Paper 7

Implementing an Educational Program to Improve Intraoperative Cell Salvage Utilisation in a Tertiary Hospital Network

A Quality Improvement Case Study

Submitted to Australian Anaesthesia Allied Health Practitioners

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Introduction

Intraoperative cell salvage (ICS) is an important component of modern patient blood management (PBM), enabling the collection, processing, and reinfusion of autologous (the patient's own) red blood cells during surgery. Its use can reduce reliance on allogeneic (donor) blood transfusion and exposure to associated risks, including immunological reactions, transfusion-transmitted infections, and transfusion-related administrative or clerical errors.

Initially used predominantly in cardiac surgery, ICS is now utilised across a range of surgical specialties, including vascular, orthopaedic, obstetric, and transplant procedures. At Fiona Stanley Fremantle Hospitals Group (FSFHG), ICS is a required component of renal transplantation and is increasingly utilised across emergency and elective surgical settings.

The expanding role of ICS has created a parallel need for a workforce capable of operating this technology safely and effectively. Anaesthetic Technicians play a central role in the delivery of ICS; however, variability in training, experience, and competency may contribute to delays, equipment-related challenges, and difficulties in providing timely ICS support, particularly during time-critical and after-hours procedures.

Despite the increasing clinical use of ICS, providing consistent and accessible education to Anaesthetic Technicians remains challenging within a large, shift-based workforce. Rotating rosters, competing clinical demands, limited opportunities to attend face-to-face education, and variability in staff experience can restrict access to structured training and opportunities for supervised practice. This identified gap highlighted the need for a flexible and standardised educational approach that could support competency development across different levels of experience and clinical settings.

This study describes the design, implementation, and outcomes of a structured educational program aimed at improving ICS competency among Anaesthetic Technicians within a large tertiary hospital network. The program sought to improve the accessibility, consistency, and flexibility of ICS education while supporting the development of workforce capability across a range of clinical settings.

National Guidelines and Compliance Standards

National Safety and Quality Health Service Standards

Standard 7 of the National Safety and Quality Health Service (NSQHS) Standards (Second Edition, 2021) focuses on identifying and managing risks associated with blood and blood products. Its objective is to ensure that a patient's own blood is optimally managed and conserved, and that any blood or blood products administered are appropriate and safe (Australian Commission on Safety and Quality in Health Care [ACSQHC], 2021).

Although Standard 7 does not explicitly identify ICS as a standalone requirement, ICS aligns with the broader principles of PBM underpinning the standard. ICS is an important autologous blood conservation strategy that enables the collection, processing, and reinfusion of a patient's own red blood cells during surgery. It's appropriate use can reduce reliance on allogeneic blood transfusion and supports the broader objectives of blood conservation and patient blood management.

National Blood Authority Guidance

The Australian National Blood Authority provides guidance to support the implementation of PBM and ICS practices within Australian healthcare settings. This guidance was used as a foundation for the FSFHG education program, particularly in relation to the basic principles and processes of autotransfusion.

The use of national guidance provided a consistent evidence-informed foundation for the development of local education and competency requirements, while allowing the program to be adapted to the equipment, workforce, and clinical environment at FSFHG.

Professional and Industry Guidance

Professional Education

The Australian and New Zealand College of Perfusionists (ANZCP) provides formal education relevant to perfusion and autotransfusion practice. Professional education provides an important theoretical foundation for clinicians involved in autotransfusion; however, the availability and delivery of practical, device-specific training may vary between healthcare organisations.

Manufacturer-Supported Training

At FSFHG, LivaNova (Sorin XTRA) provides manufacturer-supported education for users of the XTRA cell salvage system, including clinical training sessions twice a year. LivaNova also provides an autotransfusion masterclass twice a year for device users seeking to develop more advanced knowledge and skills.

Manufacturer-supported education provides valuable technical and device-specific knowledge. The XTRA training checklist and associated resources were incorporated into the FSFHG education program to reinforce this knowledge and support competency development. Additional manufacturer resources, including QR-code links to online instructional videos, also provide opportunities for flexible learning and revision.

