UK CELL SALVAGE ACTION GROUP

Intraoperative Cell Salvage: 2022 Survey of Equipment and Practice across the UK in 2019

UK Cell Salvage Action Group

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The authors would like to thank all the NHS organisations that participated in the survey. They are listed in Appendix 1

Contents

Summary

This survey was designed to provide comprehensive evaluation of UK Intraoperative Cell Salvage (ICS) practice as in 2019. Cell Salvage is widely practiced across all major subspecialty areas. The survey demonstrates that ICS contributes significantly to perioperative patient blood management, even though the exact extent of ICS use and its impact remains unknown. There is variation in delivery models, with inconsistent documentation and data collection. The variance in service delivery, education, record keeping, and incident reporting reflect the absence of a recognised and regulated national standards in ICS practice.

The authors strongly recommend development of national standards for ICS delivery, training, and governance.

Key Findings

- Data was received from 92 Trusts, covering 114 hospitals.
- Very few respondents were able to give all the information requested.
- ICS use resulted in reinfusion of at least 8,800 units of blood where data was available, (38/92 responses),
- ICS was started in at least 22,382 cases. This is likely to be a marked underestimate.
- Nearly all hospitals offering Vascular and Cardiac surgery utilise ICS.
- ICS use is most widespread in Orthopaedics, followed by Obstetrics, Gynaecology, Trauma.
- Operating Department Practitioners (ODPs) and anaesthetic nurses are the main operators of ICS machine – both setting up and running it.
- Data collection was found to be inconsistent, even within different specialties in the same organisation. Inadequate record-keeping or inability to access the data prevented accurate analysis of ICS practice in organisations and hence its impact on blood transfusion services remains unquantified.
- Theatre staff education varies between staff groups. The formal documentation of training is best for the machine operators.
- Reporting of adverse events and their management is variable with notable underreporting to SHOT.

Introduction

The United Kingdom Cell Salvage Action Group (UKCSAG) was established in 2006 to support safe implementation of cell salvage as an alternative to allogeneic red cell transfusion and to facilitate a UK-wide approach to its use. The recent blood shortages have highlighted the contribution of Intraoperative Cell Salvage (ICS) service towards Patient Blood Management (PBM) in surgical patients.

Surveys were conducted in 2007, 2010 and 2014 to understand ICS usage in the UK. The validity of the surveys was affected by low response rates and incomplete datasets. It was established that there were no robust means to identify the extent to which ICS was being practiced in the UK, and therefore it was not possible to ascertain the extent to which it was supporting perioperative allogeneic red cell transfusion. In addition, it was not clear what models were being used for the delivery of ICS and whether hospitals were following nationally approved guidelines for delivery or providing a hospital service as advised by the Association of Anaesthetists (AoA).[1]

The original plan was to survey the ICS practices in the year 2020, but due to the global pandemic it was eventually conducted in 2021-22. As surgical activity was drastically reduced during the global health crisis, it was important to survey pre-pandemic practices. In order to understand pre-pandemic performance, respondents were specifically asked to report their 2019 ICS activity.

Methods

The survey was designed with specific aims to understand:

1) the extent of ICS usage
2) the volumes of red cell product being reinfused into patients
3) the modes by which ICS is delivered in hospitals
4) the training provided to different staff groups
5) The reporting and management of adverse events

The survey was constructed using the SnapSurvey® software. A paper version was also created in order to optimise the response rate. Prior to the roll out, the survey was piloted to a small distribution group. The survey was circulated to hospitals via the Hospital Transfusion Lead, Hospital Transfusion Committee Chair and Transfusion Practitioner, requesting that it be forwarded to the designated ICS lead, should one exist. Private providers were not included in the survey. After the initial roll out, responses were reviewed, and the non-responders contacted via email to optimise the response rate. Data was collected between September 2021 and February 2022.

The data was then processed using Microsoft Excel®. Answers to each question were analysed and results are presented as proportions (n, %) with comparisons made to previous data where possible.

Results

The survey was rolled out to 225 UK NHS Organisations. There were 92 responses compared to 137 and 53 responses received in 2014 and 2010 surveys respectively. The response rate was 41%, which is consistent with more recent reviews of patient blood management and transfusion practice (e.g. the NHSBT Amber Alert Actions Survey Report[2]). The data presented here is from the 2021-22 survey of 2019 practice.

Questions 1 & 2: Trust/Health Board/Region and Hospital(s)

The 92 responses represented activity in 114 hospitals, across England, Scotland, Wales, Northern Ireland, and the Isle of Man. 92/225 = 41% response rate.

Several organisations (i.e., Trust, Health board, etc.) run ICS services across more than one hospital. Not all questionnaires were fully completed. Analysis is based on the number of responses to each question including "don't know". The organisations that completed the survey are listed in Appendix 1.

Cell Salvage Delivery

Question 3: "If your hospital/Trust does not provide cell salvage, does it refer patients to hospitals that do provide the service."

This question received two positive responses. However, these respondents did provide ICS in numerous operative specialties and had accepted patients from other organisations who did not have ICS service.

Question 4: "Is the cell salvage service your hospital provides 24 hours"

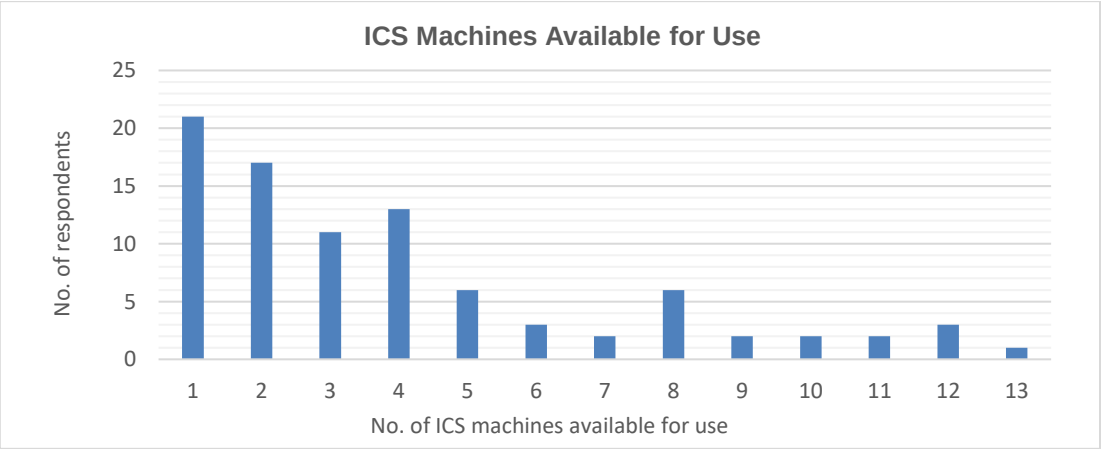
The 24-hour ICS service was provided by 71 of the 92 (77%) of respondents. This is similar to 2014 where 78% of respondents reported doing ICS outside of core working hours.

Question 5: "How many machines are available for use"

This information was provided by 89 of the 92 (97%) responders equating to 359 ICS machines. Many organisations (38/92, 41%) have only 1-2 machines. The variability in the number of machines available in each organisation reflects its size and the spread of the specialties undertaken by them.

Figure 1 demonstrates the spread of machine number per organisation.

