SELECTED ABSTRACTS

Presented at the

24th Annual Scientific Meeting

of the

Australian and New Zealand College of Perfusionists

November 9–10, 2007

Melbourne, Victoria, Australia
IMPROVING CARDIAC SURGERY: DOES CONTINUOUS BLOOD GAS MONITORING HAVE A ROLE TO PLAY?

J. Ottens, R.A. Baker, A.J. Sanderson, R.F. Newland, and J.L. Knight
Ashford Hospital, Ashford, South Australia; and Flinders Medical Centre, Bedford Park, South Australia

Introduction: The CDI-500 (Terumo Corporation, Japan) in-line blood gas monitoring device has been in clinical practice for over a decade. Few randomized studies have evaluated the value of this device with respect to improved perfusion management. We routinely use automated continuous quality indicator programs at our institutions to assess perfusion management.

Aim: The aim of this study was to investigate in a prospective randomized trial the role of in-line blood gas monitoring in the improvement of blood gas management during cardiopulmonary bypass (CPB) utilizing continuous quality indicators.

Method: 100 patients were randomised into 2 groups prior to entering the operating room. Group 1 received our standard CPB blood gas management, with intermittent blood gases measured on an ABL700 blood gas machine (Radiometer, Copenhagen, Denmark). Continuous blood gas measurements from the CDI-500 were recorded at 20 second intervals on our data management system, however the perfusionist was blinded to these measurements. Group 2 received our standard CPB blood gas management, in addition to continuous blood gas measurements visible on the CDI-500, the alarm system activated and the data recorded on our data management system. Perfusion management for all cases was guided by institutional protocols, specifically pCO2 was targeted within the range of 35–45 mmHg.

Results: There were no differences between the groups in any preoperative factors, procedure types, intra-operative factors or clinical outcome measures (ventilation time, length of stay, renal failure, mortality). There was a significant reduction in the percentage of CPB that pCO2 was outside of protocol in group 2 compared to group 1 (Mann Whitney U, z = −2.0446, p = 0.041). This was most apparent for pCO2 >45 mmHg, group 1 2.5% (median, average 10.4%, range 0–80) compared with 1.1% (2.7, 0–40) (z = −2.947, p = 0.003), resulting in 84% quality indicator compliance in group 2 compared with 62% in group 1 (p = 0.013).

Discussion: Continuous blood gas monitoring with the CDI-500 results in significantly improved blood gas management as determined by adherence to institutional protocols.

MANAGEMENT STRATEGIES FOR AIR EMBOLISM DURING CARDIOPULMONARY BYPASS

Martin Bennett, Geoff Frawley, Steve Horton, Clarke Thuys, Simon Augustin, Catie Claessen, Andrew Newcomb, and Yves d’Udekem
Cardiac Surgery Unit, Royal Children’s Hospital, Victoria, Australia; Paediatric Anaesthesia and Pain Management, Royal Children’s Hospital, Victoria, Australia; and University of Melbourne, Victoria, Australia

Air embolism during cardiopulmonary bypass (CPB) is a rare, potentially catastrophic event. Iatrogenic causes of arterial gas embolism arise from three sources; the CPB circuit, the surgical field or via intravascular catheters. Children requiring open cardiac procedures in the presence of intracardiac shunts have a higher risk of incurring cerebral air emboli with smaller gas volumes potentially having more significant sequela.

Numerous strategies have been advocated to manage air emboli including retrograde cerebral perfusion, systemic hypothermia, enhanced cardiac output, hyperoxia and hyperbaric oxygen therapy. Techniques relating to particular aspects of emboli management have changed since original protocols were first generated. The Trendelenberg position is no longer thought to be beneficial while steroids have been shown to potentiate ischemic injury. The use of retrograde cerebral perfusion is still considered a mainstay in treating cerebral air embolism but appropriate perfusion pressures continue to be debated. Hyperbaric oxygen therapy, although not readily available, is clearly associated with improved outcomes.

We describe the management of two infants with congenital cardiac disease who suffered suspected air embolism. Both were treated using a standard air embolism protocol, including hyperbaric oxygenation, for potential gas embolism which occurred during the surgical completion of their Bidirectional Cavo Pulmonary Shunt (BCPS).

