22 Cell Salvage (CS) n=17

Authors: Sarah Haynes and Catherine Ralph

Definition:

Any adverse events or reactions associated with cell salvage (autologous) transfusion methods, including intraoperative and postoperative cell salvage (washed or unwashed).

Key SHOT messages

- The safety of cell salvage is the shared responsibility of all staff within the theatre whose actions can have an impact on the quality of the final product. All staff involved in the process, including anaesthetists, surgeons and scrub staff, should receive cell salvage education and training appropriate to their role
- Institutions should have defined procedures on the infusion of cell salvaged blood which should ideally mirror the guidelines for transfusion of allogeneic blood i.e. a valid prescription, documentation of times and appropriate recorded observations. These procedures should include the management of a transfusion reaction from autologous blood similar to the procedures in place for allogeneic blood

Death n=0

There were no reported deaths associated with cell salvage in 2018.

Major morbidity n=1

There was 1 case of major morbidity in 2018, see Case 22.2. A further 4 patients were classified as having minor morbidity.

Overview

There were 17 cases reported, 12 female patients and 5 male; on review none were withdrawn, nor transferred to other categories. All cases reported were related to the use of intraoperative cell salvage (ICS).

As with last year's Annual SHOT Report, the small number of cases reported raises concerns around under-reporting of cell salvage incidents.

Obstetrics reports continue to dominate. A United Kingdom (UK) survey of 184 maternity units in 2017 demonstrated the availability of cell salvage in obstetrics was the highest it had ever been with 84% having cell salvage available and 50% of centres having 24-hour access (Nelissen et al. 2018). It is likely obstetrics is now one of the main speciality users of cell salvage. Of the 8 obstetrics incidents there were only 2 adverse reactions: a hypotension on reinfusion with a leucocyte depletion filter (LDF) resulting in minor morbidity, and a more serious reaction resulting in major morbidity where no filtration was used.

Incidents related to equipment failure and human error continue to be a feature and the new category of failure of provision of service accounting for 3 reports.

Cell salvage cases by speciality

There were 17 cases reported as shown in Table 22.1 below.

Speciality	Elective	Emergency
Gynaecology	1	0
Obstetrics	3	5
Orthopaedic	3	1
Urology	2	0
Vascular	1	1
Total	**10**	**7**

Table 22.1: Specialty for cell salvage reports

Types of cell salvage

All cases involved the use of washed intraoperative cell salvage techniques. No reports were received for postoperative cell salvage.

Cell salvage adverse events n=12

Equipment failure n=2

Within the category of equipment failure 1 incident was reported as a machine failure and reported to the Medicines and Healthcare products Regulatory Agency (MHRA) Yellow Card Scheme. Another report was made that related to faulty disposable assembly, which although reported to the manufacturer was not taken further.

Learning point

- Cell salvage consumables are also covered by medical device legislation and as such any adverse incident that caused, or almost caused, injury to a patient or wrong or delayed treatment of a patient is reportable under the Yellow Card Scheme (England & Wales) or regulatory equivalent (Scotland and Northern Ireland)

Operator errors n=6

Of the 6 adverse events attributed to operator error, 1 involved incorrect assembly of equipment, in another the misuse of equipment resulted in inadequate washing of the red cells, and in 1 case a LDF was not used where it might have been indicated.

Case 22.1: LDF not used for reinfusion of red cells in a urological case with malignancy

A patient in their 50s undergoing elective open partial nephrectomy with malignancy experienced a major haemorrhage. ICS was being used and autologous red cells were available for reinfusion. The transfusion was initiated without the use of a LDF as the operator was unaware of the patient's malignancy status. Only 20mL was infused before the error was noted. The transfusion was stopped and a LDF used for the remainder of the infusion.

Cell salvage operators and others involved in the process should be aware of all patient specific considerations that might impact on the way cell salvage is performed before surgery starts.

Learning points

- The United Kingdom (UK) Cell Salvage Action Group (UKCSAG) recommends that the intention to use intraoperative cell salvage (ICS) should be stated within the World Health Organisation (WHO) Surgical Safety Checklist 'Time Out' before the start of the intervention to give theatre staff (including the cell salvage operator) the opportunity to discuss any considerations related to ICS
- UKCSAG outputs can be accessed via the Joint UK Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee (JPAC) website:

https://www.transfusionguidelines.org/transfusion-practice/uk-cell-salvage-action-group

The use of LDF in urological malignancy remains controversial. Although generally accepted that the LDF mitigates the theoretical risk of tumour dissemination by transferring malignant cells from the surgical field into the patient's circulation, no substantiated evidence base exists to prove this. Stoffel et al. (2005) showed that in 48 patients undergoing radical prostatectomy with ICS, 88% had prostate specific antigen (PSA)-producing cells in salvaged blood samples after processing. Following reinfusion of the salvaged red cells, without LDF use, three patients (16%) had detectable PSA-producing cells in peripheral blood samples immediately after surgery. At 3-5 weeks after surgery no cells were detected. Aning et al. (2012) report a cohort of 213 patients undergoing radical cystectomy of which 192 received ICS blood without the use of a LDF on reinfusion. The authors stated that this study, along with previous published series in urological malignancy, showed no risk of reduced survival associated with ICS and concluded that there was no evidence of a conferred benefit in terms of patient outcome compared to not using a filter.

