

Clinical Skills in Hospitals Project

Intravenous (IV) therapy

Module 1: IV cannulation

Module 2: IV fluids

Module 3: Central venous access devices

Module 4: Central venous lines

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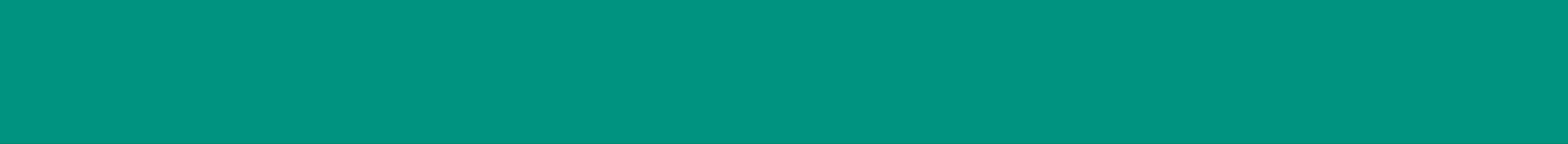
Preface

In 2007 the Department of Human Services commissioned St Vincent’s Hospital Melbourne, to design and develop simulation-based training packages for clinical skills trainers in Victorian hospitals.

The project provides Victorian health professionals—specifically, hospital clinical educators—with a resource to deliver simulation-based clinical skills training.

The information in this manual complements current training programs and should be considered as a resource in the workplace, rather than the definitive resource on the topic.

Every effort has been made to provide the most current literature references. Authors have consulted other health professionals and current programs when possible in development to ensure that the modules produced in this package are consistent with current health practices.



Course delivery in condensed form

Sample timetable for one-day workshop

This is an example of how the modules in *IV therapy* could be combined into a one-day workshop. A sample timetable is provided for a course consisting of Modules 1, 2, 3 and 4.

Course 1 (Modules 1, 2, 3 and 4)

Timing	Activity	Objective
8.30 to 8.45	Introduction to faculty and participants	
8.45 to 9.05	Facilitated discussion	Module 1: 1, 2, 3
9.05 to 9.55	IV cannulation skills session	Module 1: 3, 4, 5 and 6
9.55 to 10.05	Summary of main points from Module 1	Module 1: all
10.05 to 10.20	Morning tea	
10.20 to 10.50	Facilitated discussion	Module 2: 1 and 2
10.50 to 11.05	Skills station 1	Module 2: 3 and 4
11.05 to 11.20	Skills station 2	Module 2: 3 and 4
11.20 to 11.35	Skills station 3	Module 2: 3 and 4
11.35 to 11.50	Skills station 4	Module 2: 3 and 4
11.50 to 12.00	Summary of main points from Module 2	Module 2: all
12.00 to 12.40	Lunch	
12.40 to 1.05	Facilitated discussion	Module 3: 1, 2, 3, 8, 9
1.05 to 1.20	Skill station 1	Module 3: 4, 5, 6, 7
1.20 to 1.35	Skills station 2	Module 3: 4, 5, 6, 7
1.35 to 1.50	Skills station 3	Module 3: 4, 5, 6, 7
1.50 to 2.05	Skills station 4	Module 3: 4, 5, 6, 7
2.05 to 2.25	Summary of main points from Module 3	Module 3: all
2.25 to 2.45	Afternoon tea	
2.45 to 3.15	Introduction and facilitated discussion	Module 4: 1, 4, 5
3.15 to 3.45	Skills station	Module 4: 3
3.45 to 4.00	Summary of main points from Module 4 Course evaluation	Module 4: all



Intravenous (IV) therapy

Introduction

Intravenous insertion and *IV therapy* was developed as a teaching and learning tool for Victorian clinical educators. The information contained in each module was developed using evidence-based resources and examples of best practice. Where expert opinion varies, a discussion section is included. However, it is not within the scope of *IV therapy* to address the full spectrum of local variations. Variations can occur in several areas, including practices relating to types of equipment used, infection control processes, practice guidelines and so on. Therefore, educators should, where appropriate, adapt content to reflect their local policies, procedures and protocols. This will ensure the relevancy of the package content to your learners.

The modules are designed to be discrete courses in their own right. They are timetabled so they can be completed in a 1–2 hour timeframe. This timeframe was chosen after we received feedback from clinical educators requesting shorter courses, because health professionals often have limited time to educate away from patients. However, the packages may also be combined into a one-or two-day course.

IV therapy should be used as an educational tool to assist in the teaching of clinical skills. It is structured as a guide to assist clinical educators, and uses many concepts taught in the *Clinical Skills in Hospitals Project* (Train-the-Trainer courses). Educators are encouraged to build on this resource by adding their own scenarios which incorporate hospital/health service protocols, policies and other resources. Each module is designed as a lesson plan to incorporate the simulations into the teaching of clinical skills.

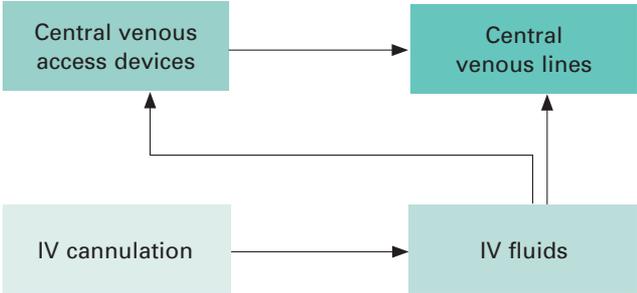
Aims

IV therapy aims to make participants confident in their use of intravenous devices—either from an insertion perspective (discipline specific) or as a therapy delivery device.

Package structure

The *IV therapy* package contains four modules, which provide learning opportunities for health professionals at all levels of experience and from medical and nursing disciplines. Modules 1 and 2 are regarded as fundamental. Modules 3 and 4 are set at the intermediate level.

The assessment for, and insertion of, IV cannula, plus knowledge of basic therapies, such as fluid types, are fundamental to this area of practice. The use of specific devices, such as central venous access ports, is less common in general health care settings, and requires specific knowledge and skill for their use. The insertion and care of central venous lines is covered in *IV therapy—Module 4: Central venous lines*. Although some skills are discipline specific, such as central line insertion, educators should consider an interdisciplinary approach to the use of these modules.

Level of complexity	Package structure
<p>Complex For participants with more than 4 years experience or who have completed Modules 1–4</p>	 <pre> graph TD A[IV cannulation] --> B[IV fluids] B --> C[Central venous access devices] B --> D[Central venous lines] C --> D </pre>
<p>Intermediate For participants in postgraduate years 3–4 or who have completed Modules 1 and 2</p>	
<p>Fundamental For participants in postgraduate years 1–2</p>	

This package was designed to develop participants' knowledge, skills and behaviours required to work with intravenous therapy, and to expose them to increasingly complex scenarios to test their ability to combine these individual skills, work as a team and problem solve in more difficult situations.

Educators delivering these modules should be aware of participants' level of experience and choose appropriate modules. Modules presume an increasing level of knowledge as they progress, ranging from a fundamental knowledge of anatomy and physiology for the fundamental modules, up to detailed knowledge of central venous access devices and central lines. Novice participants (such as first-year graduates) are expected to start with the fundamental modules, and only move onto intermediate and more complex modules as they demonstrate proficiency. More experienced participants may start at the intermediate level if the educator is satisfied that they have the prior knowledge and skills. Individual educators are responsible for assessing each participant's baseline knowledge and determining which modules they need to complete. More specific descriptions of presumed knowledge are outlined in each module.

The design of these packages presumes that the clinical educators using them have knowledge and expertise in current best practice regarding the teaching of clinical skills and conducting facilitated discussions. Knowledge and expertise are presumed commensurate with the Department of Human Services' basic and advanced Train-the-Trainer programs. Clinical educators are encouraged to refer to Department of Human Services' *Clinical Skills Facilitators Manual* for theory on:

1. Peyton's model for teaching clinical skills
2. leading small group discussions
3. giving feedback
4. crisis resource management skills.



Module 1: IV cannulation

Introduction

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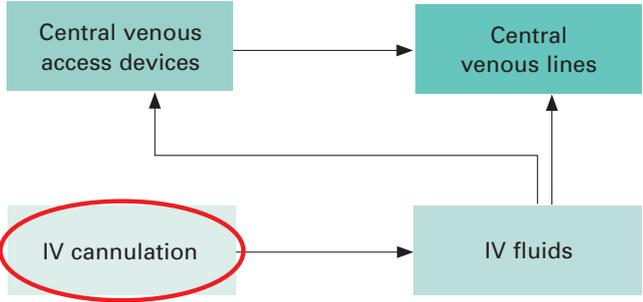
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Module 1: IV cannulation

Authors: Leanne Allen, Julian Van Dijk

Aims

This module assists the registered nurse to maintain and demonstrate current theoretical knowledge related to intravenous cannulation.

This program should be used as an adjunct to the organisation's policies and procedures related to intravenous (IV) cannulation. Therefore, participants in this module should be identified by local health service policy.

Presumed knowledge

This module is designed to provide foundational skills. Participants should be graduates of health care degrees, in which IV cannulation is an identified requirement of practice.

Objectives

By the end of this module, participants should have:

1. discussed the patient assessment required before determining the need for IV cannulation
2. discussed and identified potential intravenous cannulation sites
3. discussed and identified factors determining cannula type and size
4. discussed and identified precautions which must be undertaken when inserting an intravenous cannula
5. discussed the theoretical and practical skills required to perform intravenous cannulation
6. participated in IV cannulation skills stations demonstrating appropriate techniques and environmental safety precautions
7. during the skills station activity, identified strategies to minimise IV cannulation complications.

Background information for educators

Environmental safety and legal aspects

Standard precautions should be used consistently during IV cannulation for all patients.

In the event of a body fluid exposure incident, the organisation's local policy should be followed.

IV cannulation is an invasive procedure. Therefore, consent should be obtained from the patient before performing the procedure.

Routine or scheduled replacement of intravascular catheters is advocated as a method to prevent phlebitis and catheter-related infections.

IVs must be resited at 72 hours.

Remove cannulae at the first sign of phlebitis.

If cannula are inserted under emergency conditions, they must be resited within 12–24 hours.

Under extraordinary circumstances, a medical officer may request that the IV is left in situ after 72 hours.

Site preparation: 0.5% chlorhexidine in 70% alcohol (allow 60 seconds to dry).

Reasons for cannulating a patient

- restoring and maintaining fluid and electrolyte balance
- administration of drug therapy
- transfusion of blood and blood products
- intravenous access.

Anatomy overview

Upper compared to lower extremity

Always use veins in the upper extremity before using lower extremity sites. Veins of the lower limb are generally used only in exceptional circumstances in adults.

If necessary, the veins of the dorsum of the foot and the saphenous vein at the ankle are the sites of choice.

Veins of the upper extremity

The preferred IV cannulation sites are the cephalic and basilic veins in the forearm and the veins on the dorsum of the hand.

Cannula selection

In determining cannula size and site, consider the purpose of cannulation and the likely duration of IV therapy.

As a general rule, use the smallest gauge and shortest length cannula that will meet the patient's needs.

The cannula must be of a size that will allow good blood perfusion around the cannula, while still maintaining a large enough cannula bore, to allow adequate flow of the fluid into the vein.

Recommended cannula selection table	
14G	Trauma patients Rapid, large-volume replacement
16G	Trauma patients Major surgery Intra-partum or post-partum GIT bleeding Multiple line access Multiple blood transfusions High volume of fluids Major surgery
18G	Blood products Delivery of irritant medications, for example, antibiotics Multiple line access Large volume of fluids Major surgery
20G (most commonly used gauge)	General use IV maintenance IV antibiotics IV analgesia
22G	Paediatrics Fragile veins Cytotoxic therapy Minor day surgery
24G	Paediatrics/neonates, cytotoxic therapy

Practical requirements

Selecting an appropriate site

- start distally in the upper extremities
- choose firm, round elastic and well-filled veins
- assess the length of the vein
- inspect and palpate for problems
- look at the previous history of cannulation

- consider:
 - suitable location
 - purpose of infusion
 - duration of therapy.

Areas to avoid

- areas of flexion
- areas below a previously accessed site
- bruised, injured or phlebotic areas
- arm of a patient with lymphoedema
- arm of a patient with a mastectomy
- arm with an AV fistula or shunt
- lower limbs.

Reasons for avoiding cannulating the following areas

Areas of flexion:

- uncomfortable for the patient, because it requires splinting
- the vessel is easily occluded
- greater risk of infiltration and phlebitis.

Haematomas or injured areas:

- the peripheral return is reduced
- risk of pieces of partially clotted blood from the haematoma breaking away and forming an emboli that could be transported throughout the system.

Mastectomy and or lymphedema:

- patients have reduced peripheral return.

AV fistula or shunt sites:

- risk of compromising the haemodialysis access.

Areas distal to previous cannulation:

- these may be bruised or sclerosed from previous access
- infusion may not run as efficiently if vein is damaged.

Lower limbs:

- poor peripheral return
- increased risk of deep vein thrombosis (DVT)

- access difficulty
- reduced flow rates
- reduction in patient comfort
- reduction in patient mobility.

Equipment

- IV trolley with sharps container attached and IV start packs
- tourniquet
- non-sterile gloves
- IV cannula
- interlink bung
- 5 mL syringe and interlink needle
- normal saline flush
- skin preparation solution.

Note: The background information refers to interlink a needle system. Consider what needle system your health service requires when discussing accessing the IV bung for flushes.

IV start packs

- occlusive dressing
- sterile strips
- sterile towel
- labels for history
- gauze
- swab
- sterile basin.

Standard precautions

- one-minute hand wash
- protective barriers, gloves and protective eyewear
- handling of disposable sharps
- handling of disposable waste
- aseptic technique.

A new pair of disposable non-sterile gloves may be used in conjunction with a 'no-touch' technique for peripheral IV insertion. The planned IV insertion site is not palpated after skin cleansing, unless sterile gloves are worn. Wash hands before and after IV catheter insertion and dressing change (O'Grady *et al.*, 2002).



Figure 1: Hand washing

Set up for IV cannulation

- Introduce yourself to the patient.
- Confirm correct patient identification.
- Obtain consent for cannulation.
- Explain the procedure and its purpose.
- Check for allergies to substances such as local anaesthetic or tapes.
- Remember to take the IV trolley with a sharps container attached to the bedside.
- Prepare patient and equipment.
- Prime extension tubing and three-way tap if required.



Figure 2: Set up for IV cannulation

Tourniquet

- Apply tourniquet to the extremity proximal to the chosen site and tighten to less than arterial pressure.
- If veins are not obvious, dilation may be improved by:
 - having the patient clench and relax their fist
 - tapping the vein lightly with your fingers
 - allowing the arm to hang for a short period of time
 - applying a warm pack over the area selected.
- Choose a suitable vein.
- Cleanse the skin with antiseptic solution and allow to dry.
- Cleanse the site and allow it to dry before inserting catheter.
- Agents for skin antisepsis include, in preferred order:
 - 2% chlorhexidine gluconate (CHG)
 - 0.5% CHG in 70% isopropyl alcohol
 - 10% povidone-iodine
 - 70% alcohol¹
- Do not apply alcohol after povidone-iodine, because alcohol negates the effect of povidone-iodine.² Do not use acetone or ether to cleanse skin, because these agents are not effective skin cleansers and have a drying effect (LeBlanc and Cobbett, 2000).³
- Reapply the tourniquet and put on disposable gloves.



Figure 3: Tourniquet

Preparing the cannula



- Remove cap from cannula.
- Check to ensure the stylet will easily withdraw from cannula by twisting the stylet.