COMPARISON OF TRANEXAMIC ACID AND APROTININ IN PEDIATRIC PATIENTS UNDERGOING CARDIAC SURGERY

Kishore Kumar Jagannadhams, Preetha V, and Sujatha DI
Madras Medical Mission, Chennai, India; and Centre de Cardiologie des Mascareigns, Floreal, Mauritius

Background: Children with congenital heart disease undergoing cardiac surgery in which cardiopulmonary bypass is used are at increased risk of postoperative bleeding. So use of aprotinin or tranexamic acid (antifibrinolytic) intraoperatively would be useful to control bleeding. In this study, the possibility of reducing postoperative blood loss by using aprotinin or tranexamic acid is better is proposed to be evaluated.
**Methodology:** In this study 34 patients were equally divided into two groups. One group of patients received aprotinin and the other group received tranexamic acid. The dosage of aprotinin used was 3 mL/kg (30,000 KIU/kg) bolus over 20 minutes followed by 1 mL/kg/hr (10,000 KIU/kg) infusion till the end of the procedure. The dosage of tranexamic acid used was 10 mg/kg bolus over 20 minutes followed by 1 mg/kg/hr infusion. The parameters evaluated include the postoperative blood loss, intraoperative and postoperative blood requirements, platelet requirements, and the postoperative complications.

**Results:** Our study showed no significant difference in the blood loss in both the groups. The blood and blood product requirement were also almost similar. There was no difference in the platelet counts preoperatively and postoperatively. However the ICU and the hospital stay were higher in the patients who received aprotinin than those who received tranexamic acid.

**Conclusion:** Both tranexamic acid and aprotinin are equally effective in controlling the blood loss. Since tranexamic acid is cost effective and cheaper than aprotinin it could be used more frequently.

**COLLOIDS AND ANAPHYLACTOID REACTIONS**

Kristina Chambers

*CSL Bioplasma, Broadmeadows Victoria*

In Australia, ALBUMEX® 4% (human albumin) and the gelatin products, Gelofusine and Haemaccel (succinylated gelatin and polygeline respectively) are the main colloids used in fluid resuscitation. Medical emergencies associated with anaphylaxis, significant hypotension and/or respiratory distress have occurred occasionally following administration of such colloids.

To examine the occurrence of such adverse events (AEs) with CSL Bioplasma’s most recent generation of albumin product, ALBUMEX 4% 2VI, data was obtained on the colloid AEs (albumin and, for comparison, gelatins) spontaneously reported to the Therapeutic Goods Administration’s Australian Adverse Reactions Advisory Committee (ADRAC). The reporting period examined started from late 2000, when ALBUMEX 4% 2VI supply commenced, to December 2005. The relative incidence of cases/AEs calculated was expressed as a rate per 100,000 litres of product distributed.

Overall the relative incidence of total cases reported was 5–17 times more for gelatins (Haemaccel 23.5, Gelofusine 7.1) than ALBUMEX (1.4). The incidence of individual AEs reported was greater for gelatins than ALBUMEX for anaphylactoid reactions (12–39 times), hypotension (3–14 times greater), and symptoms of respiratory distress (4–9 times).

This analysis of ADRAC’s colloid AE data suggests that symptoms of respiratory distress, hypotension and anaphylactoid reactions were rarely reported for ALBUMEX 4% 2VI in the period examined, and were significantly less than the gelatin colloids. These findings are not in line with those reported in an ADRAC Bulletin in 2006, which suggested such reactions were reported in similar proportions with these colloids, however this may be because their reporting period included AEs reported for past, less pure, generations of albumin product.

