

Management of IA Lines

Indications

Invasive arterial blood pressure monitoring is required if:

- Unstable haemodynamic status
- Postoperatively, including cardiovascular surgery
- Titration of drug therapy
- Frequent blood gas sampling
- Respiratory failure
- Septic shock
- Head injury

Sites

The sites for arterial cannulation are:

- Radial artery is most commonly used. In older children an Allen Test should be done to check that the ulnar artery is patent and it is therefore safe to cannulate the radial artery. Allen test: compress the radial and ulnar artery at the wrist followed by releasing the radial artery to observe the return of circulation to the hand
- Femoral artery
- Posterior tibial artery
- Dorsalis pedis artery
- Axillary artery
- Umbilical artery (in the newborn infant only). See Umbilical Catheter guidelines.
- Brachial artery, rarely used as is an end artery

Keep the cannulated extremity in a neutral or slightly extended position

WAVEFORM:

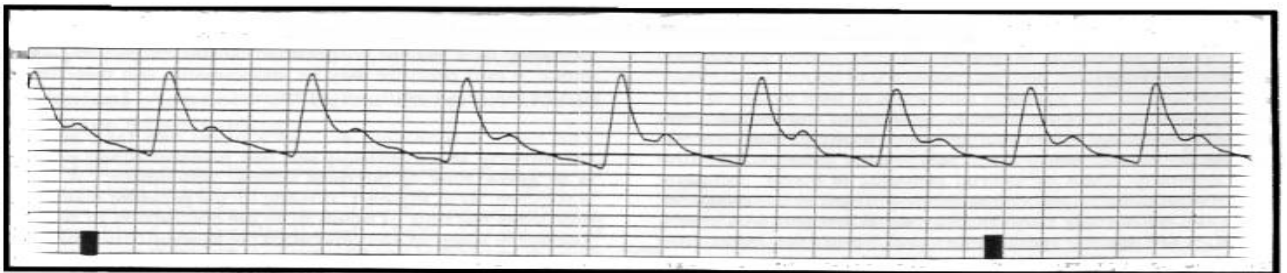
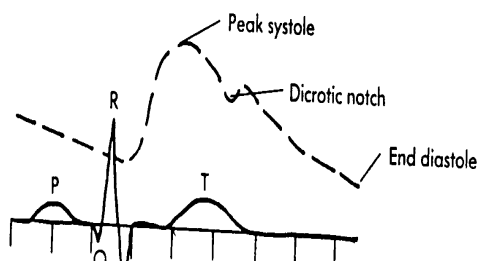


Figure 4a: Transduced IA waveform

The normal arterial trace should appear as above in Figure 4a. The arterial waveform can be divided into systolic and diastolic components as shown in Figure 4b.



Reference: Daily & Schroeder (1995)

Figure 4b: IA waveform with dicrotic notch

- The systolic component follows the ECG R wave. It consists of a steep pressure upstroke, peak, and decline, and corresponds to the period of left ventricular systolic ejection.
- The down slope of the waveform is interrupted by the dicrotic notch, which reflects aortic valve closure at end-systole.
- The remainder of the waveform occurs during diastole and the ABP reaches its lowest point at end-diastole.
- Values for systolic and diastolic blood pressure displayed are the systolic peak, the end-diastolic trough pressure and the mean arterial blood pressure.

Securing

- Cannula site must be visible
- Secure upper and lower limb to IV board with 2 pieces thin Elastoplast™ tape
- Secure cannula with Steri-Strips™ tape, placed under and crossing over opposite side of cannula
- Place Tegederm™ IV transparent dressing over cannula
- Finally secure the short Viggo to the skin with a piece of 2.5cm Leuko™ tape just above cannula site.
- Keep area dry and strapping secure.
- Change the dressing and tapes when the catheter is replaced or when the dressing becomes damp, soiled or loose