Figure 4: Preparing the cannula

Inserting cannula



- Hold cannula in dominant hand.
- With other hand, pull skin tight.
- Insert cannula with bevel up at a 15–20° angle.
- Wait for flashback.

Figure 5: Inserting cannula 1



- Once flashback appears, advance the cannula 5 mm.
- Slide the cannula away from the stylet until it is flush with the skin.

Figure 6: Inserting cannula 2



Figure 7: Application of pressure

- Release the tourniquet.
- Apply pressure above the insertion point.



Figure 8: Removal of stylet

- When the tourniquet is removed and pressure is applied, then remove the stylet.



Figure 9: Disposal of stylet

- Dispose of stylet in sharps bin attached to IV trolley.



Figure 10: Anchor cannula

- Attach interlink bung onto end of cannula.
- Anchor cannula with non-dominant hand to ensure it does not move.

- Apply occlusive dressing.
- Use strip to mark date and time of insertion.

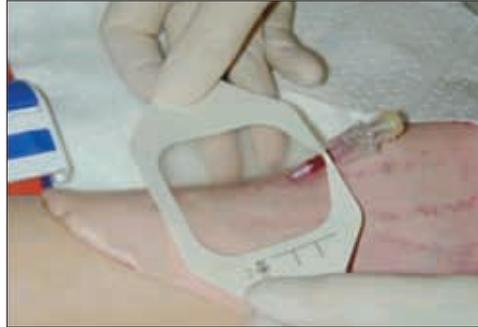


Figure 11: Occlusive dressing

- Wipe with alcohol swab.
- Flush bung with 5 mL normal saline.



Figure 12: Alcohol swab and saline

Collecting a blood sample

If a blood sample is required, take a blood test before flushing using a Vacutainer, blue connection and interlink needle.



Figure 13: Collecting a blood sample

Surveillance and monitoring

The site:

- signs of complications
- date of insertion.

The solution:

- fluid type
- infusion rate
- documentation of the order.

Complications:

- infiltration/extravasation
- thrombosis:
 - local
 - spread to adjacent area
- phlebitis:
 - infusion related
 - infective
- septic thrombophlebitis
- thromboembolism
- septicaemia:
 - endocarditis
 - metastatic infection, for example, osteomyelitis, septic arthritis
 - death.

Phlebitis:

- inflammation of the vein
- late signs include tenderness, redness, heat and oedema.

Infiltration:

- diffusion or accumulation of injected fluid into the subcutaneous space
- signs include swelling, slowing of infusion, pain, coolness of the skin.

Extravasation:

- vesicant (blistering) fluid infiltrates the tissues and tissue necrosis may follow 1–4 weeks later
- late signs include pain, burning, erythematous, swelling.

Tips

- use veins in non-dominant arm
- choose a vein large enough for the purpose
- rotate sites
- use veins which are straight and palpable
- consider where the catheter tip will be sited
- do not persist after two failed attempts
- never reinsert stylet into cannula
- order from a doctor (verbal or written)
- warm the arm if necessary.

Documentation

The patient:

- date and time on occlusive dressing.

The medication chart:

- fluid type and infusion rate
- additives and allergies.

The history:

- date, time, size and person.

Learning activities

Suggested learning activities and timetables are outlined below.

Timing	Activity	Objective
20	Facilitated discussion	1, 2 and 3
50	Skills stations	3, 4, 5 and 6
10	Summary	All
5	Evaluation	

Total time: 1 hour 25 minutes

Facilitated discussion

The facilitator should lead a discussion amongst participants about the issues covered in the background information. The facilitator should not give a didactic lecture, but instead promote open discussion and knowledge sharing amongst participants. Participants should be encouraged to describe any real-life experiences they have encountered.

Skills stations

The skills stations should be the main focus of this module. The skills stations allow participants to practise the entire procedure of assessment, cannulation, dressing the cannula and flushing the cannula.

The skills station set requires one IV arm on a table with a selection of the relevant equipment listed below. These skills stations work better with two persons per arm, and will require enough equipment to meet that requirement.

It is recommended that the participants work in groups of two; therefore, based on a group of 12, six skills stations will be required.

Facilitators may conduct the facilitated discussion and demonstration from a skills station. This has the advantage of maintaining a practical focus on the session and allowing participants repeated practice opportunities.

Resource list

The following resource list assumes two facilitators for every 12 participants, a ratio of 1:6. As a minimum, the following resources are needed to conduct this module.

Resource	Quantity	Additional comments
Facilitators	1	1:12, but 2:12 is optimal
IV arms	6 (1:2)	Manikin arms that have vascular access and will yield blood to simulate normal IV cannulation and blood taking
IV dressing packs	24	2 per workstation
IV cannulae sizes gauge 18, 20, 22	2 per table	
Tourniquets	6	
Kidney dishes	6	
Sharps bin	6	1 per table
Chemical skin preparation	12	1 per person, skin preparation health service specific
Normal saline flushes	24	2 per participant
10 mL syringes	12	1 per participant
Bungs	12	1 per participant
Blood-taking equipment	6	1 set per table (health service specific)
Non-sterile gloves	3 boxes	Small, medium, large

Summary

The summary session reinforces content covered in the learning activities, and is an opportunity for participants to reflect on what they have covered. No new material should be introduced.

Important points to include in the summary are:

- Peripheral IV cannulation is a common procedure and can be performed by a range of health care professionals.
- Vital to the success of this procedure is a health professional's attention to procedural sterility to reduce the risk of post-cannulation phlebitis.
- The program aims to ensure that participants have sufficient practice before attempting this procedure in the clinical setting.

Evaluation

A formal evaluation has been specifically developed for this module. It incorporates the objectives of the module and the perceptions of the participants about whether they have increased their understanding by working through the module. It is highly recommended that this formal evaluation be copied and completed by all participants at the completion of the module.

A range of informal evaluation tools may also be used in conjunction with this evaluation throughout the module, including those available in the Department of Human Services' *Clinical Skills Facilitators Manual* from the basic course conducted in 2007.

References

1. O'Grady, N.P et al (2002) *Guidelines for the prevention of intravascular catheter-related infections*, MMWR Recomm Ref. Aug 9, 51(RR-10): 1–29.
2. Intravenous Nursing Society (INS), *Infusion nursing standards of practise*. J Intraven Nurs 2000; 23 (Suppl 6): s 53–4, s81–8
3. LeBlanc A., Cobbett, S. (2000), *Traditional practice versus evidence-based practice for IV skin preparations*. Canadian Journal Infection Control; Spring, 9–14

Module 1: IV cannulation—evaluation

Thank you for participating in this module. As part of our commitment to quality improvement the following questionnaire will be used to plan future implementation of this module. We appreciate your time completing this evaluation.

1. Overall

How would you rate this module?

poor fair good very good outstanding

2. Learning objectives

Please consider whether this module was successful in meeting the following learning objectives:

<i>IV therapy</i> Learning objectives of Module 1: Intravenous (IV) cannulation	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
Discussed the patient assessment required before determining the need for IV cannulation	<input type="checkbox"/>				
Discussed and identified potential intravenous cannulation sites	<input type="checkbox"/>				
Discussed and identified factors determining cannula type and size	<input type="checkbox"/>				
Discussed and identified precautions that must be undertaken when inserting an intravenous cannula	<input type="checkbox"/>				
Discussed the theoretical and practical skills required to perform intravenous cannulation	<input type="checkbox"/>				
Participated in IV cannulation skills stations demonstrating appropriate techniques and environmental safety precautions	<input type="checkbox"/>				

3. Important learning outcomes

What are the three most important things you have learned from this module?

4. Module implementation

Please indicate to what extent you agree or disagree with each of the following statements in relation to the implementation of the module.

	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
The facilitator respected my experience	<input type="checkbox"/>				
The facilitator encouraged my participation	<input type="checkbox"/>				
I was able to ask the facilitator questions	<input type="checkbox"/>				
The facilitator was able to answer my questions	<input type="checkbox"/>				
The feedback I received was clear	<input type="checkbox"/>				
The feedback I received will assist me in my future performance	<input type="checkbox"/>				
There was adequate time for the skills stations	<input type="checkbox"/>				
There was adequate time for the facilitated discussions	<input type="checkbox"/>				
There was adequate time for the simulations	<input type="checkbox"/>				
I have increased my confidence in performing IV cannulation	<input type="checkbox"/>				
I have identified future learning needs in this topic area	<input type="checkbox"/>				

5. Future module implementation

Do you think the module should be altered in any way? yes no

If yes, what recommendations do you have?

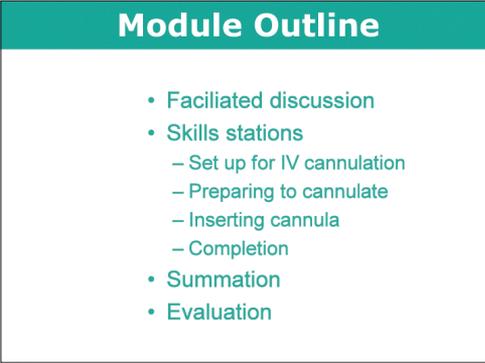
Thank you

PowerPoint presentation

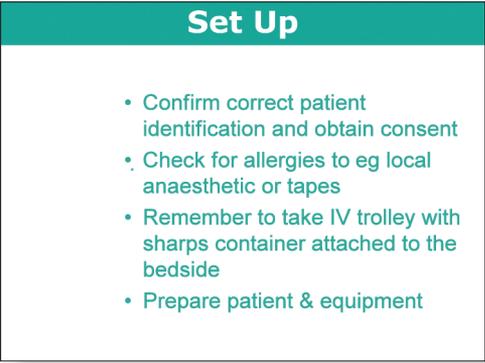
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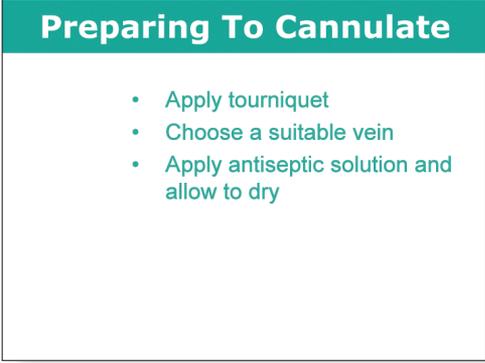
**Intravenous Therapy
Module 1
Intravenous
Cannulation**

StV A Victorian Government initiative 
2. 

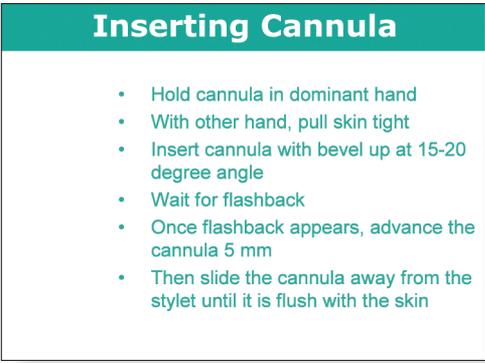
Module Outline

 - Facilitated discussion
 - Skills stations
 - Set up for IV cannulation
 - Preparing to cannulate
 - Inserting cannula
 - Completion
 - Summation
 - Evaluation
3. 

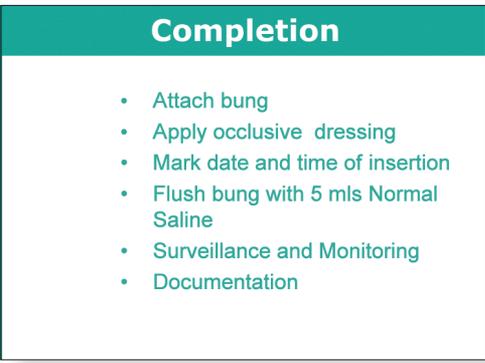
Set Up

 - Confirm correct patient identification and obtain consent
 - Check for allergies to eg local anaesthetic or tapes
 - Remember to take IV trolley with sharps container attached to the bedside
 - Prepare patient & equipment
4. 

Preparing To Cannulate

 - Apply tourniquet
 - Choose a suitable vein
 - Apply antiseptic solution and allow to dry
5. 

Inserting Cannula

 - Hold cannula in dominant hand
 - With other hand, pull skin tight
 - Insert cannula with bevel up at 15-20 degree angle
 - Wait for flashback
 - Once flashback appears, advance the cannula 5 mm
 - Then slide the cannula away from the stylet until it is flush with the skin
6. 

Completion

 - Attach bung
 - Apply occlusive dressing
 - Mark date and time of insertion
 - Flush bung with 5 mls Normal Saline
 - Surveillance and Monitoring
 - Documentation



Module 2: IV fluids

Introduction

Intravenous insertion and *IV therapy* was developed as a teaching and learning tool for Victorian clinical educators. The information contained in each module was developed using evidence-based resources and examples of best practice. Where expert opinion varies, a discussion section is included. However, it is not within the scope of *IV therapy* to address the full spectrum of local variations. Variations can occur in several areas, including practices relating to types of equipment used, infection control processes, practice guidelines and so on. Therefore, educators should, where appropriate, adapt content to reflect their local policies, procedures and protocols. This will ensure the relevancy of the package content to your learners.

The modules are designed to be discrete courses in their own right. They are timetabled so they can be completed in a 1–2 hour timeframe. This timeframe was chosen after we received feedback from clinical educators requesting shorter courses, because health professionals often have limited time to educate away from patients. However, the packages may also be combined into a one- or two-day course.

IV therapy should be used as an educational tool to assist in the teaching of clinical skills. It is structured as a guide to assist clinical educators, and uses many concepts taught in the *Clinical Skills in Hospitals Project* (Train-the-Trainer courses). Educators are encouraged to build on this resource by adding their own scenarios which incorporate hospital/health service protocols, policies and other resources. Each module is designed as a lesson plan to incorporate the simulations into the teaching of clinical skills.

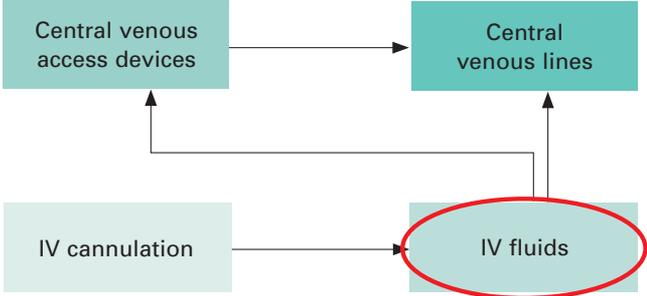
Aims

IV therapy aims to make participants confident in their use intravenous devices—either from an insertion perspective (discipline specific) or as a therapy delivery device.

Package structure

The *IV therapy* package contains four modules, which provide learning opportunities for health professionals at all levels of experience and from medical and nursing disciplines. Modules 1 and 2 are regarded as fundamental. Modules 3 and 4 are set at the intermediate level.

The assessment for and insertion of IV cannula, plus knowledge of basic therapies, such as fluid types, are fundamental to this area of practice. The use of specific devices, such as central venous access ports, is less common in general health care settings, and requires specific knowledge and skill for their use. The insertion and care of central venous lines is covered in *IV therapy—Module 4: Central venous lines*. Although some skills are discipline specific, such as central line insertion, educators should consider an interdisciplinary approach to the use of these modules.