Implications for Local Education and Competency

While national guidance and professional and industry education provide important foundations for ICS practice, they do not necessarily address the specific educational needs of a large, continuously operating hospital workforce. At FSFHG, rotating shifts, emergency and after-hours procedures, competing clinical demands, and varying levels of staff experience create challenges in providing consistent access to education.

Healthcare organisations therefore have an important role in translating national guidance and device-specific education into locally relevant competency pathways. For FSFHG, this involved combining national guidance, professional knowledge, manufacturer resources, adult learning principles, digital education, simulation, and supervised practice.

This approach provided a structured and flexible framework for developing ICS competency among Anaesthetic Technicians while maintaining alignment with patient blood management principles, national safety and quality standards, and the requirements of the local clinical environment.

Methods

Study Design and Setting

This study was conducted as a quality improvement initiative across FSFHG in Western Australia. The initiative aimed to address identified gaps in the accessibility, consistency, and competency of ICS education among Anaesthetic Technicians.

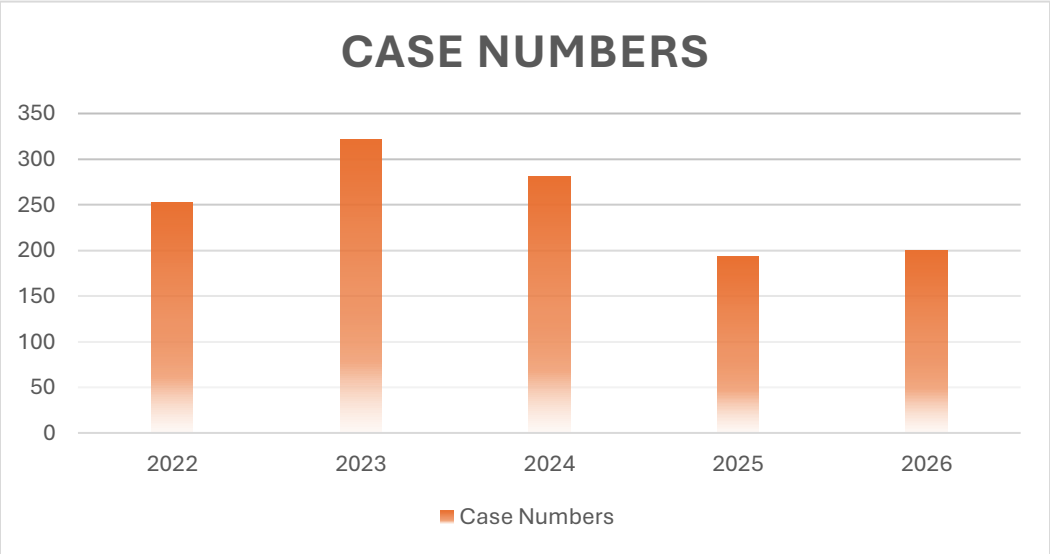
FSFHG is a network of public hospitals providing tertiary and specialist healthcare services across a range of clinical settings. Fiona Stanley Hospital (FSH), the primary tertiary hospital within the South Metropolitan Health Service, provides comprehensive healthcare services for adults, young people, and children and also serves as a major teaching and training facility.

The Anaesthetic Department across the two hospital sites comprises approximately 150 Anaesthetists and 100 Anaesthetic Technicians. Surgical services operate continuously, including emergency and after-hours procedures, requiring consistent clinical practices and access to appropriately trained staff. Prior to implementation of the education program, variability in ICS training, experience, and competency among Anaesthetic Technicians identified a need for a structured and accessible approach to ICS education and competency development.

Baseline Problem

Prior to the intervention, utilisation of ICS was increasing, with annual case numbers rising over time and creating a corresponding need for a greater number of technicians to maintain competency in ICS operation. The increasing use of ICS across elective and emergency surgical

procedures highlighted the need for consistent access to education and practical training in order to support workforce capability and PBM.



Several key issues were identified:

- Inconsistent technician competency
- Over-reliance on senior (Level 5) technicians with advanced competency
- Limited access to training for nightshift and on-call staff
- Delays in ICS set-up and troubleshooting

Existing Competency Requirements

Anaesthetic Technicians are responsible for the operation and management of ICS and are required to complete Advanced Competency Training, incorporating both theoretical and practical components specific to ICS. In addition, technicians are required to complete the BloodSafe eLearning Australia module, *Intraoperative Cell Salvage*, annually.