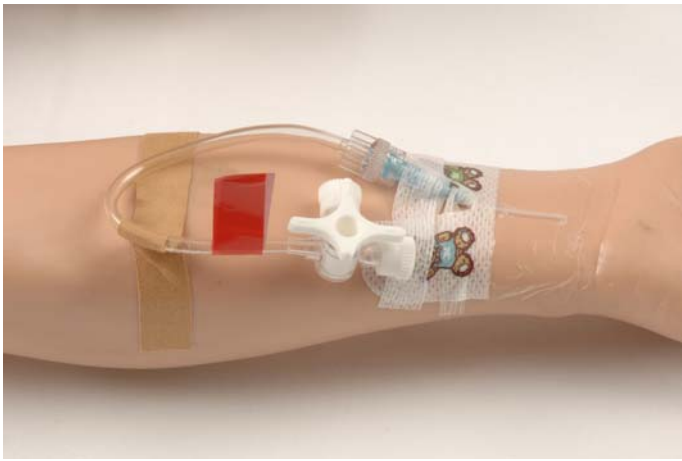


Figure 5: Securing IA cannula and dressing

Site checks

- Ensure insertion site is always visible to monitor for bleeding, line disconnection, or cannula dislodgement
- Check insertion site hourly for signs of bleeding, phlebitis, or infection
- For lines inserted in limbs: check colour, warmth, capillary return, movement, and circulation hourly. Report any significant variations and review with PICU medical staff

Blood Sampling

- Calculate volume of blood required based on tests requested and collect appropriate specimen tubes/syringes
- Put on protective eyewear
- Aseptic procedural hand hygiene
- Put on gloves
- Remove cap (and keep it aseptic) from 3 way tap and clean sampling port with alcohol swab
- Using a 2ml syringe, withdraw a minimum of 2ml dead space from line (and keep in the sterile syringe package until returned). If taking blood to check coagulation, take 5ml dead space for infants and 10ml dead space for children
- Turn 3 way tap 45° so it is off in all directions to prevent bleeding and heparin contamination of the blood sample
- Withdraw required amount of blood into appropriate syringes and place into specimen tubes
- Return dead space blood slowly to the patient. Aspirate blood from patient gently tapping any air bubbles up to the plunger end. Gently reinsert blood taken prior to sampling. The rate of replacement should be no greater than 0.5mls per 10 seconds. No air bubbles should be present in the line and if present they should be aspirated immediately. Do NOT replace fluid if thrombi or debris is visible in aspirate. Watch for any signs of blanching or increased resistance.
- Clean 3-way tap thoroughly with small swab stick and alcohol swab
- Replace cap

- Label all specimens and complete pathology request form
- Discard used equipment and wash hands
- Review results and show to PICU medical staff

Complications

- Air embolism
- Bleeding and major haemorrhage
- Vasospasm
- Infection
- Impaired perfusion to distal limb
- Ischaemia / necrosis
- Thrombosis
- Inaccurate blood pressure measurement

Trouble shooting

Dampened Trace

- Check arterial catheter insertion site and /or limb. Reposition as necessary
- Check line for air bubbles and remove
- Check complete system for leaks or disconnection
- Ensure appropriate scale on monitor
- Check for any small blood clots. Gently aspirate line-discard any clots. If any resistance is felt, reposition the line. If resistance is still present, stop and inform medical staff.

Blanching

- Inform medical staff
- Check pulses in affected limb
- Observe perfusion to finger tips/toes of affected limb
- Consider removing line

Bleeding

- Check connections
- Check insertion site and retape line as necessary
- Apply pressure and observe peripheral perfusion and check pulses
- Check coagulation and correct any coagulopathy in consultation with PICU medical staff

Infection

- Site should be observed regularly for early signs of infection and documented
- Inform PICU medical staff if infection is suspected
- Superficial infection; should the site look inflamed or the possibility of an infection is present, swab the site and smear a glass slide for microscopy prior to placing swab into charcoal medium.
- Systemic; if the patient is febrile (Temp > 38C), take blood cultures from peripheral, arterial and central lines

Extravasation

Extravasation is when the cannula tip moves into the tissues. This can be recognized by oedematous tissue and leaking from around the site.