Figure 1



Use of ICS in Surgical Specialties

Questions 6 & 7: "What specialties are there in your organisation" & "Which of these specialties in your hospital use Intraoperative Cell Salvage"

ICS is standard practice in all but one of the reporting vascular units. ICS is not available in 11% of the Obstetric and Cardiac units who responded to the survey. It is used most frequently in Vascular, Obstetrics, Cardiac, and Orthopaedics and Trauma specialities.

Table 1 illustrates the usage of ICS in the different surgical specialties.

Table 1

Specialty	%	N=
Vascular	98%	39/40
Obstetrics	89%	64/72
Cardiac	89%	22/25
Orthopaedics	84%	65/77
Trauma	80%	53/66
Gynaecology	70%	54/77
Spinal surgery	66%	21/32
General surgery	62%	48/78
Thoracic	57%	13/23
Liver	56%	10/18
Neurosurgery	56%	10/18
Urology	52%	36/70
Children's surgery	24%	11/45
Other	32%	6/19

Denominator in column N is the number of organisations offering the specialty services;
Numerator in column N is the number of organisations offering the ICS in that specialty.

Question 8: "Is your hospital a Major Trauma Centre (MTC)"

21 responses reported being MTC and all but one of these reported round-the-clock ICS provision for Trauma.

ICS Usage

Question 9: "In the year 2019, ICS was started on how many cases"

Complete data was only provided by 51 out of 92 respondents (55%). Data on ICS collection setup was incomplete or lacking in 41 respondents (45%). 37 respondents (40%) were unable to provide any information and partial data was provided by 4 respondents. Reasons given for non-submission of data are listed in Appendix 2.

Despite the lack of data, ICS was reported to have been started in 22,382 cases. It is highly likely that this is a marked underestimation of the total number of cases where ICS was used during surgical procedures.

Question 10: "Of these cases, what percentage received re-infusion"

46 out of 92 respondents (50%) provided data here, ranging from 0-100% with a median re-infusion rate of 56%.

Only 35 out of 92 respondents (38%) were able to provide data on the whole process from collection to re-infusion (questions 9-11) for all cases. Of those that could not, limitations were 'no records' (n=18), 'no access to this data' (n=5) and 'only partial dataset available' (n=8).

Reinfusion Volumes

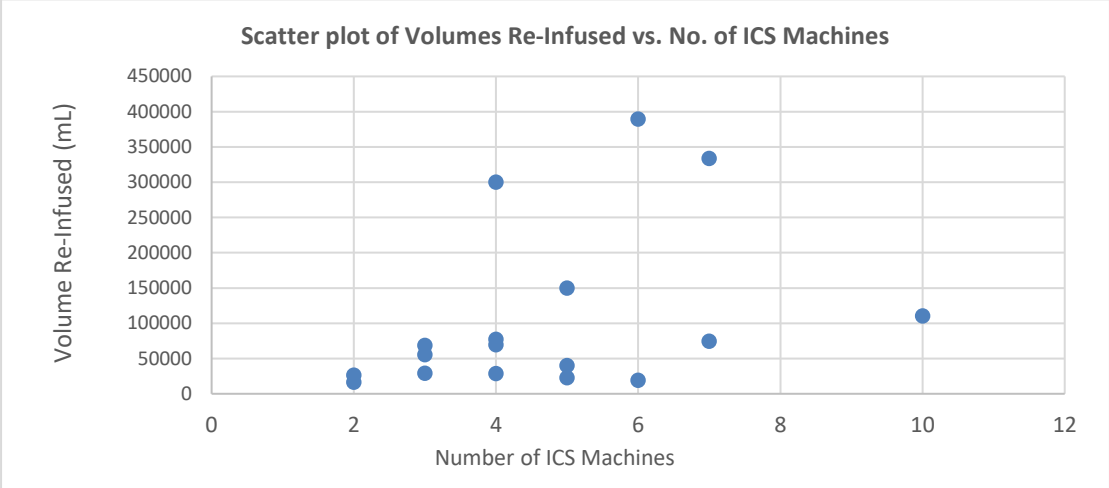
Question 11: "What was the total volume of blood (mL) returned to patients via ICS in the calendar year 2019"

Only 38 of the 92 respondents (41%) were able to provide data for this, whereas 54 respondents (59%) could not. Appendix 2 lists some of the reasons cited for this lack of data.

The total volume of red cells reinfused by the 38 organisations equates to 2,639,400mL. This is roughly equivalent to 8800 units of blood, where 300mL is approximately equal to 1 unit[3]. Total reinfusion volumes in excess of 15,000mL was reported by 21 respondents; further details showing the number of ICS cases and the precentage that were reinfused with salvaged blood in these 21 is presented in Appendix 3b. The other 17 responses here quoted volumes ranging from 0mL to 6213mL. The authors believe that this dataset contains some spurious data as well, making analysis or inclusion in the discussion challenging.

The data does not allow for correlation between specialty and yield. Interestingly, there appears to be no correlation between number of machines and large volumes of blood reinfused (>15,000mL) in 2019 (see Figure 2). This may not be significant as some specialties such as Obstetric and Cardiac units may have fewer machines but use them more frequently; others may be doing operations that have bigger blood loss and therefore have larger volumes of salvaged blood.

Figure 2



Use of Clinical Coding

Question 12: "Does your organisation use the OPCS-4 codes for ICS or equivalent within the clinical coding record"

The OPCS-4 codes were used by 27 out of 92 respondents (29%), whereas 24 (26%) did not. Majority (41/92, 45%) of respondents were not aware of these codes.

Staff Involved with ICS Delivery

Question 13 & 14: "Does your organisation use an external provider for delivery of ICS" and "Who performs the ICS in your organisation"

Table 2 shows the responses regarding the different staff groups undertaking parts of the ICS process (separated into two stages – collection set up and machine operation). The data are presented in rank order for machine operation (note: the datasets are not mutually exclusive).

Table 2

Role	Collection set up	Machine operation
Same ODP/Nurse as providing anaesthesia support	55	59
Additional Anaesthetic Nurse/ODP	39	39
Perfusionist	21	19
Anaesthetist without additional support	6	9
Clinical scientist	3	4
HCA Band 2	6	2
External provider (sub-contracted)	3	2
HCA Band 3	9	0
Associate practitioner (Band 4)	4	0

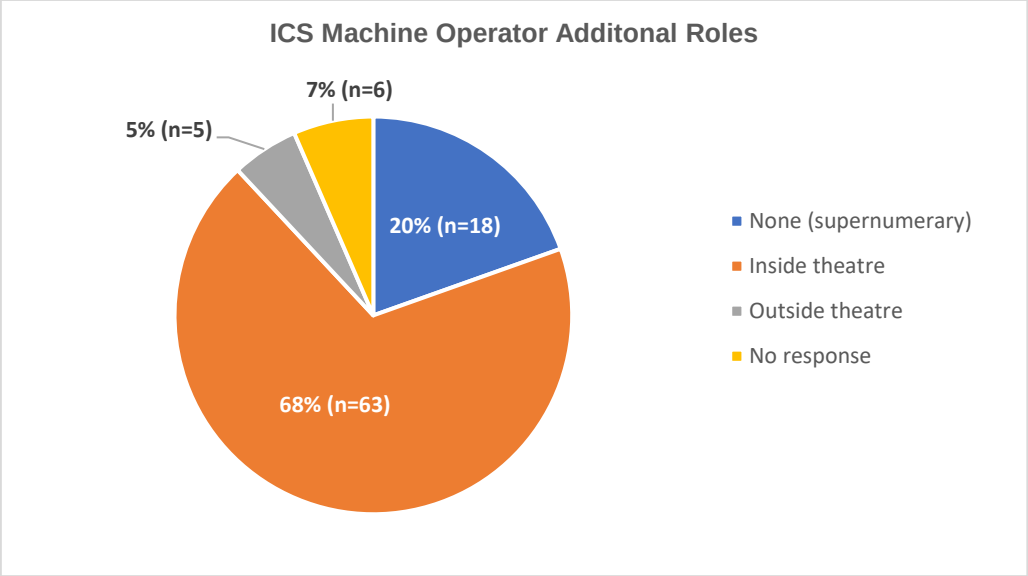
'Other' roles also reported undertaking these duties were Circulating Theatre Staff, Midwife, Transfusion Practitioner, and additional Anaesthetist.