Level of complexity	Package structure
<p>Complex For participants with more than 4 years experience or who have completed Modules 1–4</p>	 <pre> graph TD IVFluids[IV fluids] --> IVCannulation[IV cannulation] IVFluids --> CVLines[Central venous lines] IVCannulation --> CVAD[Central venous access devices] CVAD --> CVLines </pre>
<p>Intermediate For participants in postgraduate years 3–4 or who have completed Modules 1 and 2</p>	
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This package was designed to develop participants' knowledge, skills and behaviours required to work with intravenous therapy, and to expose them to increasingly complex scenarios to test their ability to combine these individual skills, work as a team and problem solve in more difficult situations.

Educators delivering these modules should be aware of participants' level of experience and choose appropriate modules. Modules presume an increasing level of knowledge as they progress, ranging from a fundamental knowledge of anatomy and physiology for the fundamental modules, up to detailed knowledge of central venous access devices and central lines. Novice participants (such as first-year graduates) are expected to start with the fundamental modules, and only move onto intermediate and more complex modules as they demonstrate proficiency. More experienced participants may start at the intermediate level if the educator is satisfied that they have the prior knowledge and skills. Individual educators are responsible for assessing each participants' baseline knowledge and determining which modules they need to complete. More specific descriptions of presumed knowledge are outlined in each module.

The design of these packages presumes that the clinical educators using them have knowledge and expertise in current best practice regarding the teaching of clinical skills and conducting facilitated discussions. Knowledge and expertise are presumed commensurate with the Department of Human Services' basic and advanced Train-the-Trainer programs. Clinical educators are encouraged to refer to Department of Human Services' *Clinical Skills Facilitators Manual* for theory on:

1. Peyton's model for teaching clinical skills
2. leading small group discussions
3. giving feedback
4. crisis resource management skills.



Module 2: IV fluids

Author: Dr Neil Cunningham

Aims

This module helps participants to become confident and competent in setting up and administering intravenous (IV) fluids.

Presumed knowledge

This module is aimed at medical and nursing health professionals involved in administering IV fluids. They are expected to have a basic knowledge of:

1. venous anatomy
2. routes of administration—peripheral IV cannulae, central venous catheters (CVCs), rapid infusion devices and intraosseous devices
3. the physiology of the cardiovascular system.

This module does not cover the insertion of peripheral IV lines, CVCs and other vascular devices. Participants wishing to practise these skills are directed to other modules within this package.

Objectives

By the end of this module, participants should have:

1. reviewed the indications for IV fluid administration
2. reviewed their own hospital policies related to IV fluid administration
3. practised setting up appropriate equipment for IV fluid administration
4. discussed strategies to identify and manage important complications of IV fluid administration.

Background information for educators

The main purpose of this module is for participants to become familiar with IV fluids and the equipment required for their safe administration. Educators should take note of the mix of health professionals in the group. While medical staff are responsible for IV fluid orders, all health professionals should be aware of the indications, techniques and problems associated with IV fluid administration. Where the group comprises non-medical staff, the focus of discussion and learning sessions should be on indications for, and complications of, IV fluid administration.

Indications

Indications for IV fluid therapy include:

- resuscitation
- delivery of maintenance fluid requirements
- delivery of replacement fluid requirements
- delivery of blood products
- when facilitating IV drug administration
- when facilitating patient nutrition (that is, total parenteral nutrition, or TPN).

Resuscitation

Rapid fluid infusion rates are usually required in the setting of patient resuscitation. Poiseuille's law states that flow is proportional to the catheter radius **to the power of four**, and inversely proportional to the catheter's length where:

$$Q = \text{flow} \quad Q \propto \frac{r^4}{L}$$

r = radius
 L = length

This means that short, fat catheters better allow maximal flow rates. Flow rates deteriorate rapidly with long, skinny catheters.

Estimated flow rates through commonly used IV cannula are:

- size 20G: 75 mL per minute
- size 18G: 150 mL per minute
- size 16G: 300 mL per minute.

Options

Access options

Large-bore, peripheral IV cannulae are the simplest, most rapid and most effective route for fluid or blood administration in the setting of resuscitation. Because of their relatively small individual lumen diameter and long catheter length, CVCs have high resistance to flow, making them less than ideal for rapid fluid infusion and resuscitation.

Several commercially available kits allow conversion of smaller peripheral IV cannulae to large-bore catheters, using a guide wire and Seldinger technique (for example, a rapid infusion catheter exchange set (RIC line). Rapid infusion device.

Fluid options

Fluid options in the setting of resuscitation include:

- crystalloid, for example, normal saline, Hartmann's solution
- colloid, for example, Gelofusine, Haemaccel, dextran
- blood products, for example, albumin, blood, fresh frozen plasma.

Disagreement persists regarding which is the better choice of initial fluids in resuscitation. One Cochrane review found no benefit—but increased cost—for the use of colloids over crystalloids in resuscitation for patients with trauma, burns or following surgery¹. However, another Cochrane review of the use of human albumin solution in resuscitation concluded that there was 'no evidence that albumin reduces mortality when compared with cheaper alternatives such as saline'².

Blood options

When blood is required for emergency resuscitation, its safety and availability depend on whether pre-transfusion compatibility testing has been completed and whether the antibody screen is negative. The transfusion of uncross-matched blood is a clinical decision determined by the level of urgency.

Fully cross-matched blood (ABO and RhD compatible) should always be administered if the patient's condition allows time for this process to occur. Antibody screening for agglutinin/non-agglutinin antibodies and antiglobulin Coomb's test takes approximately 20–30 minutes.

Type-specific (ABO and RhD compatible) blood should be available within 10 minutes.

Group O blood is described as 'universal donor blood', and can be used immediately in unstable, haemorrhaging patients. Women of childbearing age should receive O negative blood. Group-specific and cross-matched blood should be given as soon as the patient's blood group is known.

Blood administration

Blood is usually provided to the patient as 'packed red blood cells'. Most hospitals have their own protocols for the administration of blood and blood products. The Australian Red Cross Blood Service also provides guidelines³.

Hospital procedure for blood administration should include the following, as a minimum:

- An explanation to the patient of benefits and risk of transfusion, the possible adverse effects and the need to report them to hospital staff.
- Appropriate and documented orders in terms of blood product and duration of transfusion.

- A large-bore IV cannula should be present and patent. Large-bore cannulae reduce the incidence of haemolysis.
- Two qualified personnel must check:
 - the identity of the patient
 - that the donor number on the unit of blood is identical to the compatibility label attached to the blood and on the Blood Bank issue form
 - the expiry and issue date of the blood
 - that the blood is labelled as already tested for infectious diseases
 - the blood visually.
- Blood should be returned to the Blood Bank and not used if:
 - the unit is not used immediately or is outside refrigeration for more than 30 minutes
 - the expiry date has passed
 - the cross-match date has expired
 - any discrepancies in the checking process might have occurred
 - any leakages are evident or suspected
 - evidence of clots, discolouration or turbidity exists
 - the blood is frozen
 - any other uncertainties are present.
- Blood products should be mixed thoroughly by inversion.
- Blood should be administered through an infusion line that is approved for blood transfusion. This should include a standard filter to remove clots and aggregates.
- The infusion line should be connected to an appropriate blood warmer.
- Infusion adjuncts for rapid infusion should be included in the line if required, for example, inline hand pump, pressure bags, mechanical pump devices.
- The patient should be monitored for signs of transfusion reaction (see below under 'Complications of IV fluid therapy').

Other blood products

Fresh frozen plasma (FFP) transfusion is indicated for emergency reversal of warfarinisation, correction of coagulopathy, disseminated intravascular coagulation (DIC) and in the setting of massive transfusion.

Platelet transfusion is indicated prophylactically if the platelet count is < 50,000 per mL. No evidence exists to support their routine use in the setting of massive transfusion.

Maintenance, drug administration and rehydration

IV fluid therapy is mostly used for the provision of maintenance and replacement fluids, and to facilitate the delivery of IV drugs.

Infusion equipment

The equipment required for IV infusion includes:

- sterile plastic bag containing IV fluid
- sterile giving set, comprising:
 - drip chamber—transparent, which allows for the observation of flow rate
 - sterile tube connecting fluid bag to patient's IV cannula, including IV injection port and wheel/clamp device to regulate rate of flow
- specialised giving sets which may be required, and which include an inline hand pump
- burettes, which may be used for more accurate delivery of fluid volumes (in some institutions, the use of burettes is mandatory for all patients).

Infusion rate

The desired flow rate is achieved by:

- placing the IV fluid bag above the level of the patient
- using the clamp to regulate the rate
- assisting flow by the use of manual or mechanical pumps.

Adult giving sets and drip chambers are calibrated such that 20 drops of fluid = 1 mL. Paediatric sets are calibrated to deliver 15 drops for 1 mL of fluid. It is therefore possible to set a drip rate according to the number of drops per minute.

Hourly rate	mL per hour	Drops per minute	
		15 (paediatric)	20 (adult)
every 2 hours	500	125	167
every 4 hours	250	62	83
every 6 hours	166	42	55
every 8 hours	125	31	42
every 12 hours	83	21	28
every 24 hours	42	11	14

An infusion pump allows accurate control over both flow rate and total fluid delivered.

Fluid options

Water comprises approximately 60% of body weight. For an average 70 kg person, this equates to 42 litres of body fluid. Total body fluid is distributed between two compartments:

- intracellular fluid (ICF) = 40% (approximately 28 litres)
- extracellular fluid (ECF) = 20% (approximately 14 litres).

Blood volume consists in part of ICF (blood cells) and ECF (plasma), and accounts for approximately 12% (5 litres) of body fluid.

Most maintenance and replacement fluid requirements are met by the administration of crystalloid solutions. Colloids may be favoured in specific clinical situations.

Crystalloids

Different crystalloid solutions contain different concentrations of electrolytes and other compounds dissolved in water. The concentration of electrolytes within the fluid determines its distribution between body fluid compartments.

Solutions are classified as hypotonic, isotonic or hypertonic fluids, in reference to their tonicity with respect to plasma.

Hypotonic solutions:

- have low osmolality
- predominately move into the ICF
- include 5% dextrose and hypotonic saline.

Isotonic solutions:

- have the same electrolyte concentration and osmolality as plasma
- predominately stay within ECF
- include 0.9% (normal) saline and Hartmann's solution.

Hypertonic solutions:

- have a high osmolality, which tends to draw H₂O (water) out of the ICF and into plasma
- includes 3% (hypertonic) saline and 50% dextrose.

The constituents of commonly available crystalloid solutions are shown in the following table.

Solution	Sodium (Na) mmol/L	Chlorine (Cl) mmol/L	Glucose mmol/L	Other mmol/L	Effect on ECF of adding 1000 mL	Effect on ICF of adding 1000 mL
5% dextrose	0	0	278		333	667
Hartmann's	131	111	0	Lactate 29 K 5 Ca 2	900	100
0.9% NaCl (normal saline)	154	154	0		1000	0
0.45% NaCl (half-normal saline)	77	77	0		667	333
3% NaCl (hypertonic saline)	513	513	0		2100	minus 1100

Colloids

Colloids contain similar electrolytes to crystalloids, but also contain large molecules (plasma proteins or synthetic molecules), which exert oncotic pressure and prevent solution readily diffusing out from plasma. In theory, and initially at least, these fluids predominately stay within the intravascular space.

Colloid solutions may be natural or synthetic and include:

- Haemacell
- Gelofusine
- dextran
- blood products including human serum albumin solutions.

Colloid solutions may be indicated in:

- hypovolaemia
- burns management
- sepsis and septic shock
- hypoalbuminaemia.

Excessive use of colloids may result in fluid overload, because colloids may expand the intravascular space greater than the amount infused. Anaphylaxis may occur also occur with some solutions.

Aims

The aims of IV fluid therapy in the non-resuscitation situation include:

- provision of maintenance fluids to patients who are fasting or cannot tolerate oral fluids
- provision of replacement fluids to rehydrate from previous losses, or in anticipation of ongoing losses
- the delivery of certain IV drugs (for example, amiodarone via 5% dextrose infusion).

Complications of IV fluid therapy

Complications associated with IV fluid therapy are common. Most are preventable by attention to IV infusion equipment, aseptic technique and attention to fluid and electrolyte prescribing. Common problems are listed below.

Infection:

- skin-based bacteria may enter through insertion site
- local cellulitis or systemic bacteraemia are possible.

Phlebitis:

- non-infectious vein irritation
- due to the presence of the catheter/fluids or medication
- chronic scarring from recurrent phlebitis is seen in intravenous drug addicts or chronically ill patients requiring multiple and recurrent IV access.

Fluid imbalance:

- excessive or inadequate fluid infusion
- excessive fluid can result in cardiac failure or pulmonary oedema
- inadequate fluid can result in dehydration or hypovolaemic shock.

Electrolyte imbalances:

- Delivery of crystalloid solutions can result in electrolyte disturbance or rapid osmolar shift.
- The most commonly used solutions (normal saline, 5% dextrose) do not contain potassium, and hypokalaemia can easily occur if this is not considered. Appropriate fluid orders and repeated measurements of electrolytes are required to ensure that these problems do not arise.
- Excessive shift from a hyperosmolar state (DKA) with hypoosmolar fluids can cause cerebral oedema. Excessive shift from a hypoosmolar state (hyponatraemia) with hyperosmolar fluids can cause central pontine myelinolysis.

Embolism:

- an air or thrombus embolism can cause venous blockage
- peripheral IVs have a lower risk than CVCs.

Extravasation:

- delivery of fluids or medications into surrounding tissue due to leakage from the catheter or a misplaced catheter.

Transfusion reactions

Immediate blood transfusion reactions may be fatal. These must be acted upon swiftly. Non-haemolytic febrile reactions are common. More important are acute haemolytic reactions and anaphylactic reactions. Symptoms and signs of immediate transfusion reactions include:

- fever, chills, rigors
- urticaria (hives), rash
- facial flushing
- shortness of breath
- tachycardia
- headache
- nausea
- chest pain, lumbar back pain
- pain or bleeding at IV site.

In the event of a suspected transfusion reaction:

- stop the transfusion immediately
- maintain IV access
- alert senior staff to the situation
- manage airway, breathing and circulation as per BLS and ALS guidelines if needed
- return blood products and giving set to blood bank and complete a blood transfusion reaction report
- document reaction and treatment in patient's medical file.

Learning activities

Suggested learning activities and timetable are outlined below.

Timing	Activity	Objective
20 minutes	Discussion	1, 2
15 minutes (4 sessions)	Skills stations	3, 4
10 minutes	Summary	1, 2, 4
10 minutes	Evaluation	

Total time = 1 hour 40 minutes

Facilitated discussion

The facilitator should lead a discussion amongst participants about the issues covered in the background information for example, indications for IV fluid administration, options and complications of IV fluids and specific protocols for each participant's hospital. The facilitator should not give a didactic lecture, but instead promote open discussion and knowledge sharing amongst participants. Participants should be encouraged to describe any real-life experiences they have encountered.

Major issues which the facilitator should ensure are covered include:

- indications for IV fluids
- hospital-specific policies about fluid and blood administration
- access options for different scenarios (resuscitation, maintenance)
- complications of IV fluid administration
- monitoring of electrolyte changes due to treatment.

PowerPoint slides are available for the facilitator to use to summarise these main points at the end of the discussion, or as triggers if participants have not identified the major issues.

Skills stations

The skills stations allow participants to practise assembling IV infusion sets and the administration of IV fluids/blood on appropriate models. They also allow participants to practise setting up IV fluid lines and infusion pumps while receiving feedback in a structured format from peers and/or facilitators.

Each facilitator should have access to a manikin or model suitable for teaching IV fluid administration. Participants should be given the opportunity to practise assembling IV lines in addition to infusion pumps. In the absence of suitable manikins, each participant should demonstrate the technique of IV line assembly and familiarisation with the infusion pump.

