# CRYONICS UK

## Emergency Services

## Co-ordination, standby, stabilisation, perfusion, cool down & transport protocols

*July 2022*







**SECTION:**



**APPENDIX:**




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# *CHANGES FROM OCTOBER 2019 VERSION*

Section 3 Sheets 1 and 2:

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| Item 3.3<br>Item 3.4 | Change of wording to clarify the procedures and to take account of latest advice for lung ventilation. |

Section 4 Sheet 1:

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| Item 4.1 | Additional comments about CombiTube removal and patient temperature during transfer of the patient to the embalmer's table. |

Section 5 Sheets 5, 7 to 11 and 14:

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| Item 5.10 | Changes to the wording to reflect CUK's current policy on lung ventilation. |
| Item 5.14 including: | More detailed information on perfusion entry and exit pressures, temperatures and flow rates to comply with updated recommendations. |
| 5.14.1 | Updated diagrams and re-worded text to give more details about procedures for the Cryonics Institute method, especially control of pressure. |
| 5.14.2 | Slight changes to the Alcor method descriptions of how to check perfusion pressure and when to stop perfusion. |
| 5.15.2 | Additional information on size and approximate weight of transport box and allowable weights of dry ice for shipping. |
| Appendix B | Meds list and protocols updated to meet new recommendations. |
| Appendix D | Note on tieing off the carotid arteries, and change to drainage tube requirements for the cannulas to the jugular veins. |
| Appendix E<br>Restricted version | Information added: additional funeral director, transport crate maker, and paramedics organisation (provisional). |
| Appendix G<br>Restricted version | A dry ice hazardous substances label has been added. |
| General | Small changes have been made throughout the text to rectify typing errors, improve readability and improve cross-referencing. |

The numbered sections below correspond to the sections of this manual.

## 1. INITIAL PHONE CALL AND ALERTS

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| 1.1 RECEIVE INITIAL PHONE CALL - request for standby team | ● Record all contact details. |
| 1.2 PHONE ALCOR OR CRYONICS INSTITUTE | ● Verify membership and funding status. |
| 1.3 PHONE CUK MEMBERS TO FORM A CALL-OUT TEAM | ● Who will be team co-ordinator? |
| 1.4 PHONE FUNERAL DIRECTOR AND EMBALMER | ● Arrange for transport box and inner box to be taken to funeral director. |
| 1.5 LIAISE WITH RELATIVES, HOSPITAL, ETC. | ● Ensure necessary arrangements are in place. |
| 1.6 MAKE INITIAL ENQUIRIES FOR DRY ICE SUPPLIES | |
| 1.7 DECIDE WHEN TO MOBILISE TEAM | |

## 2. MOBILISATION

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| 2.1 ADVANCE PREPARATIONS of equipment and arrangements | ● Equipment, medications, new batteries, etc., in ambulance.<br>● Transport box, perfusate to funeral director, as appropriate. |
| 2.2 LAST MINUTE ARRANGEMENTS before setting out | ● Medications from fridge, ice, perfusate, etc..<br>● Keep all team members informed.<br>● Arrange for dry ice deliveries. |
| 2.3 ON ARRIVAL AT PATIENT'S LOCATION - initial appraisal | ● Liaise with family, medical staff. Give notes (appendix D)?<br>● Arrange for custody of body & rapid pronouncement of death.<br>● Team: briefing, accommodation arrangements.<br>● Keep funeral director, embalmer informed. |
| 2.4 EQUIPMENT SET UP AND ARRANGEMENTS | ● How the patient will be transferred to the ambulance. |
| 2.5 CONTINUED LIAISON AND CHECKS ON PATIENT | ● Possible pre-mortem medication. |

## 3. INITIAL COOL-DOWN

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| 3.1 CONSIDER SAFETY | ● Protective clothing, sharp objects, heavy lifting, trip hazards, etc.. |
| 3.3 CLINICAL DEATH | ● Two people to check death, independently.<br>● Start CPS, cooling, etc., as allowed by the GP.<br>● Inform doctor (or whoever will pronounce death), embalmer, etc.. |
| 3.4 ON PRONOUNCEMENT OF DEATH | ● Move patient to ice bath/ambulance (if not already there).<br>● Give medications, insert temperature probe and CombiTube.<br>● Transport to embalmer. |

## 4. PERFUSION

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| 4.1 AT EMBALMER'S - SET UP PERFUSION EQUIPMENT | ● Explain to embalmer what is needed. |
| 4.2 PERFUSION | ● Embalmer to insert cannulas, connect up tubing<br>● Perfuse with steadily increasing perfusate concentrations. |
| 4.3 FINAL COOLING WITH DRY ICE | ● Patient is placed in the Ziegler case in the transport box.<br>● Dry ice placed: periodically checked, re-packed and replenished. |
| 4.4 FINAL PREPARATIONS FOR TRANSPORTATION | ● Arrangements made with funeral director, family, etc.<br>● Temperature checks: is patient cold enough to transport?<br>● Patient is sealed in the Ziegler case, in the transport box.<br>● Transport to airport for arranged flight. |

The CUK emergency call-out team will normally be alerted to the impending death of a member by a phone call. It is anticipated that some advance warning of a member's health would normally have been received, but it may be that the phone call will not be received until the member is near death or, in the worst case, has already died. Whatever the situation, the response will broadly follow the sequence given in this manual, but details will vary according to the individual circumstances of each case.

## 1.1 RECEIVE INITIAL PHONE CALL

ENSURE ALL CONTACT AND LOCATION DETAILS ARE CORRECT so that the patient's relatives, hospital or hospice staff, and any others involved can be contacted.

| SOME QUESTIONS TO ASK |
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| NAME AND CONTACT DETAILS of the person calling. |
| PATIENT NAME, ADDRESS, DATE OF BIRTH. Any complications such as nationality? |
| WHAT FUNDING AND CONTRACT IS IN PLACE (with Alcor, Cryonics Institute, etc.)? See note 1 below. |
| IS THE PATIENT A MEMBER OF CUK or have they been a member for less than 3 years? For such cases, see notes 1 and 2 below; explain the financial implications to the caller. |
| CURRENT STATE OF PATIENT'S HEALTH, AND PROGNOSIS (how soon is death expected?). |
| ANY INFECTIOUS RISKS (see Appendix F). |
| WHERE IS THE PATIENT - if in hospital, will they be going home? |
| IS A CALL-OUT NEEDED IMMEDIATELY? |
| IS THE GP OR CONSULTANT, ETC., AWARE OF CRYONICS ARRANGEMENTS? Are they co-operative? |
| ARE THERE ANY UNCO-OPERATIVE RELATIVES? |
| RAPID COOLING AND CARDIOPULMONARY SUPPORT ON DEATH - explain the need for this. |
| RAPID VERIFICATION OF DEATH - discuss arrangements. |
| ANY OTHER SPECIAL CIRCUMSTANCES? |
| Notes |

Notes:

1. If there are no arrangements with a cryonics storage provider, CUK can give advice but cannot provide a call-out service as there will be nowhere to send the patient.
2. CUK membership is a pre-requisite if a call-out service is to be provided. Anyone making 'last minute' cryonics arrangements will be subject to CUK's late membership fee. For those requiring a call-out and having less than three years' continuous CUK membership, the late membership fees are: £5,000 within the first year, £3,000 within the second year, £1,000 within the third year. Monthly membership fees already paid count towards any late membership fee due.

## 1.2 PHONE CRYONICS PROVIDER (ALCOR OR CRYONICS INSTITUTE)

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| INFORM THE PROVIDER AND VERIFY THE FUNDING STATUS. | For Alcor, discuss arrangements for them to send call-out staff. See Appendix E for contact details. |

## 1.3 PHONE THE MAIN FUNERAL DIRECTOR

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| NORMALLY ROWLAND BROTHERS | See contact detail in Appendix E. |
| INFORM THEM OF THE SITUATION. | Ask them to arrange a local funeral director, close to where the patient is expected to die. |
| ARRANGE FOR AN EMBALMER. | Normally, ask the funeral director to arrange this.<br>Alternatively, phone an embalmer directly; usually Geoff Taylor – see contact details in Appendix E |
| LIAISE WITH THE EMBALMER AND AND LOCAL FUNERAL DIRECTOR. | Explain to the local funeral director that when dry ice arrives it should be kept in the transport box to help keep it cool. |
| ARRANGE FOR TRANSPORT BOX, PERFUSION EQUIPMENT AND PERFUSATE TO BE SENT TO WHERE THE PERFUSION IS TO TAKE PLACE. | This will normally be the local funeral director's premises. The inner box and expanded polystyrene insulation should be inside the transport box.<br><br>Ensure arrangements are in place to keep the perfusate solutions in a fridge (CI's 10%, 30%, solutions; Alcor's B1 to 6 solutions) and freezer at -18°C (CI's 70% solution; Alcor's 7 to 12 solutions). |
| CONSIDER WHEN TO ACTIVATE THE ICE MAKER | Prepare 150kg of ice. (Crushed ice from CUK's ice machine in Tim's garage is more effective at cooling than cubes from a supermarket.) |

## 1.4 CONTACT CUK MEMBERS TO ARRANGE A STANDBY TEAM

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| PHONE CUK MEMBERS and/or contact by email. | Check who is available and when. Keep members informed, and confirm availability, as the situation develops. See CUK membership list for contact details. |
| DECIDE WHO WILL BE THE OVERALL CO-ORDINATOR, responsible for ensuring that all necessary arrangements are made. | Separate individuals may take responsibility for individual stages, such as phone calls for various arrangements, the actual cool-down and perfusion, liaison on site, arrangements for final cool-down and transportation, etc., but there should be one overall co-ordinator to ensure nothing has been overlooked. |

## 1.5 ENSURE MINIMUM PROBLEMS AND DELAYS ON DEATH

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| LIAISE WITH RELATIVES, HOSPITAL, HOSPICE, ETC., to assess the condition of the patient. | This could be critical in deciding when to mobilise the team and in minimising delays on death.<br><br>Emphasise to all concerned the need for rapid treatment after death to preserve the patient in the best possible condition, with minimum ischemic damage and tissue deterioration, especially in the brain. |
| MAKE ARRANGEMENTS FOR RAPID VERIFICATION OF DEATH. | The arrangements will depend on the location of the patient and any prior arrangements he/she has made. Some possible situations, and how they affect call-out procedures, are given below. |
| CHECK WITH RELATIVES AND G.P. WHETHER THE PATIENT HAS ANY INFECTIONS | Appendix F lists dangerous infections. Check that the patient is not suffering from any of these, or others, that might pose problems. If so, liaise with the GP and funeral director to determine whether the patient can be attended by CUK and, if so, whether special precautions are needed. <u>In case of doubt, do not proceed.</u> |

The patient at home being tended by an NHS GP and possibly care workers is likely to be the most common situation. Points to note are:

- It is essential to liaise with the GP, explain the patient's wishes and emphasise the urgency of treatment on death. If possible, get the GP to agree to CPS (cardio-pulmonary support), being carried out immediately after death, before verification of death. Explain that this will consist of chest compressions, lung ventilation, and cooling of the neck with ice packs to minimise brain damage. It may also include cooling on a bed of ice, in the ice bath, but not covering with ice. Experience shows that doctors will generally view CPS as reasonable and non-life-threatening, and will agree to this. If necessary, explain that this has been carried out for nearly all previous CUK call-outs.
- Explain to the GP the need for rapid verification of death. He/she will normally say that this cannot be guaranteed under the NHS. The GP may be willing to provide such a service on a private basis, but this is unlikely.

Alternative possibilities are listed below.

- Call an ambulance on death, and have the ambulance paramedics verify death. This option should be discussed with the GP beforehand, and the ambulance service notified.
- An agency that supplies on-call doctors may be willing to help – see Appendix E for contact details of two agencies. The arrangements with the agency are currently under review in consultation with an agency. Typical fees are around £2,000, with the agency will require in advance. This option has been used satisfactorily in the past but the prompt attendance of a doctor on death is not guaranteed.
- A quicker, but more expensive, alternative may be to employ a live-in nurse who is qualified to verify death (subject to prior agreement of the patient's GP). Various arrangements may be possible through a training agency that gives the appropriate courses and supplies trained nurses. However, this arrangement has never been tried. See Appendix E for contact details.

**For a patient in a care home**, then rapid verification of death can be achieved if staff will verify death and immediate cooling can begin. Whether they will do this depends on the care home and the visiting doctor but it appears that at least some care homes will allow this. The use of care homes, and their advantages and disadvantages, is currently being explored in consultation with care home organisations.

**For a patient in a hospital**, a lot will depend on the co-operation of the medical staff, especially doctors. Liaison with them at the earliest opportunity is vital, so that decisions can be made regarding arrangements to verify death, and what they will permit. Hospital death generally leads to delays so is not ideal.

## 1.6 MAKE INITIAL ARRANGEMENTS FOR DRY ICE SUPPLIES

PHONE DRY ICE SUPPLIERS. Check their ability to supply. At the appropriate times, order deliveries as indicated below. For suppliers see Appendix E.

Typical orders: initially 150kg, delivered to the funeral director's premises and placed in the transport box before arrival of the patient (plus 5kg to be available immediately following perfusion if perfusion and cool-down will be at different locations); then typically 50kg on each subsequent day (or 50-100kg every two days) until the patient reaches -65°C (normally 3-4 days), making 250-300kg in all. Order before 11am for next day delivery.

Note that dry ice comes in three forms; 10kg blocks, 1kg slices, and pellets. Order the 1kg slices or, if unavailable, pellets: blocks are too big to be conveniently usable. Typical cost £3.50/kg, plus containers.

Do not confuse dry ice - carbon dioxide ice - with "dry ice-packs" which are ordinary ice in sealed bags.

