that the bicarbonate buffering system controlled by the lungs and the kidneys is physiologically the most important buffering system to control PH in the body.

1.2 Basic Principles of Dialysis.

Aim: To understand the basic principles of renal replacement therapy and physiological factors that limit fluid and solute removal rates.

1.2.1 Describe the basic principle of haemodialysis in terms of diffusion of solutes and ultrafiltration of fluid from the blood across a semi-permeable membrane (to replicate functions 1 and 2 of section 1.1.2).

1.2.2 Describe the roles of TMP and high flux membranes in fluid removal.

1.2.3 Recall that bicarbonate in the dialysis solution will neutralise the acidic by-products of metabolism.

1.2.4 Recall that alternative buffers such as acetate and lactate can be metabolised by the body to produce bicarbonate

1.2.5. Recall that historically bicarbonate solutions were difficult to implement, but now that these issues have been resolved, acetate is very rarely used due to biocompatibility issues especially in PD where it has been established that it damages the peritoneum.

1.2.6 Recall that in peritoneal dialysis the peritoneal membrane itself is utilised as the semi-permeable membrane

1.2.7 Describe how fluid removal is achieved in PD by osmosis

1.2.8 Recall that trying to achieve excessive fluid and solute removal rates can have adverse physiological effects on the patient.

1.2.9 Recall that while there are a range of common settings among the dialysis community some patients may be more sensitive to these factors and require more specific settings

1.2.10 Recall that dialysis machines can provide profiling where the rate of fluid and solute removal can vary in a pre-programmed way throughout the treatment.

1.2.11 Recall that the rate of solute and fluid removal from the body is ultimately limited by the rate at which the body transfers them from the “body compartments” into the blood stream

2 Extracorporeal Blood Transport

2.1 Vascular Access

Aim: To understand the requirement for adequate blood flow for renal replacement therapy, the methods employed to achieve this, the potential problem with recirculation in the vascular access site and how recirculation can be assessed.

2.1.1 Recall that adequate blood flow rates are one of the most important factors in achieving adequate dialysis.

2.1.2 Recall that 300ml/min is a typical value but that actual blood flow rates must be determined by a clinician and that one important consideration is to maintain the integrity of the vascular access site.

2.1.3 Recall that the two broad categories of vascular access are called percutaneous access and arteriovenous fistulas and grafts.

2.1.4 Recall that percutaneous access involves the insertion of a catheter via a major vein.

2.1.5 Recall that typically these catheters access the blood flow near the right atrium or in the femoral vein.

2.1.6. Explain how the introduction of a central venous catheter near the right atrium introduces an increased risk from electrical leakage currents.

2.1.7. Recall that an arteriovenous fistula is formed surgically by connecting an artery to a vein

2.1.8. Recall that the connection of two blood vessels as described in 2.1.7 is called an anastomosis.

2.1.9. Recall that subjecting the vein to arterial pressure expands the vessel to form a vascular access point that can produce adequate blood flow for dialysis.

2.1.10 Recall that for patients who do not have adequate blood vessels the connection between the artery and vein can be made with an artificial tube such as Gortex. In this case it is referred to as an arteriovenous graft.

2.1.11 Describe recirculation as being when a fraction of the treated blood returning from venous line of the extracorporeal circuit is drawn directly back out to into the arterial line at the fistula. This means that less than 100% of the blood "cleaned" by the dialyser is passing back through the patient and contributing to the transport of solutes and fluid from the patient.

2.1.12 Recall that recirculation reduces the efficiency of dialysis because only the fraction of the blood that has passed through the patient's circulatory system will continually transport toxins and fluids to the dialyser.

2.1.13 State an example of a piece of equipment designed to determine recirculation and describe its principle of operation.

2.2 The extracorporeal circuit

Aim: To know the components of the extracorporeal circuit and how they interface with the vascular access site. To understand the complications of circulating blood though artificial materials and the measures available to reduce these complications. To know the dialyser key performance parameters.

2.2.1 Recall that a basic extracorporeal circuit consists of a set of blood lines, a dialyser and a giving set.

2.2.2 Recall that chemicals used in manufacture and sterilisation methods can present biocompatibility issues for patients and that some patients have a greater reaction to the same agents.