Human and organisational factors played a part in an error where the wrong wash solution was connected to the system and the process abandoned in an orthopaedic procedure. In this case the patient was transfused with two units of allogeneic blood which may have been avoidable.

In 2 further cases, the operator misunderstood the way the machine worked and erroneously assumed the cell salvage device was not working correctly before discarding the available red cells. This action could have put the patients involved at risk of needing allogeneic blood transfusion. No adverse clinical consequences related to these errors were reported. All operators involved had been trained and competency-assessed.

Learning point

- Cell salvage operators should be trained and competency-assessed. Monitoring of competency and regular refresher training is advised. Cell salvage operators should be encouraged to identify any individual training needs as part of their professional accountability

Other events n=4

In another incident, the cell salvage operator noticed that saline for irrigation (non-intravenous (IV) grade) was being used in the surgical field and had been aspirated into the cell salvage collection. The blood collection was subsequently abandoned due to potential contamination. Although this was not classed as an operator error by the reporter, it is a reminder that the safe conduct of cell salvage is the responsibility of all staff involved in the process with the cell salvage operator being the final 'gatekeeper'.

Learning point

- Surgeons and scrub staff should be educated as to what can and cannot be aspirated from the surgical field

The further 3 adverse events involved a failure of provision of service due to the lack of a suitably trained operator. In 1 of these incidences the patient was transfused with allogeneic blood which may have been avoidable if cell salvage had been available.

Cell salvage reactions n=5

Case 22.2: Sepsis, disseminated intravascular coagulation (DIC) and renal failure following re-infusion cell salvaged blood (imputability: 1, possible)

A patient in her 20s, undergoing emergency caesarean section (Category 2) for failure to progress following induction of labour for high blood pressure, received a re-infusion of 450mL of cell salvaged blood in recovery. She went on to become septic, developed DIC and renal failure requiring dialysis. Her renal function did not significantly improve leaving the patient in need of a renal transplant.

The caesarean section was performed 22 hours after artificial rupture of membranes and a failed induction of labour. In theatre the heart rate (HR) and blood pressure (BP) were raised until delivery. Cell salvage was used, collecting blood with a single suction and the processed washed collection re-infused without a LDF. Vital signs immediately post surgery showed a raised BP with a tachycardia, poor oxygen saturations and a raised temperature indicative of an infection. Antibiotics were commenced within a few hours of the delivery. It is likely the re-infusion of autologous blood was in progress during this period in recovery, having been started in theatre, although there was no prescription or documentation of the time the re-infusion was completed. Without a LDF the re-infusion would normally be completed within a short time frame and should have been monitored according to hospital policy for allogeneic blood transfusions with any suspected transfusion reaction managed according to this policy.

Over the next 24 hours post delivery, there were worsening signs of sepsis, hypotension and anuria resulting in renal failure requiring renal support and admission to intensive care.

Whilst the efficiency of washing in cell salvage is good, clearance rates of 100% are almost never achieved, and levels of bacterial contamination whilst significantly reduced can still be present in the re-infused product (Teare et al. 2015). The use of a LDF may have reduced the quantity of any contaminants reinfused although any effect on subsequent clinical sequelae would be difficult to predict. SHOT has previously noted a move away from the use of LDF in obstetric cell salvage (Bolton-Maggs et al. 2018).

A relationship between the re-infusion of cell salvaged blood and the development of sepsis in this case cannot be excluded, however, association of re-infused cell salvage blood with sepsis in obstetrics has not previously been noted (Khan et al. 2017; Sullivan & Ralph 2019).

There were 4 further clinical reactions, all of which were classed as having minor or moderate morbidity at the time of the reaction and all recovered.

Case 22.3: Cardiac arrest during re-infusion of cell salvaged blood during nephrectomy (imputability: 0, excluded or unlikely)

A patient in their 80s underwent an elective nephrectomy for malignancy and suffered significant blood loss. Cell salvaged blood was re-infused intraoperatively using a LDF with a member of theatre staff applying manual pressure to speed up the rate of transfusion. Having re-infused 50mL over 5 minutes the patient suffered a cardiac arrest from which they were successfully resuscitated. The patient also became bradycardic and required the insertion of a permanent pacemaker. The anticoagulant used for cell salvage was acid-citrate-dextrose solution (ACD).

It is very unlikely the cardiac arrest was associated with the re-infusion of just 50mL of autologous red cells. However, the administration of blood under pressure through a LDF is not recommended due to the risk of air embolus and potential for interfering with the functionality of the filter in retaining contaminants.