Participants should be guided through the skill using Peyton’s four-step model⁴. Clinical scenarios are provided to generate discussion around each skill.

Setting up an IV line station

Scenario 1

An 80-year-old man on the medical ward requires IV fluid therapy, because he is fasting for a gastroscopy. He has been ordered 1000 mL normal saline to run over 8 hours. You are required to set up two IV lines, one with a burette and one without, and set the drip rate accordingly.

Facilitators should provide two 1000 mL bags of normal saline, two standard IV giving sets and one burette.

Setting up an IV line with hand pump

Scenario 2

A 60-year-old woman on the medical ward requires IV fluid therapy, because she has become quite dehydrated from a diarrhoeal illness. She has been ordered 1000 mL of normal saline to run over 2 hours, but she is to have a 500 mL bolus immediately. You are required to set up an IV line incorporating an inline hand pump set and deliver the 500 mL bolus.

Facilitators should provide 1000 mL bag of normal saline and a giving set incorporating an inline hand pump set.

Setting up an IV line with a blood warmer and checking a blood product before delivery

Scenario 3

A 45-year-old woman on has just returned from theatre following repair of a fractured femur. She has lost a considerable amount of blood in the operation and her post-operation notes require that she be transfused two units of blood over 3 hours. You are required to set up an IV line appropriate for the administration of blood and then to check the blood before administration.

Facilitators should provide the appropriate equipment required for administering a blood transfusion at their institution (IV giving set, filter, blood warmer and so on). A mock unit of blood should also be provided for use.

Setting up an infusion pump station

Scenario 4

A 58-year-old man in the emergency department is to receive an infusion of N-acetylcysteine for paracetamol toxicity. The initial infusion order is for 200 mL over 15 minutes, followed by 500 mL over 4 hours and finally, 1000 mL over 16 hours. You are required to set up an IV line using your hospital’s standard infusion pump (IMED?) and set the infusion rate.

Facilitators should provide the participants with appropriate IV giving sets and infusion pumps commonly used at their institution. Once the first infusion rate is set, participants can move to the second and third rates as described.

Summary

The summary session reinforces content covered in the learning activities, and is an opportunity for participants to reflect on what they have covered. No new material should be introduced.

Major points to recap in the summary include:

- indications for IV fluids
- hospital-specific protocols for IV fluid and blood therapy
- access options for different scenarios (resuscitation, maintenance)
- complications of IV fluid administration
- monitoring of electrolyte changes due to treatment.

Participants should be encouraged to review their hospital guidelines for IV fluid administration and management in their own time to reinforce the skills acquired in this module. They should be offered access to equipment and educators in the future if they need to practise or improve their skill level or confidence. Participants might also be encouraged to practise these skills in clinical areas (under supervision) to gain further experience.

Resource list

assumed ratio of facilitators to participants?

As a minimum, the following resources are needed to conduct this module.

Resource	Quantity	Additional comments
PowerPoint presentation	1	Provided with module
Resources as outlined for each of the skills station scenarios	1 set each	
Evaluation sheets	1 each	
Facilitator feedback form	1	

Evaluation

A formal evaluation has been specifically developed for this module. It incorporates the objectives of the module and the perceptions of the participants about whether they have increased their understanding by working through the module. It is highly recommended that this formal evaluation be copied and completed by all participants at the completion of the module.

A range of informal evaluation tools may also be used in conjunction with this evaluation throughout the module, including those available in the Department of Human Services' *Clinical Skills Facilitators Manual* from the basic course conducted in 2007.

References

1. Perel P, Roberts I. 1997 Colloids versus crystalloids for fluid resuscitation in critically ill patients, *Cochrane Database of Systematic Reviews* (4)
2. Alderson P, Bunn F, Li Wan Po A, et al. 2004 Human albumin solution for resuscitation and volume expansion in critically ill patients. *Cochrane Database of Systematic Reviews* (4)
3. Australian Red Cross Blood Service 2003 *Transfusion Medicine Manual 2003: Blood transfusion practice and clinical use of blood in Australia*, Australian Red Cross Blood Service: http://www.intra.svhm.org.au/documents/pdf/Quality/Transfusion_1-127.pdf
4. Peyton J. 1998 *Teaching and Learning in Medical Practice*. Manticore Europe Ltd, Great Britain

Module 2: IV fluids—evaluation

Thank you for participating in this module. As part of our commitment to quality improvement the following questionnaire will be used to plan future implementation of this module. We appreciate your time completing this evaluation.

1. Overall

How would you rate this module?

poor fair good very good outstanding

2. Learning objectives

Please consider whether this module was successful in meeting the following learning objectives:

<i>IV therapy</i> Learning objectives of Module 2: Intravenous (IV) fluids	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
Reviewed the indications for IV fluid administration	<input type="checkbox"/>				
Practised administering IV fluids	<input type="checkbox"/>				
Reviewed own hospital policies related to IV fluid administration	<input type="checkbox"/>				
Discussed strategies to identify and manage important complications of IV fluid administration	<input type="checkbox"/>				

3. Important learning outcomes

What are the three most important things you have learned from this module?

4. Module implementation

Please indicate to what extent you agree or disagree with each of the following statements in relation to the implementation of the module.

	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
The facilitator respected my experience	<input type="checkbox"/>				
The facilitator encouraged my participation	<input type="checkbox"/>				
I was able to ask the facilitator questions	<input type="checkbox"/>				
The facilitator was able to answer my questions	<input type="checkbox"/>				
The feedback I received was clear	<input type="checkbox"/>				
The feedback I received will assist me in my future performance	<input type="checkbox"/>				
There was adequate time for the skills stations	<input type="checkbox"/>				
There was adequate time for the facilitated discussions	<input type="checkbox"/>				
There was adequate time for the simulations	<input type="checkbox"/>				
I have increased my confidence and understanding of IV fluids	<input type="checkbox"/>				
I have identified future learning needs in this topic area	<input type="checkbox"/>				

5. Future module implementation

Do you think the module should be altered in any way? yes no

If yes, what recommendations do you have?

Thank you

PowerPoint presentation

1. **Clinical Skills in Hospitals Project**

**Iv Therapy
MODULE 2
'Intravenous Fluids'**

 
2. **Module Outline**

 - Facilitated discussion
 - Skills stations
 - Summation
 - Evaluation
3. **Fluid Types**

 - Crystalloid
 - Colloid
 - Blood products
4. **Aims of management**

 - Inductions (fluid type)
 - Set up requirements
 - Policy for IV fluids used
 - Monitoring
 - Potential Complications
5. **Skill Stations**

 - 4 skill stations



Module 3: Central venous access devices

Introduction

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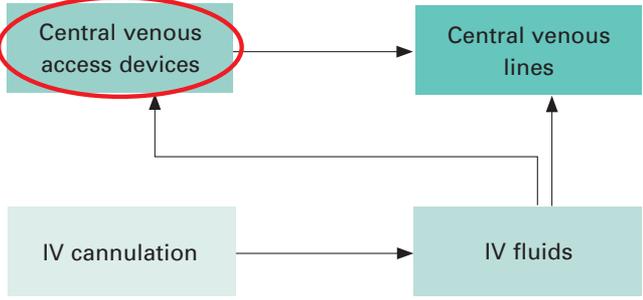
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The assessment for and insertion of IV cannula, plus knowledge of basic therapies, such as fluid types, are fundamental to this area of practice. The use of specific devices, such as central venous access ports, is less common in general health care settings, and requires specific knowledge and skill for their use. The insertion and care of central venous lines is covered in *IV therapy—Module 4: Central venous lines*. Although some skills are discipline specific, such as central line insertion, educators should consider an interdisciplinary approach to the use of these modules.

Level of complexity	Package structure
<p>Complex For participants with more than 4 years experience or who have completed Modules 1–4</p>	 <pre> graph TD IV_cannulation[IV cannulation] --> CVA[Central venous access devices] IV_fluids[IV fluids] --> CVL[Central venous lines] IV_fluids --> CVA CVA --> CVL </pre>
<p>Intermediate For participants in postgraduate years 3–4 or who have completed Modules 1 and 2</p>	
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Educators delivering these modules should be aware of participants' level of experience and choose appropriate modules. Modules presume an increasing level of knowledge as they progress, ranging from a fundamental knowledge of anatomy and physiology for the fundamental modules, up to detailed knowledge of central venous access devices and central lines. Novice participants (such as first-year graduates) are expected to start with the fundamental modules, and only move onto intermediate and more complex modules as they demonstrate proficiency. More experienced participants may start at the intermediate level if the educator is satisfied that they have the prior knowledge and skills. Individual educators are responsible for assessing each participant's baseline knowledge and determining which modules they need to complete. More specific descriptions of presumed knowledge are outlined in each module.

The design of these packages presumes that the clinical educators using them have knowledge and expertise in current best practice regarding the teaching of clinical skills and conducting facilitated discussions. Knowledge and expertise are presumed commensurate with the Department of Human Services' basic and advanced Train-the-Trainer programs. Clinical educators are encouraged to refer to Department of Human Services' *Clinical Skills Facilitators Manual* for theory on:

1. Peyton's model for teaching clinical skills
2. leading small group discussions
3. giving feedback
4. crisis resource management skills.



Module 3: Central venous access devices

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Aims

This module aims to make health professionals confident and competent in their management and maintenance of the patency of central venous access devices (CVADs) within the hospital setting. This module focuses on the clinical use of non-tunnelled peripherally inserted central catheter (PICC) and implanted ports.

Presumed knowledge

This module is aimed at nursing health professionals involved in managing PICCs and ports. They are expected to have a basic knowledge of:

1. central and peripheral venous anatomy
2. principles of aseptic technique
3. blood collection
4. principles of infection control.

Objectives

By the end of this module, participants should have:

1. identified the indications for insertion of PICCs or ports
2. identified the differences between non-tunnelled PICCs and internal ports
3. implemented the postoperative management of CVADs
4. practised and demonstrated changing the dressing and injection ports of the CVAD
5. practised and demonstrated accessing and de-accessing the CVAD port with a Huber point device
6. practised and demonstrated blood collection from a CVAD
7. practised and demonstrate the methods for maintaining CVAD patency
8. investigated hospital policies in relation to the ongoing care of PICCs and ports
9. classified and evaluated clinical complications when using PICCs and ports.

Background information for educators

Indications for the insertion of CVADs

With the increasing acuity of patients and subsequent management complexity, CVADs have become a far more common occurrence in the clinical setting than purely for the oncology/haematology patient.

Indications for the insertion of PICCs and ports include:

- protecting the peripheral vessels due to expected long-term treatment requiring multiple venepuncture (O’Grady 2002; RNAO, 2004)
- providing a secure method for drug delivery
- access for the delivery of peripherally damaging medications, such as chemotherapy and parenteral nutrition
- immediate venous access in an emergency situation.

Central venous access device—peripherally inserted central catheter (PICC)

The PICC is an external non-tunnelled device, inserted either into the basilic, median cubital or cephalic veins by a skilled operator. Placement is confirmed via X-ray or medical imaging. The PICC’s tip is advanced via the vessels of the upper arm to the lower third of the superior vena cava (Gabriel et al., 2005). PICCs are available as single or double lumen devices, and can remain in situ for up to a year.

CVADs are valved or unvalved. Valved devices are specifically designed to prevent the backflow of blood into the catheter lumen. These valved devices are the Groshong catheter or the pressure activated safety valve (PASV) PICC. Unvalved devices are considered open-ended, and generally have external clamps on the lumen. The advantages of PICCs is that they are peripherally placed, as opposed to centrally inserted. Peripheral placement reduces the risk of haemothorax/pneumothorax and arrhythmias. However, the gauge of PICCs can vary and be very fine. Thus, blood products and infusions requiring high flow rates can be difficult to administer.



Figure 1: Peripherally inserted central catheter (PICC)

Central venous access device—implanted ports

Ports are internally implanted devices that can remain in situ for many years (Camp-Sorrell, 2004). The port consists of both titanium and hollow plastic housing with a self-sealing silicone septum, attached to a catheter. The port is surgically implanted and sutured into a subcutaneous chest pocket for stabilisation. Ports are accessed using a non-coring Huber needle that has an offset, bevelled end. This design allows the needle's tip to sit flush with the bottom of the port, permitting quick flow of solution. Huber needles prevent damage to the port's septum (Camp-Sorrell, 2004). It is recommended that the non-coring needle be changed at least every seven days (Tropp et al., 2006). Ports can be single or double, depending on patient requirements. Because ports are totally implanted, they are minimally invasive on the patient's lifestyle. However, accessing the port with a Huber needle increases the nurse's risk of needle-stick injury (Dougherty, 2006).



Figure 2: Implanted port

Post insertion care of CVADs—PICCs

After catheter insertion, a chest X-ray/medical imaging must be obtained in order to:

- confirm catheter placement
- ensure no adverse events (such as a pneumothorax) have occurred.

Catheters may change position when the patient moves, up to two centimeters away from the head with arm movement. The initial catheter tip position in the lower third of the superior vena cava may have a final position in the upper end of the superior vena cava (RNAO, 2005). The anatomical placement of the catheter tip must be documented in the patient record and checked before the initiation of any therapy through the device (RNAO, 2005). Before any infusion, the integrity of the CVAD should be determined by obtaining a blood return. This confirms that the CVAD is in the venous system (Dougherty, 2006).

PICCs and ports

Post-operative observations should include:

- level of consciousness (ANZCA, 2005)
- cardiorespiratory status (ANZCA, 2005)
- pain (ANZCA, 2005)
- insertion site for swelling, bleeding or other complications (CNSA CVAD working party).

After insertion, the dressing should be changed within the first 24 hours (RCN, 2003).

Central venous access device (CVAD)—dressing theory

The CVAD insertion site should be assessed daily, using inspection and palpation through the dressing or port pocket (Camp-Sorrell, 2004). Remove the dressing to enable closer inspection if tenderness/pain, swelling or exudate is present. Document suspected signs and symptoms of infection and report these to a medical officer for appropriate treatment.

CVADs should be accessed using a sterile technique (Tropp et al., 2006; Camp-Sorrell, 2004). A 2% chlorhexidine gluconate and 70% alcohol solution is recommended to cleanse the CVAD site. Allow the site to air dry before applying the dressing. Skin cleaning and antisepsis are essential for preventing CVAD-related infection. Organisms that may cause infections are introduced either from the patient's own skin, the hands of health care workers or through catheter movement in and out of the insertion site (RNAO, 2005).

The dressing should be changed once the integrity of the dressing is compromised and as appropriate for the dressing product (RNAO, 2005; O'Grady et al., 2002). Integrity is compromised when the dressing becomes damp, unsealed or soiled. Diaphoretic patients should have their dressings changed more frequently. The choice of dressing is made according to clinical context, including patient allergies and preference (Gillies et al., 2003; O'Grady et al., 2002). It is currently recommended that gauze dressings be changed every 48 hours and transparent semi-permeable dressings weekly. When showering, patients should cover the exit site and the external catheter with a waterproof cover, to minimise introducing organisms into the catheter or exit site (Camp-Sorrell, 2004; O'Grady et al., 2002).

The injection access cap should be changed for a sterile cap each seven days or earlier if compromised by presence of blood or if the integrity of the cap is compromised (MHRA, 2005; RCN, 2005; Perucca, 2001).