2.2.3 Recall that the blood will naturally react with the materials in the extracorporeal circuit to clot and that anticoagulants therefore must be introduced into the patient's blood.

2.2.4. State two commonly used anti-coagulants and the methods of application.

2.2.5. Recall that as well as removing air, priming the blood circuit with saline can flush out some chemical residues and also tiny shards of debris produced in the manufacturing process.

2.2.6 Recall that sharp edges in the extracorporeal circuit and kinks in the blood tubing etc. can damage blood cells as the blood travels round the circuit.

2.2.7 Recall that vascular access in a fistula or graft is achieved by placing needles into the fistula/graft. Ideally one needle will provide output flow to the extracorporeal circuit and another will provide the return flow. However the vascular access site in some patient's cannot accommodate two needles and so a single needle must be used for both flow out and return.

2.2.8 State the key parameters that determine the performance of a dialyser.

2.3 Basic function of the Blood Monitor (BM)

Aim: To familiarise the technician with the extracorporeal circuit and the functions of the BM, in order to diagnose problems with the blood circuit and vascular access site, as well as being able to recommend treatment parameter changes to achieve the optimum dialysis under compromised conditions.

2.3.1 Explain how a BM controls the circulation of blood in the following modes

- Single pump double needle
- Double pump single needle

Specifically mention

- How it controls the blood flow rate
- How it measures the blood flow rate
- What pressures it monitors
- What safety features it incorporates i.e. alarms etc. and automatic actions by the BM in certain alarms conditions to safeguard the patient. Highlight the risks to fistulas/grafts due to the pressures the BM can generate

2.3.2 Demonstrate the competence to line and prime a dialysis machine and describe the procedure for the following configurations.

- Single pump double needle
- Double pump single needle
- HDF.

2.3.3 Observe and describe a patient being put on dialysis by a nurse for each of the modes in 1.5.2 from needle insertion to commencement of treatment

2.3.4 Observe and describe a patient being taken off dialysis by a nurse from wash back to removal of needles.

3. Water quality

3.1 Introduction to water quality

Aim: To develop an understanding of how renal water quality is achieved by further processing of water that already meets DWI standards for human consumption. To highlight the use of chlorine in drinking water and understand why it needs to be removed from renal water supplies. To develop awareness of the relevant staff involved in the assurance of general water quality and of renal water quality within the technicians own organisation.

3.1.1 Recall that different geographical sites may differ in water quality and therefore new units and home patient installations require an assessment when planning installations for dialysis.

3.1.2 Recall that the water supply to a renal water plant must comply with the DWI standards for water intended for human consumption.

3.1.3 Recall that testing regimes for compliance for renal water quality standards do not give complete validation of the water quality. This is also reliant on the water supplier assuring compliance with 1.3.2 above.

3.1.4 Recall the importance of assessing the level of quality assurance offered by water suppliers to meet 1.3.2 particularly in consideration of smaller private companies and local borehole supplies etc.

3.1.5 Recall that chlorine is a common agent introduced into drinking water supplies to control the microbiological levels.

Recall that chlorine must be removed from renal water supplies to prevent harm to patients on dialysis.

3.1.6 Identify the member of staff who has ultimate responsibility for the provision of renal water quality at your own location.

3.1.7 Identify other staff members who are involved in the quality assurance, specifying their role.

3.1.8 Identify the key members of the Water Safety Group at your Trust

3.2 Water Plant Equipment

Aim: To be able to identify and state the basic functions of the main components in a renal water plant system.

3.2.1 Recall that the break tank provides compliance with the requirement to isolate the renal plant from the mains supply and provides a reservoir capacity that can maintain the renal water supply during short interruptions of the mains water supply.

3.2.2 Recall that a booster pump produces the required water pressure from the tank supply.

3.2.3 Recall that the water softener is a vessel filled with resin beads which remove calcium and magnesium molecules from the water supply by exchanging them for sodium molecules.

3.2.4 Recall that the softener resin will be exhausted after a time period that depends on the capacity of the vessel and the flow rate of water through it and its hardness.