- Inform PICU medical staff
- Remove line
- Elevate affected limb

Removal

- Perform aseptic procedural hand hygiene.
- Put on clean gloves and protective eyewear.
- Carefully remove the tape, sutures (if applicable), and cannula.
- Apply pressure with gauze or cotton wool to prevent bleeding, for a minimum of 5 minutes, or until bleeding stops
- When bleeding ceases, cover site with band-aid TMor cotton wool and tape
- Check the site for bleeding or haematoma formation
- Check perfusion to extremity by observing colour, temperature and capillary refill

Management of CVP Lines

Indications

- Fluid volume administration
- Monitoring effectiveness of volume administration
- Manipulation of central venous pressure
- Drug administration
- Administration of Total Parental Nutrition

Sites

The sites for venous cannulation are

- Subclavian vein
- Internal and External Jugular vein
- Umbilical vein (see Umbilical Catheter guidelines)
- Femoral vein

Waveform

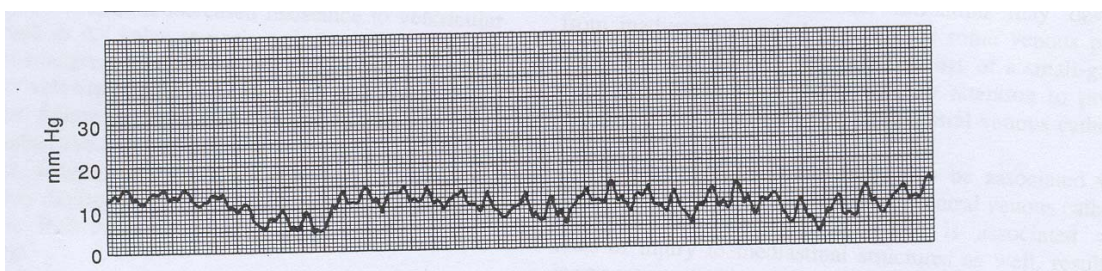
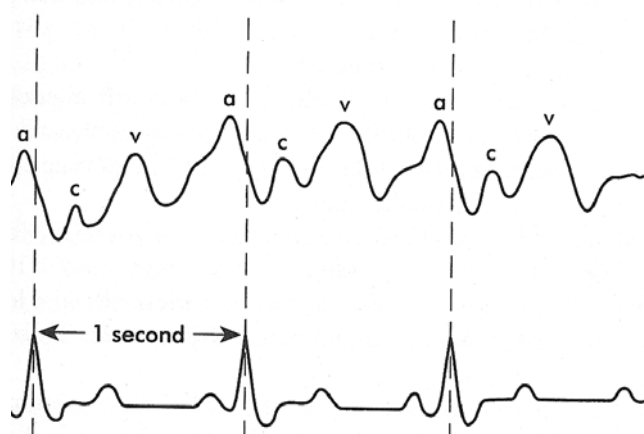


Figure 6a: Transduced CVP recording



Reference: Daily & Schroeder (1995)

Figure 6b: CVP waveform (a = atria contraction, c = triscupid valve closure, v = ventricle contraction)

- Central venous pressure is a reflection of pressure changes in the right atrium. These changes consist of three positive deflections; 'a', 'c' and 'v' wave. The correlation between the ECG and the pressure waveform is close
 - The 'a' wave is the atria contracting,
 - The 'c' wave is the closure of the AV valve (triscupid) and maybe absent in paediatric patient because of the distensibility of the atria in children
 - The 'v' wave indicates an increase in pressure due to the contraction of the ventricle
- Trends in CVP over time or in response to fluid administration are more useful than absolute numeric values
- Patients should be positioned supine for measuring CVP. Mean CVP is higher in the supine position than in right or left lateral positions
- Haemodynamic pressures should be measured at end-expiration

Securing cannula

- Central cannulas are sutured in place. The line is secured with a Tegaderm™ transparent dressing sandwiching the line and an anchoring Leuko™ tape (Figure 7). Additionally the line is anchored to the bed sheet with safety pin and elastic band.



Figure 7: CVC traction dressing

Filter

- Central lines require a 0.22 micron filter attached to prevent air and debris entering the circulation. This filter is placed in the line as close to the cannula insertion site as possible. However blood products (excluding albumin), lipids and some drugs (eg Profol, Cyclosporin, Prostin, Octreotide, Amphotericin) are not to go through the filter, so extra three way taps are placed after the filter and before the cannula insertion point to enable administration of these products. Additionally this will enable the rapid infusion of volume in an emergency. Most of the common drugs used in ICU are able to go through the .2 micron filter, for example heparin, sedatives and inotropes and dilators.