## 1.7 CONTINUED LIAISON

CONTINUE CHECKING WITH RELATIVES. Assess how the situation is developing and ensure that all others involved are kept informed, including the GP, hospital, main and local funeral directors, and embalmer.

DECIDE WHEN TO MOBILISE THE CALL-OUT TEAM. If in doubt, err on the safe side. This may mean mobilising the team or a partial mobilisation: possibly parking the ambulance and having a team member on standby at the patient's premises.

## 2.1 ADVANCE PREPARATIONS

The timing of advance preparations will depend mainly on the progress of the patient's health.

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| PREPARE ALL EQUIPMENT AS EARLY AS POSSIBLE. | The co-ordinator or other agreed volunteer should prepare as much as possible beforehand. |
| REPLACE ANY PART-USED BOTTLES USED IN TRAINING. | Normally only one bottle will have been used: the others should be full (check seals). |
| ASSEMBLE PERFUSION EQUIPMENT TUBING | Check there is a set of assembled tubing. If not, assemble a set to form the tubing systems indicated in Figures 5.23 to 5.25 and Appendix A. |
| SEND TRANSPORT BOX, PERFUSION EQUIPMENT AND PERFUSATE TO FUNERAL DIRECTOR. | If not already sent, take or send the transport box and perfusion equipment to the funeral director where perfusion is to be carried out. The perfusate should also be sent to the funeral director, to be kept in a fridge and a freezer (at about -18C), according to concentration: see section 5.14.<br><br>If the perfusate is to be taken in the ambulance instead of being sent in advance, place it in a fridge and freezer to pre-cool it. |
| CHECK THE AMBULANCE EQUIPMENT LIST. | Put equipment in the ambulance as early as possible. Keep a record of what is not put in and make sure it is ready when needed. See equipment list kept in the ambulance. |
| CHECK THE MEDICATIONS. | Check against the list in the meds box. Remember, some items are kept in the fridge, not in the box. |
| CHECK THE AMBULANCE. | Make sure it is running properly – check engine oil, tyre pressures, etc., and charge the batteries as a precaution.<br><br>Ensure the ambulance keys are available when needed. |
| RUN THE ICE MAKING MACHINE. | This is in Tim's garage. See Section 5.1 for how to run it. Prepare 150kg of ice. |
| BUY ASSORTED BATTERIES. | For small items of equipment - see equipment list in ambulance. |
| CALL-OUT AND CASE NOTES. | Put in ambulance • case notes and contact details, in a blue folder;<br>• a copy of these call-out notes. |

## 2.2 SHORTLY BEFORE SETTING OUT

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| LOAD THE PERFUSATE. | Put in the ambulance if it has not already been sent ahead. |
| LOAD THE ICE. | Scoop into cool boxes (normally stored in the ambulance or Tim's garage). Plug the cool boxes into the ambulance electrics - 12v DIN outlets - some will also work off 240v mains. |
| LOAD THE MEDICATIONS. | These should be mostly in the ambulance already. Add the medications that are being kept in the fridge - these can be placed into one of the cool boxes along with the ice. |
| INFORM FAMILY YOU ARE LEAVING . | You may also want to inform the local funeral director, embalmer, doctor, hospital/hospice, etc., at this time or may prefer to wait until arrival at the patient's location, depending on circumstances and urgency. |
| INFORM OTHER TEAM MEMBERS | Any who may be involved in the call-out at any stage. |

## 2.3 ON ARRIVAL AT THE PATIENT'S LOCATION

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| APPRAISE THE SITUATION. MEET UP WITH THE TEAM. | Consider the best approach for team operation. |
| LIAISE WITH FAMILY. | Ensure that CUK will have clear custody of the patient immediately on pronouncement of death.<br>If possible, discuss the documentation that will be needed for transport/shipping arrangements – See Appendix G. |
| ASSESS SAFETY. | The team should check for any hazards to team members or others. |
| LIAISE WITH MEDICAL STAFF AND ASK FOR CO-OPERATION. | Stress the need for urgency in pronouncing death, discuss possible arrangements to minimise delays.<br>Ask for any IV lines to be left in and any other help. |
| TEAM ACCOMMODATION. | Decide where the team will stay (e.g. in the patient's house or a nearby hotel) and how night shifts will be covered. |
| CONTINUED LIAISON WITH FUNERAL DIRECTOR AND LOCAL FUNERAL DIRECTOR/EMBALMER. | When appropriate, ensure facilities and personnel will be available when needed. Discuss procedures with the embalmer - give him a copy of the Notes for Embalmer given in Appendix D. |
| FIND A SUITABLE LOCATION TO PARK THE AMBULANCE. | A place convenient for transferring the patient to the ambulance discretely after death and, if possible, where it can be connected to mains electricity. |

## 2.4 EQUIPMENT AND MEDICATIONS PREPARATION

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| TEAM PREPARATION. | Discuss and constantly review the situation; decide on details and order of events (for instance, how to obtain rapid verification of death, what treatment can be given before verification, how the patient will be transferred to the ambulance, and who will do what).<br>Issue protective clothing. Consider any problems specific to the location.<br>The team should check equipment and run through procedures as indicated below. |
| ICE BATH. | Check it is set up on the trolley, with stretcher, meds stand and cover. (See Sections 5.2 and 5.3.) |
| ICE. | Check the cool boxes and where ice can be bought locally (supermarket) - buy as needed. |
| PATIENT EXTRACTION - STRETCHER, LIFTING SHEET. | Check equipment is available to quickly lift the patient on pronouncement of death and plan how the patient will be removed to the ambulance. Ensure everybody understands the difficulties and dangers of lifting a heavy weight - advise where necessary.<br>Do a practice run of extracting the patient (without the patient). |
| CHEST COMPRESSION DEVICE | Set up the equipment where it will be needed – connect to gas bottle and test out to check equipment and refresh memory on operation. (Sections 5.4 and 5.5.) |
| TRANSPORT VENTILATOR. | Check and keep available where it will be needed – see Section 5.10. |
| MANUAL COMPRESSION DEVICE & BAG VALVE MASK. | Keep available for emergencies; normally near the ice bath. (Sections 5.6 and 5.10.) |

PERFUSATE & WASHOUT SOLUTION.

If the perfusate and washout solutions are being kept with the ambulance, transfer the washout solution and the 10% and 30% perfusate to a fridge and the CI 70% solution (VM1) or Alcor 7-12 solutions to a freezer. If necessary, buy a cheap chest freezer.

**Do not forget to transfer them back into the ambulance** before departure to the funeral director.

SMALL ITEMS.

Check the following items are ready and somebody is designated to use them.

- CombiTube, laryngoscope and Guedel/Berman Oral Airway. (Sections 5.7 and 5.8.)
- FAST1 intraosseous infusion device, with chest template. (Section 5.11.)
- Temperature probe with data logger. (Section 5.13.)
- Rectal plug, if used.
- IV equipment: stopcock manifold, IV extensions, syringe drivers, etc., for medications. (Section 5.12.)
- Miscellaneous batteries; check batteries fitted to all equipment that needs them. (See equipment list in ambulance.)
- Miscellaneous items (duct tape, scissors, etc.), normally kept in the ambulance.
- Gas bottle spanners.

AMBULANCE LOCKERS.

Familiarise yourself with the contents of the ambulance lockers so you can quickly locate any items.

PROCEDURES CHECKS.

Designated people should run through the operation of equipment to refresh their memories.

EQUIPMENT LOCATION.

Avoid leaving equipment around - keep a note of any items removed from the ambulance.

MEDICATIONS PREPARATION.

Medications are normally administered via lines connecting to the FAST1 infusion device in the top of the sternum (or E_Z IO intraosseous infuser in side of the shoulder) - see Section 5.11 - or possibly to an intravenous (IV) line left in by medical staff, if available.

Open the meds box and check through each numbered packet in turn, starting at no. 1 and working in numerical order. Prepare as given in the instruction sheets in the box. Meds should only be drawn if you are confident that the patient has less than 12 hours left.

Meds can be divided into two kinds:

- meds that are ready to use;
    - prepare these by drawing into syringes or, if they are to be administered by drip, simply removing them from the packet;
    - lay them out on a suitable clean surface, in numerical order, ready for use;
- meds that need to be mixed, and have a short life (typically 1-2 days) once mixed;
    - delay preparation of these until shortly before death is expected.

*An indication of typical meds is given in Appendix B. However, meds will vary over time, so the instructions in the meds box should be followed.*

## 2.5 BEFORE DEATH: PATIENT CARE AND VIGILANCE

PATIENT CARE AND VIGILANCE.

CUK team members are not expected to look after the patient; this will be carried out by relatives, care workers, hospital staff or others, as appropriate. However, the team should ensure that somebody, usually a relative but otherwise a team member, is checking on the patient at all times so that there is minimal delay between death and the start of procedures.

LIAISON WITH DOCTOR AND/OR MEDICAL STAFF.

There should be continued liaison with the doctor and any visiting nurses or hospital medical staff to maintain the best possible co-operation of all medical staff.

PRE-DEATH MEDICATION.

If possible obtain permission from the doctor to administer pre-death medication to minimise ischemic damage:

- vitamin E – a high-dose tablet (~400iu) twice a day;
- aspirin – one 300mg tablet two or three times a day;
- a cough suppressant containing dextromethorphan – as recommended dose (e.g. Benylin Dry Cough: two 5ml spoonfuls 4 times a day).

## 3.1 PRECAUTIONS

PROTECTIVE CLOTHING.

Wear a face mask, eye protection, hair cover, latex gloves and overalls during all cool-down and perfusion operations to minimise risk of exposure to body fluids, which pose a risk of infection. Protective clothing and equipment should be issued in good time.

SHARP OBJECTS.

Current CUK procedures minimise the use of sharp objects such as needles and blades but take care when using any – wear puncture-resistant gloves where practicable.

If you are handling a needle, keep it clear of others; don't turn around or wave it about. Never reach across somebody holding a needle.

Used sharps must be placed in a 'sharps bin' immediately after use.

HEAVY LIFTING.

Take care during lifting the patient or heavy equipment to avoid risk of back injury.

HAZARDS.

Beware of any trip or slip hazards and dangers to yourself and others when moving equipment. Beware of trapping fingers when moving, loading and unloading the stretcher.

## 3.2 RECORDING EVENTS

RECORD AS MUCH DETAIL AS POSSIBLE.

This will include: times of death, transfer to cooling bath, start of perfusion, etc.; details of medications given; temperature and pressure readings; and any other information that might be relevant.

## 3.3 ON DEATH - BEFORE CONFIRMATION OF DEATH

CHECK THAT THE PATIENT IS DEAD.

Two people to check independently.

- Check for pulse and breathing: at wrist or carotid artery in the neck; using a finger pulse oximeter; and using a stethoscope. Use all three methods to be certain.
- Shine a torch into the eye - does the pupil contract or is it fixed and dilated, which indicates death (but is not conclusive alone).

Be sure to record the checks made – video if possible, as proof.

START CARDIO-PULMONARY SUPPORT (CPS).

**Subject to prior agreement by the patient's doctor.** Start chest compression as soon as possible, plus ventilation where appropriate. Continue until just before perfusion begins – see Sections 5.4 to 5.10.

Normally use a chest compression device and transport ventilator, but may be done manually in an emergency.

PLACE ICE BAGS AROUND THE NECK.

**Subject to prior agreement by the patient's doctor.** From past experience, approval is usually given.

IMMEDIATELY INFORM THE GP, ON-CALL DOCTOR, ETC., to obtain verification of death as quickly as possible.

It may be possible to put ice around the neck or, preferably, place the patient on ice, before verification of death, with prior permission of the attending doctor.
**Do not administer meds before verification of death.**

INFORM THE EMBALMER AND/OR FUNERAL DIRECTOR.

Ensure that the embalmer will be available on arrival at the local funeral director's premises.

KEEP A CHECK ON BLOOD OXYGEN LEVELS using the finger pulse oximeter.

An oxygen reading of 98-100 is normal; 90+ is good order; 80+ is satisfactory. Note that there will appear to be a pulse once the CPR is started but this does not mean that the patient has been resuscitated unless there are other signs.