3.2.5 Recall that the resin can be regenerated with a brine solution.

3.2.6 Describe the stages in the operating cycles of a dual vessel softener, from vessel one being initially in use to the time it goes back into use again.

3.2.7 Recall that chlorine removal is achieved by passing the water through a vessel containing activated carbon.

3.2.8 Recall that the carbon is capable of removing other toxins in the water supply.

3.2.9 Describe the operating cycle of a carbon vessel.

3.2.10 State the filtration stages in the water treatment plant including the RO membranes

3.2.11 State what is meant by the permeate or product water

3.2.12 State what is meant by the concentrate or reject water

3.2.13 Evaluate the use of permeate conductivity measurement as an indication of water quality.

3.3 Water Plant Maintenance

Aim: To develop an appreciation of the risks to the user from repairs and maintenance of renal water plant and also the risks that can arise from maintenance on the general water supply

to the site. To highlight the need to assess risks that may threaten continuation of the supply and the need to prepare remedial strategies. To develop the competence to safely carry out chemical disinfection procedures.

3.3.1 Recall that maintenance on the general water distribution system that may be deemed safe to conduct "live" on the drinking water supply may not be safe to carry out on a system supplying a renal water plant.

3.3.2 Recall that some procedures that may be applied to water distribution systems can compromise components of a renal water plant.

3.3.3 Recall the importance of communication between the authorised persons responsible for managing the general water system maintenance, the nurse manager and senior technician of the renal unit.

3.3.4 Understand that in normal circumstances any work that breaks into the water pathway on the "clean side" of the RO membrane should be followed by disinfection before the system is next used for dialysis.

3.3.5. Recall that if there is urgent need for continued dialysis following emergency work, then the risk must be assessed within the multidisciplinary team (taking into consideration factors such as the extent to which the clean side of the system has been exposed and what other protective measures are in place e.g. endotoxin filters).

3.3.5 Carry out a risk assessment to consider the implications of both discontinuation of treatment or continued treatment on a ring that has had a minor leak repaired at the beginning of the first of three shifts at a twenty station dialysis unit.

3.3.6 Produce a risk assessment to determine possible controls for the following failures on a renal water plant system and consider the impact of operating with these control measures in place.

- Failure of a single stage of a double stage RO
- Blockage of carbon vessel/valve
- Chlorine level too high after carbon vessel
- Blockage or of one vessel of a duplex water softener
- Failure of one pressure booster pump in a system that employs two parallel pumps with automatic changeover.
- Failure of water feed to break tank.

3.3.7 Produce a risk assessment for planning and carrying out a chemical disinfection on a unit out of normal hours.

3.3.8. Produce a risk assessment for planning and carrying out a chemical disinfection on a renal ward that is in use.

3.4 Water quality testing

Aim: To understand the requirements for water quality testing.

3.4.1 Recall the limits set in standards and guidelines for dialysis water for the following, along with the frequency of testing required and reasoning behind this.

- Chlorine
- Hardness
- TVC/ml
- EU/ml
- Chemical limits as per ISO 13959

3.4.2 Describe a testing regime for monitoring chlorine levels with some redundancy to ensure sampling frequency requirements are always met and that provides the ability to take remedial action before the RO is challenged with levels above the limit specified.

3.4.3 Describe a testing regime for a duplex water softener including recording of other important data in addition to the actual hardness.

3.4.4 Describe a testing regime to monitor TVC and endotoxin levels in dialysis water.

3.4.5 Provide evidence of testing carried out for all of the quantities specified above.

4 Asset management and quality control

Aim: To understand the need for asset management and quality control systems, how this can integrate with other information systems in a hospital and in particular for controlling the risks from BBV in the use of dialysis machines.

4.1 Recall that the trust needs a record of the equipment it owns for both financial management and identification of liabilities.

4.2 Recall the following basic information that needs to be provided by an asset management system

- Individual equipment identification
- Equipment ownership
- Equipment location
- Records of work done on the equipment
- Records of parts fitted
- Records of service carried out
- Record of disposal

4.3 Recall that data on this system can be used as the basis for a planned equipment replacement program.

4.4 Recall that additional clinical records may be required to identify particular equipment use on patients. Recall that such records must comply with patient confidentiality and data protection.