**THE INTERNATIONAL CONSORTIUM FOR EVIDENCE-BASED PERFUSION: MOVING FROM CONCEPT TO REALITY**

Robert A Baker, Timothy A. Dickinson, Donald S. Likosky, and Kenneth G. Shann

*International Consortium for Evidence-Based Perfusion (ICEBP), Executive Member; ICEBP, Chair; and ICEBP Executive Committee*

The profession of extra-corporeal perfusion embraces clinical specialists from a multitude of backgrounds with varying skill sets which has contributed in a very positive manner to the advancement of the profession. The diversity has fostered innovation on many fronts including technical development, creation of electronic data management systems, and basic and clinical research. The specialty has continued to widen its scope of practice to include modalities such as hyperthermic chemotherapy and perioperative blood management. Despite these advancements, the systematic organization of the evidence base and integrating this into the general practice of extra-corporeal support has lagged behind.

In part to overcome this deficit and to provide a framework into the future the International Consortium for Evidence-Based Perfusion (ICEBP) was formed in 2006. The purpose of the ICEBP is to partner and collaborate with perfusion societies, professional medical societies, and interested clinicians, to improve continuously the delivery of care and outcomes for our patients. It is hoped that this mission will be achieved by:

- Evaluation of current practice through a dedicated international perfusion registry.
- Development and publication of evidence based guidelines, and supporting their integration into clinical practice.
- Identifying gaps in the medical literature and empowering clinical teams to conduct research in areas where evidence is lacking.
- Identifying gaps between current and evidence-based clinical practice to promote the improvement in patient care.

The ICEBP has held two “Best Practices in Perfusion” meetings, most recently in Montreal (Quebec, Canada). In addition to these successful meetings, the ICEBP has progressed over the last 12 months:
**Membership:** We have grown to 10 international members and 2 US state societies.

**Communication Subcommittee:** Has developed and implemented the ICEBP website (www.icebp.org) which now allows communication and access to ongoing projects.

**Guidelines Subcommittee:** Has begun the task of developing guidelines in 2 areas: (1) Examine evidence relating to the interaction of perfusion and inflammation, and (2) examine evidence in relation to current strategies in platelet preservation. This task is currently supported by nearly 50 perfusionists from all over the world.

**Registry Subcommittee:** Has developed the initial data set for the ICEBP Perfusion Registry and is currently developing the web based data entry format for β testing late 2007.

**Paediatric Subcommittee:** Has been working with the Society of Thoracic Surgeons (STS) Congenital Database Taskforce and the Multi-Societal Database Committee for Paediatric and Congenital Heart Disease to develop a complete list of uniform and standard definitions for complications secondary to congenital heart surgery. The ICEBP has been tasked with the complications associated with cardiopulmonary bypass, extracorporeal life support, and ventricular assist devices. A manuscript is being drafted from this work.

The last year has been an exciting growth period for the ICEBP, allowing the ICEBP to move from concept to reality. The ICEBP seeks to deliver tangible outcomes along the way, such as a registry and set of ever-evolving guidelines. The support of international perfusion groups and individual perfusionists will see this venture prosper.

**TOTAL ARCH REPLACEMENT WITH ANTEGRADE SELECTIVE CEREBRAL PERFUSION UNDER MODERATE HYPOTHERMIA**

Yuzo Takahashi, Teruyuki Hayashi, Yasunori Yamasaki, Hideki Yotsuida, Takayuki Nishigaki, Kotaro Yoshida, Koji Ogawa, Hiroki Tatsukawa, Hitoshi Ogino, and Toshikatsu Yagihara

*Department of Clinical Engineering, National Cardiovascular Center, Osaka, Japan; and Department of Cardiovascular Surgery, National Cardiovascular Center, Osaka, Japan*

**Introduction:** Antegrade selective cerebral perfusion (ASCP) has been well established for brain protection during total arch replacement (TAR). It is expected that this adjunct might not always require deep hypothermia because of its physiological flow. Since 2002, we have used moderate hypothermia at 25–28 in TAR with ASCP.

**Objectives:** The study is to investigate the impact of moderate hypothermia on the outcomes of TAR with ASCP.

**Methods:** Between January 2005 and November 2006, 53 patients underwent elective TAR using ASCP. Deep hypothermia at 20–23 was still used for 25 patients (Group D) having preoperatively cerebral hypoperfusion due to carotid or intracranial arterial lesions or having renal failure. The other 28 patients (Group M) underwent TAR under moderate hypothermia.