As part of the local competency pathway, Anaesthetic Technicians are required to complete a minimum of 10 full ICS cases, including at least two emergency or time-critical cases. These cases provide opportunities to develop familiarity with the equipment and practical skills required to manage ICS across a range of surgical scenarios.

For the purposes of this program, emergency cases are defined as unplanned situations in which the need for cell salvage arises unexpectedly, rather than elective or pre-planned procedures.

All 10 cases are completed under the direct supervision of the ICS Coordinator or a Senior Anaesthetic Technician. Supervised practice provides opportunities for technicians to develop consistent techniques, receive feedback, and build confidence across the key stages of ICS practice, including set-up, collection, processing, and reinfusion.

Intervention: Educational Program Design

A structured educational program was developed based on **adult learning theory and multimedia learning principles**. These frameworks informed the design and delivery of learning activities to provide relevant, accessible, and practical education for Anaesthetic Technicians working across a range of clinical settings and shift patterns.

The program was designed to align with the principles of PBM and the *NSQHS Standards*, particularly Standard 7, while addressing the specific educational and competency requirements associated with ICS.

Key Components

1. Multimodal Learning Framework

The educational program incorporated multiple learning modalities to support the development of theoretical knowledge and practical skills:

- Self-directed eLearning modules, including BloodSafe resources
- Multimedia instructional videos
- Simulation-based training
- Supervised clinical practice and exposure

This multimodal approach provided learners with opportunities to access theoretical content independently before progressing to practical application and supervised clinical experience.

2. Competency Requirements

The program incorporated defined competency requirements to support consistent ICS practice:

- Minimum of 10 supervised ICS cases
- At least 2 emergency or time-critical cases
- Annual mandatory refresher training

These requirements were designed to provide technicians with repeated exposure to ICS procedures across different clinical scenarios and to support the development and maintenance of competency.

3. Digital Accessibility

Training materials were hosted on Microsoft Teams and SharePoint, allowing staff to access educational resources remotely using approved devices. This provided greater flexibility for staff working across rotating shifts, night duty, on-call rosters, and varying clinical workloads.

Digital access also enabled learners to revisit educational content as required, supporting ongoing learning and revision outside scheduled face-to-face education sessions.

4. Educational Content Structure

Training content was organised into key stages of the ICS process:

- Collection
- Processing
- Reinfusion
- Special clinical scenarios, including considerations for patients who decline blood products

The content was structured to progress from foundational knowledge to practical application, allowing learners to develop an understanding of the complete ICS process.

Application of Adult Learning and Multimedia Principles

The technician education model integrated adult learning methodologies and Mayer's multimedia learning principles throughout the development and delivery of the program. Hands-on training was designed to reflect real-world clinical scenarios, supporting experiential and problem-based learning through practical application.

The flexible delivery model allowed staff to engage with digital learning resources according to their individual schedules and clinical commitments. Educational content was divided into manageable sections and supported by multimedia resources to facilitate information processing and reduce unnecessary cognitive load.

The program also recognised learners' existing clinical knowledge and professional experience. Participants were encouraged to draw on previous experiences, discuss clinical scenarios, and reflect on their existing knowledge when developing their ICS skills. This approach supported the relevance of learning to clinical practice and enabled new knowledge to be integrated with existing professional experience.

Outcome Measures

Outcomes were assessed using:

- Training completion records
- Competency progression rates
- Workforce coverage indicators
- Informal staff feedback

Given the quality improvement nature of the study, outcomes focused on **process measures rather than patient-level clinical endpoints**.