Site checks

- Check for swelling or oedema in the neck and above the insertion site
- Check insertion site and sutures for signs of bleeding, line disconnection, cannula dislodgement, or infection
- Apply clean dressing to site and change 6 daily or prn as required
- Assess site and document this when dressing is changed
- Report any significant variations and review with PICU medical staff

Blood Sampling

CVC lines are not routinely accessed for blood sampling, however on occasions a Blood Culture or venous sample may be required. Refer to CVAD Guideline (www.rch.org.au/policy_rch/index.cfm?doc_id=7845)

Complications

- Injury during insertion; pneumothorax, punctured vessel or myocardium
- Air embolism
- Tamponade; during insertion
- Arrhythmias; due to line migrating into the atrium
- Bleeding; due to unsecured connections or catheter disconnection
- Infection; local or systemic
- Thrombosis
- Dislodgment
- Venous stasis and discoloration of distal limb

Trouble shooting

Dampened Trace

- Check cannula insertion site.
- Check line for air bubbles and remove any present
- Check complete system for leaks or disconnection
- Ensure appropriate scale on monitor
- Gently aspirate line and discard any blood clots.

Bleeding

- Check connections
- Check line position on chest x-ray
- Check insertion site and retape line as necessary with traction dressing
- Check coagulation and platelet count and correct any coagulopathy in consultation with PICU medical staff

Infection

- Site should be observed regularly for early signs of infection and documented
- Inform PICU medical staff if infection is suspected
- Superficial infection; should the site look inflamed or the possibility of an infection is present, swab the site and smear a glass slide for microscopy prior to placing swab into charcoal medium
- Systemic; if the patient is febrile (Temp > 38C), take blood cultures from peripheral, arterial and central lines

Extravasation

Extravasation is when the cannula tip moves into the tissues. This can be recognized by oedematous tissue and leaking from around the site, or displacement on CXR.

- Inform PICU medical staff
- Remove line

Removal

- Discontinue infusions prior to removal

- Perform aseptic procedural hand hygiene.
- Put on clean gloves and protective eyewear.
- Carefully remove the tape, sutures, and cannula.
- Apply pressure with gauze or cotton wool to prevent bleeding, for a minimum of 5 minutes.
- When bleeding ceases, cover site with band-aid TM or cotton wool and tape

Management of Direct Transthoracic Cardiac Lines

Intracardiac lines include Direct Left Atrial (LA), Direct Right Atrial (RA) and Pulmonary Artery Line (PA). These lines are inserted directly into the heart usually in the operating theatre under direct vision. They are secured with a purse string suture to the epicardium and exit the mediastinum via the chest wall.

Pressures transduced from these lines add to clinical assessment, evaluation of therapies and haemodynamic management of the post-operative cardiac child.

Waveform

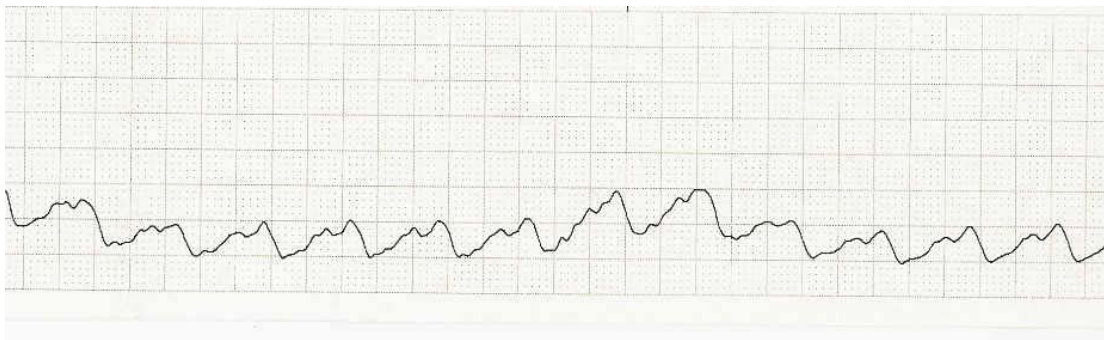


Figure 8a: Direct line waveform

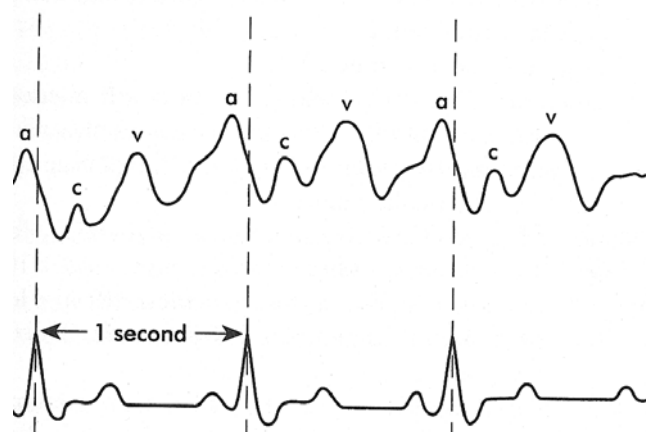


Figure 8b: Direct line waveform (a = atria contraction, c = valve closure, v = ventricle contraction)

Left atrial pressure is a reflection of pressure changes in the left atrium.