**Results:**

The durations of surgery were generally shorter in Group M (Table 1). There was one hospital death (4.0%) in Group D from sepsis. There were no permanent neurologic defects in the both groups, although temporary ones occurred at 10.7% in Group M and 28% in Group D.

**Conclusions:** TAR under moderate hypothermia can be securely performed in conjunction with reliable ASCP.

### Table 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group M (n = 28)</th>
<th>Group D (n = 25)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPB (min)‡</td>
<td>200.5 ± 30.6</td>
<td>226.5 ± 35.4</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Myocardial ischemia (min) ‡</td>
<td>111.6 ± 19.5</td>
<td>133.8 ± 33.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>ASCP (min)‡</td>
<td>135.5 ± 20.3</td>
<td>153.2 ± 33.1</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Lower part of body circulatory arrest (min) ‡</td>
<td>57.0 ± 9.3</td>
<td>76.0 ± 29.0</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Operation (min)‡</td>
<td>416.8 ± 79.3</td>
<td>502.8 ± 124.0</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>30-day mortality</td>
<td>0%</td>
<td>4%</td>
<td>0.285</td>
</tr>
<tr>
<td>Temporary neurological deficit</td>
<td>10.7%</td>
<td>28%</td>
<td></td>
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</tbody>
</table>

*mean ± SD

### EXPANDING THE SCOPE OF NURSING PRACTICE IN CARING FOR PATIENTS SUPPORTED ON ECMO

S. O’Brien, V. Pellegrinom, G. Lee, and J. Currey

*The Alfred Intensive Care Unit, La Trobe University, and Deakin University, Victoria, Australia*

**Introduction:** Extracorporeal membrane oxygenation (ECMO) therapy was implemented at The Alfred ICU in 1990. In recent years, the demand for this therapy has grown to where approximately 20 patients require ECMO annually. In 2003, nurses
assumed greater responsibility in managing these patients and the ECMO device as perfusionists no longer remained on site 24 hours/day to provide support. To prepare nurses for this increase in scope of practice, a collaborative educational program was developed that involved a two day course, a period of clinical exposure and a bedside competency assessment. Since its inception, 109 Alfred nursing staff have participated in the ECMO course. Forty of these nurses (37%) remain employed within the unit.

**Aim:** The aim of the study was to determine if nurses thought the ECMO education program prepared them to competently care for patients supported on ECMO therapy. The study also explored their attitudes to this expansion in their scope of practice.

**Methods:** This exploratory study was conducted in a single centre following ethics approval. A survey toll using a Likert scale was developed and piloted. No changes were made to the tool subsequently. All current ECMO trained nurses were surveyed (n = 40). The response rate was 70% (n = 28).

**Results:** The survey results demonstrated that all ECMO trained nurses (n = 28) reported that the educational program prepared them to competently care for patients supported on ECMO therapy. The majority felt competent if required to manage a critical incident and 23 nurses (79%) reported involvement in at least one incident. The majority of nurses (96.8%) supported this expansion to their scope of practice.

**Conclusion:** The survey results show support for the educational program and expanded scope of practice for intensive care nurses and has contributed to the growth of ECMO services at The Alfred ICU.

**PAEDIATRIC EXTRACORPOREAL MEMBRANE OXYGENATION, THE CHANGING PATIENT AND TREATMENT DEMOGRAPHICS**

Clarke Thuys and Derek Best  
Department of Cardiac Surgery, and the Paediatric Intensive Care Unit, Royal Children’s Hospital, Victoria, Australia

This retrospective study has examined the patient demographics and treatment methods used at the Royal Children’s Hospital since the inception of the Extracorporeal Membrane Oxygenation (ECMO) program in 1988. Many parameters were examined including age, weight, diagnosis, length of support, pre-ECMO pH, survival, blood product usage and complication rates.

While the annual caseload has increased significantly since 2003, there has been a steady decline in the percentage of respiratory patients, and as expected a concurrent decrease in average oxygenation and ventilation indices. Median values for age and weight show no clear pattern of change over the program duration.

Complication rates have generally been higher with respect to patients than circuits, and as might be expected non survivors with respect to survivors. The survival rate has increased markedly over the last five years since the advent of polymethylpentene hollow fibre oxygenators, particularly in post cardiac patients.