Central venous access device—PICC dressing procedure

1. The patient should be positioned comfortably, and the procedure explained to allay any patient concerns.
2. Perform hand wash.
3. Prepare appropriate equipment.
4. Perform hand wash.
5. Don clean gloves.
6. Remove old dressing without touching exit site.
7. Remove gloves and discard.
8. Perform hand wash and don sterile gloves.
9. Cleanse exit site.
10. Allow exit site to air dry.
11. Cleanse catheter length and injection caps.
12. Assess exit site for signs of infection and take appropriate action.
13. Assess catheter for signs of damage and take appropriate action.
14. Clamp catheter, unless device has a valved tip, and change injection caps.
15. Apply dressing.
16. Discard all waste appropriately.
17. Document procedure, status of the exit site, action taken, and outcome for patient. (adapted from Cancer Nurses Society of Australia, 2007)

Sterile gauze and tape

Sterile gauze dressings are appropriate immediately after catheter insertion when the insertion site may be bloody and oozing. Gauze dressings do not provide an occlusive barrier, but do have an absorbent action (Camp-Sorrell, 2004). With a gauze dressing in situ, the health care professional should be mindful that they cannot view the insertion site. Gauze dressings should be changed every 48 hours using an aseptic technique (RNAO, 2005). Dressings (such as a Duoderm window) can be used for patients who are allergic to particular dressing adhesives, and are diaphoretic.

Sterile transparent semi-permeable dressings

While acting as a barrier to extrinsic liquid and microorganisms, semi-permeable dressings allow moisture evaporation (RNAO, 2005; Camp-Sorrell, 2004). If sterile gauze is placed under a transparent dressing, it is considered a gauze dressing (RNAO, 2005). Transparent semi-permeable dressings should be applied without stretching the skin and smoothed from the centre to the edge. Edges should not be

sealed with tape (RNAO, 2005). Phlebitis and infiltration rates are decreased with transparent semi-permeable dressings (Tripepi-Bova et al., 1997). Visibility of the insertion site permits assessment of the CVAD without compromising the dressing's integrity.

Central venous access device—port dressing procedure

Inserting a Huber needle

1. Position the patient comfortably and explain the procedure to allay any patient concerns.
2. Perform hand wash.
3. Prepare appropriate equipment. Ensure that the Huber needle device has been primed with sterile 0.9% sodium chloride solution.
4. Perform hand wash.
5. Don sterile gloves.
6. Cleanse the area over the port body using a circular outward motion.
7. Locate port landmarks, including port walls and septum.
8. Secure the port body and push the non-coring needle into the port septum until it reaches the port base.
9. Assess patency of the port by checking for blood return.
10. Once the blood return is obtained, flush with sterile 0.9% sodium chloride solution.
11. Apply sterile transparent semi-permeable dressing.
12. Attach infusion or injection cap as required for treatment.
13. Document procedure and any changes in patient status or concerns.



Figure 3: Gripper plus safety needle

Removing a Huber needle

1. The patient should be positioned comfortably and the procedure explained to allay any patient concerns.
2. Perform hand wash.
3. Prepare appropriate equipment.
4. Flush and lock lumens, using the appropriate technique.
5. Don clean gloves.
6. Remove dressing and assess site.
7. Discard gloves and dressing.
8. Perform hand wash.
9. Don sterile gloves.
10. Stabilise the port with one hand, and grasp the non-coring needle hub with the dominant hand.
11. Pull the needle from port while firmly stabilising the portal body. Use a technique that protects the practitioner from needle-stick injury.
12. Apply pressure at site. Apply a dressing as required.
13. Discard all waste appropriately.
14. Document procedure and any changes in patient status or concerns.
(adapted from Cancer Nurses Society of Australia, 2007)

It is recommended that the non-coring needle, add-ons and dressing are changed every seven days.

Accessing and de-accessing the central venous access device

Gaining entry into a CVAD is termed 'accessing'. The minimum size syringe used to access or flush CVADs is 10 mL. Smaller syringes exert higher output pressure and may cause catheter rupture (RNAO, 2005; Camp-Sorrell, 2004). Most manufacturers recommend a minimum size of 10 mL (Primhak, Gathercole and Reiter, 1998).

Excessive force should **never** be used when flushing the CVAD. The equipment utilised to access the CVAD will depend on facility policy. CVADs should be accessed using a sterile technique (Tropp et al., 2006; Camp-Sorrell, 2004).

Before infusion of any solution, the integrity of the system should be determined by obtaining a blood return. This confirms that the CVAD is in the venous system and reduces the risk of extravasation (Dougherty, 2006). Once the intervention is complete, the CVAD should be flushed and de-accessed. CVADs are flushed using a 'push-pause' technique. This technique creates an intra-luminal turbidity purported to

be beneficial in cleaning the catheter lumens of debris (RNAO, 2005). A 0.9% sterile sodium chloride solution, flushing with 10–30 mL is recommended pre and post:

- administration of medication
- administration of blood and blood products
- intermittent therapy
- after obtaining blood specimens
- when converting from intermittent therapy
- for device maintenance when not in use (RNAO, 2005).

After the flush, the CVAD must be de-accessed, using the correct technique to prevent catheter occlusions by preventing blood flow back into the catheter when the CVAD device is not in use.

Accessing and de-accessing the central venous access device—PICC

1. Prepare the patient—explanation and positioning.
2. Prepare medication/infusion for administration and 10 mL 0.9% sterile sodium chloride solution for flushing and locking catheter.
3. Perform hand wash.
4. Don gloves.
5. Maintaining strict aseptic technique, swab injection cap with 70% alcohol solution and allow to air dry.
6. Obtain a blood return to confirm that the CVAD is in the venous system.
7. Administer medication/connect infusion. When complete, prepare to de-access the PICC.
8. Flush the PICC using push/pause technique.
9. While holding the injection port, use a positive pressure locking method to lock the PICC.
10. Discard waste.
11. Document procedure, outcomes for patient and device.

Accessing and de-accessing the central venous access device—port

1. Prepare the patient—explanation and positioning
2. Prepare medication/infusion for administration and 10 mL 0.9% sterile sodium chloride solution for flushing and heparin for locking the catheter
3. Perform hand wash
4. Don gloves.

5. Maintaining strict aseptic technique, swab injection cap with 70% alcohol solution and allow to air dry.
6. Remove/open clamp on Huber device.
7. Obtain blood return to confirm that the CVAD is in the venous system.
8. Administer medication/connect infusion. When complete, prepare to de-access port.
9. Flush port using push/pause technique.
10. Lock the Huber device line with 0.9% sodium chloride solution or heparinised saline and reapply the clamp.
11. Discard waste.
12. Document procedure, outcomes for patient and device.
(adapted from Cancer Nurses Society of Australia, 2007)

If at any time the injection port is placed on the skin it must be re-swabbed.

Positive pressure locking method

For valveless or open-ended devices, maintain pressure on the syringe plunger while clamping the CVAD line. For valved devices, maintain pressure on the syringe plunger before removing the syringe from the CVAD (RNAO, 2005). This prevents blood flow back into the catheter, thrombus formation and catheter occlusion (RNAO, 2005). Incorrect technique can cause the CVAD to become totally occluded.

The positive pressure lock technique should not be used when using a positive fluid displacement device (RNAO, 2005).

There is limited evidence to suggest a definitive solution for, and subsequently the correct frequency of, flushing and locking CVADs.

Heparin is a common locking solution utilised in facilities. Heparin lock is used to lock the CVAD when not in use by preventing occlusions via blood flow back into the catheter. Heparin should be used in the lowest concentration and volume possible, and only when necessary (RNAO, 2005). Also, heparin may be contraindicated with some CVADs, mainly Groshong PICCs.

Unvalved open-ended ArrowCaths, without positive pressure caps, are at risk of intraluminal blood reflux and subsequent clotting (RNAO, 2005; Camp-Sorrell, 2004). Heparin inhibits coagulation and fibrin build-up (RNAO, 2005). To reduce the risk of clot formation and fibrin build-up, locking open-ended catheters with heparinised-saline is recommended. Open-ended device implanted ports are commonly locked utilising a 50 IU heparin in 5 mL 0.9% sterile sodium chloride solution concentration (CNSA CVAD working party). Dormant ports should be routinely flushed and locked every four to six weeks (RCN, 2005; Camp-Sorrell, 2004).

Blood collection from a CVAD

One of the many patient benefits of CVADs is that they are designed to permit blood collection for specimens. This method of blood collection protects the integrity of the patient's peripheral venous system. To ensure the accuracy of laboratory tests, the previous solution instilled to lock the lumen should be withdrawn and discarded. The volume of blood that should be discarded to ensure test results are accurate is variable—between 3–10 mL, with 5–6 mL the most frequently used volume (Camp-Sorrell, 2004). Twice this volume is recommended when collecting for coagulation tests (RNAO, 2005).

Where there is a choice, blood should be collected from a dormant lumen, or collected from lines which are not used to instil medications, electrolytes or parenteral nutrition (CNSA CVAD working party). Blood collection from a CVAD should be documented on the laboratory, because values may be falsely prolonged due to heparin flushes (Camp-Sorrell, 2004). Blood results that appear to be inaccurate should be repeated using a sample drawn from a peripheral vein (Camp-Sorrell, 2004).

When blood cultures are to be collected from a CVAD, the specimen should include the lock solution (Everts and Harding, 2004).

Blood collection—Groshong PICC

1. Identify patient against name on pathology request.
2. Prepare the patient—explanation and positioning.
3. Prepare blood collection equipment according to hospital policy.
4. Perform hand wash.
5. Don gloves.
6. Maintain strict aseptic technique. Swab injection cap with 70% alcohol solution and allow to air dry.
7. Withdraw discard blood via syringe or Vacutainer system.
8. Another sterile syringe or Vacutainer is used to obtain the blood samples.
9. Flush PICC using push/pause technique with 10—20 mL 0.9% sodium chloride solution.
10. While holding the injection port, use a positive pressure locking method to lock the PICC.
11. Discard waste.
12. Correctly label pathology tubes after blood collection.
13. Document concerns related to blood withdrawal or flushing.
(adapted from Cancer Nurses Society of Australia, 2007)

Blood collection—port

1. Identify patient against name on pathology request.
2. Prepare the patient—explanation and positioning.
3. Prepare blood collection equipment according to hospital policy.
4. Perform hand wash.
5. Don gloves.
6. Maintain strict aseptic technique. Swab injection cap with 70% alcohol solution and allow to air dry.
7. Remove/open clamp on Huber device.
8. Withdraw discard blood via syringe or Vacutainer system.
9. Another sterile syringe or Vacutainer is used to obtain the blood samples.
10. Flush port using push/pause technique with 10—20 mL 0.9% sodium chloride solution.
11. Lock the Huber device line with 0.9% sodium chloride solution or heparinised saline and reapply the clamp.
12. Discard waste.
13. Correctly label pathology tubes after blood collection.
14. Documents concerns related to blood withdrawal or flushing.
(adapted from Cancer Nurses Society of Australia, 2007)

CVAD complications—infection

Nurses have an important role in the prevention, early detection and management of complications related to CVADs (Dougherty, 2006). Information relating to CVAD events, including the cause, action taken and outcomes should be documented in the patient's record (CNSA CVAD working party).

CVAD infections can occur within three weeks of insertion, and are commonly associated with contamination from skin flora upon insertion (Ray, 1999). Infections range from localised to systemic. Localised infections occur at the CVAD insertion site, along the cutaneous tunnelled tract or at the skin pocket containing the implanted port (Rosenthal, 2004). Systemic CVAD infections, also known as bacteraemia/septicaemia occur where both CVAD and peripheral blood cultures are positive for the same pathogen (Rosenthal, 2004; O'Grady et al., 2002). Unfortunately, many CVAD infections are undiagnosed or only recognised when septicaemia ensues (Dougherty, 2006).

Nurses must practise hand hygiene procedures before, during and after any CVAD manipulations or procedures (O’Grady et al., 2002). The use of gloves does not negate the need for hand washing (O’Grady et al., 2002). It is better to limit the number of CVAD accessing where possible (Rosenthal, 2004; O’Grady et al., 2002). Nurses should document their CVAD assessment findings and notify the medical officer when the patient’s temperature increases or when symptoms of suspected infection are found (CNSA CVAD working party).

Nurses also have an educative role in ensuring health care professionals. Patients and carers must utilise infection-control measures to prevent CVAD-related infections (O’Grady et al., 2002).

CVAD complications—CVAD occlusion

CVAD occlusion is defined in two ways:

1. Blood withdrawal occlusion

The catheter will flush, but the blood cannot be aspirated from the lumen. This occlusion not only greatly decreases the functionality of the CVAD, but also reduces the ability to verify both the position and patency of the CVAD (Mayo, 2001).

2. Total occlusion

The CVAD is unable to be flushed or yielded (Mayo, 2001).

An increasing resistance when flushing the CVAD is the first sign of a CVAD occlusion. Utilising the push-pause method to flush and positive pressure locking with the CVAD is the better way to prevent CVAD occlusion (Dougherty, 2006; Hamilton, 2006; Tezak, 2003). It is imperative that health care professionals document line patency with each access, including the observation of blood return and any resistance experienced (CNSA CVAD working party). Accurate documentation provides for early detection of CVAD problems. Unfortunately, the longer the catheter remains occluded, the lower the clearance success rate (RNAO, 2004).

The cause of CVAD occlusion is divided into two categories:

Non-thrombotic occlusions

- Mechanical obstructions caused by external factors, such as kinked or clamped IV tubing or a clamped CVAD lumen; and internal factors, such as CVAD tip malposition, damage or malposition of needle (Camp-Sorrell, 2004).
- Chemical occlusions may be caused by precipitates or lipid deposits from infusions of incompatible solutions (Dougherty, 2006; Hamilton, 2006; Steiger, 2006).

Nursing management

- Ensure lumen and IV tubing clamps are open before infusing.
- Prepare and place IV administration tubing and CVAD lumens to prevent kinks.
- Ensure infusion of compatible solutions.
- Flushing the tubing and lumen as recommended (CNSA CVAD working party).

Thrombotic occlusions

- A fibrin sheath or tail forming on the catheter tip acts as a one-way valve permitting infusion, but not blood aspiration.
- Fibrin deposits and/or sludge accumulation within the portal reservoir.
- An intraluminal blood clot (Camp-Sorrell, 2004; Gorski, 2003; Mayo 2001).

Nursing management

- Flush the tubing and lumen as recommended (CNSA CVAD working party).
- Using a 10 mL syringe, gentle flush and aspirate with 0.9% sodium chloride solution. This may clear the line and blood flashback may be returned (Dougherty, 2006).
- If complete thrombotic occlusion is suspected, instillation of a thrombolytic agent should be considered by the medical unit (Dougherty, 2006; Camp-Sorrell, 2004; McKnight, 2004).

PICC removal

When the medical unit decides to remove a PICC, the patient's coagulation profile must be reviewed to minimise the risk of bleeding (Dougherty, 2006). If the device is removed due to suspected or confirmed infection, the tip may be cut off using a sterile procedure and sent for culturing (Dougherty, 2006). After removal, the integrity and length of the CVAD should be checked to ensure the CVAD is intact (Dougherty, 2006). The health care professional must apply firm digital pressure post CVAD removal until haemostasis is achieved (CNSA CVAD working party), then a sterile occlusive dressing should be applied for at least 72 hours (RCN, 2005). Air embolism has been shown to occur up to 72 hours following device removal (RCN, 2005). The site should be reviewed and the following documented in the patient record:

- date and time of removal
- integrity of the device when removed
- whether the tip was sent for culture
- status of the site
- details of dressing applied and ongoing care required
- patient's status following removal (CNSA CVAD working party).