Right Atria pressure is a reflection of pressure changes in the right atrium.

These changes consist of three positive deflections; 'a', 'c' and 'v' wave. The correlation between the ECG and the pressure waveform is close

- The 'a' wave is the atria contracting,
- The 'c' wave is the closure of the AV valve and maybe absent in paediatric patient because of the distensibility of the atria in children
- The 'v' wave indicates an increase in pressure due to the contraction of the ventricle

Haemodynamic pressures should be measured at end-expiration

Securing cannula

- The cannula is sutured in place intra-operatively
- Secure line externally with traction taping using a 2.5cm Leuko™ tape and Tegaderm™ IV (Figure 9). Secure line to bed sheet with safety pin and elastic band



Figure 9: Direct line traction dressing

Site checks

- Check insertion site for bleeding, line disconnection, or cannula dislodgement

- Check insertion site for signs of infection
- Apply clean dressing to site and change 6 daily or prn as required
- Assess site and document this when dressing is changed
- Report any significant variations and review with PICU medical staff

Blood Sampling

- Sampling from direct lines is not routine practice and only occurs upon request from the PICU Consultant or Cardiac Surgeon.
- To prevent air or emboli directly entering the circulation (especially for LA lines, or patients with mixed circulations) extreme care must be taken to ensure no air, thrombi, or debris is injected
- If necessary to take blood, except for the specific items below, follow the procedure for removing blood from an intra-arterial line (see page 8)
- Do not return dead space blood. This is discarded
- Following completion, flush the cannula directly via the 3 way tap with Heparinised dextrose solution
- If there is any resistance do not push flush solution. Report to doctor immediately

Filter

- All direct lines require a 0.22 micron filter to prevent air and debris entering the circulation. On transducer lines this filter is placed between the syringe and the transducer so that pressure monitoring remains accurate (see Figure 10).

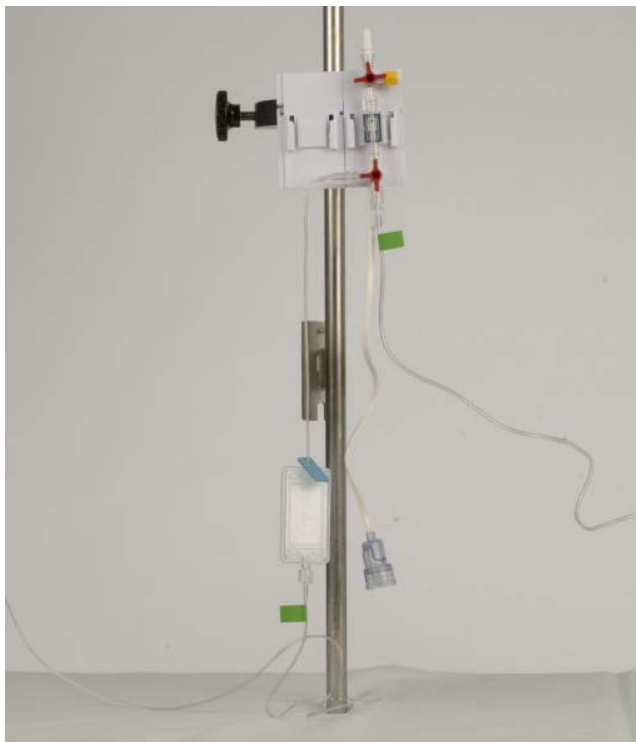


Figure 10: Filter position in direct monitoring lines.