Blood usage measured in mL/kg/hr has been variable but since 2003 has remained relatively constant. FFP usage has been variable while platelet transfusion has remained fairly uniform. Median length of ECMO run has again been variable.

The results of this study show that we are treating more patients, sicker patients and patients with a greater range of disease processes than even 5 years ago, and a greater proportion of these patients are survivors.

**EXTRACORPOREAL MEMBRANE OXYGENATION/EXTRACORPOREAL LIFE SUPPORT FOR A SUB-GROUP OF PATIENTS WHO DO NOT RESPOND TO CONVENTIONAL TREATMENT FOR AUTOIMMUNE/INFLAMMATORY CONDITIONS**

James McMillan Dip Perf, CCP, CCP(USA), Michael McDonald Dip Perf, CCP, CCP(USA),  
Ravi Kapoor MSc, Dip Perf (India), G. Maheshkumar BSc, Dip Perf CCP, Kevin Menezes BSc, Dip Perf (India),  
Christopher Morley BSc, Dip Perf, CCP, Scott Carson CCP(USA), and Rowan Carpenter Dip Perf, CCP  
Perfusion Services Pty. Ltd, Melbourne, Victoria, Australia

We have previously been involved in the treatment of several patients who presented with acute onset inflammatory symptoms which had not responded to conventional treatment in the intensive care setting, including a combination of high dose steroids, antibiotics, inotropes, haemodialysis and plasmapheresis in conjunction with endotracheal intubation with maximum ventilator support. Treatment with extracorporeal membrane oxygenation (ECMO)/extracorporeal life support (ECLS) allowed the acute phase of these conditions to be managed and resulted in successful outcomes.

A young female patient, who had been previously diagnosed with Goodpasture’s Syndrome and medically managed accordingly, presented in an acute condition which required ECMO support for 132 hours before making a complete recovery.  
These inflammatory disease syndromes are rare and usually can be treated without intervention using cardiopulmonary support. However, when these patients present either in great respiratory and/or cardiac distress then ECMO/ECLS can be a lifesaving mode of treatment which can be implemented in almost any hospital setting.

The success of the treatment in this patient was mainly due to the fact that the patient was not allowed to become moribund before ECMO was instituted.
Perfusionists need to be aware that these patients will present from time to time, and that a portable ECLS/ECMO system should be available for such a situation.

**RISK FACTORS FOR DEVELOPMENT OF ACUTE RENAL FAILURE REQUIRING DIALYSIS IN PATIENTS UNDERGOING CARDIAC SURGERY**

Kishore kumar Jagannadham and Somanathan, Benjamin Ninan

Madras Medical Mission, Chennai, India; and Centre de Cardiologie des Mascareigns, Floreal, Mauritius

**Background:** Acute renal failure after cardiac surgery results in high morbidity and mortality. Recognition of the risk factors permits the timely institution of proper treatment, which is a key to reduce adverse outcome.

**Aim:** The aim of the present study is to investigate the risk factors for the development of ARF following cardio pulmonary bypass.

**Methods:** In our study 474 patients above the age of 56 undergoing cardiac surgery between May 2005 and April 2006 were retrospectively analyzed. Patients with pre operative chronic renal failure with dialysis support were excluded. A univariate analysis was done for 27 variables which include thirteen pre operative variables-age, sex, DM, hypertension, atherosclerosis, pre operative renal insufficiency, pre operative congestive cardiac failure, left ventricular end diastolic dimension (LVEDD) >5 cm, smoking, hyperlipidemia, LV function, re-do surgeries, surgery type, six intra operative variables-duration of CPB, AXC time, intra operative IABP, usage of Cefazoline, Reflin and Ofloxacin, duration of low mean perfusion pressure (MPP) < 50 mmHg. The post operative variables which include, post operative hypotension, blood loss with in twenty four hours, post op complications (re-exploration, infection, re-intubations and peritoneal dialysis), duration of ICU and hospital stay.