Four respondents (4%) reported they used an external provider for all their ICS. Other two (2%) reported that they used an external provider for specific specialties.

Question 15: "Is the person responsible for the ICS machine expected to perform roles inside or outside of theatre during the time ICS is being used"

Figure 3 shows the proportion of ICS machine operators that have additional roles/duties (includes where no response was given to this question).

Figure 3



Only 18 out of 92 respondents (20%) indicated that staff operating ICS were supernumerary. Majority (63/92, 68%) reported that staff had other concurrent roles inside the operating theatre with a much smaller percentage (5/92, 5%) outside this environment. 6 respondents (7%) did not submit a response to this question. A descriptive list of the additional roles reported is given in Appendix 4.

Incident Reporting and Governance

Question 16 & 27: "Where are incidents (e.g., reactions, errors, device failures, availability issues) relating to the use of cell salvage reported to" and "Are Serious Hazards of Transfusion (SHOT) resources related to cell salvage accessible and used"

There were 90 responses out of 92 (97%) to question 16. More than one answer was given by 55 respondents (59%). Table 3 shows where ICS incidents are reported.

Table 3

	N=	%
A local incident reporting system	85	92%
Serious Hazards of Transfusion (SHOT)	53	58%
MHRA yellow card scheme or equivalent (machine or disposable failure)	28	30%
Other	8	9%

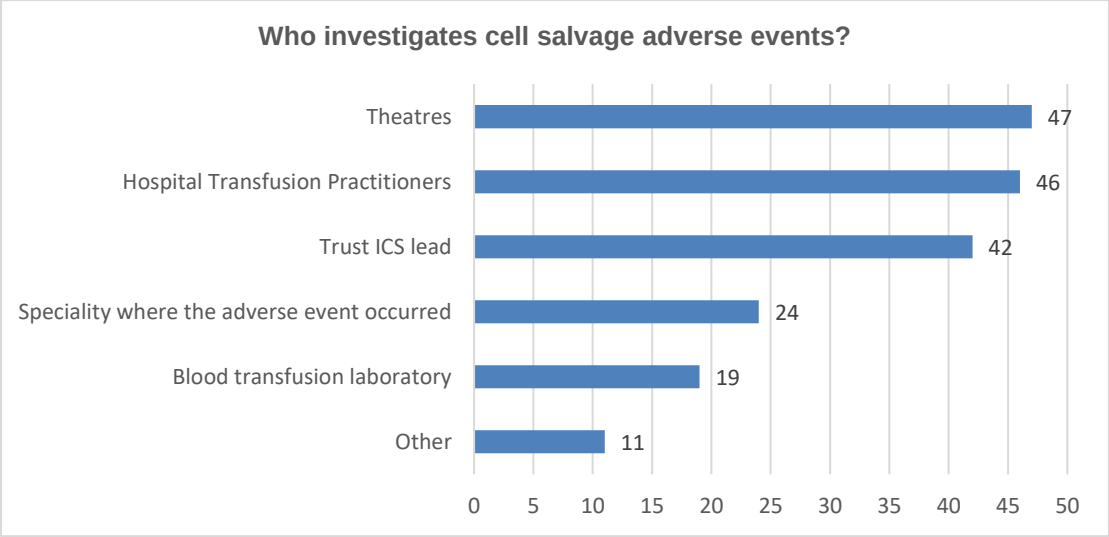
Majority of respondents (85/92, 92%) indicated that ICS related incidents were reported and investigated through their local incident reporting system. However, only 58% submitted reports to SHOT and submission to the MHRA yellow card system was even less at 30% for ICS events. 'Other' included reporting to ODP and/or Transfusion Lead, Medical Engineering, Manufacturer, and Perfusionist Safety Report.

SHOT reports and recommendations (question 27) were used by majority of respondents (66/92,72%). However, a significant minority (25/92, 27%) were not aware of the resources available on SHOT website. One respondent did not give an answer here.

Question 17: "Who investigates the adverse events"

There was marked heterogeneity regarding the forums in which the adverse events were reported, ways of investigation and how the clinical teams received feedback. It was identified that multiple options were used in the same organisation. Figure 4 illustrates the staff groups responsible for ICS related adverse incident.

Figure 4

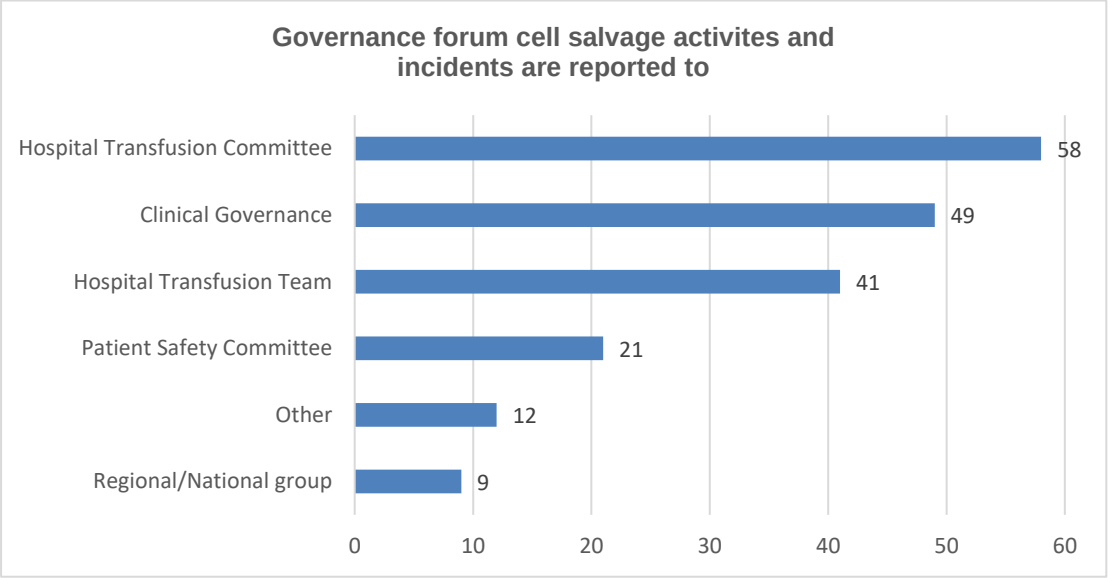


'Other' included Anaesthetist, Blood Conservation Co-ordinator, Hospital Patient Blood Management Team, Cell Salvage Co-ordinator, and Clinical Governance Team.