CVAD removal PICC

1. Verify order for CVAD removal.
2. Prepare the patient—explanation and positioning.
3. Perform hand wash.
4. Prepare appropriate equipment.
5. Don clean gloves.
6. Remove dressing.
7. Assess site and discard gloves.
8. Perform hand wash and don sterile gloves.
9. Cleanse exit site.
10. Remove catheter at the same angle of insertion, parallel to the skin, using a gentle tension.
11. Send the tip for culture if the catheter was removed due to infection.
12. Apply constant firm pressure to exit site until bleeding stops.
13. Apply airtight dressing.
14. Inspect device for appropriate length and integrity.
15. Document procedure and any changes in patient status or other concerns.
16. Regularly inspect exit site for bleeding, swelling and discharge.
(adapted from Cancer Nurses Society of Australia, 2007)

Learning activities

Suggested learning activities and timetable are outlined below.

Timing	Activity	Objective
25 minutes	Facilitated discussion	1, 2, 3, 8, 9
60 minutes	Skills stations: <ul style="list-style-type: none"> ■ Applying a PICC dressing ■ Insertion/removal of a Huber needle ■ Blood collection from a PICC ■ Accessing/deaccessing a PICC 	4, 5, 6, 7
20 minutes	Summary	All
10 minutes	Evaluation	

Total time = 2 hours

Facilitated discussion

The facilitator should lead a discussion amongst participants about the issues covered in the background information and module objectives 1, 2, 3, 8 and 9. The facilitator should not give a didactic lecture, but instead promote open discussion and knowledge sharing amongst participants. Participants should be encouraged to share any real-life experiences they have encountered and reflect on the patient's psychological experiences in relation to treatment with and without the CVAD.

Major issues which the facilitator should ensure are covered include:

- the indications for insertion of PICCs or ports
- differences between non-tunnelled PICCs and internal ports
- the postoperative management of CVADs
- hospital policies for the ongoing care of PICCs and ports
- clinical complications when using PICCs and ports.

PowerPoint slides are available for the facilitator to use to summarise these main points at the end of the discussion or to act as triggers for discussion if the participants have not identified them.

Skills stations

The skills stations allow participants to practise and demonstrate:

- changing the dressing and injection ports of the CVAD
- how to access and de-access the CVAD port with a Huber point device
- blood collection from a PICC
- methods for maintaining CVAD patency.

The skills stations allow participants to practise while receiving feedback in a structured format from peers and/or facilitators.

The program and resources required assume two facilitators for every six participants, a ratio of 1:3.

Applying a PICC dressing

The facilitator requires a manikin or model suitable for practising removing and applying PICC dressings, such as Chester Chest. Participants should have the opportunity to practise removing and applying PICC dressings. Feedback should be provided at the completion of the skill. Each participant should observe the facilitator initially and then spend 15 minutes on this task while observing the performance of two other participants.

Insertion/removal of a Huber needle

The facilitator requires all the necessary equipment to set up for insertion/removal of a Huber needle from a port. Participants should be given the opportunity to practise insertion/removal of a Huber needle, and receive feedback at the completion of the skill. Each participant should observe the facilitator initially and then spend 10 minutes on this task while observing the performance of two other participants.

Blood collection from a PICC

The facilitator requires a manikin or model suitable for practising collecting blood from a PICC, such as Chester Chest. Participants should be given the opportunity to practise collecting blood collection from a PICC, and receive feedback at the completion of the skill. Each participant should observe the facilitator initially and then spend 10 minutes on this task while observing the performance of two other participants.

Accessing/de-accessing a PICC

The facilitator requires a manikin or model suitable for practising accessing/de-accessing a PICC, such as Chester Chest. Participants should be given the opportunity to practise accessing/de-accessing a PICC, and receive feedback at the completion of the skill. Each participant should observe the facilitator initially and then spend 10 minutes on this task while observing the performance of two other participants.

Summary

The summary session reinforces content covered in the learning activities, and is an opportunity for participants to reflect on what they have covered. No new material should be introduced.

Major points to recap in the summary include:

- the indications for insertion of PICCs or ports
- differences between non-tunnelled PICCs and internal ports
- the post-operative management of CVADs
- hospital policies for the ongoing care of PICCs and ports
- clinical complications when using PICCs and ports.

Participants should be encouraged to review their hospital guidelines for management of PICCs and ports in their own time to reinforce the skills acquired in this module. They should be offered access to equipment and educators in the future to allow them to practise these skills if they need to improve their skill level or confidence. Participants might also be encouraged to attend and observe clinical areas of the hospital where this procedure is regularly performed to gain further experience and put these skills into a clinical context.

Resource list

The following resource list assumes two facilitators for every six participants, a ratio of 1:3. As a minimum, the following resources are needed to conduct this module.

Resource	Quantity	Additional comments
Facilitators	2	
Manikin or model capable of CVC insertion	2	
PICC devices	2	
Port devices	2	
Sterile packs, sterile and non-sterile gloves, gowns, injection ports and dressing material	6 sets	One for each participant
10 mL syringes and blunt cannulae	26	
Chlorhexidine skin preparation	6	
Alcohol swabs	10	
0.9% sodium chloride 10 mL ampoules	20	
Heparin saline 50 units: 5 mL	5	
Blood collection equipment:		
■ Vacutainer tubes	26	
■ Vacutainer barrel	4	
■ gloves	6	
■ alcohol swabs	10	

Evaluation

A formal evaluation has been specifically developed for this module. It incorporates the objectives of the module and the perceptions of the participants about whether they have increased their understanding by working through the module. It is highly recommended that this formal evaluation be copied and completed by all participants at the completion of the module.

A range of informal evaluation tools may also be used in conjunction with this evaluation throughout the module, including those available in the Department of Human Services' *Clinical Skills Facilitators Manual* from the basic course conducted in 2007.

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Resources

Facilitator feedback form

The following form should be used to assist you in giving feedback after each participant has practised their CVAD skills at the skills station.

Feedback using the Pendleton model

Pendleton's model of feedback assists learners to maximize their potential at different stages of training, raise their awareness of strengths and areas for improvement, and identify actions to be taken to improve performance. Pendleton's rules are structured in such a way that the learner identifies the positives first, in order to create a safe environment. This is followed by the facilitator or group reinforcing these positives and discussing skills to achieve them. Different techniques are then suggested. The advantage of this method is that the learner's strengths are discussed first. Avoiding a discussion of weaknesses right at the beginning prevents defensiveness and allows reflective behaviour in the learner.

Below is a series of questions to assist you in this technique:

1. Ask the learner how they feel.
2. Ask the learner what went well and why (this can be combined with question 1 and 3).
3. Tell the learner what went well and why.
4. Ask the learner what could have been done better and why.
5. Tell the learner what could have been done better and why.
6. Summarise the learner's strengths and identify up to three things to concentrate on.

Note: This form does not need to be given to the participant — it is a guide for you, the group facilitator.

Module 3: Central venous access devices—evaluation

Thank you for participating in this module. As part of our commitment to quality improvement the following questionnaire will be used to plan future implementation of this module. We appreciate your time completing this evaluation.

1. Overall

How would you rate this module?

poor fair good very good outstanding

2. Learning objectives

Please consider whether this module was successful in meeting the following learning objectives:

<i>IV therapy</i> Learning objectives of Module 3: central venous access devices	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
Identified the indications for insertion of PICCs or ports	<input type="checkbox"/>				
Distinguished the differences between non-tunnelled PICCs and internal ports	<input type="checkbox"/>				
Implemented the postoperative management of CVADs	<input type="checkbox"/>				
Practised and demonstrated changing the dressing and injection ports of the CVAD	<input type="checkbox"/>				
Practised and demonstrated accessing and de-accessing the CVAD port with a Huber point device	<input type="checkbox"/>				
Practised and demonstrated blood collection from CVADs	<input type="checkbox"/>				
Practised and demonstrated the methods for maintaining CVAD patency	<input type="checkbox"/>				
Investigated hospital policies for the ongoing care of PICCs and ports	<input type="checkbox"/>				
Classified and evaluated clinical complications when using PICCs and ports	<input type="checkbox"/>				

3. Important learning outcomes

What are the three most important things you have learned from this module?

4. Module implementation

Please indicate to what extent you agree or disagree with each of the following statements in relation to the implementation of the module.

	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
The facilitator respected my experience	<input type="checkbox"/>				
The facilitator encouraged my participation	<input type="checkbox"/>				
I was able to ask the facilitator questions	<input type="checkbox"/>				
The facilitator was able to answer my questions	<input type="checkbox"/>				
The feedback I received was clear	<input type="checkbox"/>				
The feedback I received will assist me in my future performance	<input type="checkbox"/>				
There was adequate time for the skills stations	<input type="checkbox"/>				
There was adequate time for the facilitated discussions	<input type="checkbox"/>				
There was adequate time for the simulations	<input type="checkbox"/>				
I have increased my confidence in inserting or dealing with CVA devices	<input type="checkbox"/>				
I have identified future learning needs in this topic area	<input type="checkbox"/>				

5. Future module implementation

Do you think the module should be altered in any way? yes no

If yes, what recommendations do you have?

Thank you

PowerPoint presentation

- Clinical Skills in Hospitals Project**

**Iv Therapy
MODULE 3
'Central Venous
Access Devises'**


- Module Outline**

 - Facilitated discussion
 - Skills stations
 - Summation
 - Evaluation
- Module Outline**

 - Indications for the insertion of CVAD's
 - Indications for the insertion of PICC's and Port's include
- Devices**

 - **Peripherally Inserted Central Catheter (PICC)**
- Devices**

 - **Implanted Ports**
- CVAD Management**

 - Standard care requirements
 - Line patency
 - Dressing changes
 - Access port devices
 - Monitoring
- CVAD Skill Stations**

 - 4 skill stations

Module 4: Central venous lines

Introduction

Intravenous insertion and *IV therapy* was developed as a teaching and learning tool for Victorian clinical educators. The information contained in each module was developed using evidence-based resources and examples of best practice. Where expert opinion varies, a discussion section is included. However, it is not within the scope of *IV therapy* to address the full spectrum of local variations. Variations can occur in several areas, including practices relating to types of equipment used, infection control processes, practice guidelines and so on. Therefore, educators should, where appropriate, adapt content to reflect their local policies, procedures and protocols. This will ensure the relevancy of the package content to your learners.

The modules are designed to be discrete courses in their own right. They are timetabled so they can be completed in a 1–2 hour timeframe. This timeframe was chosen after we received feedback from clinical educators requesting shorter courses, because health professionals often have limited time to educate away from patients. However, the packages may also be combined into a one- or two-day course.

IV therapy should be used as an educational tool to assist in the teaching of clinical skills. It is structured as a guide to assist clinical educators, and uses many concepts taught in the *Clinical Skills in Hospitals Project* (Train-the-Trainer courses). Educators are encouraged to build on this resource by adding their own scenarios which incorporate hospital/health service protocols, policies and other resources. Each module is designed as a lesson plan to incorporate the simulations into the teaching of clinical skills.

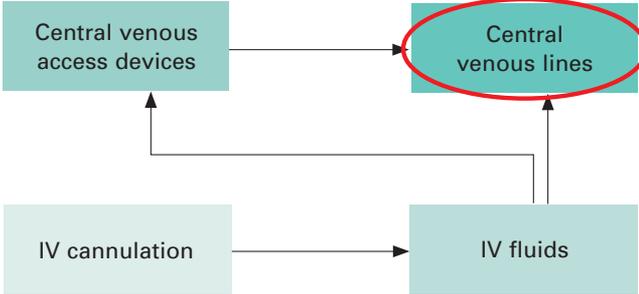
Aims

IV therapy aims to make participants confident in their use intravenous devices—either from an insertion perspective (discipline specific) or as a therapy delivery device.

Package structure

The *IV therapy* package contains four modules, which provide learning opportunities for health professionals at all levels of experience and from medical and nursing disciplines. Modules 1 and 2 are regarded as fundamental. Modules 3 and 4 are set at the intermediate level.

The assessment for and insertion of IV cannula, plus knowledge of basic therapies, such as fluid types, are fundamental to this area of practice. The use of specific devices, such as central venous access ports, is less common in general health care settings, and requires specific knowledge and skill for their use. The insertion and care of central venous lines is covered in *IV therapy—Module 4: Central venous lines*. Although some skills are discipline specific, such as central line insertion, educators should consider an interdisciplinary approach to the use of these modules.

Level of complexity	Package structure
<p>Complex For participants with more than 4 years experience or who have completed Modules 1–4</p>	 <pre> graph TD IV_cannulation[IV cannulation] --> IV_fluids[IV fluids] IV_fluids --> CVA[Central venous access devices] IV_fluids --> CVL((Central venous lines)) CVA --> CVL style CVL stroke:#f00,stroke-width:2px </pre>
<p>Intermediate For participants in postgraduate years 3–4 or who have completed Modules 1 and 2</p>	
<p>Fundamental For participants in postgraduate years 1–2</p>	

This package was designed to develop participants' knowledge, skills and behaviours required to work with intravenous therapy, and to expose them to increasingly complex scenarios to test their ability to combine these individual skills, work as a team and problem solve in more difficult situations.

Educators delivering these modules should be aware of participants' level of experience and choose appropriate modules. Modules presume an increasing level of knowledge as they progress, ranging from a fundamental knowledge of anatomy and physiology for the fundamental modules, up to detailed knowledge of central venous access devices and central lines. Novice participants (such as first-year graduates) are expected to start with the fundamental modules, and only move onto intermediate and more complex modules as they demonstrate proficiency. More experienced participants may start at the intermediate level if the educator is satisfied that they have the prior knowledge and skills. Individual educators are responsible for assessing each participant's baseline knowledge and determining which modules they should complete. More specific descriptions of presumed knowledge are outlined in each module.

The design of these packages presumes that the clinical educators using them have knowledge and expertise in current best practice regarding the teaching of clinical skills and conducting facilitated discussions. Knowledge and expertise are presumed commensurate with the Department of Human Services' basic and advanced Train-the-Trainer programs. Clinical educators are encouraged to refer to Department of Human Services' *Clinical Skills Facilitators Manual* for theory on:

1. Peyton's model for teaching clinical skills
2. leading small group discussions
3. giving feedback
4. crisis resource management skills.



Module 4: Central venous lines

Authors: Dr Stuart Dilley

Aims

This module helps health professionals to become confident and competent in inserting, or assisting in the insertion of, central venous catheters (CVC) and femoral lines. It also teaches recognition of and actions in response to important complications, as well as procedures for managing these lines in terms of monitoring and maintenance.

Presumed knowledge

This module is aimed at medical and nursing health professionals involved in inserting, using and maintaining CVCs. They are expected to have a basic knowledge of:

1. central venous anatomy—great vessels of the neck, subclavian vessels
2. chest and neck anatomy—clavicle, sternocleidomastoid muscle, trachea, lungs
3. femoral triangle anatomy—femoral vein, artery and nerve
4. physiology of central venous pressure.

Objectives

By the end of this module, participants should have:

1. reviewed the indications for CVC or femoral line insertion
2. practised inserting or assisting in the insertion of internal jugular, subclavian and femoral lines on a simulated training model
3. practised using the CVC to measure central venous pressure (CVP) on a simulated patient
4. reviewed their own hospital policies related to the ongoing care of CVC
5. discussed strategies to identify and manage important complications of CVC insertion.

Background information for educators

The main purpose of this module is for participants to become familiar with central lines. Educators should take note of the mix of health professionals in the group. While medical staff are responsible for insertion of lines, all health professionals should be aware of the indications, techniques and problems associated with central line insertion. Where the group comprises non-medical staff, the focus of discussion and learning sessions should be on familiarity with equipment and assisting medical staff with CVC insertion.