**Results:** In our study, 110 patients (23.2%) developed ARF before discharge from the hospital (p = 0.000). The demographic data such as age, sex showed a significant association. In the pre operative variables, DM (p = 0.026), hypertension (p = 0.035), pre operative renal insufficiency, left ventricular end diastolic dimension (LVEDD) >5 cm (p = 0.040), LV function (p = 0.000), surgery type (p = 0.018) had significant association. Similarly in the intra operative variables-duration of CPB (p = 0.000), AXC time (p = 0.000), intra operative IABP (p = 0.000), duration of low mean perfusion pressure (MPP) < 50 mmHg (p = 0.001) had significant association. In the postoperative variables- postoperative hypotension (p = 0.000), blood loss with in twenty-four hours (p = 0.005), postoperative complications [re-exploration (p = 0.58), infection (p = 0.000), re-intubations (p = 0.046) and peritoneal dialysis (p = 0.000)], Duration of ICU and hospital stay (p = 0.000) had significant association. Overall mortality was 2.7% (p = 0.001).

**Conclusion:** Recognizing the risk factors, careful perioperative renal monitoring in those under risk and timely management with today’s advanced therapeutic modalities should substantially decrease the incidence of this complication.

**PREDICTING WHEN TO BLOOD PRIME THE CARDIOPULMONARY BYPASS CIRCUIT. WHAT ARE THE RISKS?**

Kuljeet N. Farrar, BSc, Dip Perf, CCP, Robert A. Baker, PhD, Dip Perf, CCP, and Rebecca A. Stanley, B.InfoTech.

Flinders Medical Centre, and Flinders University, Bedford Park, South Australia, Australia

At our perfusion quality control team meeting it was noted that a high proportion of patients were having donor blood transfused during cardiopulmonary bypass (CPB), despite the pre-bypass predicted haemoglobin (Hb) being with-in our protocol range (Hb > 7 g/dL).

The aim of this report was to investigate the reasons for the apparent inconsistency between the predicted Hb values and the actual Hb values during CPB. Could these discrepancies be due to an incorrect formulae being used? Is the volume of crystalloid being added by the anaesthetist playing a significant role in the incorrect prediction of low Hb on CPB? Are there other parameters available that can be used to predict low Hb?

**Methods:** A retrospective audit was undertaken on first time coronary artery bypass graft cases performed on CBP between January 2005 and December 2006 inclusive. Two groups were identified, group 1 (n = 98) had a blood prime or were transfused with RBC on CPB, while group 2 (n = 415) received no blood products on bypass. Patients who underwent a blood prime and had further RBC transfused while on CPB were excluded from the study. The formula used by the Data Management System (Stockert, Germany) to calculate the predicted Hb on CPB is:

$$Hb_{\text{pre}} = \frac{(Hb_{\text{preOP}} \times V_{\text{blood}})}{(V_{\text{prime}} + V_{\text{blood}})}$$

where $V_{\text{blood}}$ is blood volume (calculated at 45 mL/kg). This formula takes into account weight, preoperative Hb and the priming volume ($V_{\text{prime}}$) (1610 mL). We modified this formula to take into account the amount of volume administered by the anaesthetist once the patient entered the operating room, by including volume anaesthesia ($V_{\text{anaesth}}$) in the denominator. To determine if there was a better method to determine when a blood prime may be required we evaluated the method of McDonald et al (2005) (1) who reported the transfusion predictor product (TTP, body surface area × preoperative Hb), which they used to determine the need for patient cross matching prior to bypass. They chose a TTP less than 21.17 gHb/dL/m² as an arbitrary point of review.
The specificity of the original formula was 100% (by definition), however it’s sensitivity, was only 11.2%, the modified formula was more sensitive (72.4%) at the expense of specificity (10.8%), whilst the TTP method had a sensitivity of 47.9% and 97.3% specificity.

Comment: None of the methods presented, accurately predict which patients require a blood prime, and may therefore avoid transfusion on bypass. This raises the question “Do the benefits of a blood prime and hence avoidance of a NADIR Hb <7.0 g/dL during bypass (71/98 modified formula or 47/98 patients TTP formula) out-weight the risks of an unnecessary RBC transfusion via a blood prime (45/415 patients modified formula or 11/415 the TTP)?