## 3.4 ON CONFIRMATION OF DEATH - INITIAL COOL-DOWN

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| INSERT RECTAL PLUG. | Before transfer to ice bath. Optional – not usually used. |
| MOVE PATIENT INTO AMBULANCE AND INTO ICE BATH. | The patient is may be either transferred on the stretcher (Section 5.2) and placed in the ice bath (Section 5.3) in the ambulance or transferred directly into the ice bath which is then wheeled into the ambulance on the trolley. How and when this is done will depend on circumstances.<br>If the patient has an incontinence pad, be sure it stays in place. |
| PACK ICE AROUND THE PATIENT. | The head is important. Typically 100-150kg of ice is sufficient. Put a layer of ice in the ice bath before transferring the patient. |
| TIP THE HEAD BACK AND INSERT COMBITUBE INTO THE THROAT. | This may be done after the start of CPS if lung ventilation is not carried out.<br>If the CombiTube cannot be used, keep the airway open with a Guedel/Berman Oral Airway.<br>Before inserting the CombiTube, remove any mucous from the throat using the suction unit - mucous can impede ventilation. The Yankauer suction tip, which is rigid with an angled tip, should be used for this purpose. Upper airway suction level - 100mm Hg max.<br>Mechanical CPS can encourage gastric reflux: this is where the stomach contents are ejected into the oesophagus. The gastric fluid can be sucked up using the suction unit with the longer, flexible trauma catheter; alternatively, it can be extracted directly from the stomach if a catheter can be successfully inserted. See Section 5.9. |
| START (OR CONTINUE) CARDIO-PULMONARY SUPPORT (CPS). | This would normally have started on clinical death, before confirmation of death, subject to agreement of the patient's GP. See details under Start Cardiopulmonary Support heading in section 3.3. |
| INSERT THE FAST INTRAOSSEOUS INFUSER INTO THE STERNUM. | This may be omitted if there is an intravenous (IV) line that can be used. |
| ADMINISTER MEDICATIONS. | Via the FAST infuser in the sternum, an EZ-IO infuser in the side of the shoulder, or the IV line – see Section 5.11. |
| INSERT THE TEMPERATURE PROBE INTO THE NASAL CAVITY. | Insert the probe about 15cm (6") up the nose, which leaves it close to the base of the brain. It can be fixed in place with a silicone ear plug inserted in the nostril. Connect to the readout unit. This may be done just before perfusion, if there is insufficient time. See Section 5.13. |
| TAKE PATIENT IN AMBULANCE TO AGREED FUNERAL DIRECTOR'S OR EMBALMER'S PREMISES. | **Make sure the perfusate and any washout (saline) solution are transferred to the ambulance before setting off** if they are not already with the embalmer. |
| INFORM THE EMBALMER YOU ARE SETTING OUT | Phone the embalmer to say you are setting out for their premises - give an estimated arrival time. If there are any delays, keep them informed. |
| CARRY OUT ESSENTIAL CHECKS THROUGHOUT THE JOURNEY. | GAS SUPPLY – The Lucas chest compression machines use a lot of gas, so bottles will need changing periodically during the journey.<br>TRANSPORT VENTILATOR – has a 5- 5½-hour battery life so should work throughout the journey.<br>SYRINGE DRIVERS may be still delivering meds during the journey and may need changing over when initial syringes are empty. |

## 4.1 PATIENT PREPARATION

LEAVE THE PATIENT IN THE ICE BATH UNTIL THE PERFUSION EQUIPMENT IS SET UP

Also continue with CPS and keep the CombiTube in place. This will minimise the time between lifting the patient out of the ice bath and placing them in dry ice.

EXPLAIN TO THE EMBALMER WHAT IS REQUIRED.

Have a copy of Appendix D available to give to the embalmer, if he/she wants it.

SET UP THE PERFUSION EQUIPMENT.

Two methods are possible (see Section 5.14 for set-up details):

- using a pressure system ; or
- using a gravity system.

CUK usually prefer the pressure system but Alcor may require the gravity system for their members.

PRIME THE PERFUSION SYSTEM.

Assemble the tubing, connect up and prime the system ensuring there are no leaks and no bubbles in the tubing or filter. Take special care to ensure there are no leaks in the tubing to the pressure gauge and that the diaphragm is not stretched. Connect up the heat exchanger and test. See Section 5.14.

TRANSFER THE PATIENT TO THE EMBALMER'S TABLE.

Remove the CombiTube after transferring the patient to the embalmer's table. Note that the patient should have cooled to 20°C or lower before removing from the ice bath.

## 4.2 PERFUSION

EMBALMER TO INSERT CANNULAS - ENSURE INCISIONS ARE PROTECTED FROM CONTAMINATION.

See Appendix D, which may be given to the embalmer.

- Insert cannulas into the two inner jugular veins, directed towards the head. Two further cannulas should be similarly inserted, directed towards the body.
- Insert the two cannulas connected to the perfusion circuit into the two common carotid arteries, directed towards the head, with minimal perfusion flow to exclude air from the system.

All cannulas should be tied in place - see Appendix D.

BEGIN PERFUSION.

Remove any clamps to allow perfusate to flow, and start the pump (pressure system), taking it slowly to the required pressure (normally 100mm Hg; 0.13 bar).

CONTINUE REMAINING STAGES OF PERFUSION.

Add further perfusate into the reservoirs (pressure system) or hang additional bags on the stand (gravity system), gradually increasing the concentration.

Keep a close check on pressures - see Sections 5.14.1, 5.14.2 and 5.14.4.

Check the refractive index of the draining fluid to determine when to stop perfusion - see Section 5.14.5. If the criteria are not met, continue until either all the perfusate is used or flow stops - check flow meter.

This process may take several hours.

KEEP CHECKING TEMPERATURE READINGS.

These are stored in the temperature data logger, but take manual readings periodically, as a back-up.

## 4.3 FINAL COOLING WITH DRY ICE

| | |
|---|---|
| PREPARE THE TRANSPORT BOX | Do this while perfusion is taking place. Pre-cool with dry ice. |
| ON COMPLETION OF PERFUSION, TRANSFER THE PATIENT TO THE TRANSPORT BOX. | Remove all sensors, lines and catheters from the patient. The patient is then washed, dried, placed in a body bag then placed into the inner case (Ziegler case) within the transport box. |
| PLACE DRY ICE AROUND THE PATIENT. | The dry ice (usually slices, in bags) is placed around the body bag and between the inner case and transport box. |
| ENSURE THE TEMPERATURE PROBE IS WORKING CORRECTLY. | It is normally set to take readings once per hour. Readings should also be taken manually at least twice a day. |
| PLACE THE LIDS LOOSELY ON BOTH BOXES AND KEEP THEM ON EXCEPT FOR CHECKING THE DRY ICE. | The temperature data logger is left on top of the transport box – ensure the leads, going into the patient's nose, are not trapped or damaged. |
| ORDER ADDITIONAL DRY ICE OVER THE NEXT FEW DAYS, AS NEEDED. | Order extra when topping-up is needed - see Section 1.6 or Section 5.15.1 for typical requirements. |
| CHECK THE TRANSPORT BOX ONCE OR TWICE A DAY, RECORDING THE TEMPERATURE AND REARRANGING AND ADDING DRY ICE AS NEEDED. | Repacking the dry ice slices has been found to aid cooling of the patient.<br>The target maximum temperature before shipment is -65°C. |
| LIAISE WITH THE FUNERAL DIRECTOR ABOUT TRANSPORT ARRANGEMENTS DURING THIS PERIOD. | Check transport/export arrangements are proceeding smoothly. If necessary, the family may need to help with documentation. |

## 4.4 PREPARATION FOR TRANSPORTATION

Just before shipment, carry out final checks and preparation. See Section 5.15.2 for details.

| | |
|---|---|
| MANUALLY RECORD THE PATIENT'S TEMPERATURE AND REMOVE TEMPERATURE PROBE. | Remove the probe before shipping (unless express permission has been given by airport security). |
| REMOVE ALL DRY ICE FROM THE INNER CASE. | This is essential as it would cause a build-up of pressure within the box, which is sealed air-tight, possibly damaging it. |
| SEAL THE INNER CASE. | Silicone sealant is used, then the lid is screwed on. These operations are tricky – see Section 5.15.2 for tips. |
| REMOVE THE DRY ICE FROM THE TRANSPORT BOX, THEN PUT BACK 45kg, MAKING UP THE SPACE WITH EXPANDED POLYSTYRENE. | 45kg is the maximum amount of dry ice we can use, to comply with airline regulations. Ensure the dry ice is against the inner case, surrounded by polystyrene insulation, usually in the form of 25mm- or 50mm-thick sheets. |
| PLACE AND CLAMP THE TRANSPORT BOX LID. | This needs to be done carefully – see Section 5.15.2. |
| FIX CABLE TIES THROUGH THE PADLOCK LOOPS ON THE CLAMPS. | Funeral directors, Rowlands, normally add ribbon seals, threaded through the padlock loop then taken over the lid where they are sealed by a stamped sealing wax. |
| DRY THE OUTSIDE OF THE TRANSPORT BOX. | This is necessary to clear the airport authority. |
| STICK SHIPPING DETAILS ON TO THE TRANSPORT BOX. | Stickers will be supplied by the funeral director, and should be stuck on the top and sides of the transport box. Consignment documents are stuck in a plastic wallet on the top. |

## 5.1 ICE MACHINE

The ice machine (Figure 5.1) is kept in Tim's garage. It should be switched on and kept full of ice in preparation for the call-out. Further supplies can be obtained from supermarkets as needed. Operation is straightforward.

- Ensure the machine is connected to the water and electricity supplies, and switch on.
- Keep a check on the level of the ice, because the machine will switch off automatically if the ice reaches the sensor bar near the top of the hopper. If this happens, clear the ice away from the sensor bar and press the 'reset' button on the front of the machine - after a few minutes, when the sensor bar has warmed up sufficiently, the machine will restart.

*Figure 5.1 Ice machine*

ICE STORAGE - after making or buying, ice is transferred to electric cool boxes. These can be plugged in to the ambulance 12v DIN outlets - some will also work off a 240v mains supply.

## 5.2 SCOOP STRETCHER

The scoop stretcher (Figure 5.2) is stored on the back door of the ambulance, secured by webbing straps. Split the stretcher into two halves and slide under the patient, then clip them together and lift with one or two people at each end. The narrow end goes towards the feet. Alternatively, use a lifting sheet.

*Figure 5.2 Scoop stretcher stowed on ambulance door*

## 5.3 ICE BATH

The ice bath (Figure 5.3) consists of a frame of uPVC tubing with a waterproof inner reinforced polythene lining. The tubes slot into each other so that it can be dismantled for transportation. Tube ends and corner connectors are colour coded to aid assembly. However, the ice bath is normally kept fully assembled in the ambulance.

When placing the patient into the ice bath, make sure the head is at the end with the cut-out. This is essential if the old style 'thumper' chest compression machine is used.

Before putting the patient into the ice bath, put a layer of ice on the bottom. This aids cooling. Cold water may also be added to improve cooling but this should be kept to a minimum to prevent excess water building up as the ice melts.

In the ambulance, the ice bath cut-out should be towards the front of the vehicle. The stretcher will not lock in place if it is the other way around.

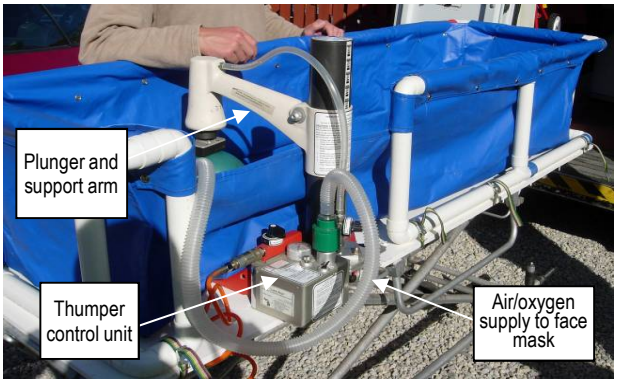



*Figure 5.3 Ice bath on trolley*

## 5.4 LUCAS CHEST COMPRESSION DEVICE

Figure 5.4 shows the device as it would be positioned over a patient, along with its connection to the gas supply. The machine is fully automated, requiring fewer of the adjustments needed for the older 'thumper' chest compression machine – see Section 5.5, below.

*Figure 5.4 Lucas chest compression device*

A gas/oxygen bottle needs to be prepared in advance of use.

- Screw the regulator valve on to the bottle (Figure 5.5). Connect to tubing and turn on the gas supply when ready (spanner needed).

Operation is fairly straightforward.

- Place the base under the patient at chest level (just below armpit level).
- Clip the main section of the machine on to the base, holding the two upper sides. This can be tricky, especially with a large patient, and takes practice.
- Adjust the position so that the suction cup is over the base of the sternum (breast bone).
- Ensure the machine is switched off (dial set to position 1 as shown in Figure 5.5), then connect the air supply hose to the air/oxygen bottle and turn on the gas supply.
- With the dial still in position 1, push the suction head down until just touching the patient's chest. Turn the dial to position 2 to lock it in place.
- Turn the dial to position 3 to start operation.

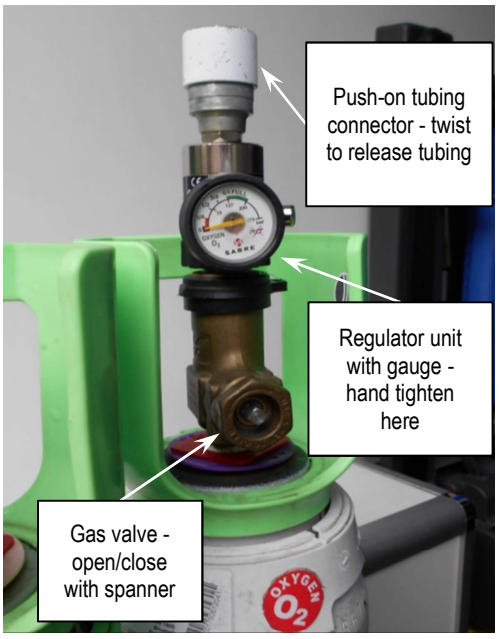



*Figure 5.5 Lucas pressure regulator*

Special points to note.

- The machine has no adjustment beyond that described above and it is quite aggressive so be prepared for this.
- It uses a lot of air, which can deplete the supply quite quickly, so bottles need to be changed regularly with prolonged use.
- The high air usage can also result in cooling and frosting up of the valve on top of the gas cylinder.

## 5.5 MICHIGAN INSTRUMENTS 'THUMPER'

This is an alternative to the Lucas device. Figure 5.3 shows the device as it would be positioned in the ice bath.

A gas bottle needs to be prepared in advance of use.

- Screw the regulator valve on to the bottle (Figure 5.6), using a spanner to tighten (moderately – not too – tight).

Operation is more complicated than for the Lucas machine but, set against this, more control is possible.

Place the thumper under the ice bath liner at the level of the patient's chest and position the thumper head over the base of the sternum.