Indications

Serious complications—including death—can occur with CVC insertion. Up to 15% of patients who undergo this procedure experience one or more complications¹ (see section below 'Complications'). Health professionals must determine the risk of CVC insertion based on indications and contraindications.

Indications for the insertion of a CVC include^{1, 2}:

- administration of certain drugs—adrenaline, amiodarone, TPN
- haemodynamic monitoring—measurement of central venous pressure
- insertion of transvenous cardiac pacing wire
- the need for haemodialysis/haemofiltration
- inaccessible peripheral lines
- prolonged intravenous therapy.

Because of the relatively small individual lumen diameter and long catheter length, these catheters have high resistance to flow, which makes them less than ideal for rapid fluid infusion and resuscitation. In this instance, large-bore, short, peripherally placed catheters are more appropriate.

Because CVC may be life saving, there are no absolute contraindications to CVC insertion. However, the need for CVC insertion should strongly be reconsidered in the following circumstances:

- coagulopathy, including warfarin use
- morbid obesity
- local infection/burns at site of CVC insertion
- obstructive airways disease due to the risk of pneumothorax
- positive pressure ventilation due to the risk of pneumothorax.

Pre-insertion considerations

Catheter

Single or multiple lumen catheters are available. The complication rate is not affected by the number of lumens, so catheters should be chosen to suit the clinical needs of the patient. Multi-lumen catheters are usually used, and may negate the need for multiple venous access points.



Figure 1: Catheter

Site

Multiple approaches to the central veins include the internal jugular (IJ), external jugular (EJ) veins and subclavian (SC) veins. The right IJ vein is preferred over the left because it provides a more direct route to the superior vena cava (SVC) and avoids the thoracic duct, which is on the left. The dome of the left lung also rises higher in the neck than the right, making the risk of pneumothorax theoretically higher on the left.

There is probably a higher risk of arterial puncture with IJ catheterisation compared with SC catheterisation³, but this might be because carotid artery puncture is more easily recognised than subclavian artery puncture. Inadvertent carotid artery puncture is more easily managed than subclavian artery puncture. The risk of haemothorax or pneumothorax appears to be equal for both IJ and SC catheterisations³. While femoral vein catheterisation has no risk of pneumothorax, and can be performed in patients who cannot lie completely flat, infectious complications have been reported as 3–4 times more likely in femoral catheters than subclavian⁴.

Technique

Standard CVC line is the most commonly required central line. PICC lines, Hickman's catheters and dialysis lines have specific indications and are usually inserted by dedicated staff and departments within the hospital, for example, radiology.

The following technique applies to the insertion of standard CVC lines and femoral lines.

Pre-procedure

Vital to the success of CVC insertion is preparation of the patient. Preparation should include the following:

- explanation of procedure to patient, including rationale for insertion and potential complications
- obtaining consent to proceed
- cardiac monitoring
- assembling and checking all equipment
- optimal positioning of patient.

Patient position is influenced somewhat by the venous access site chosen.

Correct positioning for IJ and SC catheter insertion should include:

- supine, Trendelenburg position (on their back, 15° head down)
- head turned away from side of access
- a rolled-up towel placed between shoulderblades may assist access to the SC vein.

For femoral line insertion, the patient should be fully reclined if possible, but head-down tilt is not required, and may make catheterisation more difficult by draining the leg veins.

Procedure

Having prepared the patient and identified landmarks, CVC insertion can proceed. A Seldinger technique is used, meaning the CVC catheter is fed over a guide wire, which has been placed in a central vein, directing the catheter to the desired location and then removing the guide wire. CVC insertion should adhere to the following points:

- adherence to aseptic technique—that is, hand washing, gown, gloves and mask
- skin cleaning with an appropriate disinfectant (chlorhexidine, iodine, alcohol)
- application of sterile drapes
- confirmation of anatomical landmarks and site of skin puncture (see below)
- infiltration of skin with local anaesthetic (for example, approx 5 mL 0.5—1.0% lignocaine)
- estimation of distance from entry site to SVC by placing catheter over patient's chest.

Technique

- Insert the catheterisation needle, bevel up, to locate the central vein. The direction of insertion depends on the CVC site chosen (see below).
- Gentle suction is applied at all times so that localisation of the vein is immediately identified by rapid flush of venous blood into the barrel of the syringe.
- The guide wire is then passed through the needle and into the central vein. Some CVC kits allow the wire to be passed directly through the syringe. Others require that the syringe be removed from the needle first. In this case, a thumb should be placed over the hub of the needle to reduce the risk of air embolisation.
- Guide wires may be long enough to enter the heart, and the monitor should be checked for ventricular ectopy. If ectopic beats occur, the guide wire should be withdrawn until this no longer occurs.
- Remove the catheterisation needle while holding the guide wire in place.
- A scalpel and/or plastic dilator are then used to open the skin and dilate the subcutaneous tissues before insertion of the catheter.
- The CVC catheter is then introduced over the guide wire to the predetermined depth (see below). The tip of the catheter should rest just above the junction of the SVC and right atrium.
- The guide wire is then removed while holding the CVC catheter in place.

- Free flow of blood from the catheter lumen confirms correct placement.
- Each catheter lumen is then aspirated to ensure removal of air and flushed with 10 mL of 0.9% saline (normal saline). It is acceptable to flush all but the central lumen in this manner before inserting.
- Secure the catheter to skin with sutures.
- Apply sterile dressing.
- Before use, confirm correct placement and absence of pneumothorax with an erect chest X-ray.

Landmarks, direction and depth

The two most common routes for CVC insertion are the infraclavicular approach to the SC vein and the central approach to the IJ vein. While not universally available, some authors suggest that placement of central lines under ultrasound guidance is associated with a reduction in the frequency of complications^{5, 6}.

For the SC vein:

- The operator should position themselves at the head of the bed.
- The entry site is 1 cm caudal to junction of middle and medial thirds of the clavicle.
- Advance beneath the clavicle parallel to frontal (horizontal) plane.
- Aim for the sternal notch.
- Advance the needle 3–5 cm, depending on the size of the patient.
- The CVC catheter should be advanced to a depth of 14–15 cm for right-sided catheters and 18–19 cm for left-sided catheters⁷.

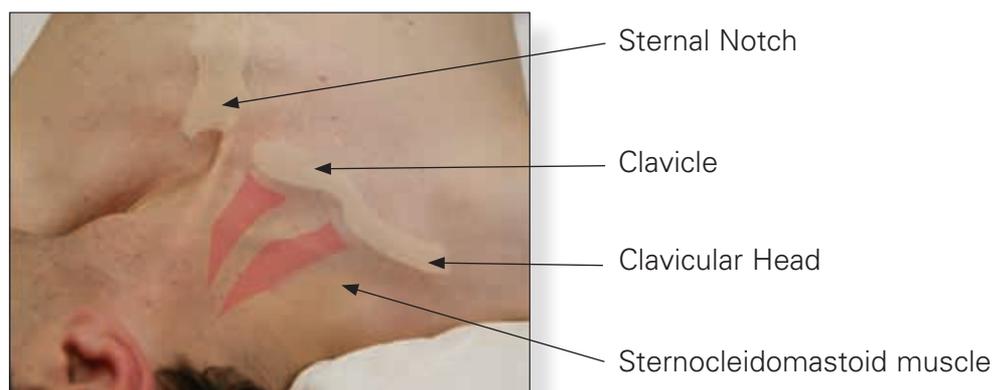


Figure 2: The SC vein

For the IJ vein:

- The operator should position themselves at the head of the bed.
- Identify the triangle formed by medial and lateral heads of the sternocleidomastoid muscle and the clavicle.
- Identify the pulse of the carotid artery lying medial and deep to the IJ vein.

- The entry site is at the apex of the triangle, at an angle of 45° to the frontal (horizontal) plane.
- Direct the needle caudally and laterally, towards the ipsilateral nipple.
- Advance the needle 3–5 cm, depending on the size of the patient.
- Advance the CVC catheter to a depth of 16–17 cm for right-sided catheters and 19–21 cm for left-sided catheters⁷.

For the femoral vein:

- The patient should be supine, with legs slightly abducted.
- The operator should position themselves at the side of the bed.
- Identify the anterior superior iliac spine (ASIS) and pubic tubercle.
- Insert the needle below the line joining these two points (inguinal ligament).
- The femoral artery is identified by a palpating pulse.
- The femoral vein lies parallel, 1 cm medial to the femoral artery.
- The entry site over the femoral vein is 1–2 cm below the inguinal ligament and 1 cm medial to the femoral artery.
- Direct the needle cephalad, at a 45° angle to the frontal (horizontal) plane.
- Advance the needle to a depth of 3–5 cm, depending on the size of the patient.

Complications

Complications of CVC insertion are not uncommon^{1, 3}. They include:

- pneumothorax
- haemothorax
- arterial puncture
- haematoma formation
- infection
- venous thrombosis
- foreign body embolisation (guide wire)
- arterio-venous fistula formation.

CVP monitoring

Individual hospitals may have site-specific preferences about equipment and protocols. Educators should take these preferences into account when facilitating this module. The general principles of CVP monitoring and pressure measurements are outlined below.

Transducer preparation

The following steps are a guide to preparing a transducer for CVP measurements. Individual hospital protocols may vary, and should be presented by facilitators during this module.

- Attach a standard giving set to a 500 mL bag of 0.9% saline, and prime the line.
- Place the saline bag within the pressure bag and inflate to 300 mmHg.
- Attach the transducer to the primed line and flush.
- Using an aseptic technique, aspirate the distal (brown) lumen of the CVC to remove air or clots.
- Still using aseptic technique, connect a transducer to the distal lumen.
- Flush the CVC lumen.
- Connect the CVP transducer to the monitor.
- Label the waveform 'CVP'.
- Locate the level of the patient's right atrium (fourth intercostal space, mid-axillary line) and mark with ink marker.
- Using a spirit level, position the transducer on a rack at the same height as the marker, or place it on the patient's chest at that level.

CVP reading

CVP readings should be done in a standardised manner to ensure consistency in measuring and recording the CVP. The following method is suggested.

- Elevate the patient's head 30°.
- Make sure the patient is settled—not coughing, straining or talking.
- Pause any infusion running through the CVP monitoring lumen.
- Ensure that the pressure bag is inflated to the appropriate level (300 mmHg).
- Inspect the monitoring line for air bubbles, loose connections or blood, and remedy any irregularities by aspirating the line and tightening connections.
- Turn the tap on the introducer so that it is off to the patient. Remove the cap on the injection site and open the system to atmospheric pressure (air).
- Access the CVP menu of the monitor and zero the monitor and transducer to air. The monitor should display a CVP value of zero.
- Replace the injection site cap and re-open the tap to the patient.
- The monitor should now display the CVP waveform and a mean value for CVP.
- CVP measurements should be obtained at end of expiration. CVP falls during normal inspiration.

CVP interpretation

- Normal CVP is 0–8 mmHg.
- CVP > 8 mmHg suggests excess intravascular fluid.
- CVP < 0 mmHg suggests insufficient intravascular fluid.

CVC care and troubleshooting

Once inserted, central venous lines should be observed for the occurrence of complications, including:

- infection
- migration in or out
- blockage
- disconnection.

Dressings should be changed regularly, according to individual hospital protocols. Transparent dressings provide for security of the CVC while allowing health professionals to observe the site of entry for bleeding, infection or migration. Routine antibiotics and routine replacement (for example, weekly change) is not shown to reduce the risk of infection² and is not recommended. CVCs should be removed if they are obviously infected, or thought to be the focus of sepsis. Giving sets should be changed on a regular basis according to hospital protocols, (for example, every 72 hours routinely, immediately following blood transfusion, daily for TPN administration and so on).

Positive pressure flushing should be maintained to prevent blockage. The use of heparin compared to saline remains controversial, although the efficacy of heparin is unproven². Follow individual hospital protocols. Flush catheters after each access if used intermittently. Maintain positive pressure while removing the syringe, in order to prevent a reflux of blood into the catheter.

Catheter blockage is evidenced by difficulty in infusing fluid or aspirating blood. Forcible introduction of fluid down the catheter lumen may damage the catheter and cause embolisation of foreign material. Thrombosed catheters may potentially be unblocked with the use of heparin and/or a fibrinolytic agent (for example, urokinase, alteplase and so on). Individual hospital protocols should exist for the use of these agents, including indications and doses.

Pain around the insertion site during infusion should prompt the cessation of infusion and medical review to ascertain the location of the catheter. Leakage around the insertion site suggests loose connections or catheter damage.

Learning activities

Suggested learning activities and timetable are outlined below.

Timing	Activity	Objective
30 minutes	Facilitated discussion	1, 4, 5
30 minutes (two sessions)	Skills stations: <ul style="list-style-type: none"> ■ CVC insertion ■ CVP set-up and measurement 	2, 3
10 minutes	Summary	All
10 minutes	Evaluation	

Total time = 1 hour 50 minutes

Some educators may not have access to models or manikins that allow for the practice of CVC insertion. In this instance, the CVC insertion skills station part of this module may not be completed. However, the module may still be conducted in a shorter form, with the emphasis on CVP set-up and measurement. An alternative timetable for this situation is provided below.

Alternative timetable in the absence of CVC insertion models

Timing	Activity	Objective
30 minutes	Facilitated discussion	1, 4, 5
30 minutes	Skills station: <ul style="list-style-type: none"> ■ CVP set-up and measurement 	3
10 minutes	Summary	All
10 minutes	Evaluation	

Total time = 1 hour 20 minutes

Facilitated discussion

The facilitator should lead a discussion amongst participants about the issues covered in the background information, for example, indications for CVC insertion, technique of insertion, complications and CVP monitoring. The facilitator should not give a didactic lecture, but instead promote open discussion and knowledge sharing amongst participants. Participants should be encouraged to describe any real-life experiences they have encountered.

- Major issues which the facilitator should ensure are covered include:
- indications for CVC insertion
- institution-specific policies for CVC insertion and management
- techniques for CVC insertion

- complications of CVC insertion
- CVP measurement and monitoring.

PowerPoint slides are available for the facilitator to use to summarise these main points at the end of the discussion, or as triggers if participants have not identified the major issues.

Skills stations

The skills stations allow participants to practise insertion of, or to assist in the insertion of CVCs on appropriate models. They also allow participants to practise setting up CVP measurement lines and to practise CVP measurements while receiving feedback in a structured format from peers and/or facilitators.

Some educators may not have access to models or manikins that allow for the practice of CVC insertion. In this instance, the CVC insertion skills station part of this module may not be completed, and the alternative timetable provided for this situation should be followed.

The program and resources required assume two facilitators for every six participants, a ratio of 1:3.

CVC insertion station

One facilitator should have access to a manikin or model suitable for teaching CVC insertion. Participants should be given the opportunity to practise inserting IJ and SC CVC lines in addition to femoral lines. Participants should be guided through the skill using Peyton's four-step model⁸. Feedback should be provided at the completion of the skill. Each participant should observe the facilitator initially and then spend 7–8 minutes on this task while observing the performance of two other participants.

CVP measurement station

The other facilitator should have all the necessary equipment to set up for CVP monitoring. Participants should be guided through the process of setting up for and measuring CVP using Peyton's⁸ four-step method, as for the CVC insertion station. Each participant should observe the facilitator initially and then spend 7–8 minutes on this task while observing the performance of two other participants. This station might finish ahead of the CVC insertion station, in which case, facilitators should use this opportunity to discuss CVC positioning (using the X-ray provided), CVC care, complications and troubleshooting with their participants. Several case studies are provided to stimulate this discussion if needed.