Infusions

- Infusions of Heparinised Dextrose are required continuously to maintain line patency
- No drugs are to be infused into direct cardiac lines, unless under specific orders from the PICU consultant. These lines are labelled “Monitoring Only”

Complications

- Air embolism directly into the systemic circulation
- Thrombosis directly into the systemic circulation
- Tamponade: due to displacement of the line out of the heart, followed by bleeding
- Arrhythmias
- Infection: can be local or systemic
- Bleeding due to unsecured connections, coagulopathy
- Catheter kinking
- Dislodgement: the direct line migrates out of its insertion site into the cardiac muscle or chest wall. This can be due to tension on the catheter or migration with increasing chest wall oedema post-operatively

Troubleshooting

- Check for debris or clots in the line or taps which can cause artifact
- Check for correct levelling of pressure transducer
- Check that transducer is zeroed
- A dampened pressure waveform, where it becomes rounded and loses its sharp definition, can be related to:
 - presence of air bubbles or blood
 - loose connections
 - kinked tubing
 - catheter kinking at the insertion site, wedged inside against a vessel wall, or due to fibrin deposits on the catheter tip

Disconnection & removal

- Intracardiac lines are disconnected and capped off when the cardiac surgical team decide the lines are not required
- Intracardiac lines are usually removed 4 days after cardiac surgery
- Ensure Heparin is off for a minimum of 2 hours prior to removal
- Check patient's coagulation and platelet count on the day of removal
- Correct any coagulopathy prior to removal
- Ensure blood products are available
- Give pain relief medication as ordered

- Perform aseptic procedural hand hygiene
- Put on clean gloves and protective eyewear
- Carefully remove the occlusive dressing, sutures and line
- Apply manual pressure until bleeding stops
- When bleeding ceases, cover site with band-aid TM
- Observe closely post removal for signs of cardiac tamponade: tachycardia, extreme pallor or mottled discoloration, increased chest drain losses, increased CVP or LA or direct RA pressures, jugular venous distension, muffled heart sounds, hypotension, or pulsus paradoxus >10mmHg
- An echocardiogram is performed 4-6 hours post removal

Left Atrial Line

Indications

- Accurately assess left ventricular filling pressure (preload)
- Left ventricular failure
- Mitral valve incompetence

Specific complications

- Air or thrombi directly circulating to the cerebral and systemic circulation

Specific precautions

- Never infuse or administer drugs directly
- Never use for blood sampling
- Never push on an apparently blocked line
- Cardiac surgeons only can manipulate lines

Right Atrial Line

Indications

- Usually used for patients who will be having a cavo-pulmonary shunt at a later stage and who should avoid having their SVC cannulated and damaged
- Accurately assess right ventricular filling pressure (preload)
- Right ventricular failure
- Tricuspid valve incompetence

Specific complications

- In patients with mixed circulations or who have a right to left shunt, there is a risk of air or thrombi directly circulating to the cerebral and systemic circulation

Specific precautions

- Avoid infusing or administer drugs directly
- Minimise use for blood sampling
- Never push on an apparently blocked line
- Cardiac surgeons only can manipulate lines

Pulmonary Artery Line

- Three PA pressures are measured: the systolic, diastolic & mean
- The upstroke of the PA waveform & the systolic pressure represent the pressure generated by right ventricular ejection of blood into the pulmonary vasculature
- The systolic pressure is equal to the RV systolic pressure. When the RV pressure is less than the PA pressure, the pulmonary valve closes. This causes the dicrotic notch on the descending wave form
- The PA end diastolic pressure is an indicator of the left atrial pressure, and left ventricular end diastolic pressure when there is no elevated pulmonary vascular resistance or downstream obstruction eg. mitral stenosis
- The PA mean pressure is the average pressure over the entire cardiac cycle

Indications

- High pulmonary vascular resistance
- Right ventricle failure
- Tricuspid valve incompetence
- Mixed venous oxygen saturation monitoring

Specific complications

- In patients with mixed circulations or who have a right to left shunt, there is a risk of air or thrombi directly circulating to the cerebral and systemic circulation

Specific precautions

- Avoid infusing or administer drugs directly
- Minimise use for blood sampling

- Never push on an apparently blocked line
- Cardiac surgeons only can manipulate lines

Family Centred Care

Families are kept informed of the haemodynamic monitoring technology in use on their child. Appropriate explanations of the technology are provided at all times. Families are informed when decisions to initiate and discontinue monitoring are made.

Links

- **RCH CVAD Policy (www.rch.org.au/policy_rch/index.cfm?doc_id=7845)**

Administration

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