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Review article

Cell salvage at caesarean section: the need for an evidence-based approach

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Haemorrhage, a leading cause of maternal morbidity and mortality, is frequently associated with caesarean section. Allogeneic blood is an increasingly rare and scare resource. Intraoperative Cell Salvage (IOCS) offers the possibility of improving outcome and reducing allogeneic blood transfusion in cases of haemorrhage at caesarean section. The available literature on the use of IOCS in obstetrics demonstrates that there is limited evidence to support or refute the use of IOCS at caesarean section. However, this procedure has been introduced into obstetric practice. Before opinions about its use become solidified, there is a window of opportunity to launch a large multicentre randomised controlled trial to address the current equipoise.

Keywords Autologous transfusion, caesarean section, cell salvage, intraoperative, obstetrics.

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Introduction

Haemorrhage is a leading cause of maternal morbidity and direct maternal death in the UK[1,2] and worldwide.[3,4] A majority of the deaths in the UK related to haemorrhage are associated with caesarean section.[2] In the UK, approximately 140 000 caesarean sections are performed annually and approximately, 70 000 units of Packed Red Cells (PRC) are given annually in the obstetric setting at a current cost of £140 per unit.[5] Caesarean section rates have been steadily increasing in middle income countries as well as developed countries in recent years. In the WHO Survey on intrapartum practices conducted in eight Latin American countries, the median caesarean section rate was 33%.[6] At private facilities, the caesarean section rate was 51%.

Approximately, half the women receiving blood do so during or after caesarean section. The rates of maternal intensive care admission and emergency hysterectomy are approximately 1.0–2.1 and 0.04 per 1000 deliveries respectively; the majority are due to haemorrhage.[7–9] Allogeneic transfusion rates for caesarean sections vary widely from 1.8–23.5%.[10,11]

Blood is a scarce and expensive resource. Blood availability is limited worldwide and, especially in countries with high HIV prevalence, it is desirable to limit blood transfusion to most essential cases. The National Health Service (NHS) in the UK recently changed policy to exclude donors who have themselves received a blood transfusion prior to 1980 reducing the number of available blood donors. A recent communication from the National Blood Service in the UK has highlighted the shortage of national stocks of some blood groups.[12] The number of available blood donors is projected to fall even further should a reliable test for vCJD become available.[13] This will increase the scarcity and the cost of blood. Allogeneic blood transfusion is also associated with mortality and morbidity including transfusion transmitted infection, Transfusion Related Acute Lung Injury (TRALI), incorrect blood component transfusion and acute transfusion reactions.[14]

Intraoperative autologous blood transfusion (or cell salvage) (IOCS) offers a technique that may reduce the need for allogeneic blood transfusion.[11] In other specialties, this has been associated with a lower complication rate (mostly infections),[15] reduced length of stay in hospital and an

increased postoperative haemoglobin level[11] associated with earlier mobilisation.[16]

Cell salvage technique

IOCS is a technique, which allows the blood lost during a surgical procedure to be returned to the patient in an attempt to avoid risks of allogeneic transfusion. Attempts to perform this procedure at the time of obstetric haemorrhage have been recorded as early as the 19th century.[17,18] To be performed safely, however, it requires the shed blood to be processed by a machine, which filters, washes and centrifuges blood aspirated from the surgical site, to allow only the red cell component to be re-infused. A schematic diagram of a typical cell salvage device is shown in Figure 1. Blood is sucked away via a dual lumen tube, which mixes the blood immediately with an anticoagulant. The blood and anticoagulant are collected in the reservoir and filtered to remove large clots and debris. Blood and anticoagulant are drawn from the reservoir into a centrifuge to be processed and a saline solution is pumped into the centrifuge bowl. When the centrifuge is activated, the less dense blood components and anticoagulant move toward the centre of the bowl where they spill over into a waste bag. Red blood cells are therefore separated from the waste products and collected in a separate bag to be given back to the patient.

The first prototype was built in 1968 at the Mayo clinic and further developed by Latham at the Haemonetics Corporation in 1974[19,20] and since this time has been extensively used in a number of surgical specialties including orthopaedic,[21–23] cardiac,[24] urologic,[25,26] vascular,[27] intracranial[28] and gynaecological surgery.[29] More recently, cell salvage has been increasingly used in obstetric practice, mainly at caesarean section,[11,20,30–41] but what is the evidence for its use? Unfortunately the quality and quantity of available data to inform the decision making processes are poor. A recent Health Service Circular identified the need for more 'high quality clinical research on the safe and effective use of blood particularly in…obstetrics'[42].