Question 18: "In which governance forum are ICS activities and incidents reported"

Whilst majority of respondents (87/92, 94%) gave an answer here; a significant minority (6%) indicated that they don't report in any governance forum of their organisation. 54 responses (59%) demonstrated that incidents were reported in multiple forums in their organisation. Figure 5 shows the response rates for the different adverse event reporting routes.

Figure 5



'Other' included clinical effectiveness group, ICS user group, Surgical Team involved, Theatre Quality and Safety Governance Team.

Quality, Safety and Record Keeping

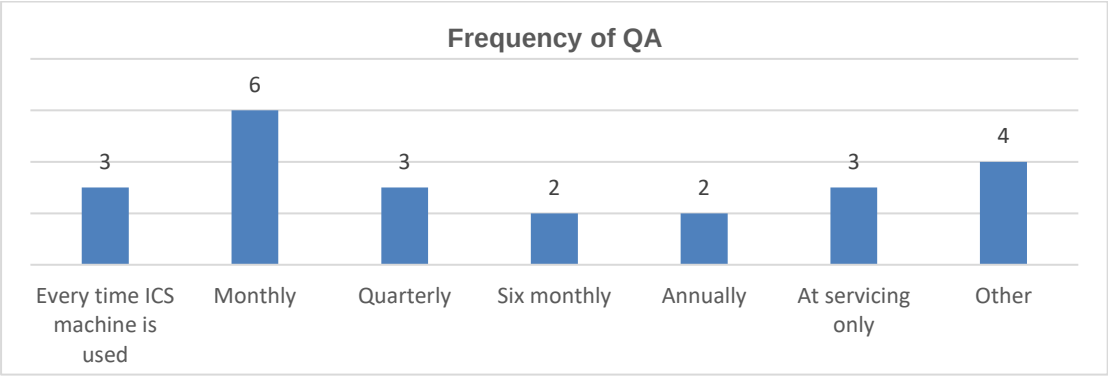
Question 19: "Are your ICS machines covered by a service contract"

All but 5 organisations (87/92, 95%) had their machines maintained and serviced by the ICS machine manufacturers.

Question 20 & 21: "Is Quality Assurance (QA) performed on the processed blood" and "If QA is performed, how frequently does this happen."

When considering QA of ICS product, 27 organisations out of 92 (29%) performed some type of quality assurance, and there was large variance on when and how frequently the testing was performed. Only 23 respondents provided further detail regarding the frequency of this process which is detailed in Figure 6.

Figure 6



'Other' responses to question 21 were weekly, 2 monthly, after 25 processes, and no fixed interval.

Question 22: "If QA is performed, what parameters are measured"

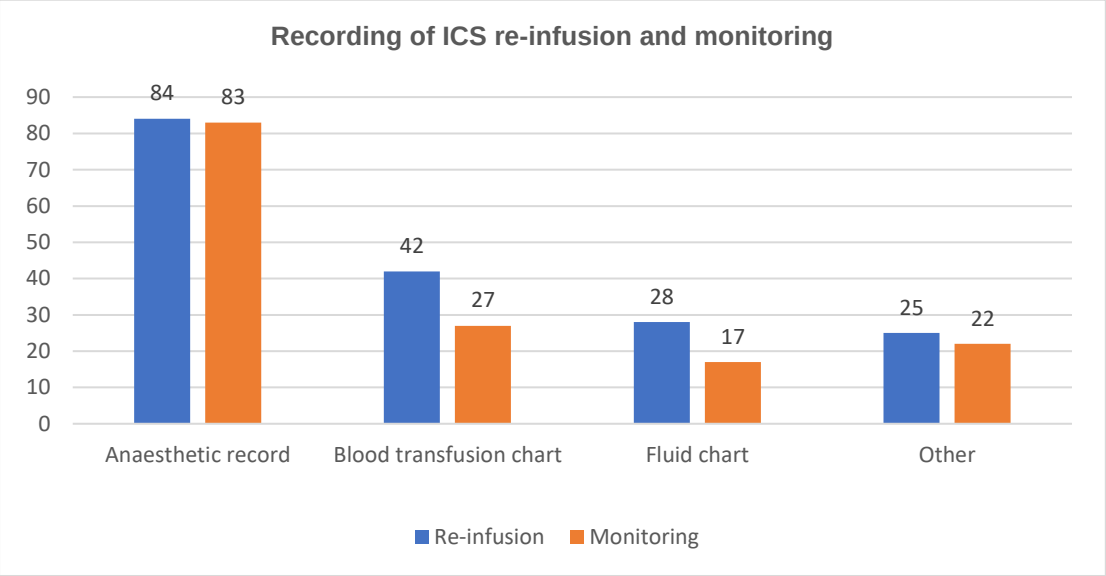
Parameters measured as part of the QA process included haematocrit (20/27, 74%), free haemoglobin (12/27, 44%), anti-factor Xa (4/27, 15%) and potassium (2/27, 7%)

Other parameters measured included a full blood count, albumin and further tests based on Anti Xa results (modified thrombin clotting test).

Question 23 & 24: "Where is ICS re-infusion recorded" & "Where are the monitoring parameters related to re-infusion recorded"

The re-infusion was recorded in more than one place in majority of organisations (63/92, 68%), whilst significant number of respondents (45/92, 49%) recorded re-infusion related monitoring parameters in more than one place as well. Figure 7 shows the responses to these two questions paired alongside each other.

Figure 7



'Other' places where reinfusion of ICS blood was recorded included ICS form, Audit form, Theatre ICS Book, Perfusion Record, Prescription Chart, Clinical Portal, Electronic Records (EPR)/patient notes, Care pathway/ Plan, and Major Haemorrhage Proforma.

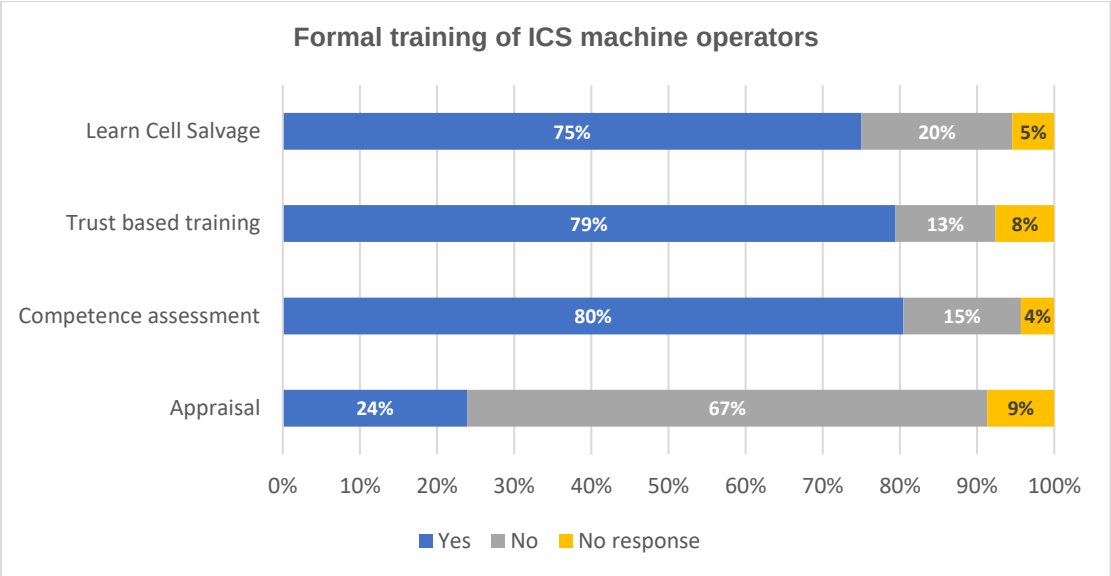
'Other' responses to monitoring for reinfusion included: Audit form, Theatre ICS book, Observation/NEWS chart, Patient notes, Perfusion Record, Anaesthetic Record, Cardiac Intensive Care Records, Peri-operative Care Plan, Recovery Pathway, and EPR.