4.5 Recall that systems must be put in place to control the use of equipment on patients with BBV or at high risk of BBV.

4.6 Carry out a risk assessment for the use of equipment on patients with BBV

4.7 Explain the BBV policy in place at your own particular unit.

4.8 Recall the need for decontamination of all equipment prior to carrying out service or repairs

4.9 Describe the decontamination protocols at your own particular unit.

4.10 Recall that the main purpose of a quality control system is reliably achieve a defined level of quality in service.

4.11 Recall that this will involve defining aspects such as

- Expected response times
- Typical repair times
- Tolerances on compliance with service due dates
- Minimum percentages for compliance with targets etc.

4.12 Explain the importance of standard operating procedures and document control in achieving consistent quality and ensuring that work done complies with current manufacturer's requirements and department policies.

4.13 Explain the importance of attaching PPM and Electrical Safety Test labels to medical equipment.

5. Standards and Guidance

Aim: To familiarise the Renal Technologist with the standards and guidance that apply to the areas of responsibility within their job role

5.1 Electrical Safety

State the purpose of the following and their relevance to a Renal Technical Department

5.1.1 IEC 60601-1

5.1.2 IEC 60601-1-11

5.1.3 BS EN 60601-2-16 (highlight the relationship between the general requirements of IEC 60601)

5.1.4 BS EN 60601-2-39

5.1.5 IEC 62353

5.1.6 State which section of BS7671 is most relevant to the Renal Technologists and give a brief overview of this section.

5.1.7 Describe the measures for patient leakage testing specified in BS EN 60601-2-16

5.1.8 Describe the provisions for patients with CVCs specified in BS EN 60601-2-16

5.2 Water Quality

State the purpose of the following and their relevance to a Renal Technical Department

5.2.1 BS ISO 13959 (Water for haemodialysis and related therapies)

5.2.2 BS ISO 26722 (Water treatment equipment for haemodialysis applications and related therapies)

5.2.3 BS ISO 11663 (Quality of dialysis fluid for haemodialysis and related therapies)

5.2.4 BS ISO 13958 (Concentrates for haemodialysis and related therapies)

5.2.5 BS ISO 23500 parts 1-5

5.2.6 The Renal Association and the Association of Renal Technologists Guideline on water treatment systems, dialysis water and dialysis fluid quality for haemodialysis and related therapies

5.2.7 Explain the role of the DWI and give examples of the legislation they provide.

5.2.8 Explain the purpose of the Water Regulations Advisory Scheme

5.3 BBV and infection control

5.3.1 State the purpose of the Department of Health Good Practice Guidelines for Renal Dialysis/Transplantation Units Prevention and Control of Blood-borne Virus Infection specifically reference the purposes of the material in chapters 3, and 7 - 11

5.3.2 State the purpose of the Renal Association- Guidelines - Blood Borne Virus Infection by stating which aspects are specifically dealt with in each of the sections.

5.4 Equipment management

5.4.1 State the purpose of BS EN ISO 13485

5.4.2 Give a brief overview of Managing Medical Devices Guidance for healthcare and social Services organisations April 2015 (MHRA) by stating what aspect each of the chapters deals with in relation to equipment management.

5.5 Building Design

State the purpose of the following documents and give an overview by stating some specific aspects they deal with

5.5.1 Health Building Note 07-01

5.5.2 Health Building Note 07-02

6 Electrical safety

6.1 Recall that The Electricity at Work Regulations Act 1989 is the legal enforcement document for the implementation of electrical safety measures within the work environment.

6.2 Recall that following regulations and standards such as IEC 60601-1 and BS7671 provide assurance of compliance with the legal requirements of The Electricity at work Act.

6.3 Recall that The Electricity at Work Regulations Act stipulates the requirement that electrical equipment is “electrically maintained” but does not stipulate any specific guidance on how this is achieved.

6.4 Recall that the HSE produce guidance notes for implementing effective electrical maintenance programmes on general electrical equipment.