Higher fidelity manikins may be employed to demonstrate CVP waveforms, but these manikins are not widely available. In that instance, this module provides some additional resource material (still shots of CVP monitor waveforms and DVD footage of CVP monitor waveforms) which can be presented to the participants for their interpretation.

Scenario 1

You are reviewing a patient who has had a CVC inserted, and has just had a CXR to confirm its position. You are provided with the CXR. What is your role in the patient's management at this point (medical, nursing, allied health)?

Participants should comment on the location of the CVC by reviewing the CXR. They should be asked to discuss their role in management at their health professional group, and then be led in a discussion about correct catheter placement and also the need to exclude pneumothorax. (The chest X-ray is located in the Appendix.)

Scenario 2

You are reviewing a patient who has had a CVC present for the last three days. The CVP pressure is no longer reading on the monitor and the infusion pump is constantly beeping for an occlusion in the line. What is your role in the patient's management at this point (medical, nursing, allied health)?

Participants should identify that the CVC has become occluded. They should discuss their role in management with respect to their health professional group, and then be led in a discussion regarding procedures and protocols in place at their institution about this problem.

Scenario 3

You are reviewing a patient who has had a CVC present for the last week. You note that he is hot, clammy and shaking. There is some redness around the CVC insertion site. His nursing observation chart shows that he has a fever of 38° Celsius. What is your role in the patient's management at this point (medical, nursing, allied health)?

Participants should identify that this patient has signs of infection, and that CVC site or line infection is a possibility. They should be asked to discuss their role in management with respect to their health professional group, and then be led in a discussion regarding prevention and management if CVC site infection.

Summary

The summary session reinforces content covered in the learning activities, and is an opportunity for participants to reflect on what they have covered. No new material should be introduced.

Major points to recap in the summary include:

- indications for CVC insertion
- techniques and traps for successful CVC insertion
- complications of CVC insertion
- CVP measurement and monitoring.

Participants should be encouraged to review their hospital guidelines for CVC insertion and management in their own time to reinforce the skills acquired in this module. They should be offered access to equipment and educators in the future to allow them to practise these skills if they need to improve their skill level or confidence. Participants might also be encouraged to attend and observe clinical areas of the hospital where this procedure is regularly performed (for example, ICU, theatre) to gain further experience and to put these skills into a clinical context.

Resource list

The following resource list assumes two facilitators for every six participants, a ratio of 1:3. As a minimum, the following resources are needed to conduct this module.

Resource	Quantity	Additional comments
Facilitators	2	
Manikin or model capable of CVC insertion	1	
CVC devices	2 sets	One for each station More than two sets are desirable, because guide wires become bent and difficult to pass
Drapes, sterile packs, gloves, gowns	2 sets	One for each station
Drug props—local anaesthetic, saline	1	
Suture material/dressing material	1	
500 mL saline bag and giving set	1	For CVP station
Pressure bag	1	
CVC transducer	1	
Spirit level	1	
Manikin capable of CVP simulation	1	Optional
Simulated CVP monitoring trace	1	Provided with module
Chest X-ray	1	In Appendix

Evaluation

A formal evaluation has been specifically developed for this module. It incorporates the objectives of the module and the perceptions of the participants about whether they have increased their understanding by working through the module. It is highly recommended that this formal evaluation be copied and completed by all participants at the completion of the module.

A range of informal evaluation tools may also be used in conjunction with this evaluation throughout the module, including those available in the Department of Human Services' *Clinical Skills Facilitators Manual* from the basic course conducted in 2007.

References

1. Taylor R, Palagiri A 2007 Central venous catheterization. *Crit Care Med* 35: 1390–1396
2. Bishop L, Dougherty L, Bodenham A et al. 2007 Guidelines on the insertion and management of central venous access devices in adults. *Int Jnl Lab Hem* 29: 261–278
3. Ruesch S, Walder B, Tramer M 2002 Complications of central venous catheters: Internal jugular versus subclavian access—A systematic review. *Crit Care Med* 30: 454–460
4. Hamilton H, Foxcroft D 2007 Central venous access sites for the prevention of venous thrombosis, stenosis and infection in patients requiring long-term intravenous therapy. *Cochrane Database of Systematic Reviews*, Issue 3. Art. No.: CD004084.DOI:10.1002/14651858.CD004084.pub2
5. Calvert N, Hind D, McWilliams R et al. 2002 The effectiveness and cost-effectiveness of ultrasound locating devices for central venous access. National Institute for Clinical Excellence: www.nice.org.uk/nicemedia/pdf/ULD_assessment_report.pdf (accessed April 2008)
6. Randolph A, Cook D, Bonzales C et al. 1996 Ultrasound guidance for placement of central venous catheters: A meta-analysis of the literature. *Crit Care Med* 24: 2053–2058
7. Czepizak C, O'Callaghan J, Venus B 1995 Evaluation of formulas for optimal positioning of central venous catheters. *Chest* 107: 1662–1664
8. Peyton J. 1998 *Teaching and Learning in Medical Practice*. Manticore Europe Ltd, Great Britain

Module 4: Central venous lines

Thank you for participating in this module. As part of our commitment to quality improvement the following questionnaire will be used to plan future implementation of this module. We appreciate your time completing this evaluation.

1. Overall

How would you rate this module?

poor fair good very good outstanding

2. Learning objectives

Please consider whether this module was successful in meeting the following learning objectives:

<i>IV therapy</i> Learning objectives of Module 4: Central venous lines	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
Reviewed the indications for CVC and femoral line insertion	<input type="checkbox"/>				
Practised inserting or assisting the insertion of IJ, SC and femoral lines on a simulated training model	<input type="checkbox"/>				
Practised using the CVC to measure CVP on a simulated patient	<input type="checkbox"/>				
Reviewed their own hospital policies related to the ongoing care of CVCs	<input type="checkbox"/>				
Discussed strategies to identify and manage important complications of CVC insertion	<input type="checkbox"/>				

3. Important learning outcomes

What are the three most important things you have learned from this module?

4. Module implementation

Please indicate to what extent you agree or disagree with each of the following statements in relation to the implementation of the module.

	Strongly disagree	Disagree	Slightly agree	Agree	Strongly agree
The facilitator respected my experience	<input type="checkbox"/>				
The facilitator encouraged my participation	<input type="checkbox"/>				
I was able to ask the facilitator questions	<input type="checkbox"/>				
The facilitator was able to answer my questions	<input type="checkbox"/>				
The feedback I received was clear	<input type="checkbox"/>				
The feedback I received will assist me in my future performance	<input type="checkbox"/>				
There was adequate time for the skills stations	<input type="checkbox"/>				
There was adequate time for the facilitated discussions	<input type="checkbox"/>				
There was adequate time for the simulations	<input type="checkbox"/>				
I have increased my confidence in inserting or dealing with CVCs	<input type="checkbox"/>				
I have identified future learning needs in this topic area	<input type="checkbox"/>				

5. Future module implementation

Do you think the module should be altered in any way? yes no

If yes, what recommendations do you have?

Thank you

PowerPoint presentation

1. **Clinical Skills in Hospitals Project**

Intravenous Access and Therapy
MODULE 4
'Central Venous Lines'

 
2. **Module Outline**

 - Facilitated discussion
 - Skills stations
 - CVC insertion
 - CVP set up and measurement
 - Summation
 - Evaluation
3. **CVC Insertion**

 - Indications
 - Considerations
 - Technique
 - Complications
4. **CVP Monitoring**

 - Preparation
 - Measurement
 - Interpretation
 - Care and complications



Appendix 1

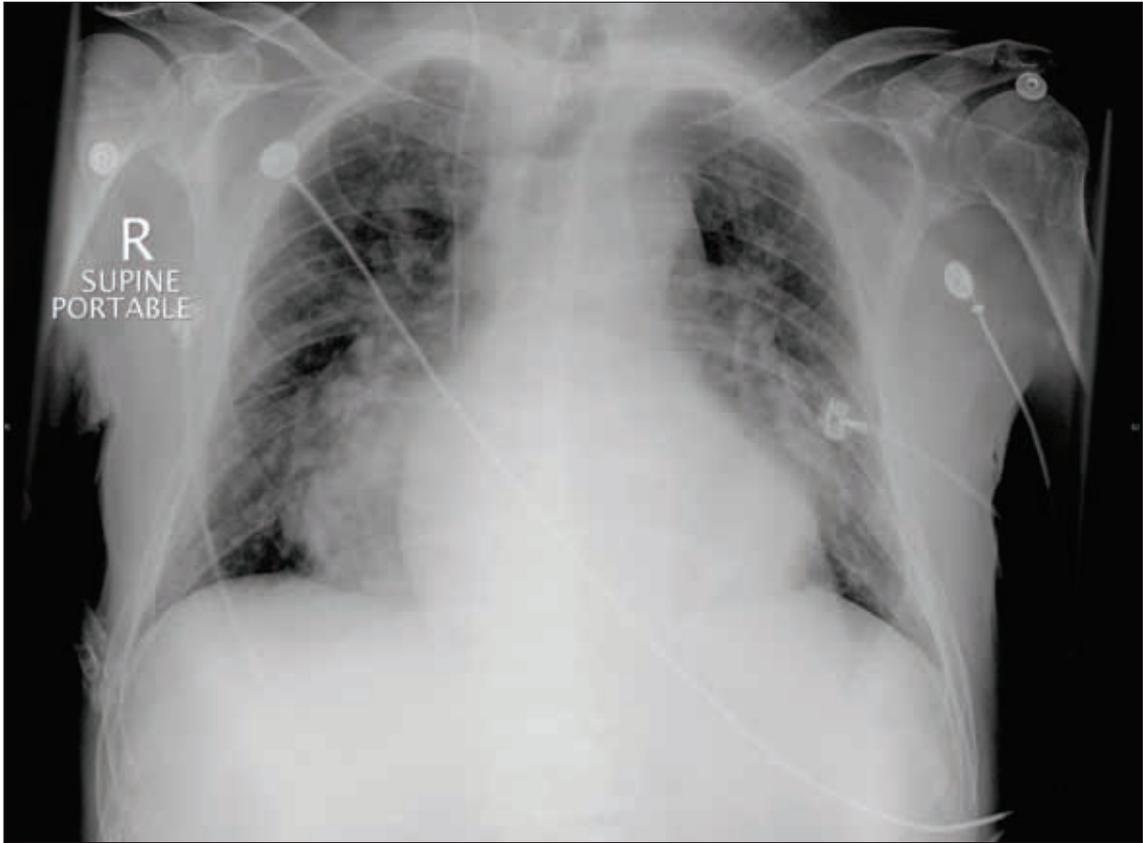


Figure 4: CVC chest X-ray



Acronyms, abbreviations and measurements

Acronyms

A/C	assist control
AAFB	acid and alcohol fast bacilli
ABG	arterial blood gas
ACS	acute coronary syndromes
AEDs	automated external defibrillator(s)
AF	atrial fibrillation
AHA	American Heart Association
ALS	advanced life support
AMI	acute myocardial infarction
APO	acute pulmonary oedema
APTT	activated partial thromboplastin time
ARC	Australian Resuscitation Council
ASB	assisted spontaneous breathing
AV node	atrioventricular node
BBB	bundle branch block
BiPAP	bilevel positive airway pressure
BLS	basic life support
BUN	blood urea nitrogen
CABG	coronary artery bypass graft
cath lab	catheterisation laboratory
CE	cardiac enzymes
CHB	complete heart block
CK	creatine kinase
CKMB	creatine kinase Mb
CMV	controlled mandatory ventilation
CNS	central nervous system
COAD	chronic obstructive airways disease
COPD	chronic obstructive pulmonary disease
CPAP	continuous positive airway pressure
CPR	cardiopulmonary resuscitation
CRM	crisis resource management
CVA	cerebrovascular accident
CVC	central venous catheter
CVS	cardiovascular system
CXR	chest X-ray
DIC	disseminated intravascular coagulation
DKA	diabetic ketoacidosis
DKS	Damus-Kaye-Stansel [procedure]

DRABC	D: danger R: response A: airway B: breathing C: circulation
DVT	deep vein thrombosis
ECF	extracellular fluid
ECG	electrocardiogram
ED	emergency department
EMD	electromechanical dissociation
ENT	ear, nose and throat
EPAP	expiratory positive airways pressure
ET	endotracheal
FBE	full blood examination
FFP	fresh frozen plasma
FRC	functional residual capacity
g	gram
GCS	Glasgow Coma Scale
GI	gastro-intestinal
GIT	gastro-intestinal tract
GTN	glyceryl trinitrate
Hb	haemoglobin
HIV	human immunodeficiency virus
HME	heat moisture exchanger
HPS METI	a brand (Human Patient Simulator) of fully automatic, high-fidelity patient simulator
HR	heart rate
I:E ratio	inspiration-to-expiration ratio
ICF	intracellular fluid
ICP	intracranial pressure
INR	international normalised ratio
IO	intraosseous
IPAP	inspiratory positive airways pressure
IPPV	intermittent positive pressure ventilation
IV	intravenous
LBBB	left bundle branch block
LDH	lactate dehydrogenase
LMA	laryngeal mask airway
mA	milliampere
MET	medical emergency team
NBM	nil by mouth

NGT	nasogastric tube
NIMC	national inpatient medication chart
NIPPV	non-invasive positive pressure ventilation
NIV	non-invasive ventilation
NP airways	nasal prong airways
NSEACS	non-ST elevation acute coronary syndrome
NSR	normal sinus rhythm
OP	oropharyngeal airway
OTC	over-the-counter medications
PCA	patient-controlled analgesia
PCI	percutaneous coronary intervention
PEA	pulseless electrical activity
PEEP	positive end expiratory pressure
pH	the measure of the acidity or alkalinity of a solution
PICC	peripherally inserted central catheter
PIP	peak inspiratory pressure
PRVC	pressure regulated volume control
PS	pressure support
PTX	pneumothorax
QRS	wave form seen on electrocardiogram
RA	room air
RBBB	right bundle branch block
RIC line	rapid infusion catheter exchange set
RMO	registered medical officer
rPA	retaplastase
RR	respiration rate
RSI	rapid sequence induction
rt-PA	alteplase
RV	right ventricular
SIMV	synchronised intermittent mandatory ventilation
SK	streptokinase
SR	Sinus rhythm
STEMI	ST elevation myocardial infarction
SVC	superior vena cava
TPN	total parenteral nutrition
UWSD	underwater seal drainage
V/Q mismatch	ventilation/perfusion mismatch
VF	ventricular fibrillation
VT	ventricular tachycardia
WCC	white cell count
WOB	work of breathing
WPW	Wolf-Parkinson-White syndrome

Chemical formulae

CaCl ₂	calcium chloride
CO ₂	carbon dioxide
ETCO ₂	end-tidal carbon dioxide
FiO ₂	fraction of inspired oxygen
H ₂ CO ₃	bicarbonate
MgCl ₂	magnesium chloride
MgSO ₄	magnesium sulphate
PaCO ₂	partial pressure of carbon dioxide in arterial blood
PaO ₂	partial pressure of oxygen in arterial blood
SpO ₂	percentage of oxygen saturation in blood
SaO ₂	saturation of oxygen in arterial blood flow

Units of Measurement

abbreviation	unit
mmHg	millimetres of mercury
L	litre
mL	millilitre
µg	microgram — one-millionth (10 ⁻⁶) of a gram
mmol	millimole
J	joule
mg	milligram
cm	centimetre
m	metre

