BLOOD COLLECTION and PROCESSING

KEY MESSAGES

Intraoperative Cell Salvage (ICS) starts with aspirating blood lost within the surgical field into a collection reservoir, which **must** be appropriately anticoagulated prior to aspiration into the blood collection reservoir. This is achieved via a dual lumen 'Aspiration and Anticoagulation' line that delivers anticoagulant to the tip of the line and then aspirates it along with fluid from the sterile field into the collection reservoir. Insufficiently anticoagulated blood will clot, which may result in blockages in the system and/or a reduction in salvageable red cells.

Blood loss removed from the operative site by swabs has been estimated at between 30%[1] and 50%[2] of the total surgical blood loss. The efficiency of red cell recovery by ICS is very much dependent on the ability to recover the blood lost in a useable form, and by washing swabs, the blood that is normally discarded can be collected and the overall efficiency of red cell recovery improved.[3]

ICS collection of blood can be undertaken with or without processing and subsequent reinfusion.

TARGET STAFF GROUP

All staff involved in the cell salvage process.

PROCEDURE – BLOOD COLLECTION

Aspiration of blood and vacuum pressure

Avoid aspiration of contaminants: it is essential that contraindicated substances i.e. bone cement/bowel content are not aspirated into the collection reservoir. This can be avoided by the use of a 'dump' suction – usually a standard surgical Yankauer connected to a surgical suction unit. Following adequate irrigation, the use of the cell salvage suction may then be resumed.

To reduce haemolysis the vacuum pressure should always be set as low as practicable, typically between -100 and -150 mmHg (avoid excess pressures).

To optimize the yield and quality of salvaged blood a large bore, single lumen, suction tip (minimum 4mm, e.g. Yankauer sucker) should be used and surface skimming avoided (as this creates more damage to red cells).

In the event of significantly increased blood loss, the vacuum level can be temporarily raised to clear the field and then reduced to a lower level for lower flows.

Setting up the cell salvage equipment

Before setting up, check the mechanical integrity of the device by powering up to allow the "self-test" to be completed and any problems highlighted. When handling disposables, aseptic non-touch technique should be used and disposables contaminated with blood should be handled in accordance with local policy. Personal Protective Equipment should be used at all times.

Cell salvage might be set up with the initial plan to utilise it in different ways – see sections **A.**, **B.**, and **C.** on the next page.

A. Collect only

In many situations it may be advisable to collect the shed blood and wait to see if sufficient volume has been collected before progressing to the processing phase. Most cell salvage devices will allow this approach, using only the reservoir and aspiration line in the first instance. Once sufficient blood has been collected the processing set can then be loaded.

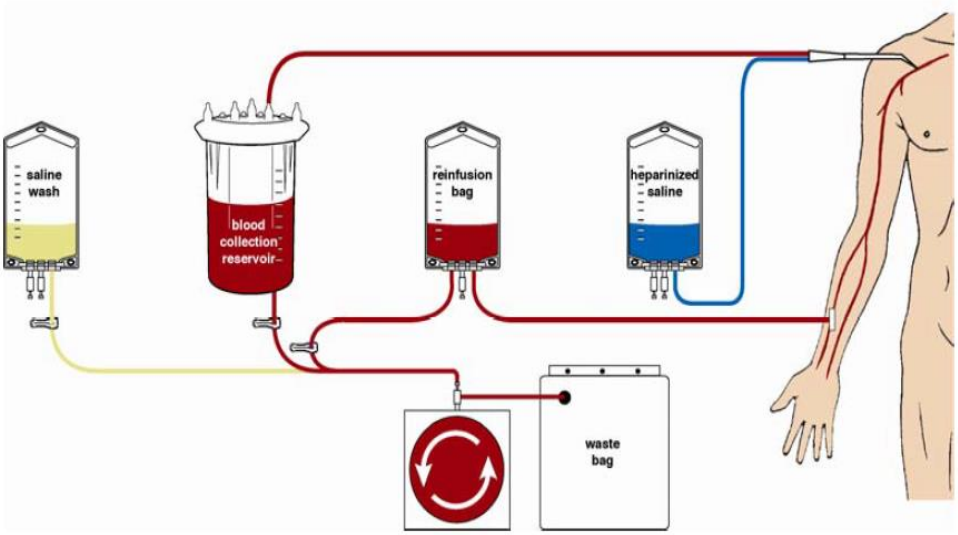
B. Collect and process

When it is likely that sufficient blood loss will be experienced to justify processing, the machine can be set up with the full disposable set at the beginning of the surgical procedure.