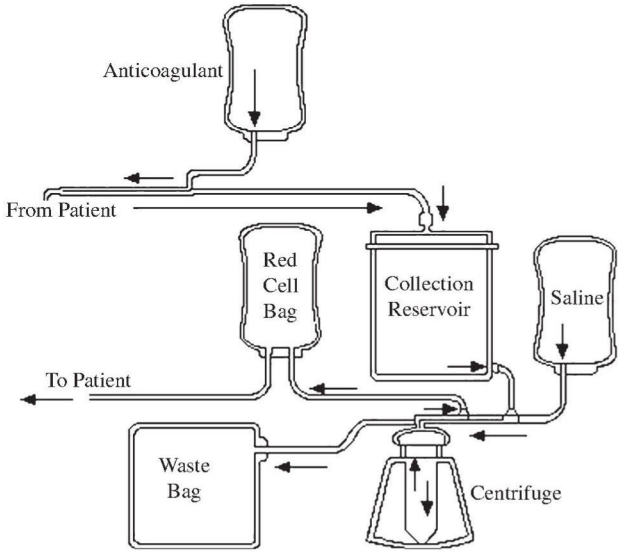

Figure 1. Diagram of cell salvage device.

Literature sources

We conducted a comprehensive literature search to identify all the published observational and randomised studies evaluating the efficacy of IOCS during caesarean section. A combination of keywords was used for a sensitive search to identify the maximum number of relevant citations in Medline, Embase and Cinahl from database inception to September 2008 without language restrictions. We also searched the United Kingdom National Research Register, National Library for Health Guidelines finder and the Cochrane Library. The reference lists of all known primary and review articles were examined for additional relevant citations. After completing the electronic literature search, the citation lists (titles, medical subject headings and abstracts, where available) were reviewed. The following criteria were used to determine study eligibility:

Population: Women undergoing caesarean section.

Intervention: Treatment with IOCS with or without comparison to standard medical treatment.

Outcome: Rates of blood transfusion, complication rates where available, health economics where available.

Results

To date, there has only been one, small, randomised controlled trial looking at the elective use of IOCS at caesarean section.[11] The trial reported a large reduction in the number of patients requiring transfusion in those that received IOCS versus those that did not (1/34 versus 8/34, OR: 0.17, CI: 0.04 to 0.69, $P = 0.01$). This is, however, on a background transfusion rate of 23.5% in the control group, which is considerably higher than what could be considered 'normal' in current practice; also, the threshold for postoperative transfusion was not pre-defined. The postoperative haemoglobin levels were significantly higher in the IOCS group for all 4 days of postoperative follow up. However, no intergroup comparison of change in haemoglobin concentration was made. The group that received IOCS had a significantly shorter stay. Although the patients were 'randomised', no mention was made of how this was achieved. There are also imbalances in age, weight and haemoglobin between the treatment and control groups in this study and this risks invalidating the findings due to selection bias.

A multicentre cohort study[34] found no difference between the two groups regarding infectious complications, need for ventilatory support, disseminated intravascular coagulopathy or length of postoperative stay. The authors stated in their results that 11 of the 186 women receiving IOCS completely avoided blood transfusion because of IOCS, but gave no data to support this. There was no comparison of transfusion rates between the groups. Cell salvage started at different times during surgery depending on the hospital and different models of the cell saver were used over the years of the study. By the nature of the selection criteria, all patients receiving cell salvage were considered high risk patients; no woman appeared to receive IOCS for an uncomplicated, elective caesarean section.

Beyond these two papers, we are limited to case series and case reports. Historically, the use of IOCS within obstetrics has been limited because of concern about amniotic fluid embolus (AFE). However, as our understanding of the pathophysiology of AFE has increased, it could be argued that this theoretical risk has been overestimated. A review of 46 cases of AFE came to the conclusion that AFE was a misnomer and that a more descriptive term of 'anaphylactoid syndrome of pregnancy' should be used.[43] Other authors have suggested 'sudden obstetric collapse syndrome'[44]. To date, there have been at least 250 cases in the literature where salvaged blood has been returned to women during caesarean section[11,20,30–41] with a presumptive diagnosis of AFE being reported in only one case,[37] although this patient had significant other co-morbidities, which may have contributed to her death. Other reported complications include: operator error using the cell saver;[11] heparin toxicity[34] and coagulopathy.[20,35] There is a need to generate reliable safety data for IOCS in obstetrics.