6.5 State the different classifications of electrical equipment along with their symbols and explain the differences between these classifications.

6.6 Explain the difference between the purposes of the testing defined in IEC 60601-1 and IEC 62353.

6.7 Explain why more comprehensive testing is required after some repairs and give an example of a post repair procedure.

6.8 State the basic purpose of an insulation resistance test. State the test conditions required and the pass criteria.

6.9 Explain in relation to 6.5 situations where the test conditions specified in 6.6 may need to be revised

6.10 State the basic purpose of an Earth continuity test. State the test conditions and the pass criteria.

6.11 Explain in relation to 6.5 situations where the test conditions specified in 6.8 may need to be revised.

6.12 Leakage currents

i) Explain how leakage currents occur in electrical equipment.

ii) Explain the role of the earth lead in safely conducting these currents to Earth.

iii) Explain the importance of the single fault condition Earth Leakage test

iv) Explain the additional risks of leakage currents with patient applied parts.

v) Explain the risk of leakage currents from general electrical equipment within the "patient area" and the purpose of equipotential bonding points.

7 Professional standards

Aim: To ensure that the technician develops the professional standards required of the post of Renal Technologist.

7.1 Recall basic infection control policy requirements that apply to you in the areas that you work

7.2 Provide a witness statement from an authorised person to show adherence to these policies

7.3 Recall the dress code for your job role.

7.4 Provide a witness statement from an authorised person to show adherence to this dress code.

7.5 Provide a witness statement from an authorised person to acknowledge that you have demonstrated an appropriate level of professionalism in your communication with staff and patients.

7.6 Recall the protocols for visiting other departments within your hospital.

7.7 Provide a witness statement from an authorised person to show adherence to these protocols.

7.8 Provide a witness statement from an authorised person to show that you maintain your tools and test equipment in good condition.

7.9 Describe the requirements for planning and prioritising your workload. (prioritising may require discussion with you line manager).

7.10 Provide a witness statement to acknowledge that you have demonstrated effective planning in your work and in particular when you are planning to carry our work offsite.

8 Units of measurement

Aim: To develop familiarity with the units of measurement used to quantify properties within the field of renal technology.

8.1 Water Hardness

8.1.1 Recall that the total water hardness is the sum of the molar concentrations of Ca2+ and Mg2+ in mol/L or mmol/L

8.1.2 Recall that water hardness is more commonly expressed with a various units rather than as molar concentrations.

8.1.3 Give a definition for each of the following units

8.1.4 Degree of general hardness alternatively referred to as German Degree

8.1.5 Grains per Gallon

8.1.6 Clark Degree alternatively known as English Degree

8.1.7 French Degree

8.2 Produce a conversion table for converting between the following units using the appropriate symbols

8.2.1 milli-mols per Litre

8.2.2 Parts per million

8.2.3 Milligrams per litre

8.2.4 Degree of general hardness alternatively referred to as German Degree

8.2.5 Grains per Gallon

8.2.6 Clark Degree alternatively known as English Degree

8.2.7 French Degree

8.3 Compounds in solution

8.3.1 Recall that compounds in solution are often referred to as either electrolytes or nonelectrolytes.

8.3.2 Recall that electrolytes are substances which break down into ions in a solution (e.g. NaCL) and non-electrolytes do not (e.g. dextrose, urea).

8.3.3 Recall that 1 Mole (mol) of a substance is equal to 6.023 x 1023 of molecules (Avogadro's number)

8.3.4 Recall that the molecular weight of a substance is the weight in grams of 1 mol of the substance

8.3.5 Recall Valence as the amount of charge carried by an ion

8.3.6 Recall that many important substances in the body are measured in "milli-equivalents (mEq)"

8.3.7 Recall that an "equivalent" is the number of moles of a substance that has a total valence equal to that of 1 mole of hydrogen ions.

8.3.8 Recall that the equivalent of a substance can therefore be calculated as (1 mol)/v where v is the valence of the substance.

8.3.9 Carry out conversions between g/L to mmol/L

8.3.10 Recall that electrolyte concentrations in dialysis are controlled via measurements of the conductivity of the solution.