C. Standby

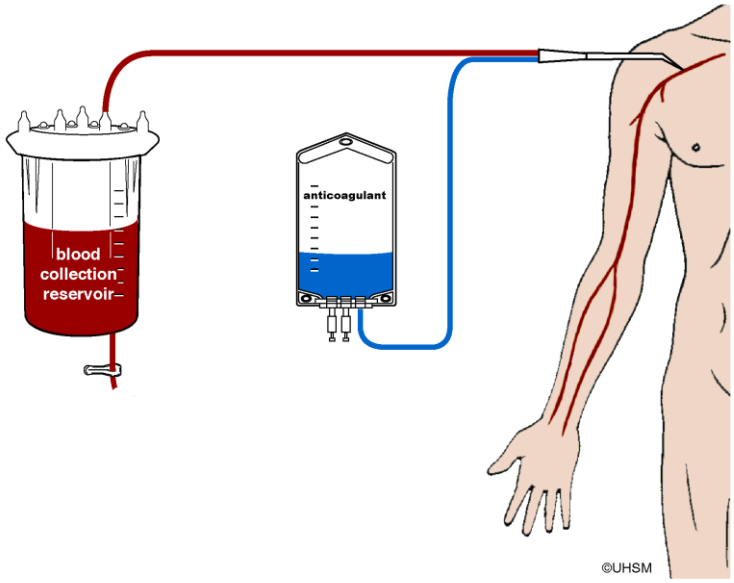
In some circumstances it may be favourable to set up the equipment for cell salvage in advance, ensuring that it is available quickly when needed without unnecessary delay:

- The disposables are loaded "unprimed" on the device. Only spike solution bags when required (this will extend the useable time limit on the prepared machine).
- The dual lumen suction line can only be connected once the patient is *in* situ as it is passed from the sterile surgical field by the scrub nurse.
- To ensure a closed system, the caps protecting any unused port must remain in place.
- The time of set up and an expiry date and time should be recorded and the disposable set labelled accordingly. There is no definitive guidance for how long the equipment can be left. When reviewing practice in relation to apheresis machines it would appear that an unprimed system could be used for up to 24 hours but once primed (in this case the saline bags spiked) these should be used within 8 hours or disposed of.
- If the device and disposables are not used within the allotted time-frame, the device is cleared down and all the consumables discarded.



PROCEDURE – ANTICOAGULATION

Each organisation should determine and document within their policy which anticoagulant will be used for intraoperative cell salvage.



Heparinised saline solution or Acid Citrate-Dextrose Anticoagulant (ACD-A) may be used for anticoagulation during blood collection.

Heparin

A solution of 25,000 - 30,000 IU of heparin per 1 litre of intravenous (IV) normal saline (0.9% NaCl) solution is recommended with a dosage of 20ml of solution per 100ml of collected blood. This type of solution is not available commercially and will need to be made up locally. It is imperative that the heparinised saline is labelled correctly and clearly to make it obviously distinguishable from saline wash solutions.

The use of heparin should be avoided in patients who have had a prior diagnosis of Heparin induced thrombocytopenia.

ACD-A

It is recommended to use a quantity of 15-20ml ACD-A per 100ml of collected blood. Pre-prepared ACD-A solutions are available commercially for this purpose.

For either Heparin or ACD-A: The quantity of anticoagulant introduced into the blood collection system must be adapted to the volume of blood loss. A rate of 60 to 80 drops of anticoagulant per minute is typical in moderate blood loss but **should be monitored closely and adjusted accordingly** to avoid clotting in the reservoir.

N.B. Anticoagulation when using ICS in Neurosurgical procedures.

Some manufacturers recommend 60,000 units of heparin in 1 litre of IV normal saline (0.9% NaCl) solution or, if using ACD-A, doubling of the flow rate when using ICS in Neurosurgery to compensate for the increased likelihood of clotting in blood salvaged from this type of surgical field. Please check with your manufacturer if using ICS in Neurosurgical procedures.

Points to note:

Heparin

1. Heparin is a prescription only medicine and consideration should be given to this when developing the organisation's cell salvage policy. A Patient Group Directive (PGD) for use of heparin as an anticoagulant in ICS may be considered appropriate.
2. The UK Cell Salvage Action group recommend:
    a. To help reduce the risk of administration error written documentation of the heparin requirement should not be entered on the general prescription chart. An appropriate alternative for documenting the use of heparin for cell salvage, such as on the cell salvage audit form, should be identified in the local cell salvage policy.
    b. The batch number and dosage of heparin used should be documented.