Training

Question 25: "What specific formal training do ICS machine operators receive"

Figure 8 shows the levels of learning, training, competency assessment and review of practice undertaken as reported by the respondents. In this context, Learn Cell Salvage relates to the online resource available through the JPAC website (https://transfusionguidelines.org).

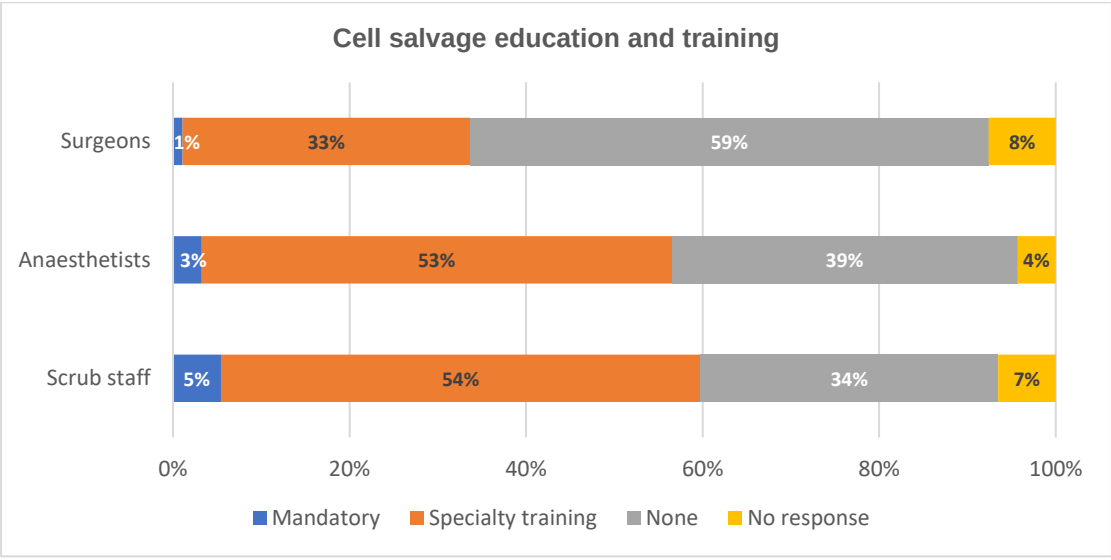
Figure 8



Question 26: "What do the following staff groups receive in terms of education around use of ICS (consistent with their role)"

Figure 9 shows what ICS education and training is provided for specific staff roles in the operating theatre environment.

Figure 9



Discussion

The 2021-22 survey was a pragmatic review of ICS practice in the year 2019 from 225 NHS organisations. The response rate was 41%, which is consistent with more recent reviews of patient blood management and transfusion practice, such as the 2023 NHSBT survey report[2] on actions taken by hospitals during the red cell Amber Alert of 2022[2]).

Although the dataset is incomplete, it is clear that ICS is practiced across a wide range of surgical specialties across UK.

Continued usage of ICS in Vascular, Obstetrics, Cardiac, and Orthopaedics & Trauma in similar proportions to those reported in earlier surveys reflects that ICS is successful in conserving blood and reducing the need for allogeneic transfusion. However, it is unclear whether the low usage of ICS in other specialty areas reflects poor ICS yield, lack of knowledge, resource limitation or reluctance amongst clinical staff. The data is unable to delineate whether ICS is used optimally in any of the operative settings. For such inferences to be made it would be necessary to understand the allogeneic red cell usage and to identify whether ICS could have been used in a greater number of cases to reduce this. It is also not possible to identify how effectively ICS is being utilised and whether there is greater scope for usage.

The fact that 11% of reporting obstetric and cardiac units did not use ICS suggests an underutilisation of the technique and variance from recommended practice.

The variation in the operation of ICS (ref. table 2) demonstrates the individualised development of ICS services across UK which were based on local needs and resource availability. Outsourcing of ICS services does still occur; however, this has reduced since the 2014 survey. The use of a designated staff member with the sole responsibility for operating the ICS machine is reported by only 20% of respondents, with most of the centres using staff that have other responsibilities in the same theatre. This is relevant, as a dedicated individual for operating ICS makes the provision of 24-hour service more challenging both in terms of staffing and financial resources. The fact that majority of the ICS is provided by the member of theatre team already assigned to the case demonstrates that ICS can be carried out safely and without additional staffing cost.

It is encouraging that 20 of the 21 MTCs report having 24-hour ICS service. This cannot be said for obstetric practice, where 15/64 responding Obstetric Units reported not having 24-hour ICS. A trained member of the theatre team operating the ICS machine would enable 24-hour provision in most organisations. A 24-hour ICS service in Obstetrics, where major haemorrhages frequently occur out of hours, will significantly reduce the demand of allogeneic blood.

This survey does not provide adequate data regarding the impact of ICS on the demand of allogeneic red cells. Drawing a clear conclusion is difficult as a considerable number of respondents did not collect or have access to relevant data about ICS in their organisation. Whilst information might be recorded at an individual patient level, a failure to capture and collate data centrally limits the ability to scrutinise the effectiveness of the ICS service or to provide evidence of the impact on patient outcomes and blood transfusion services.

The collated numbers from the 38 organisations that provided complete datasets equates to a total red cell re-infusion volume of 2,639,400mL, which is roughly equivalent to 8800 units of blood (one unit being approximately equal to 300mL[3]). It is difficult to speculate what the

remaining 54 organisations would have reinfused, but the total figure would certainly be higher. Additionally, the data from private providers may further increase the volume of red cells salvaged and reinfused.

This survey was not designed to delineate the quantitative use of ICS including the reinfusion volumes at individual speciality level.

It is important to note that the figure of 'volume reinfused' is not a reliable measure of the potential reduction in allogeneic blood transfusion as there may be a considerable difference in the haematocrit of the two products and the practice of using transfusion triggers to initiate the allogeneic blood transfusion. However, this does indicate that ICS makes a significant contribution towards patient blood management reducing both the workload and the financial burden placed on transfusion services. Secondly, allowing for patients to be re-infused with their own red cells at haemoglobin concentrations above transfusion triggers used to initiate allogeneic red cell transfusion provides the benefit of reducing post-operative anaemia, contributing to reduced length of stay, and supporting enhanced recovery principles. In addition, the current practice of early use of blood components in acute haemorrhage further increases pressures on universal components such as Group O red cells and ICS can help to alleviate the pressure.