Learning point

- The potential risk of tumour cell dissemination needs to be considered in context and in situations of haemodynamic instability the benefit of removing the filter to re-infuse blood more rapidly is likely to outweigh the theoretical risks associated with tumour cells contaminating the circulation

Case 22.4: Allergic reaction to salvaged red cells (imputability: 2, likely/probable)

A patient in her 30s undergoing myomectomy developed red tracking marks proximal to the cannula on reinfusion of salvaged red cells. The reinfusion was stopped and the marks disappeared only to reappear on resumption of the infusion. The reinfusion was therefore discontinued. There were no further complications and the patient made a complete recovery. The anticoagulant used was ACD.

Whilst it may be unlikely, an allergic reaction to an autologous transfusion is still possible. It is theoretically conceivable that, despite adequate washing, allergens may have remained in trace amounts in the final salvaged red cell product.

Case 22.5: Hypotension on reinfusion of salvaged red cells in an obstetric case with the use of a LDF (imputability: 2, likely/probable)

A patient in her 30s underwent an elective caesarean section where cell salvage was used with ACD as the anticoagulant. On reinfusion of the salvaged red cells via a LDF, the patient's pulse increased from 81 to 130 beats per minute (bpm) and BP dropped from 107/72 to 54/34mmHg. The patient reported feeling light-headed, dizzy and nauseous. The reinfusion was stopped and infusion of clear fluids commenced with continuous patient monitoring. The patient quickly improved and reinfusion of the salvaged red cells was recommenced at a slower rate at the patient's insistence with no further issues.

Case 22.6: Hypotension on reinfusion of salvaged red cells in an orthopaedic case without the use of a LDF; (imputability: 3, certain)

A patient in their 70s underwent revision hip surgery of adverse reaction to metal debris (ARMD). During reinfusion of 240mL of salvaged red cells over 2-3 minutes, the patient exhibited a profound hypotension with systolic BP of 60mmHg for approximately 5 minutes. This was corrected with the use of vasopressors and fluid infusion. The anticoagulant used for cell salvage was ACD.

These 2 cases bring the total number of hypotensive events related to ICS to 29 over the past 8 years. The majority (21) have occurred with the use of a LDF. However, hypotensive reactions can also occur in the absence of the filter with the current case bringing the total to 8 such incidents.

There is very little evidence of how effective ICS is at removing the metal fragments that might be encountered during metal on metal hip revision surgery. Reijngoud et al. (2009) reported greater than 70% removal of the metal but still advised caution. Some companies manufacture a collection reservoir with a finer filter designed to catch the metal debris, or the use of a LDF on reinfusion may prove useful.

Learning point

- There is as yet no evidence to confirm the effectiveness of filtration in removing metal particles. The United Kingdom (UK) Cell Salvage Action Group (UKCSAG) advises avoiding aspiration of blood for the duration of surgery if there is evidence of metallosis as there is a potential risk of contaminating the collection

References

Aning J, Dunn J, Daugherty M, et al. (2012) Towards bloodless cystectomy: a 10-year experience of intra-operative cell salvage during radical cystectomy. *BJU Int* 2012;**110(11 Pt B)**:E608-13.

Bolton-Maggs PHB (Ed), Poles D et al. (2018) on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. The 2017 Annual SHOT Report. https://www.shotuk.org/shot-reports/ [accessed 30 May 2019].

Khan KS, Moore PAS, Wilson MJ, et al. (2017) Cell salvage and donor blood transfusion during cesarean section: A pragmatic, multicentre randomised controlled trial (SALVO). *PLoS Med* 2017;**14(12)**:e1002471.

Nelissen E, Vaughan-Williams S, Birchall J, et al. (2018) Exploring the availability and acceptability of cell salvage after vaginal birth in the UK: the SalVage Study. Poster abstract P37.19th Annual Symposium on patient blood management, haemostasis and thrombosis (NATA): http://www.nataonline.com/sites/default/files/imagesC/19th_Annual_NATA_Symposium_Abstract_Book.pdf [accessed 31 May 2019].

Reijngoud LW, Pattyn C, De Haan R et al. (2009) Does intraoperative cell salvage remove cobalt and chromium from reinfused blood? *J Arthroplasty* 2009;**24(7)**:1125-9.

Stoffel JT, Topjian L, Libertino JA. (2005) Analysis of peripheral blood for prostate cells after autologous transfusion given during radical prostatectomy. *BJU Int* 2005;**96(3)**:313-5.

Sullivan IJ, Ralph CJ. (2019) Obstetric intra-operative cell salvage: a review of an established cell salvage service with greater than 1000 re-infused cases. *Anaesthesia* 2019; doi: 10.1111/anae.14630.

Teare KM, Sullivan IJ, Ralph CJ. (2015) Is cell salvaged vaginal blood loss suitable for re-infusion? *Int J Obstet Anesth* 2015;**24(2)**:103-110.