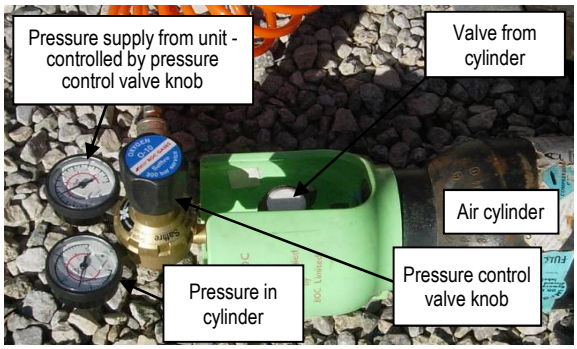



*Figure 5.6 Thumper pressure regulator*

Adjust the plunger height so that only the bottom ring is showing, then tighten the knob on the side of the support column to lock it in place.

- Look at the lowest whole diagram visible on the side of the support column and note how many rings are shown on it.
- Check that all controls are set to off (Figure 5.7) and that the plunger adjustment (knob 3) is set for no movement. This should have been done previously but check as a precaution.
- Connect to the regulator valve on the gas bottle if not already connected.
- Turn on the gas supply and adjust the pressure to about 4 bars (60 psi) – the equipment will work satisfactorily at between 3.5 and 6 bars. Note that the operation of the regulator's control is counter-intuitive: clockwise raises the pressure, anticlockwise lowers it.

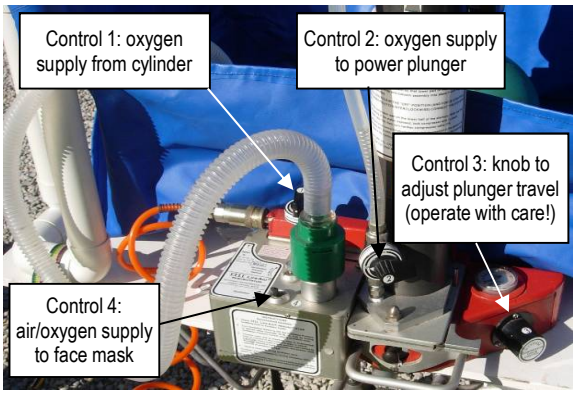



*Figure 5.7 Thumper controls*

- Turn on control knobs 1 and 2 (Figure 5.7) then CAREFULLY turn knob 3 to start the piston travel, adjusting the number of rings exposed on each down stroke to match those on the last whole diagram on the plunger support column.
- Keep a check on gas pressure and change the cylinder when necessary.

Note that control 4, which controls air/oxygen supply to lung ventilation, is not used, as we now use a separate device for this – see Section 5.10.

## 5.6 MANUAL CHEST COMPRESSIONS

Manual operation would be used only in an emergency if no chest compression machine could be used; for instance, if the gas cylinders were all empty.

The effectiveness of the hand method may be improved by use of a cardiopump (a manual CPS aid), shown in Figure 5.8. The person using the cardiopump should be changed frequently, as this is a strenuous procedure.

- Locate the correct pressure point: at the centre of the chest, over the base of the sternum. To locate the base of the sternum, place two fingers on the sternum and work down until you come to the V-shape.
- Use the Cardiopump (or if not available, place the palm of your hand, with the other hand on top), elbows locked, whilst leaning over the patient. Push down briskly, depressing the sternum 4-5cm (1½-2") at about 100 times per minute.

*Figure 5.8 Cardio pump*

## 5.7 COMBITUBE

A CombiTube provides passageways to both the lungs and the stomach, allowing lung ventilation to be carried out and antacid to be administered. It also isolates gastric reflux (vomit) from the airway, allowing it to be sucked away whilst ventilating.

The CombiTube, shown in Figure 5.9, is normally inserted during the initial stages of cool-down.

- Tip the head backwards, open the mouth and gently insert the tube down the throat until printed lines on the tube lie between the teeth. Take care not to push the tongue back and cause a blockage. If difficulty is experienced inserting the tube, use a laryngoscope to aid insertion - see Figure 5.10.
- If necessary, lubricate with KY jelly to aid insertion.
- If there are continued problems in inserting the tube and gastric reflux is not a problem, use a Guedel or Berman oral airway – see alternative, Section 5.8, below.
- Once in position, the tube needs to be sealed in place by inflating the two bladder seals on the tubes (Figures 5.9 and 5.11). Inject the correct amount of air using syringes provided, to ensure a seal. Avoid over-inflating which risks bursting the seal bladders.
- On insertion, the tube may enter either the oesophagus or the trachea, as shown in Figure 5.12. Insertion into the oesophagus is more usual and preferable but, either way, it allows antacid to be administered to the stomach, via the oesophagus, and air to be administered to the lungs, via the trachea, as shown in the figure.
- Use a bag valve to check which tube goes to the stomach and which to the lungs (Figure 5.16).

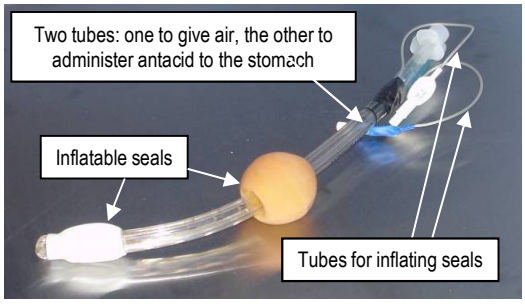
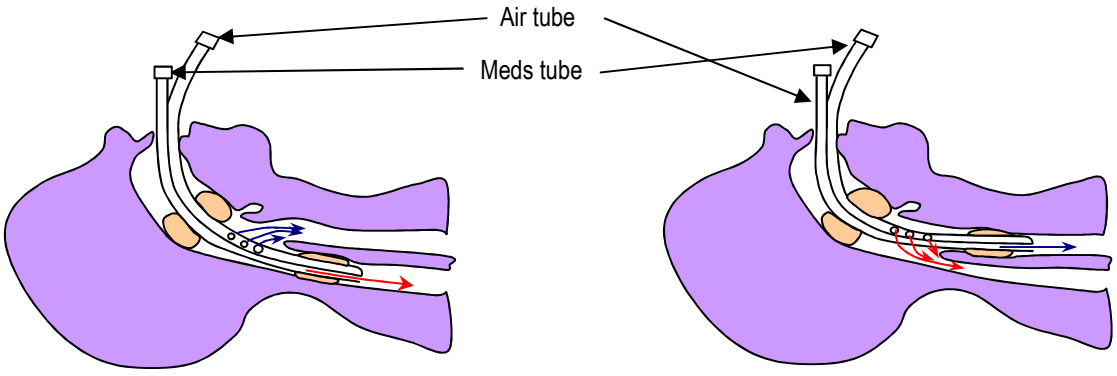



*Figure 5.9 CombiTube*

*Figure 5.10 Laryngoscope, to aid insertion of CombiTube*

*Figure 5.11 Inflating the seals in the CombiTube*




*(a) Oesophageal placement (80)%* *(b) Tracheal placement*

*Figure 5.12 CombiTube placement*

## 5.8 GUEDEL OR BERMAN ORAL AIRWAY

If the CombiTube cannot be inserted into the throat, a Berman Oral Airway insert may be used (Figure 5.13). Select the correct size by rolling the curved part of the inset from the corner of the jaw towards the chin. The correct size is the one whose outer curve length is the same as the distance from the corner of the jaw to the centre of the chin.

Insertion is similar to that for the CombiTube, described above.

- Tip the head back. With the Oral Airway turned sideways, slide it down the cheek, then rotate so the hook is pointing down the throat while sliding it down behind the tongue. Check visually.

*Figure 5.13 Berman Oral Airways*

## 5.9 SUCTION UNIT

The suction unit (Figure 5.14) is used to remove fluids from the throat. The degree of suction is set by the control knob; typically to a maximum of 100mm Hg (mercury). Two tips may be fitted:

- a short, stiff Yankauer tip, used to remove mucus; and
- a longer, flexible trauma catheter, used to remove gastric reflux from the oesophagus and stomach.

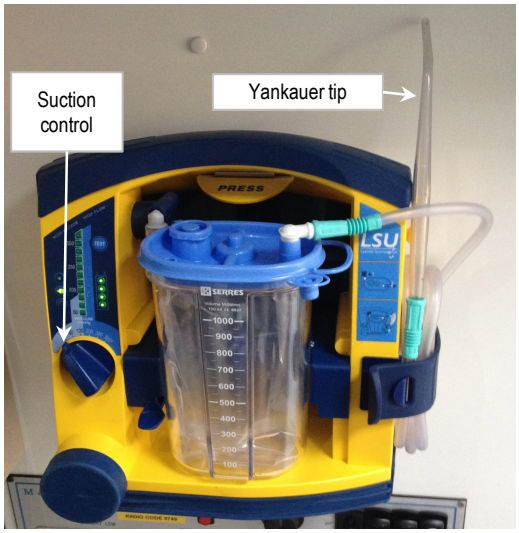



*Figure 5.14 Suction unit*

## 5.10 LUNG VENTILATION

*Note: opinions vary about when lung ventilation should be carried out, with some experts saying that it is always beneficial. Others say that should not be carried out if there is a significant delay between death and start of ventilation. However, the definition of 'significant delay' varies between a few minutes and a few hours. Under CUK current practice, it is usually carried out.*

Ventilation may be administered via a face mask but it is preferable to use a CombiTube, inserted into the throat, as described in Section 5.7, above.

Ventilation is normally carried out using a transport ventilator – see Figure 5.15. During initial preparation, the ventilator should have been put on charge to ensure maximum operating time. Operation is very simple.

- Ensure the patient's airway is clear, with the head back to hyper-extend the neck and, if possible, a CombiTube inserted in the throat.
- Attach the ventilator hose to the correct CombiTube outlet or, if a Berman Oral Airway is used, to a face mask placed in position over the nose and mouth.
- Rotate the control knob clockwise to the first position. *Note that all positions will switch the machine on but with varying levels of malfunction warnings. The last position has no warnings.*

If the transport ventilator is not available, use a bag valve attached to the CombiTube or a face mask – Figure 5.16.

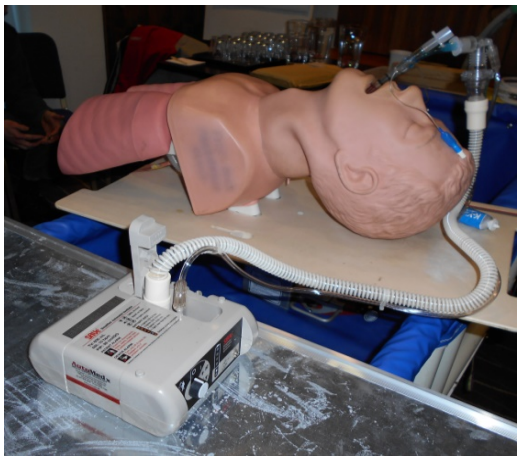


*Figure 5.15 Transport ventilator used with CombiTube*

*Figure 5.16 Bag valve used with CombiTube*

## 5.11 FAST1 INTRAOSSEOUS INFUSION DEVICE

Medications may be administered via an intravenous (IV) line but are normally administered via the FAST1 intraosseous infusion device system inserted in the sternum.

- Insert the FAST1 into the sternum using a template that is stuck on to the chest to find the correct location - see Figure 5.17.

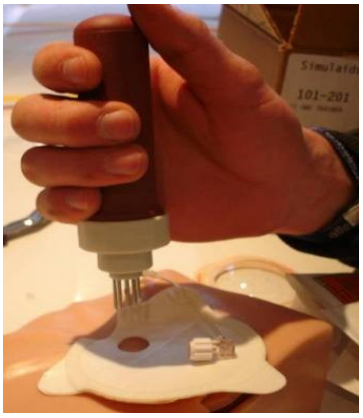


*Figure 5.17 Insertion of FAST1*

### 5.11.1 EZ-IO intraosseous infusion system

As an alternative to the FAST1, the EZ-IO system may be used to insert a needle into the upper humerus (shoulder). The EZ-IO uses a purpose-made power driver to drill the intraosseous needle into place. This system is currently being trialled by Cryonics UK. Instructions on its use will be made available if trials are successful.

## 5.12 ADMINISTERING MEDICATIONS

Medications should already have been prepared for use as described in Section 2.4.

Appendix B gives typical medications, with their dosages, functions, and any special storage requirements. However, you should follow the list in the meds case and on containers for the most up-to-date information.

- Connect the short tubing assembly that comes with the FAST1 to a short IV extension tube and a multi-port stopcock manifold (Figure 5.18). High volume meds are hung on a stand (Figure 5.19) and delivered via IV lines connected to the manifold. Low volume meds are drawn into syringes and delivered via a port on the manifold.
- In addition, antacid is administered orally, via the CombiTube, as soon as convenient. Check the CombiTube insertion to determine which tube to use - be sure it goes into the stomach, not the lungs.

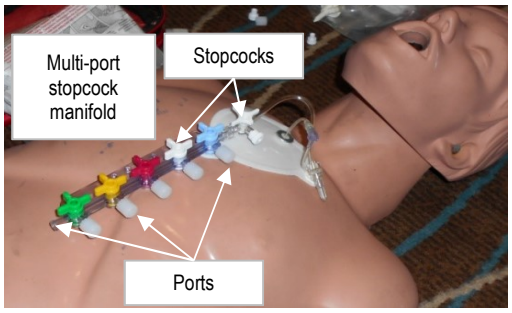



*Figure 5.18 Stopcock manifold*

### 5.12.1 Syringe drivers

Some medications need to be administered slowly, over time. This is done by means of a syringe driver - Figure 5.20

- First check that the syringe will fit into the syringe driver: some larger syringes are too long.
- Draw the medication into the syringe.
- Note time, $T$, (hours) over which the medication is to be given.
- Using the scale on the driver (Figure 5.21), check distance, $D$ (mm) that the syringe plunger is to be pushed.

  Insert the syringe into the driver.