The amber alert for supply of red cells in England issued by NHS Blood and Transplant (NHSBT) in October 2022 reinforces the importance of blood conservation strategies. ICS is a critical component of such a strategy in the surgical arena, with the potential to significantly reduce the demand for allogeneic red cells, permitting many operations with risk of haemorrhage to go ahead. Including the suitability of cell salvage for various procedures within their Maximum Blood Ordering Schedule (MSBOS) could help organising surgical lists during the amber alerts at operational level.

The use the OPCS-4 codes for cell salvage (see Appendix 5) was minimal and a significant number of respondents were not aware of them. This deficiency in coding reduces the visibility of ICS service at the local and national level, impacting negatively on resource allocation with the inevitable consequences of reducing availability and development of ICS services within organisations. Consistent and comprehensive coding would allow the NHS to understand the impact of cell salvage in peri-operative transfusion and provide a denominator for SHOT reviews to understand the incidence of ICS related errors or adverse events. It will also help to make the efficiency of the service visible at the operational level of the individual organisation.

Welsh Blood Service has supported a nationwide network of cell salvage operators and clinicians in providing safe, standardised ICS through the provision of ICS equipment, audit forms, and data collection. This enables an annual report to be produced which allows individual sites to benchmark themselves against a national database.

It is encouraging that 75% of respondents reported that the UKCSAG supported learning platform was used for training, in conjunction with local learning packages. The rate of training and competency assessment of ICS machine operators remains virtually the same as it was in 2014 (82%). However, this implies that almost a fifth of ICS operators do not have formal training or any form of competency assessment.

ICS education and training appears to have increased amongst anaesthetists since 2014. The RCOA has formally recognised it as part of the curriculum. Whilst this is encouraging, there remains a deficit in the formal education and training for surgical and nursing staff.

Governance is an important part of the delivery of any service, aiming to reduce errors by enabling learning from these incidents and improving safety. The lack of consistency in incident reporting is concerning as some centres are not reporting incidents to any governance forum. The requirement for embedding governance processes needs to be emphasised to all users. A substantial number (42%) of organisations have acknowledged failure to report ICS related incidents to SHOT. This demonstrates lack of appreciation of the requirements, and the resultant missed opportunities to review safety and efficiency. Awareness of the reports and resources produced by SHOT related to safety in ICS is high, however, there is still room for improvement. It is essential that robust reporting systems are used, with SHOT as part of this process. The educational and regulatory bodies can gain important information about quality of education and the safety of ICS delivery models from adverse event reporting.

Organisations are constantly looking for economical and flexible models for delivery of care. This survey provides no insight into the "best" mode of ICS delivery. Most organisations are delivering the service by utilising theatre staff already present in the team, without any reported adverse outcomes. The incorporation of ICS within the roles of the current team members would be financially more attractive, enable the delivery of a 24-hour service but require greater investment in education of the whole theatre team.

There is no published guidance in the UK on the use of Quality Assurance (QA) in ICS and guidance from manufacturers varies. This is reflected in the variation of practice in the survey. QA of the product is a contentious issue. It would be prudent for organisations using ICS to have risk-assessed the requirement for QA locally.

Conclusion

ICS is well recognised globally as a blood conservation measure in surgical patients which decreases the use of donor red blood cells and prevents post operative anaemia.

Unfortunately, this survey of 2019 ICS practice in UK demonstrates that information regarding ICS - both the activity coding and the clinical data is either not recorded or is not accessible within the organisations. Despite our incomplete dataset, ICS was used in at least 22, 000 operations and at least 9000 units of red cells equivalent were re-infused in 2019. It is very likely that a significant greater volume than this was reinfused. The survey also identified that safe delivery of ICS was possible by appropriate training of the theatre team without needing an additional staff member.

The dataset is incomplete for many of the metrics that would be necessary to understand the total usage of ICS including how it is delivered and the volumes of salvaged blood reinfused within UK. It doesn't provide information regarding the potential scope for ICS as an alternative for transfusion in patients undergoing surgery, nor is it possible to quantify the numbers of donor red cell units that could be avoided if ICS were to be optimally used. One of the main reasons for the lack of information is that, unlike allogeneic blood transfusion, ICS provision has no stringent regulations regarding training, administration of the reinfusion

product, documentation, data collection, or adverse event reporting. This has meant that resources (financial, staff, time) are not allocated to build robust training and information systems that links ICS with the blood transfusion services within the organisations. This dearth of information at organisational level translates to inability of generating an accurate picture on ICS usage nationally.

Allogeneic blood transfusion is considered safe but carries significant cost. The associated risks are rare but can be responsible for major morbidity in patients leading to shorter lifespan and issues related to quality of life. Further, it is associated with financial risk to the providers (consider the current Infected Blood Inquiry). In view of the significance of ICS in peri-operative transfusion, the potential benefits to supporting vulnerable blood stocks, as well as the clinical benefits of salvaged blood over that of allogeneic product, there appears a strong case for stakeholders in Transfusion Services to include the ICS as an integral part of their PBM measures. Further, ICS should be integrated within the stakeholders' forums of Operation, Education and Governance, and resources invested to regulate ICS delivery. Additionally, the regulatory bodies of clinical staff need to stipulate appropriate role-based education for staff. In order to maximise the safe and efficient usage of ICS, accurate data collection is crucial, and a recognition of nationalised standards of training and delivery is necessary. Further, a robust system for reporting adverse events to national bodies is essential. The service providers need to be incentivised to optimise ICS as an integral aspect to PBM and develop links with the Transfusion Services.

The UK Cell Salvage Action Group would strongly urge all organisations to review their ICS service alongside the findings and recommendations of this report, with a view to improving the delivery and safety of such a service.

Recommendations

Hospitals:

- ICS delivery and governance should be standardised across all specialities offering the service within the organisation.
- Role-specific ICS training should be mandatory for those working in theatres where ICS is utilised. This could be enabled by making ICS training a part of the mandatory transfusion training package.
- Data from every ICS episode should be captured centrally for audit and service analysis, including volume for reinfusion to the patient.
- ICS episode/usage should be coded using OPCS system.
- Maximum Surgical Blood ordering schedule (MSBOS) should include information about cell salvage suitability for the surgical procedures.
- There should be processes in place for quality assurance (QA) of the machine and local risk assessment for the QA of the salvaged blood.
- There should be representation of ICS service in the Hospital Transfusion committee.
- Anaesthesia, Surgery, Theatres, and Transfusion should be involved in audit and review of practice.
- All ICS related incidents reported locally should also be reported to the Serious Hazards of Transfusion (SHOT) scheme or MHRA as appropriate. Agreed incident keywords (e.g., cell salvage) on local reporting systems will enable automatic flagging of these to Hospital Transfusion Team.

Royal Colleges:

- Training in the safe and appropriate use of ICS equipment should be incorporated into all relevant specialty training programmes.

Regional Transfusion Committees:

- There should be oversight of the ICS activities within the region as part of PBM report.
- The PBM educational resources and events should include cell salvage topics.
- Promote formation of regional cell salvage networks for collaborative projects and support.

Development of National Standards:

- There is a need for national standards for:
  - The role-based training of the staff involved in the ICS.
  - Data to be collected and documented for individual patients.
  - Data to be collated centrally for the Cell Salvage Lead/Co-ordinator to be able to report on the efficacy and safety of the service to the Hospital Transfusion Committee or equivalent forum.
  - Adverse event reporting including those to be reported to the national Haemovigilance Organisation like SHOT.