Other studies involving IOCS during caesarean section have salvaged blood from the operative field, processed and then analysed it without returning it to the patient. These studies have shown that the cell saver can: remove functionally active tissue factor,[45] protein elements of amniotic fluid,[46] most fetal cells,[47,48] alpha-fetoprotein[46,48–50] and process blood without significant bacterial contamination[11,46,49–51] and significantly reduce particulate contaminants to a concentration equivalent to maternal venous blood.[50] However, because of the presence of fetal red blood cells in the salvaged blood, one study suggested that using the cell saver may still cause maternal alloimmunisation.[46]

A Cochrane review of cell salvage in adult elective surgery concluded that it was efficacious in reducing the need for allogeneic blood transfusion.[52] Because of the limitations put on the selection criteria (only elective or non urgent surgery was considered), the only randomised controlled trial using IOCS in obstetrics was not included in this review (it included some cases that were likely to have been emergent). The authors also commented that the overall quality of trials included in their review was poor.

A more detailed health technology assessment updated this Cochrane review and assessed the clinical and cost effectiveness of cell salvage and other autologous transfusion strategies in elective surgery.[53] It suggested that IOCS may be an 'effective and cost-effective alternative to the allogeneic blood transfusion strategy'. Unfortunately, because of the scope, the review, the study selection criteria were similar to the Cochrane review and no obstetric papers were included in the clinical effectiveness review. Consequently, no studies in the obstetric setting in the review of economic evaluations were identified either, although we have identified an abstract looking retrospectively at theoretical cost savings.[54] This abstract showed a financial benefit if IOCS had been used in Caesarean sections where a blood transfusion was subsequently required. Although this abstract did not comment on the appropriateness of the decision to administer blood, another study showed that inappropriate blood transfusion and non adherence to transfusion guidelines are causes of increased transfusion rates[55] and therefore costs. Therefore, stricter control on the use of allogenic transfusion may significantly alter these findings.

Deliberations for practice and research

In the setting of an obstetric haemorrhage emergency, IOCS has been recommended by American Society of Anesthesiologists in the United States, the Confidential Enquiry into Maternal and Child Health, the National Institute for Health and Clinical Excellence (NICE), the Obstetric Anaesthetists Association and the Association of Anaesthetists of Great Britain and Ireland.[1,56–58] Although these recommendations are not based on randomised controlled trials, they seem sensible, based on our understanding of pathophysiology; however, obstetric haemorrhage often presents itself without prior warning. There are currently no recommendations for the use of IOCS outside the obstetric haemorrhage emergency setting. Given that there are possible benefits both clinical and economical to the use of IOCS at caesarean section and potential harm, we urgently need a large randomised controlled trial looking at the routine use of IOCS to determine if these theoretical benefits are borne out in clinical practice.

A trial examining the effect of cell saver on reduction in blood transfusion rates and patient's quality of life needs to be launched with a parallel economic evaluation. An audit at the Birmingham Women's Hospital (UK) of the 1674 women undergoing caesarean section in 2006 showed a transfusion rate of 5%; with the women who received a transfusion receiving 3.6 ± 3 (mean [SD]) units of blood (unpublished data). This is probably representative of UK practice. If cell salvage were to reduce this to 3.3% (33% proportional reduction), the aforementioned trial would

need to recruit approximately 4500 caesarean deliveries to be adequately powered; so, multicentred collaboration will be required to address this important question. This approach will also improve the generalisability of the findings. In the obstetric setting, significant blood loss may occur preoperatively, for example, placental abruption or postoperatively, for example, uterine atony; therefore, this proposed trial would only address intra-operative blood loss. We hope that obstetricians and anaesthetists will support this evaluation before cell saver machines are introduced into routine practice without reliable evidence to support their effectiveness and safety.

Disclosure of interest
None.

Contribution to authorship
J Geoghegan performed the literature search, drafted the original article and approved the final version. All authors were involved in the conception, design and revision of the article and approved the final version.

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