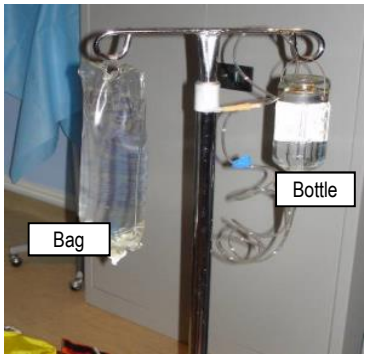



*Figure 5.19 Meds stand*

- Calculate the required rate of movement, $R$, of the syringe plunger as $R = D/T$ mm/hour.
- Using a small screwdriver, adjust the rate of delivery to the required value, see Figure 5.21.
- Connect the syringe up to the patient via the stopcock manifold; de-air etc.
- Put a battery into the syringe driver - it should start at once. Check it is working.
- Make sure the driver is kept out of the ice bath water and stays dry.

*Figure 5.20 Syringe driver with syringe*


*Figure 5.21 Syringe driver setting*

## 5.13 TEMPERATURE PROBE

This is inserted into the nasal cavity, either during initial cool-down or it may be delayed until the start of perfusion if no time is available without delaying cool-down.

Operating instructions are kept with the unit and should be studied during initial preparations. The data logger has an SD card installed in the bottom of the unit. Temperatures and times are recorded in Excel spreadsheet format on the logger's SD card, allowing easy transfer to a laptop for analysis, but manual readings should be taken at intervals, as a back-up.

- Connect a probe wire to the data-logger (Figure 5.22) and insert the tip into the patient's nasal cavity.
- Seal with a silicone ear plug or similar.
- Press and hold the 'log' button to start data recording. 'LOGGER' should flash on the screen when recording.


*Figure 5.22 Data logger and temperature probe*

## 5.14 PERFUSION

The perfusate needs to be administered using a controlled pressure, and CUK use either of two methods to attain the desired pressure:

- a pressure system controlled by a specialised pump; or
- a gravity feed, broadly similar to that used for medications on a drip.

Note the following general point for perfusion

***Perfusion pressure.*** *It is essential that perfusion pressure is carefully controlled to avoid damaging blood vessels and tissue, especially in the brain. Perfusion is normally carried out at 80-100 mm Hg (mercury) (0.10-0.13 bar, 1.5-1.9 psi), and should NEVER exceed 120 mm Hg ((0.16 bar, 2.3 psi). Lower pressures may be used to reduce flow rates.*

***Perfusion exit pressure.*** *To avoid excess pressure in the jugular veins and to increase perfusion flow rates, tubing shoud be connected to the jugular cannulas and drained into a container about 40cm below the patient. This will produce a siphoning effect, reducing pressure in the jugular veins by about 30mm Hg.*

***Perfusate temperature.*** *Lower concentrations (CI's VM1 below 70% and Alcor's M22 bags 1-7) are kept in a refrigerator so that they can be given at about 0 to 3° C. Higher concentrations (VM1 70% and M22 bags 8 onwards) are kept in a freezer at about -18°C so that they can be given at about -3° C. If necessary, a heat exchanger may be used to cool the perfusate as it is given - see section 5.14.3.*

***Perfusion time.*** *Normally the flow of perfusate is slow, so there will be sufficient time for perfusate to fully perfuse tissues. However, if it is too fast, the perfusion pressure should be reduced. The final stage, with full perfusate concentration, should last at least 30 minutes but is usually longer.*

***Avoiding air in the system.*** *Fluid levels in the perfusate bags or reservoirs should be as low as possible before changing to the next reservoir or bag but do not let levels go too low: IT IS ESSENTIAL THAT NO AIR IS INTRODUCED INTO THE PATIENT. Note that some mixing between the various concentrations of perfusate is desirable so that the concentration reaching the patient ramps up rather than jumps in distinct steps.*

### 5.14.1 Pressure system

This is usually used with the Cryonics Institute's perfusate, VM1, which is supplied in plastic containers.

Figure 5.23 shows a simplified schematic of the system. In practice, there will be two reservoirs connected in parallel so that the system can quickly be switched over to the second reservoir once the first is nearing empty. The first reservoir can then be refilled while the second is in use. The actual equipment, with two reservoirs, is shown in Figure 5.24. Full details of the tubing are shown in Appendix A.

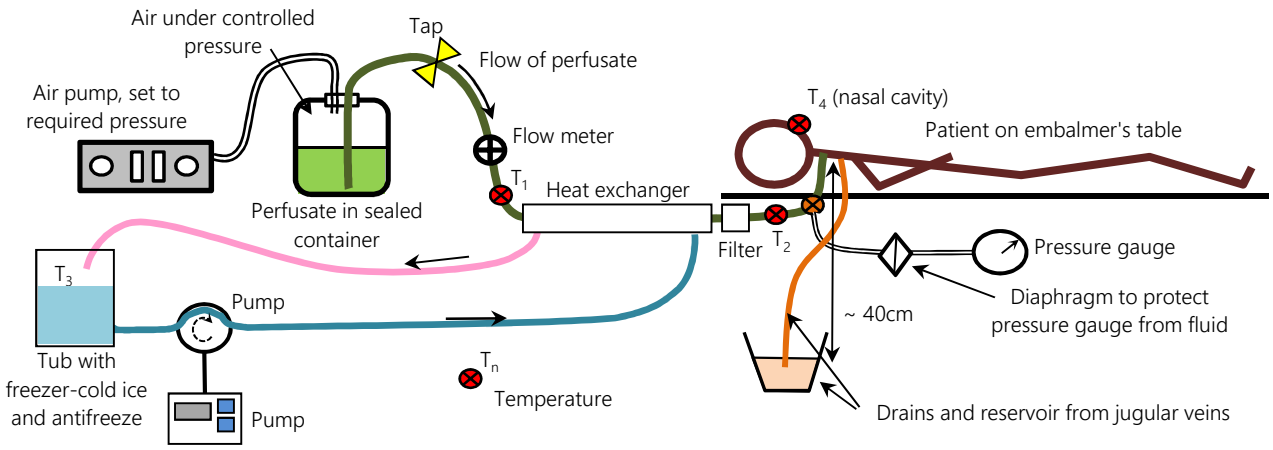



*Figure 5.23 Essentials of the perfusion pressure system*

Initial set-up:

- When using new reservoirs, make sure the spanner (included) has been removed from the inside.
- Identify the air inlet and fluid outlet tubes on the pressure reservoir – the outlet extends to the bottom of the reservoir.
- Assemble the tubing including filter, flow meter, temperature probe ports ($T_1$,$T_2$), pressure gauge with diaphragm, Y-connector and carotid cannulas as shown in Figures 5.23 and 5.24 and Appendix A.
    - Connect the air inlet tube to the right-hand pump outlet and the fluid outlet tube to the flow meter, as shown in Figure 5.23.
    - Ensure all connections are air-tight, especially that to the pressure gauge: if the gauge connection leaks the gauge readings will be meaningless - see Section 5.14.4.
- Add 3-5 litres of sterile water or saline solution to each container and check the outlet taps are closed.
- Connect the pump to mains power and switch on to pressurise the reservoirs.
- Open the outlet taps, allowing flow through the tubing onto the embalming table to flush the system and remove air bubbles - pay special attention to tubing connectors, heat exchanger, filter, filter bypass and pressure monitor, where bubbles may get trapped.
    - Bleed the filter by unscrewing the vent cap slightly - not too far or it will come off.
- When de-bubbled, continue to flush out the saline until about half a litre remains in each reservoir:
    - Clamp the tubing as close to each cannula as possible and close the outlet taps.
    - Clamp the filter bypass and clamp the pressure hoses as close to the reservoirs as possible.
- Switch off the pump and add the 5L of CI's 10% perfusate to one reservoir and half the 5L of 30% perfusate (from the fridge) to the other. Repressurise the reservoirs.
- Connect and prepare the cooling circuit for the heat exchanger – see Section 5.14.3, below.

Perfusion procedure

- Release clamps and open taps in the perfusate tubing to allow perfusate to flow from the first pressure reservoir (containing 10% perfusate). NOTE: keep the tap to the second reservoir closed.
- Turn on the perfusate pump until perfusate starts to run very slowly from the two cannulas then insert and secure the cannulas into the two carotid arteries - you may wish to ask the embalmer to do this.

- Adjust the pump to the required pressure (see general notes on perfusion, above) by turning the right-hand knob slowly, to begin perfusion. Continuously monitor pressure and flow, adjusting as necessary – it takes time for the pressure to build up.
    - *Note that the pressure gauge on the pump is accurate and does not suffer from the leakage problems that can affect the readings of the external gauge, next to the patient. However, there could be pressure losses over the length of the tubing during flow. The gauge next to the patient can be checked by clamping off the tubing just before it enters the cannulas so there is no flow. The true pressure at this gauge will then be the same as that at the pump provided the pump is at the same height as the patient. If it is significantly higher or lower then a correction will be needed to allow for the head of fluid in the pipes - for each 14mm height difference, add or deduct 1 mm Hg as appropriate. See section 5.14.4 for pressure gauge setup. If in doubt, simply use the pump gauge.*
- When the first pressure reservoir is almost empty (see note 3 below), switch over to the second reservoir. Close the outlet tap and clamp off the air inlet tube to the first pressure reservoir, then open the outlet tap and unclamp the air inlet tube to the second pressure vessel.
- Fill the first pressure vessel with the second half of the 30% perfusate, using about half the final 5L of 30% solution.
    - *Note that the 30% perfusate is split between two pressure vessels to avoid putting the below-freezing 70% perfusate into a pressure vessel with some residual 10% solution in it, as this risks ice crystals forming in the remaining 10% solution.*
- Continue, (with 70% solution from the freezer) switching reservoirs as necessary until either all perfusate has been used, flow stops or, for the final strength perfusate, refractometer readings indicate that perfusion is complete: for VM1 this is when the draining fluid has the same refractive index as the perfusate going in.

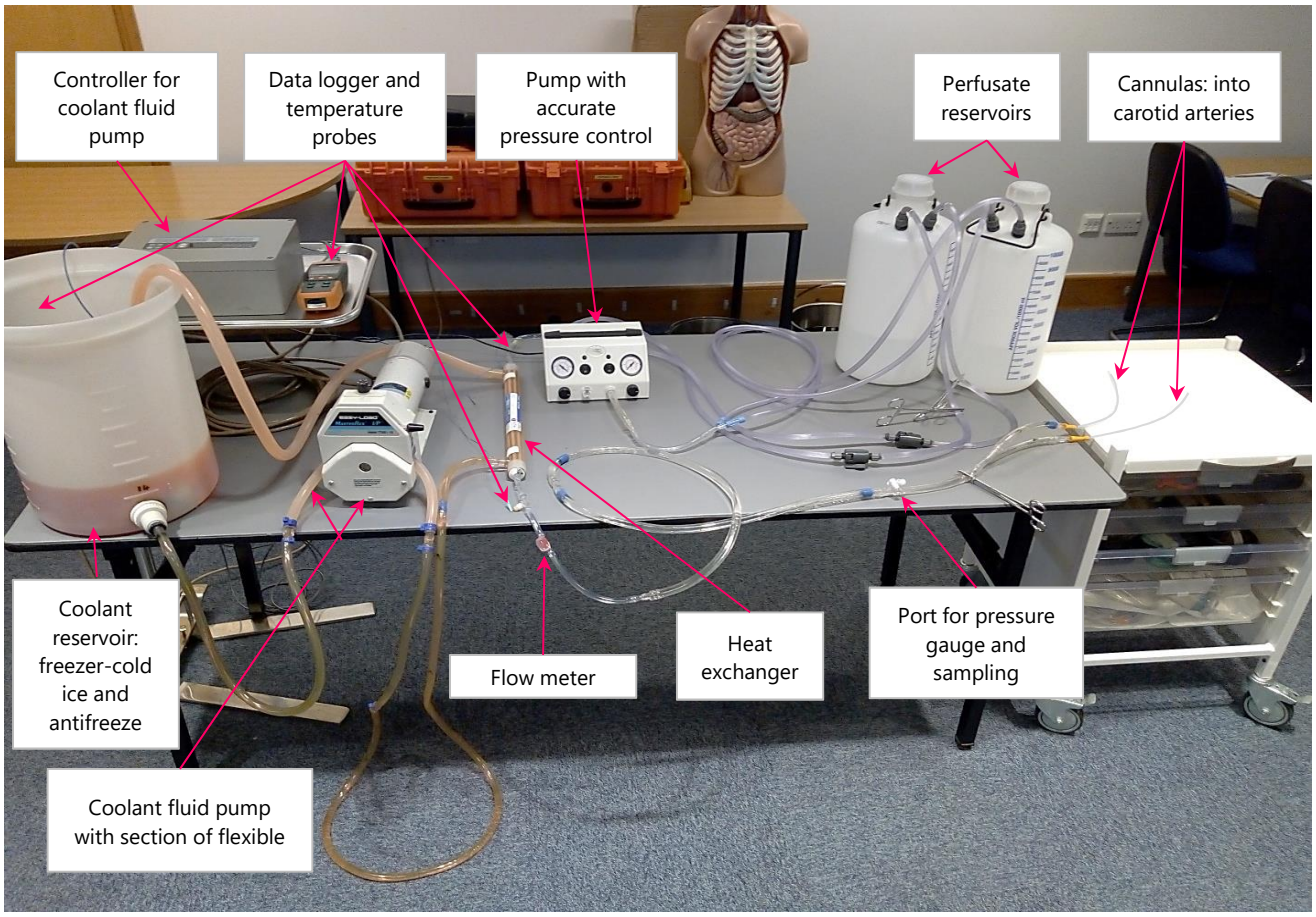



*Figure 5.24 Perfusion pressure system equipment*

## 5.14.2 Gravity system

This is usually used with Alcor's M22 perfusate, which is supplied in bags. It may, however, be used with CI's VM1 perfusate by either transferring it to bags or using containers hung from a stand. Figure 5.25 shows a schematic of the gravity system.