Results

Training Uptake and Competency

The educational program demonstrated positive uptake and progression among junior Anaesthetic Technicians:

- Approximately **20% of junior technicians achieved full ICS competency**
- A further **30% were actively progressing through the established training pathway**
- The **majority of technicians demonstrated competency in ICS set-up and Stage 1 (collection)**

Improved Workforce Capability

The implementation of the education program supported broader distribution of ICS knowledge and skills across the Anaesthetic Technician workforce. Observed impacts included:

- **Reduced reliance on Level 5 Senior Technicians** for routine ICS support
- **Increased availability of technicians with ICS competency** during after-hours and on-call periods
- **Broader distribution of ICS skills and competency** across the workforce
- **Improved workforce capacity to provide ICS support** across elective and emergency surgical procedures

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Enhanced Training Accessibility

The introduction of digitally accessible educational resources improved the flexibility and accessibility of ICS training. Key observations included:

- **Improved access to training materials** through remote digital platforms
- **Greater opportunities for participation** among night-shift and weekend staff

- **Early indications of improved competency progression** among junior staff
- **Greater flexibility for staff to access learning resources around clinical and rostered commitments**

Operational Impact

The implementation of the educational program was associated with several observed improvements in operational capability, including:

- **Improved efficiency in ICS set-up and utilisation**
- **Reduced delays associated with ICS preparation and theatre workflow**
- **Improved alignment between workforce competency and increasing demand for ICS**
- **Increased availability of technicians with the skills required to provide ICS support across elective, emergency, and after-hours procedures**

Staff Feedback

Staff feedback following implementation of the educational program was generally positive, with participants identifying several aspects of the program as beneficial, including:

- **Flexibility and accessibility of learning**
- **Clarity and adaptability of educational resources**
- **Relevance to clinical practice**
- **Blended learning approach**, incorporating self-paced learning, hands-on practice, and multimedia resources
- **Use of multimedia and simulation** to support practical learning and skill development

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Discussion

This study demonstrates that a structured, multimodal educational program can provide a practical approach to addressing variability in workforce competency in ICS within a large tertiary hospital system.

The integration of **adult learning principles**, including self-direction, experiential learning, and relevance to clinical practice, informed the design and delivery of the program. The incorporation of **multimedia resources and simulation-based training** provided learners with multiple opportunities to access educational content and practise ICS procedures in a structured environment. These approaches are consistent with established principles of adult education and skills-based clinical learning.

A key strength of the initiative was its focus on **accessibility**, particularly for staff working outside traditional education hours. The use of digital learning platforms provided staff with greater flexibility to access educational resources around clinical and rostered commitments. This approach helped address identified barriers associated with time, shift work, and availability for face-to-face education.

Despite these strengths, several challenges remain. The cost of consumables required for ICS training continues to limit opportunities for simulation-based education. Access to expired blood products for realistic training scenarios is also inconsistent, restricting the ability to replicate all aspects of the ICS process. Workforce scheduling constraints and competing clinical demands further affect participation in face-to-face training.

Importantly, although improvements in competency, confidence, compliance, and service coverage were observed, this study did not directly measure patient-level outcomes such as transfusion rates, transfusion-related complications, or clinical outcomes associated with ICS use. The findings should therefore be interpreted primarily in relation to workforce education and service capability. Future research could investigate whether improvements in staff competency and ICS utilisation are associated with measurable changes in patient-level outcomes and patient blood management indicators.

Generalisability

Although conducted within a single institution, the principles underpinning this program are broadly applicable. The combination of:

- Structured competency pathways
- Flexible digital learning
- Simulation and supervised practice

provides a framework that could potentially be adapted for use in other institutions, including those with limited resources. However, further evaluation across different institutions and settings would be required to establish the generalisability of the program.

Challenges Encountered and Key Insights

Access to Education and Workforce Constraints

The implementation of ICS education for Anaesthetic technicians at FSFHG identified several key barriers that made meeting the learning needs of staff particularly challenging. With over 100 technicians working across constantly rotating shift schedules, many staff members miss out on formal training opportunities. During theatre shifts, it is often difficult for technicians to leave the operating suite to attend education sessions due to ongoing case demands and staffing constraints, especially when all areas are actively running.

Additionally, junior staff face further limitations in accessing education due to scheduling conflicts with their external TAFE commitments. Variability in staff competency also creates challenges, as some technicians lack the confidence or capability to support others with ICS procedures during live cases.