ACD-A

1. ACD-A is not a prescription medicine as it is not included in The British National Formulary
2. If ACD-A is quoted in the product specification (CE marking) for the cell salvage machine in use there is no requirement for ACD-A to be prescribed. However, the batch number and dosage should be documented on the cell salvage audit form.
3. If it is not part of the product specification then the ACD-A used for cell salvage procedures should be documented and the following should apply:
    a. To reduce the risk of administration errors, documentation for the use of ACD-A should not be entered on the general prescription chart but on the cell salvage chart/form to help ensure that the anticoagulant is used correctly.
    b. The batch number and dosage of ACD-A used should be documented.

PROCEDURE – SWAB WASHING

1. Set up a sterile bowl with 1000ml IV normal saline (0.9% NaCl)*.
2. Soak blood soiled swabs† for a few minutes in the saline to extract red cells. Gently compress the swabs to express any residual solution before discarding.
3. At the end of the procedure# aspirate the swab wash solution into the cell salvage reservoir using the suction line and process in the same manner as for blood aspirated directly from the sterile field.

*Some centres use anticoagulant in the swab wash e.g. 10,000 IU heparin per litre saline.

†Avoid washing swabs contaminated with betadine or other substances contraindicated in cell salvage.

#In a long procedure consider evacuating the swab wash every two hours to avoid stagnation; with high blood loss, consider retrieving the blood in the swab wash earlier to expedite reinfusion.

Caution: swab washing may not be appropriate in procedures where sharp bone shards may be present in the swabs and therefore pose a risk of sharps injury.

Estimating blood loss

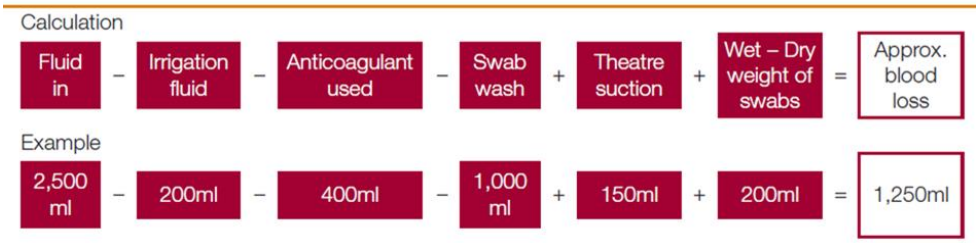
Estimated blood loss can be calculated using the formula below.

At the end of the procedure, when all of the blood from the collection reservoir has been processed, an estimate of the volume of blood the patient has lost during the procedure can be made using a simple calculation.

The information you will need is:

- **'Fluid in' volume** (machine read out) – Total volume of fluid processed by the machine, includes: blood aspirated from the surgical field, anticoagulant and irrigation from the surgical field.
- **Irrigation fluid** – Volume of sterile irrigation fluid used within the surgical field and aspirated into the ICS collection reservoir, (this is **not** the volume of IV normal saline (0.9% NaCl) wash solution used by the machine – this volume is **not** required for the blood loss calculation).
- **Anticoagulant used** – An estimate of the volume of anticoagulant that has been used.
- **Swab wash** – Volume of IV normal saline (0.9% NaCl) used to wash swabs.
- **Theatre suction** – Volume of blood in theatre suction.
- **Wet-dry weight of swabs** – Compensates for blood *and* saline swab wash retained on swabs and allows them to be weighed outside of the sterile field after washing. Alternatively, a sterile drape may be placed over a scale near the surgical field and the swabs weighed prior to washing

Once you have all of this information, an estimate of blood loss can be calculated as shown below:



REFERENCES

1. Takaori M. Perioperative autotransfusion: haemodilution and red cell salvaging. Can J Anaesth. 1991; **38**:604-7.

2. Ronai AK, Glass JJ, Shapiro AS. Improving autologous blood harvest: recovery of red cells from sponges and suction. Anaesth Intensive Care 1987; **15**:421-4.

3. Haynes SL, Bennett JR, Torella F, McCollum CN. Does washing swabs increase the efficiency of red cell recovery by cell salvage in aortic surgery? Vox Sanguinis 2005; **88**: 244–248.