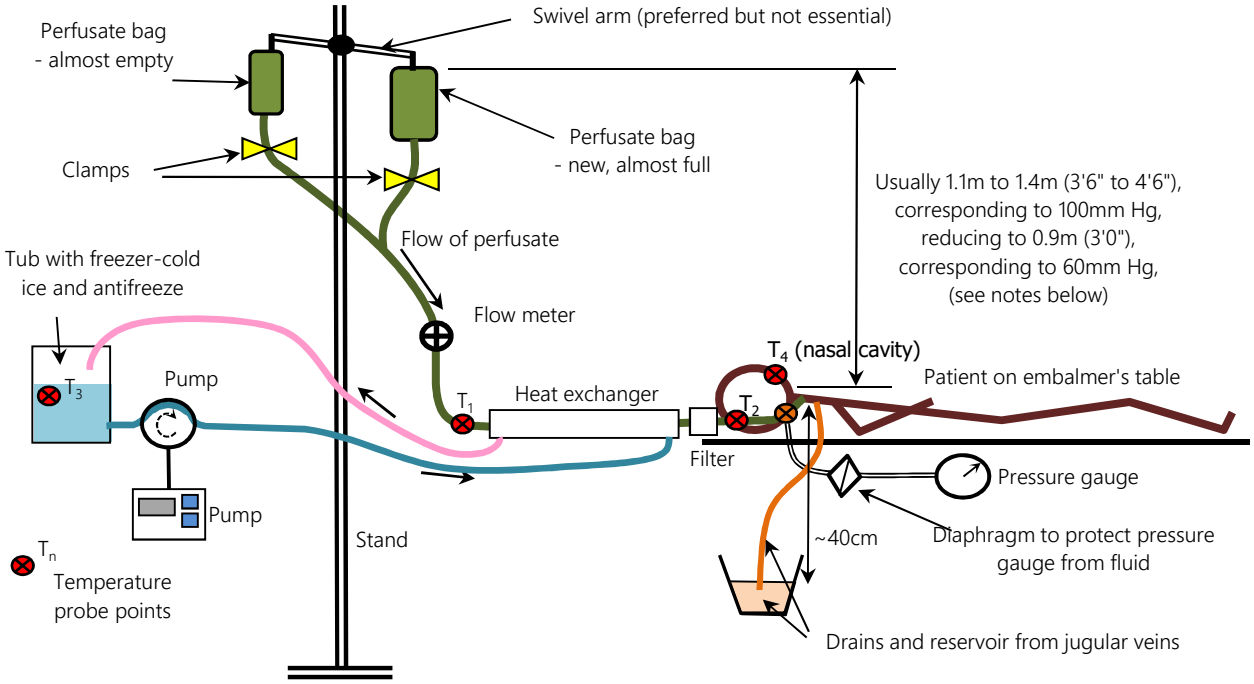



*Figure 5.25 Perfusion gravity system equipment*

Initial set-up:

- Assemble the tubing including filter, flow meter, temperature probe ports ($T_1$,$T_2$), pressure gauge with diaphragm, Y-connector and carotid cannulas as shown in Figure 5.25 and Appendix A.
- Connect up to the first bag of perfusate (weakest solution) and hang it on a stand next to the patient's head – see note 1 below for recommended heights.
- Release the clamp (see Figure 5.25) and allow perfusate to just start flowing out of the carotid cannulas, then clamp the tubing as close to the cannulas as possible to stop the flow. Squeeze the perfusate bag slightly if necessary to start flow and remove all air bubbles.
- Release the clamp on the short length of second line until perfusate just starts to flow out of it then connect up the second bag, ensuring no air bubbles are in the line. Immediately re-clamp.
- Ensure the tubing is bubble-free and that all connections are air-tight, especially to the pressure gauge - see below and Section 5.14.4.
- Connect up and prepare the heat exchanger as described in Section 5.14.3, below.

Perfusion procedure

- Insert and secure the two cannulas into the carotid arteries, allowing some flow to ensure no air is introduced into the system, then fully unclamp to allow perfusate to flow - you may wish to ask the embalmer to do this.
- Make sure any tap or clamp on the tubing is full opened/released (Figure 5.25) to begin perfusion.

- Check the pressure on the pressure gauge but note that this can suffer errors if there is any leakage in the line to the gauge. The true, accurate pressure (when there is no or little flow) is obtained by dividing the height of the perfusate bag, in mm, by 13.6 to obtain the pressure in mm Hg (mercury). See section 5.14.4 for pressure gauge setup.
    - Note, however, that at high flow rates, there may be some pressure loss through the tubing, so the pressure gauge may show a slightly lower pressure than indicated by the height of the bag above the patient. If you are confident the gauge is accurate, raise the bag height slightly to compensate. If in any doubt, do not do this.
    - You can check the accuracy of the gauge by briefly clamping the line close to the cannulas; then the gauge reading should tally with the measured head (in m) of perfusate - pressure gauge reading should be: head x 73.5 = mm Hg; or head x 1.42 = psi; or head x 0.1 = bar.
- When perfusate in the first bag is getting low, open the clamp on the second bag. Close the clamp on the first bag when it is almost empty (see note 2 below).
- Replace the first bag with bag 3, ensuring no air bubbles are in the tubing. Change over to bag 3, using the clamps as before, when the second bag is almost empty.
- Continue, switching reservoirs as necessary until either all perfusate has been used, flow stops or, for the final strength perfusate, refractometer readings indicate that perfusion is complete: for M22 this is when the refractive index of the draining fluid is 49.9 on the BRIX scale, or as advised by Alcor.
    - *Note that the refractive index BRIX value of fresh 70% M22 is 51.5.*
- Ideally, the two bags should be hung from pivoting arms as shown in Figure 5.25, as this causes the near-empty bag to rise, increasing its pressure and emptying it in preference to the new bag. The slight mixing also means that perfusate concentration is increased gradually, not abruptly.

## 5.14.3 Heat exchanger cooling system

If perfusate is kept in a refrigerator (dilute solutions) and freezer (final, concentrated solution), it should not normally be necessary to use the heat exchanger. If in doubt, it is better to include the heat exchanger in case it is needed. It will be needed if:

- it has not been possible to keep the perfusate cool in a fridge/freezer until just before use, and/or
- perfusate flows are very slow, allowing the perfusate to warm up in the reservoir during perfusion.

- Set up the pump, controller and coolant fluid tub in a convenient location and connect the controller to the mains and to the pump. Connect up the heat exchanger tubing as shown in Figures 5.23, to 5.25, then clamp the silicone tubing section section in the pump roller head (Figure 5.24). Coolant fluid should ideally flow through the heat exchanger in the opposite direction to perfusate flow though, in practice, the direction of flow will have little influence.
    - Connect up the pressure gauge, and connect temperature probe points to locations $T_1$ and $T_2$ in the tubing, with a third probe point ($T_3$) in the fluid in the tub.
    - Add a small amount of antifreeze or water to the tub and briefly run the pump, using the controller, to check that the system works and clear the tubing of air.
- When the heat exchanger is needed to cool the perfusate, add ice and antifreeze to the tub (about half full should be sufficient). Both ice and antifreeze should have been kept in a freezer, and must initially be at -10°C or (preferably) lower.
- Control the amount of cooling to achieve the desired perfusate temperature at $T_2$ by varying the pump speed - a higher rate of flow increases cooling so lowers perfusate temperature.

*Notes:*

1. *Use of the heat exchanger with dilute perfusate solutions is fairly straightforward. However, with concentrated solution, which is delivered at below freezing, it is imperative that the ice used is cold enough to keep the coolant fluid at about -10° C or colder: otherwise, it will not be able to cool concentrated perfusate sufficiently, and may in the worst case even warm it.*
2. *Even if the heat exchanger is not used, the temperature probe at $T_2$, measuring the perfusate temperature as it enters the patient, must be used, and temperatures monitored during perfusion.*

### 5.14.4 Pressure gauge setup

A pressure gauge is normally located in the tubing just before the patient's head, as shown in Figures 5.23 and 5.25. This may be a standard Bourdon (dial) gauge as shown in Figure 5.26 or it may be digital. For either type, the gauge is connected to the system via a diaphragm as shown in the Figures.

- Ensure, as far as possible that the tube as far as the diaphragm is filled with water. The process of removing air from the tubing depends on the details of the tubing and air vents and can be tricky.
- Ensure that the tubing to the gauge is fully sealed.

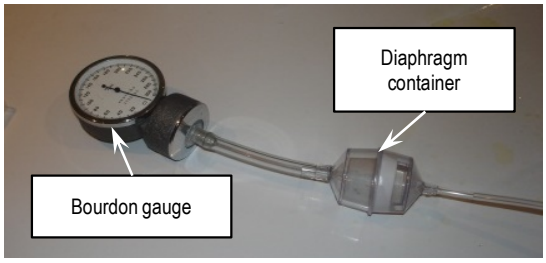



*Figure 5.26 Pressure gauge with diaphragm*

Check the tubing connections and the diaphragm. Gross errors can occur in the pressure gauge readings if:

- there are any leaks in the tubing to the gauge, especially in the air-filled section between the diaphragm and the gauge; or
- the diaphragm is stretched to the top or bottom within its container (Figure 5.26) - it must be unstretched in a central position.

If there is any doubt between the gauge readings and the pressure given at the pump (pressure system) or calculated from the head of water (gravity system) then the pressure gauge reading should be ignored.

- The accuracy of the pressure gauge can be checked as explained in Sections 5.15.1 and 5.15.2.

Note also that for the pressure system, the reservoir should ideally be at the same level as the patient's head, as described in note 2 in section 5.14.1.

### 5.14.5 Completion of perfusion

Ideally, perfusion should be terminated when the refractive index of the outflowing final stage perfusate (from the jugular veins) reaches the value given in Section 5.15.1 or 5.15.2. However, flow may also stop prematurely due to vascular dehydration or oedema (swelling), preventing further perfusion.

- Clamp the perfusate tube and, if using the pressure system, stop the pump.
- Ask the embalmer to remove all cannulas and tie off all blood vessels to prevent leakage. The incisions in the neck should be sutured (stitched).

Dismantle and rinse the perfusion tubing. Place items that will be re-used in a bucket or bowl. Items that cannot be re-used, such as the filter, should be placed in clinical waste.

Clean up and disinfect everything that has been used or may have become contaminated.

Transfer the patient to the transport box as described in Section 5.15, below.

## 5.15 TRANSFER TO THE TRANSPORT BOX

Ideally, the transport box (Figure 5.27) should have been prepared by the funeral director, with the inner box inside it and dry ice in place, to pre-cool it. If not, carry out the following steps.

- Place the inner box into the transport box, with 50mm-thick expanded polystyrene beneath it.
- Place dry ice in the transport box, in and around the inner box. About 150kg of dry ice is sufficient initially.

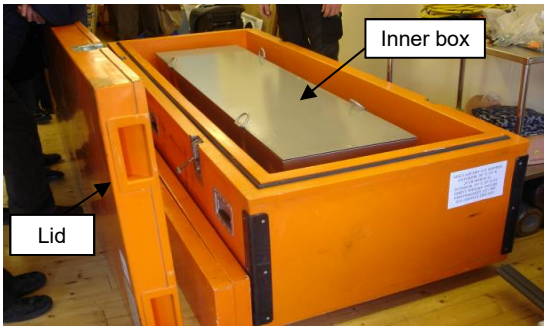



*Figure 5.27 Transport box*

### 5.15.1 Transfer and cool-down

- Clean the patient and place in a body bag to protect the skin.
- Ensure there is a temperature probe in the patient (usually the nose), connected to a data logger.
- Set the data logger to record readings at least every hour, but take manual values frequently, as a back-up. The funeral director may be able to do this.
- Place lids loosely on the boxes, leaving the data logger on top of the transport box lid but ensuring the wires to the temperature probe are not snagged or damaged. Always keep the lids on the boxes when not checking or filling with dry ice.

At least one standby team member will need to visit every day or two to check the transport box and ensure that a supply of dry ice is ordered and delivered as needed, and placed in the box on delivery.

- Check the dry ice and temperature regularly - initially hourly, then at extended intervals over the following days. The initial 150kg of dry ice will need to be topped up, typically about 50kg a day or 50-100kg every two days. The patient needs to be cooled to -65°C before shipping; this will take 3-5 days so about 250-300kg will be needed in total. ENSURE TIMELY DELIVERIES OF DRY ICE.
- Dry ice can also be placed in the inner box, alongside the patient and especially around the head (not touching the skin).
- Experience shows that regular repacking of the dry ice, to make sure it is in contact with the inner box, significantly increases the rate of cooling.
- Remove any frost build-up around the transport box lid .