Accessibility and Flexibility of Learning

To address these issues, the education team has initiated an ongoing program aimed at increasing staff knowledge and familiarity with ICS. While ICS is recognized as an advanced skill, the need for all technicians - particularly those covering night shifts and on-call duties - to be competent in its use has made training a high priority. This is especially critical given the high volume of emergency (Category 1) cases at FSH.

Initially, access to educational materials was limited to the hospital's internal network. However, in 2025, FSFHG transitioned to Microsoft Teams, a collaborative platform that now allows technicians to access learning materials remotely on personal devices. This has significantly improved the reach and flexibility of ICS education.

Challenges with Simulation-Based Training

A recent ICS-focused education session held on a Thursday morning in-service in August provided technicians with the opportunity to practice a full set-up of the cell saver machine, progressing through each stage. However, the session was impacted by a malfunction caused by fluid leakage from reused consumables. The failure highlighted the importance of using new, functional consumables during training to avoid equipment issues and ensure effective learning outcomes.

Successful ICS simulation sessions require not only unused consumables but also blood products to demonstrate the collection and processing stages realistically. For training purposes, expired blood products are used, as they are no longer viable for patient transfusion. However, these are not readily available, which further limits the quality of hands-on training.

Financial Constraints

A significant barrier to training remains the cost of ICS consumables, which continues to place pressure on the hospital's education budget. While Stage 1 (collection) is relatively low-cost, Stage 2 (processing and reinfusion) are considerably more resource intensive. The financial burden associated with using consumables for educational purposes has been a long-standing challenge.

Cost of consumables

The costs associated with the consumables required for each stage of the ICS process are outlined below.

Stage 1 – Collection

Consumables	Cost (AUD)
Collection Reservoir	$77.13
Aspiration / Anticoagulation Lines	$29.77
Vacuum Lines	$11.31
ACD-A	$13.67

Stage 2 – Processing and Reinfusion

Consumables	Cost (AUD)
225ml Bowl Set	$225.08
125ml Bowl Set	$225.08
NaCl	$1.45
Extra Waste Bag	$41.17

Total cost of cell salvage for one patient is **$379.33**, assuming the use of two bags of ACD-A and six bags of NaCl, with no additional waste bag.

Conclusion

As ICS continues to expand across surgical practice, investment in accessible, high-quality education is essential to support safe and effective utilisation. This study highlights the role of targeted educational interventions in supporting PMB strategies and perioperative care.

The implementation of a structured and flexible educational program at FSFHG was associated with improvements in ICS competency, confidence, and access to education among Anaesthetic Technicians across a range of surgical settings. By aligning training with adult learning principles and incorporating multimedia resources, the program addressed identified gaps in accessibility, consistency, and engagement, particularly for staff working night shifts and emergency rosters.

The increasing use of ICS across elective and emergency procedures highlighted the need for accessible and standardised training. The education initiative provided technicians with opportunities to develop the knowledge and practical skills required to support ICS procedures, while contributing to a broader distribution of ICS competency across the workforce and reducing reliance on a limited number of Level 5 Senior Technicians with advanced competency.

Positive staff feedback, improved compliance rates, and increased theatre coverage provide evidence of improvement in the targeted areas of the program. These findings suggest that a structured and flexible approach to ICS education can strengthen organisational capacity to support increasing surgical demands while aligning with patient blood management principles and national safety and quality standards.

Challenges remain, particularly in relation to training costs, consumable availability, and staff time. However, ongoing refinement based on staff feedback, together with flexible delivery methods and accessible digital resources, provides a foundation for the continued development and potential sustainability of the program.

This case study demonstrates the potential value of investing in accessible, high-quality ICS education to support workforce capability, strengthen clinical practice, and enhance

organisational capacity to deliver safe and effective perioperative care. Further evaluation using objective measures of competency, training participation, operational efficiency, and patient-level outcomes would help determine the longer-term impact and sustainability of the program.

Key Takeaways

- **ICS utilisation is increasing** across a range of surgical specialties.
- **Workforce competency is an important factor** in the safe and effective implementation of ICS.
- **Multimodal and flexible education supports training uptake** and competency development.
- **Digital learning platforms improve accessibility** for staff working across rotating, night, and on-call shifts.
- **Education-focused workforce models can strengthen service capacity** by increasing the number of technicians able to provide ICS support.

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