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Appendix 1: Organisations submitting response(s)

Alder Hey Children's NHS Foundation Trust	NHS Greater Glasgow & Clyde
Aneurin Bevan University Health Board	NHS Lothian
Barking, Havering and Redbridge University Hospitals NHS Trust	NHS Tayside
Barts Health NHS Trust	North Bristol NHS Trust
Belfast Health and Social Care Trust	North Middlesex University Hospital NHS Trust
Betsi Cadwaladr University Health Board	Northern Devon Healthcare NHS Trust
Birmingham Women's and Children's NHS Foundation Trust	Nuffield Health Bristol Hospital
Blackpool Teaching Hospitals NHS Foundation Trust	Portsmouth Hospitals NHS Trust
Bolton NHS Foundation Trust	Royal Brompton and Harefield NHS Foundation Trust
Buckinghamshire Healthcare NHS Trust	Royal Cornwall Hospitals NHS Trust
Cardiff and Vale University Health Board	Royal Devon and Exeter Foundation Trust
Chelsea and Westminster Hospital NHS Foundation Trust	Royal Free London NHS Foundation Trust
Chesterfield Royal Hospital NHS Foundation Trust	Salford Royal NHS Foundation Trust
Countess of Chester Hospital NHS Foundation Trust	Sheffield Teaching Hospitals NHS Foundation Trust
Cwm Taf Morgannwg University Health Board	Somerset NHS Foundation Trust
Dartford and Gravesham NHS Trust	Southport & Ormskirk Hospital NHS Trust
Dorset County Hospital NHS Foundation Trust	Spire Cheshire Hospital
East Kent Hospitals University NHS Foundation Trust	Spire Manchester Hospital
George Eliot Hospital NHS Trust	St Helens & Knowsley Teaching Hospitals NHS Trust
Gloucestershire Hospitals NHS Foundation Trust	Stockport NHS Foundation Trust
Guy's & St Thomas' NHS Foundation Trust	Surrey and Sussex Healthcare NHS Trust
Hampshire Hospitals NHS Foundation Trust	Swansea Bay University Health Board
Homerton University Hospital NHS Foundation Trust	The Christie NHS Foundation Trust
Imperial College Healthcare NHS Trust	The Pennine Acute Hospitals NHS Trust
Isle of Man Department of Health & Social Care	The Robert Jones & Agnes Hunt Orthopaedic Hospital NHS Foundation Trust
Isle of Wight Healthcare NHS Trust	The Royal Orthopaedic Hospital NHS Foundation Trust
Kettering General Hospital NHS Foundation Trust	The Royal Wolverhampton NHS Trust
Lancashire Teaching Hospitals NHS Foundation Trust	The Shrewsbury & Telford Hospital NHS Trust
Lewisham and Greenwich NHS Trust	Torbay and South Devon NHSFT
Liverpool Heart and Chest Hospital NHS Foundation Trust	United Lincolnshire Hospitals NHS Trust
Liverpool University Hospitals NHS Foundation Trust	University Hospitals Birmingham NHS Foundation Trust
Liverpool Women's NHS Foundation Trust	University Hospitals Coventry & Warwickshire NHS Trust
London North West University Healthcare NHS Trust	University Hospitals Dorset NHS Foundation Trust
Manchester University NHS Foundation Trust	University Hospitals of Leicester NHS Trust
Mid Cheshire Hospitals NHS Foundation Trust	University Hospitals of North Midlands NHS Trust
Mid Yorkshire Hospitals NHS Trust	University Hospitals Plymouth NHS Trust
NHS Ayrshire & Arran	Warrington and Halton Hospitals NHS Foundation Trust
NHS Dumfries & Galloway	Wirral University Teaching Hospital NHS Foundation Trust
NHS Forth Valley	Wrightington, Wigan & Leigh NHS Foundation Trust
NHS Grampian	Wye Valley NHS Trust

Appendix 2: Reasons for non-submission of data

In the year 2019, ICS was started on how many cases; if you are unable to obtain this information can you state why?
Cases were not recorded on an electronic database.
Data entry incomplete despite an electronic, many are still on paper records. however, from routine auditing, approx. 25% are re-transfused
Data filed off-site
Data not recorded
Didn’t work within the hospital at this time
Do not collect this information at present
Do not have access to these figures
Don’t have the data
Figures not available
Have data, haven’t had a chance to look at it
I could not obtain the audit forms from 2019
I don't have access to this information
I don't keep a complete record I am not sure if our transfusion department keep a record of our completed forms.
I would only know the data for the cardiac specialty.
In obstetrics, the reinfusion rate is 8%. In rest, data not validated. The volume returned doesn't include cardiac. Underestimated in rest.
Information not available at time of submission
Information not immediately available for this survey. ~50 cases for vascular.
It's used for every cardiac surgery, around 1000 cases a year
Lack of staff to do an audit on this
Many sets of notes unavailable - most ICS cases used in obstetrics who have separate notes from 'main notes' - obs. notes are stored off site
Need more time to gather data
No one has job role of keeping audit data
Not all practitioners were keeping records accurately
Online data not available
Our forms when used the cell saver are forwarded on to Blood bank, we don’t keep a record of the annual use in theatre.
Records not kept
Routine in all cardiac cases – approx. 950 cases, on demand other specialties
Staff changes meant no lead/auditor
Staff member in charge, absent
Staff sickness and not sure we keep a record
There were an estimated 8 obstetric cases and 4 general surgery cases.
This data includes vascular cases. Vascular surgery has since moved to another hospital.
This figure is for Gloucester only
Unable to obtain information at present, diary is kept in Obstetrics which is in a separate building. Could find out and forward you figures.

Appendix 3a: ICS Cases Started vs %ICS Cases Reinfused vs Volume Reinfused – all

Q9: In 2019, ICS was started on how many cases	Q10: What percentage received re-infusion	Q11: What was the total volume reinfused
0	0%	0
Don't know	*Don't know*	100
27	1%	254
47	4.3%	525
20	30%	1000
17	41%	1075
50	25%	1250
22	18.2%	1455
36	17%	1583
52	13.5%	1628
18	11%	1660
57	25%	3491
18	55.6%	3981
70	40%	4450
22	73%	5065
51	22%	5522
19	84.2%	6213
20	90%	16452
97	75%	19021
117	65%	22817
61	23%	26232
60	93.3%	28480
318	57.3%	28977
88	88%	40000
167	92%	55339
2122	*Don't know*	60017
145	72%	68476
322	71.7%	69506
360	75%	74548
684	48.3%	77096
542	*Don't know*	110449
1254	51%	149679
1373	56%	156830
1964	41%	177350
643	95%	300000
982	100%	333776
1084	95%	389285
965	88%	395819
60	*Don't know*	*Don't know*
2000	25%	*Don't know*
204	85%	*Don't know*
4	0%	*Don't know*
13	0%	*Don't know*
218	40%	*Don't know*
600	75%	*Don't know*
Don't know	90%	*Don't know*
2000	100%	*Don't know*
Partial (used for all cardiac ~1000 cases a year)	100%	*Don't know*
158	57%	*Don't know*
1200	90%	*Don't know*
2	*Don't know*	*Don't know*
57	*Don't know*	*Don't know*
672	*Don't know*	*Don't know*
1300	*Don't know*	*Don't know*

Appendix 3b: ICS Cases Started vs %ICS Cases Reinfused vs Volume Reinfused – highest volumes reinfused

No ICS cases started	% ICS cases reinfused	Volume reinfused (mL)
965	88%	395,819
1,084	95%	389,285
982	100%	333,776
643	95%	300,000
1,964	41%	177,350
1,373	56%	156,830
1,254	51%	149,679
542	–	110,449
684	48%	77,096
360	75%	74,548
322	72%	69,506
145	72%	68,476
2,122	–	60,017
167	92%	55,339
88	88%	40,000
318	57%	28,977
60	93%	28,480
61	23%	26,232
117	65%	22,817
97	75%	19,021
20	90%	16,452

The table above gives the data for the 21 respondents with a total re-infusion volume in excess of 15,000mL in 2019, alongside the number of cases ICS was started and the percentage of those cases that were reinfused with salvaged blood.