### 5.15.2 Preparation for transportation

*Equipment needed: silicone sealant and gun, screwdriver, bradawl, weighing scales (to 50kg, for dry ice), heavy duty gloves, scraper, towels, gaffer tape, cable ties, scissors.*

JUST BEFORE SHIPMENT, CARRY OUT FINAL CHECKS:

- Remove all the dry ice from the inner and outer boxes, then weigh out and pack the maximum allowable amount around the sides and ends of the inner box (on the outside), making up any space with expanded polystyrene.
    - For Delta Airlines, the maximum allowable dry ice is 45kg for standard-bodied jets and 100kg for wide-bodied jets. This needs to be checked with the funeral director or airline beforehand.
- Pack the space between the inner box and transport box with expanded polystyrene sheets. Typically 25mm- or 50mm-thick sheets are used. This will add insulation and prevent the inner box moving. The polystyrene should be against the sides of the transport box, with dry ice against the inner box.
- Remove the temperature probe and data logger.
- No dry ice must be left in the inner box, which must be sealed with silicone sealant or similar;
    - the sealant will not stick to the cold metal of the inner box – just lay a bead of silicone around the lip and lower the lid carefully to ensure a seal;
    - the inner box lid is then screwed on – note that it is difficult to line up the lid for the first screw so you will need a small screwdriver or bradawl to poke through to find the hole.
- Adjust the clamps on the outer box lid so they are just tight enough to stay closed – push down on the lid to ensure they stay closed.
    - Note that the transport box lid will probably have warped: this is due to temperature differential between the inner and outer surfaces, and is normal – it will not affect the effectiveness of the box once the lid is clamped.
- Fix cable ties through the padlock loops on the clamps.
- The outside of the shipper must be dry to clear the airport authority, so wipe off any condensation that has built up during cool-down.
- Printed shipping details, supplied by the funeral director, must be stuck on several sides of the transport container. A Dry Ice warning label will also need to be fixed to the side of the box - see Appendix G (full version).

TRANSFERRING THE TRANSPORT BOX TO THE AIRPORT

The transport box is very heavy, weighing typically about 300kg with patient and dry ice, so will require a suitable van to take the weight and sufficient people to move it.

*Equipment needed:* *- half a dozen strong men/women*
*- a long wheelbase van or Luton van with tail lift*
*- a handsaw, ratchet straps*
*- timber to place under the transport contain to keep its wheels off the van floor so it does not move around during transportation.*

The size and weight of the transport container are often requested by the funeral director to aid when making transportation arrangements. For CUK's re-usable transport box, these are:

- size - 247cm long x 97cm wide x 74cm high
- approximate weight - 300-350kg including weight of patient and 45kg of dry ice.

For custom-made transport crates, weight and dimensions should be checked so that this information is available whenever needed.

## 5.15.3 Documentation requirements

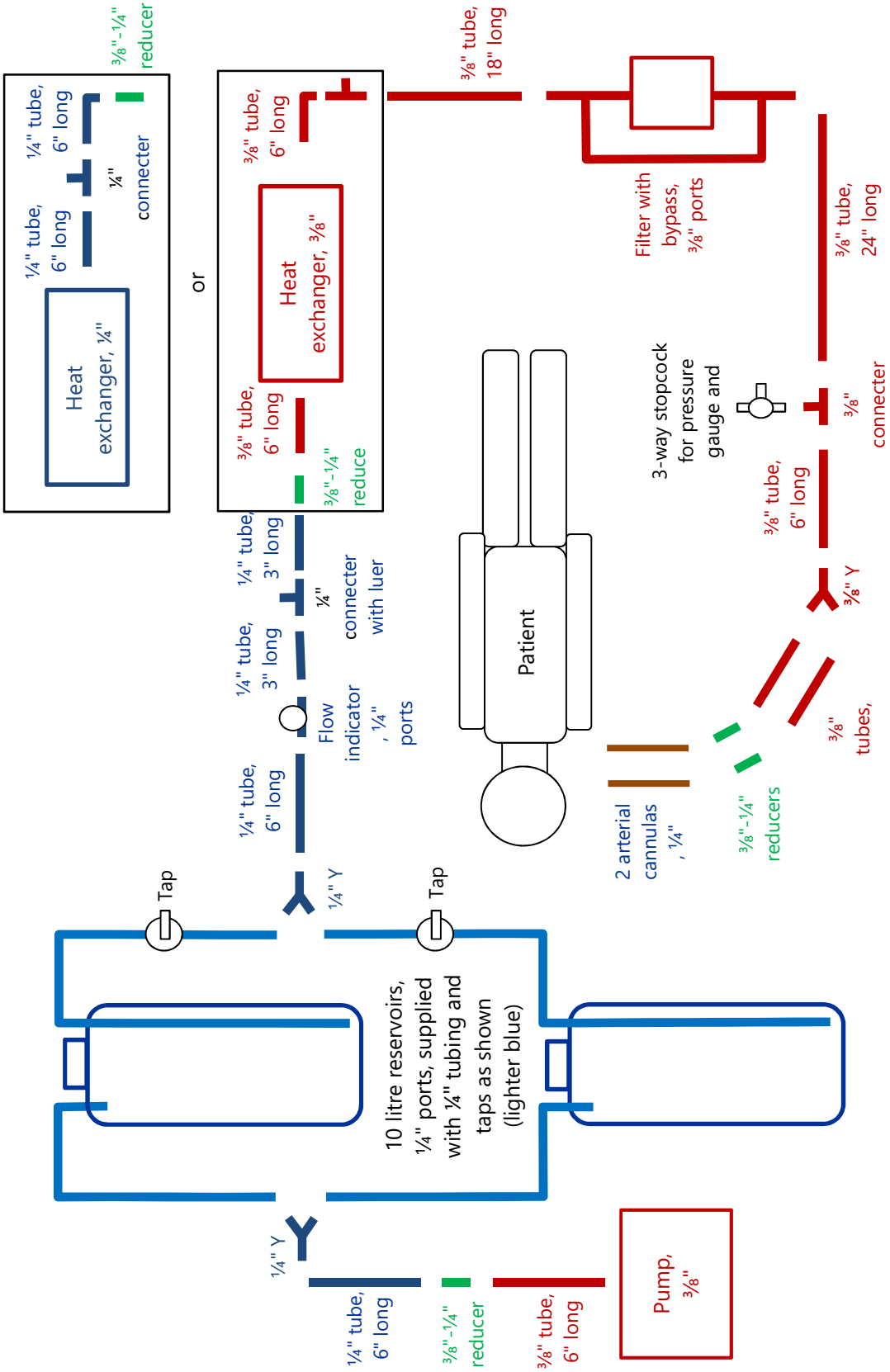
The death certificate must be obtained by the patient's relatives, who should also hand over the patient's passport. The funeral director should be able to help with other documents.

Documentation requirements are given in Appendix G, a full version of which is available to members and the patient's relatives on request.

# APPENDIX A: PERFUSION TUBING DIAGRAM



The diagram below shows the tubing and connectors needed for perfusion using the pressurised system described in Section 5.14.1. The diagram for the gravity system is similar except that the pressure vessels and pump are replaced by suspended bags of perfusate, as indicated. *Note that details may vary slightly according to equipment details, so the tubing should be made up well in advance of when it is required to allow time to sort out any snags or variations.*



The list below gives typical medications that may be administered during the initial cool-down based on recent Alcor recommendations. However, details will vary as development continues, and the list is intended only to give an indication of the range of medications and their purpose. The Cryonics Institute prefer fewer medications, primarily heparin.

**Chest compressions must be given continuously when meds are administered.** Ideally, small and large volume meds should be given together but if this is not possible, administer small volume meds first.

| PRE-DEATH MEDICATIONS - GIVEN ORALLY, SUBJECT TO AGREEMENT OF PATIENT'S DOCTOR | | |
|---|---|---|
| P1. | **Vitamin E**<br>400 IU twice a day | The most beneficial of all pre-treatment anti-oxidants at reducing ischemic damage. |
| P2. | **Aspirin**<br>300mg twice a day | Reduces blood clots, muscle relaxant. |
| P3. | **Dextromethorphan**<br>(e.g. *Benylin Dry Coughs* cough syrup) | Reduces brain ischemia. |

| LOW VOLUME MEDICATIONS - DRAWN INTO SYRINGES | | |
|---|---|---|
| 1. | **Propofol (Diprivan)**<br>200mg | A general anesthetic that reduces brain metabolism and oxygen demand, reducing risk of brain oedema. |
| 2. | **Sodium citrate**<br>10g (patient < 40kg)<br>20g (patient > 40kg) | Anti-coagulant (with a longer shelf life than heparin). Administered as a custom formulation of sodium citrate in water, in 50mL vials. Stored in a refrigerator |
| 3. | **Heparin**<br>50,000 IU | Anti-coagulant - prevents blood clotting. Loses effectiveness at low pH (<6.7) so it is important to control pH and give other anti-coagulants. |
| 4. | **Vasopressin**<br>**(ADH-antidiuretic hormone)**<br>2 x 40 IU | Constricts main blood vessels, helping to maintain blood pressure. Administered in two doses, second dose with Vital-Oxy. It is ineffective at low temperatures so no need to give if patient's temperature is below about 20°C |
| 5. | **Minocycline**<br>200mg dissolved in 10mL saline | Antibiotic - used to treat a wide variety of bacterial infections. Also a free radical scavenger. |
| 6. | **SMT (S-methyl-isothiourea)**<br>400mg dissolved in 10mL saline | Protects the brain from ischemic injury. Also raises blood pressure. Stored in refrigerator. Powder: needs dissolving. |

| HIGH VOLUME MEDICATIONS - BAGS/BOTTLES HUNG UP ON STAND | | |
|---|---|---|
| 7. | **Decaglycerol/THAM**<br>2 x 200ml<br>If not available mixed, use: | **Decaglycerol** is used to inhibit brain oedema (similar to mannitol). THAM is a buffer, used to mitigate acidosis. Administered as a custom formulation. First dose is given after small meds, second after all other meds. **Mannitol** is also used to inhibit brain oedema, similar to decaglycerol. Both meds are effective for only about one hour. |
| 7(i) | **Mannitol**<br>100g as 500mL of 20% solution | |
| 7(ii) | **THAM (Tris (hydroxymethyl) aminomethane)**<br>100mL See note -> | If the **mannitol/THAM** mixture is used, administer half after small volume meds and half after all other meds, as for decaglycerol/THAM |
| 8. | **Vital-Oxy (formerly Oxynil)**<br>(0.7mL per kg weight, max 70mL dissolved in 150mL saline | Proprietary anti-ischemic drug used to suppress inflammation and limit free radical production. Stored in refrigerator. |

| HIGH VOLUME MEDICATION - ADMINISTERED ORALLY VIA COMBITUBE | | |
|---|---|---|
| 9. | **Antacid (Maalox)**<br>250mL | Important; reduces stomach acidity, prevents bleeding of stomach wall. Be careful to give down the correct tube to avoid it entering the lungs. |

**ABBREVIATED SET OF MEDICATIONS IF ADMINISTERED MORE THAN 1 HOUR AFTER DEATH**

If medication is delayed beyond one hour after death, only the following items are given:

| | |
|---|---|
| **Sodium citrate** | As item 2 above. |
| **Streptokinase** | 250,000 IU plus 250,000 IU added to blood washout or initial cryoprotectant |
| **Heparin** | As item 3 above. |
| **Minocycline** | 200mg |
| **Decaglycerol** | 200mL |
| **Antacid (Maalox)** | as item 9 above. |

Name of patient

The above-named patient has contracted with *the Cryonics Institute / the Alcor Life Extension Foundation** to be cryogenically preserved in the event of his/her death. Arrangements have also been made by the patient with Cryonics UK to carry out emergency treatment and transportation to the above cryonics storage provider. It is the patient's wish that the following be done IMMEDIATELY after clinical death.

* delete as appropriate

A Please liaise with Cryonics UK regarding the patient's condition and pronouncement/post mortem arrangements. See contact details below.

B Please ensure that Cryonics UK are called out if death is expected within 48 hours. Cryonics UK can then mobilise a team to treat the patient as soon as possible after death to minimise tissue deterioration in preparation for cryogenic suspension. This process requires:

- rapid confirmation of death;
- immediate cooling with ice with simultaneous chest compressions and lung ventilation; and
- administration of medications to reduce ischemic damage and other tissue damage.

Cryonics UK has a specially equipped ambulance and a team to carry out the appropriate procedures.

## IN THE EVENT THAT THE CRYONICS UK TEAM IS NOT ON SITE AT THE TIME OF DEATH, PLEASE CARRY OUT THE FOLLOWING:

1. **Cool patient using ice or other coolant, with special attention to the head.**
   If the ice is directly from the freezer, it should be used lightly or with a towel between the ice and patient to avoid surface freezing.
2. **Administer heparin** (intravenously if possible). Use 100,000 units.
3. If possible, after pronouncement of death, **maintain heart and lung function by cardiopulmonary support (CPS)**.
4. **Call Cryonics UK**, of which the patient is a member, who work in collaboration with the Cryonics Institute and the Alcor Foundation. See contact details below.
5. **Release the patient with minimum delay to Cryonics UK** or the appropriate funeral director (normally F A Albin and Sons, Rowland Brothers or such local funeral director appointed by them to act for them).
6. **Leave in place any access or drainage tubes** such as IV, NG, ET and/or tracheotomy tube or oxygen line.
7. PLEASE DO NOT AUTOPSY OR FREEZE.

## CRYONICS UK CONTACT DETAILS

**A full version of this appendix including contact details, is available to CUK members, on request.**

# AIM OF THE PROCEDURE

The aim is to replace the blood in the head with a perfusate solution which permeates the tissue and protects against the formation of ice crystals during freezing.

## PROCEDURE - STANDARD METHOD

- INSERT A CANNULA INTO EACH OF THE TWO COMMON CAROTID ARTERIES (one either side of the neck) - see Figure D1;
  - directed towards the head, tied in place;
  - connected to the washout/perfusion kit tubing via a Y-connector.
- Tie off the body-side ends of the carotid arteries.
- INSERT TWO CANNULAS INTO EACH OF THE TWO INNER JUGULAR VEINS (one either side of the neck) - see Figure D1;
  - one directed towards the head and one towards the body, tied in place;
  - with the head-facing cannulas connected to lengths of tubing about 80-100cm long so that they drain into a container about 40cm below the table.

## SPECIAL CARE REQUIREMENTS

Please observe the following precautions.

- Sterilise the skin with an iodine swab before making incisions.
- Protect the neck area from contact with fluid on the table;
- When connecting cannulas and tubing, it is essential that no air be allowed to enter the system.
- On completion of perfusion, tie off all blood vessels and close the incision with sutures to prevent leakage or entry of infection.

## ALTERNATIVE PROCEDURES

Two alternative procedures, with their advantages and limitations, are described in sheet 2. These will not normally be carried out, but you may wish to discuss them with our team if you feel confident to perform them.

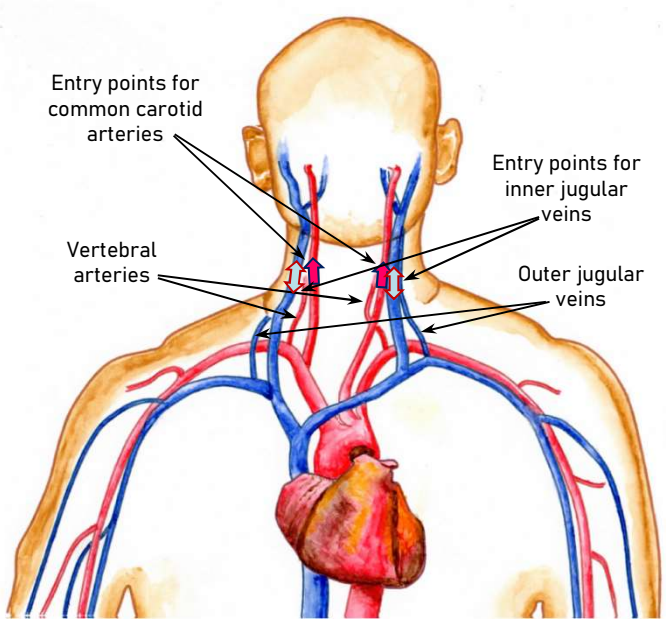



**Figure D1 Entry points for carotid arteries and jugular veins**

### Background information

The common carotid arteries split into the external carotid arteries, which supply blood to structures external to the skull, and the internal carotid arteries, which supply blood to structures internal to the skull, including the brain, pituitary gland, eyeball, nose and ear (see figure D1). Extensions of the internal carotid arteries form an arrangement of blood vessels at the base of the brain known as the cerebral arterial circle, or the Circle of Willis, from which arteries supply blood to most of the brain. The purpose of the cerebral arterial circle is to equalise blood pressure to the brain and provide alternative routes to the brain if arteries become damaged.

However, the Circle of Willis is incomplete in some people, raising concerns that, in these cases, perfusion may not reach all parts of the brain, although this is not certain. To allow for this possibility, it has been suggested that perfusion should take place through the vertebral arteries (Figure D2) as well. Two methods may be used to accomplish this.

### Alternative method 1: inserting cannulas in the vertebral arteries

This procedure follows that of the standard procedure given above, with cannulas being placed in the common carotid arteries, but, additionally, the two vertebral arteries (Figure D2) are exposed and cannulas are inserted into them.

Whilst this procedure sounds straightforward, it is in practice not an easy task, as the vertebral arteries are small and difficult to locate.

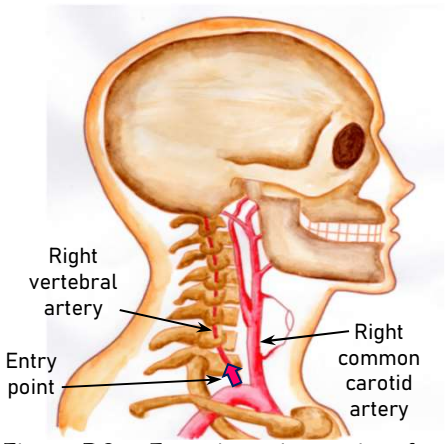



**Figure D2 Extra insertion points for Alternative 1**

### Alternative method 2: perfusing through the ascending aorta

This requires opening the chest and inserting a cannula (directed towards the head) into the ascending aorta - figure D3. In addition, the following arteries need to be clamped off, as shown.

- The left and right subclavian arteries must be clamped just beyond where the vertebral arteries branch off, to prevent perfusate flowing to the arms and torso.
- The descending aorta will need to be clamped to avoid perfusing the lower part of the body.

Drainage is via the jugular veins as described for the standard method.

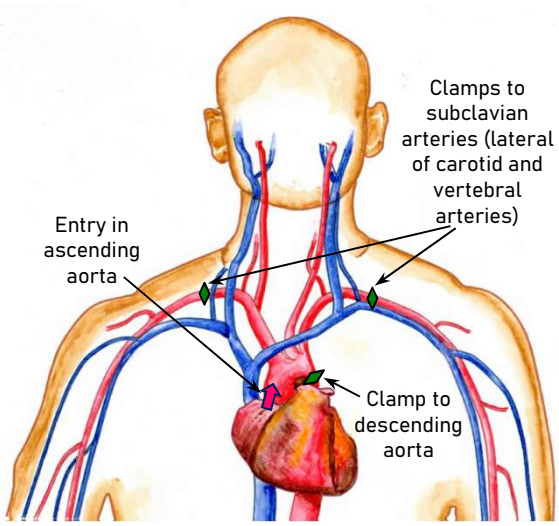



**Figure D3: insertion point and clamps for alternative 2**

## BENEFITS AND DISADVANTAGES OF THE DIFFERENT METHODS

In both methods, the advantage of perfusing additionally through the vertebral arteries is questionable, since they are very small, which severely restricts perfusate flow.

The standard method is the least complicated, and all embalmers should be able to locate the carotid arteries and jugular veins, and insert cannulas into them. Both alternative methods require some experience and practice, and embalmers may not feel confident to carry out the procedures properly, possibly resulting in incorrect procedures and a worse perfusion than with the standard method.

Set against the problems of the alternative methods is the advantage of possibly better perfusion in people whose brains do not have a complete Circle of Willis. However, there is doubt about the effectiveness of these methods, in practice, because tests suggest that the narrowness of the vertebral arteries will severely restrict the flow of perfusate.

## RECOMMENDATIONS

Alcor and the Cryonics Institute recommend that, in view of the difficulties of the alternative methods, and the doubts about their advantages, then for CUK, perfusion through the common carotid arteries be adopted as the standard method. However, one of the alternative methods could be used if the embalmer were willing to do this and confident that he/she could do so correctly.

If alternative 1 is used, the line to the carotid arteries could be clamped off for a time to encourage flow through the vertebral arteries, but first lowering the pump speed to avoid a sudden pressure increase as the carotid line is clamped.

A full version of this appendix, including a list of contacts for key CUK members and all organisations used by CUK, is available to CUK members on request.

## INITIAL COOL-DOWN

| | |
|---|---|
| HANDLING EQUIPMENT | Be careful not to strain your back when lifting heavy and/or unwieldy items and not to trap fingers or knock yourself, especially if it catches on doorways, etc., when moving. Note the 'Compressed Air and Oxygen Bottles' section, below. |
| | Lifting and moving the patient, who will be heavy, also risks back and other injuries, as for handling equipment. |
| TRANSFERRING THE PATIENT TO THE AMBULANCE | Be aware of the difficulty of moving the patient on death to the ambulance, especially down stairs or through tight entrances or corners. If necessary, try a dry run (without the patient) to check that the proposed procedure is feasible and safe. |
| ADMINISTERING MEDS | Be especially careful of syringes with needles: do not wave them around or lean over anybody if either of you is using a needle. Immediately dispose of used needles in a 'sharps' box. |
| PROTECTIVE CLOTHING | Be aware of the risks from splashes of chemicals and body fluids - wear protective overalls, gloves and face masks. Protective equipment should be issued early in the standby. Note the 'Risk of Infection' section, below. |

## TRANSPORTING THE PATIENT IN THE AMBULANCE

Ensure that the trolley, ice bath and any other loose equipment are fully secured before starting off . Also make sure your seat is folded down ready and familiarise yourself with the seat belt operation. Take care when carrying out operations such as changing over gas bottles or syringe drivers. If necessary, ask the driver to pull over briefly.

## PERFUSION

| | |
|---|---|
| HANDLING EQUIPMENT AND PATIENT | As with cool-down, be aware of hazards associated with lifting the patient and equipment. |
| TRIP AND SLIP HAZARDS | Be aware of trip hazards, and keep items as tidy as possible. Also be aware of the possibility of liquids splashed on the floor; keep the floor dry as far as possible. |
| INFECTION AND CHEMICALS RISKS | Wear protective clothing and avoid contact with the water in the ice bath or fluids from the patient. Also avoid contact with perfusate solutions. If splashed, immediately wash the splashed area vigorously. Note the 'Risk of Infection' section, below. |

## COMPRESSED AIR AND OXYGEN BOTTLES

| | |
|---|---|
| DESCRIPTION | Air or oxygen is kept in steel pressure cylinders under high pressure (about 200 bar - 200 atmospheres - 3,000psi - when full). |
| STORAGE CONDITIONS | Store where bottles will not be heated above 50°C - avoid storing in direct sunlight. |
| STOWAGE AND STANDING UP | Because of their weight, the bottles have the potential to cause injury and damage. Make sure they are properly stowed and secured when in the ambulance. When in use, make sure they are laying flat or are secured - a falling bottle can be dangerous. |
| LIFTING | Make sure you are in a stable position before lifting. Do not bend over excessively - beware overstraining your back. Get somebody else to lift if you are not sure you are strong or fit enough. |
| OPENING VALVES | Ensure the bottle is connected to equipment (with taps turned off) before turning on the supply. Keep the valve spanner handy so the gas can be turned off quickly. |
| OXYGEN | Fire risk if it comes into contact with flame or flammable substances. Will cause some substances to burn spontaneously even at room temperature. If there is a release of oxygen, evacuate personnel and, if possible ventilate immediately. Do not operate electrical devices. **Do not smoke.** Ensure the area is well ventilated when using. |
| | Grease will spontaneously combust in the presence of oxygen, so do not grease any connections. |

## DRY ICE

DESCRIPTION

Dry ice is frozen carbon dioxide, which occurs naturally in the atmosphere and is not poisonous. However, it can cause drowsiness and eventually death in confined spaces - see 'Ventilation', below.

At atmospheric pressure, frozen carbon dioxide turns directly from a solid to a gas (sublimation) at -79°C.

STORAGE CONDITIONS

Keep in the expanded polystyrene boxes that the ice is supplied in and keep these in the transport box to minimise sublimation. Also, keep in a well-ventilated area to avoid an excessive build-up of carbon dioxide.

VENTILATION

Carbon dioxide gas is heavier than air so tends to flow along the ground, displacing air. This can lead to drowsiness or eventually death, by asphyxiation (lack of oxygen), so it must be used only in well-ventilated areas.

TRANSPORTATION

If it is necessary to transport dry ice, it should always be separated from the passengers, especially the driver, by a partition that prevents carbon dioxide from entering the passenger compartment, causing drowsiness and possibly asphyxiation.

HANDLING

The dry ice used by CUK comes in easily handleable slices, with each slice wrapped in polythene. Casual touch is not dangerous but prolonged contact can freeze the skin, so protective gloves should be used when handling.

## RISK OF INFECTION

Protective clothing should be warn during all operations of the call-out as described in Section 1.

Before agreeing to attend a call-out, a member of the call-out team should check with the patient's relatives and attending doctor whether the patient is suffering from any infection that might cause a health risk to CUK volunteers. **If the patient is suffering from an infections disease, especially any listed below, seek advice from the funeral director and the patient's attending doctor before attending. Where a body bag is required, the risk is likely to be too great for CUK to attend the call-out.**

*The table below is based on advice given to funeral directors and embalmers.*

| INFECTION | IS A BODY BAG NEEDED? | CAN THE BODY BE VIEWED? | WHAT CAN BE CARRIED OUT? | |
|---|---|---|---|---|
| | | | HYGIENIC PREP? | EMBALMING? |
| **Intestinal infections:** transmitted by hand-to-mouth contact with faecal matter or faecally contaminated objects. | | | | |
| Dysentery (bacillary) | Advised | Yes | Yes | Yes |
| Hepatitis A | No | Yes | Yes | Yes |
| Typhoid/paratyphoid fever | Advised | Yes | Yes | Yes |
| **Blood-borne infections:** transmitted by contact with blood (and other body fluids which may be contaminated with blood) via a skin-penetrating injury or via broken skin. Through splashes of blood (and other body fluids which may be contaminated with blood) to eyes, nose and mouth. | | | | |
| HIV | Yes | Yes | Yes | No |
| Hepatitis B and C | Yes | Yes | Yes | No |
| **Respiratory infections:** transmitted by breathing in infectious respiratory discharges. | | | | |
| Tuberculosis | Advised | Yes | Yes | Yes |
| Meningococcal meningitis (with or without septicaemia) | No | Yes | Yes | Yes |
| Non-meningococcal meningitis | No | Yes | Yes | Yes |
| Diphtheria | Advised | Yes | Yes | Yes |
| **Contact:** transmitted by direct skin contact or contact with contaminated objects | | | | |
| Invasive Streptococcal infection | Yes | Yes | No | No |
| MRSA | No | Yes | Yes | Yes |
| **Other infections** | | | | |
| Viral haemorrhagic fevers (transmitted by contact with blood) e.g. Lassa fever, Ebola virus | Yes | No | No | No |
| Transmissible spongiform encephalopathies transmitted by puncture wounds, 'sharps' injuries or contamination of broken skin, by splashing of the mucus membranes) Various prions, e.g. Creutzfeld Jacob disease/variant CJD | Yes | Yes | Yes | No |

A full version of this appendix, including documents required and who should obtain them, is available to CUK members on request.