Shaded areas in the table indicate respondents that also reported performing cell salvage for cardiac surgery.

Appendix 4: ICS operating staff additional roles

Is the person responsible for the ICS machine expected to perform roles inside/outside of theatre during the time ICS is being used? Please explain roles if applicable
Anaesthetic assistant
Anaesthetic assistant for that list, supporting the anaesthetist and maintaining patient safety throughout operation
Anaesthetic nurse/ODP, anaesthetist, perfusionist allocated for that patient. There is a floater available if required.
Anaesthetic Practitioner Role
Anaesthetic practitioner provides IOCS service in addition to all other Anaesthetic ODP role requirements
As an ODP the usual roles are expected alongside the set up and use of ICS
As part of the theatre team
Assist in anaesthetics as well as cell saver duties
Assisting the anaesthetist and theatre team if required
Blood gases, fluids, PCA, cleaning trolleys, stock ordering, audits
Cardiopulmonary Bypass
Circulating member of theatre team
Circulating team member
Clinical e.g., managing the heart lung machine & other life support apparatus. Outside of theatre admin, teams' meetings etc
Depending on time of day and clinical need in other areas one ODP might provide anaesthesia support and operate the ICS.
Depends on staffing levels but often also provides anaesthetic support to anaesthetist
Either perfusion or anaesthetic support duties
Generally Anaesthetic ODP
Generally same ODA allocated runs the machine. Rarely if enough staff if complex case there will be two ODAS. Two anaes can run CS
ICS operation is part of the Perfusionist intraoperative duties inside of the operating theatre
ICS run by Anaesthetist and Anaesthetic Assistant
Inside theatre helping to set up infusions & devices. Leaving theatre to collect blood & equipment, preparing for next patient
Member of circulating nursing team or perfusionist in cardiac cases
Not expected to perform any roles outside of theatre at time of use
Occasionally a supernumerary ODP supports with ICS but more commonly the same ODP provides anaesthetic support & ICS
ODP and Anaesthetist mange cell salvage together
ODP doing the case
ODP providing anaesthetic support - however in difficult (predicted bleeds of >1L elective cases the TP is booked to do ICS
ODP will assist anaesthetic team
ODP, perfusion and HCA all perform normal clinical role in addition to cell salvage
On occasion we use 2 anaesthetic practitioners where feasible. Where not the person using the cell saver has normal duties
Only in Theatre
Operate the Heart Lung Machine
Operator can also be acting as the Team Leader or Theatre Co-ordinator
Other normal day to day duties within their role
Out of hours might not be supernumerary due to cover being on call
Perfusionist run the ICS in conjunction with the heart lung machine, the cell saver is set up routinely for every cardiac case
Perfusionists also simultaneously operate heart lung bypass machine
Person operating cell saver will also be assisting anaesthetist
Provides support to Anaesthetists, plus oversee cell salvage process. If used in a major trauma case then used solely for ICS
Running the cardiopulmonary bypass machine daily perfusion tasks- ECMO maintenance in ITU- adult & paediatrics
Setting up for next case in the anaesthetic room. Supporting anaesthetist during surgery. Stocking up of the anaes. room
Sometimes supernumerary depends staffing levels otherwise also providing support for anaesthetists is usual but not normally onerous
Supernumerary at present but staffing pressures may change this
The anaesthetic practitioner runs the ICS machine as well as the list. If they are agency an ODP from the hospital will run it
The ODP assists the anaesthetist with other duties
The perfusionist who runs the ICS case for cardiac surgery also runs the heart lung machine during cardiac surgery
They are not expected to, however one practitioner insists he is safe to dual role for airway management and cell salvage
Two ODPs on shift but second ODP may need to be available for second theatre
Typically operated by a senior scrub nurse/ sister who will have other leadership and or oversight roles within the theatre
Usually set up / run by ODP also supporting anaesthesia for case. Variable support from case anaesthetist
We have same ODP/ anaesthetist performing the cell salvage duties
We still assist the anaesthetist with the anaesthetic provided for the patient
When short staffed
While providing anaesthetic support
Will assist the anaesthetist as needed with checking of blood products, drugs, lights with primary responsibility to ICS

Appendix 5: The OPCS-4 code.

The OPCS-4 code is an approved NHS Fundamental Information Standard for interventions carried out in NHS and is mandatory for use by healthcare providers to support various forms of data collections for operational and secondary uses.

The **OPCS-4 codes** are for ICS are as follows:

- X36.4 Autologous blood salvage – use if ICS is set up for the patient.
- X33.7 Autologous transfusion of red blood cells – use if blood is returned to the patient.

Appendix 6: SHOT reportable cell salvage related events

Category	What to report
Operator error	Equipment not assembled correctly to include both collection and processing equipment
	Incorrect preparation of heparinised saline anticoagulant
	Inadequate delivery of anticoagulant leading to clotting of reservoir, lines or other parts of disposable
	Contraindicated substances aspirated into the collection reservoir or washed from soiled swabs
	Non IV grade saline used for wash e.g. use of saline for irrigation
	Time exceeded for collection for either ICS or PCS according to local guidelines
	Reinfusion bag not labelled for the patient or incorrectly labelled - either ICS or PCS
Machine/System failure	Any malfunction of the device that prevents the reinfusion of autologous red cells by effecting the quality, safety or timeliness of the product
	Any manufacturing fault that effects the functionality of the disposable e.g. faulty seals or connections, missing parts etc.
Clinical events	Patient Identification error - Incorrect blood component transfused (IBCT)
	Time exceeded for reinfusion (ICS or PCS) according to local guidelines
	Incorrect reinfusion of product resulting in potential harm, e.g. Fat embolism, air embolism
	Signs of acute transfusion reaction, e.g. pyrexia, rigors, anaphylaxis or other allergic reaction
	Hypotensive episode on reinfusion of processed red cells - not related to hypovolaemia
	Failure of provision of cell salvage which results in transfusion of allogeneic blood that could have been avoided (e.g. availability of staff, technical issues etc)
	Other - please state

Extract from *Reporting adverse events and reactions relating to Cell Salvage to SHOT: Guide for staff involved in the use of perioperative and postoperative cell salvage equipment*.
Accessed at:
https://www.shotuk.org/wp-content/uploads/myimages/Reporting-adverse-events-and-reactions-relating-to-Cell-Salvage-to-SHOT-Oct-2017.pdf