



"Concepts in Perfusion"

7th European Conference on Perfusion Education and Training

PROGRAM & ABSTRACTS

Saturday, 15th September 2007 Geneva, Switzerland

7th European Conference on Perfusion Education and Training
Saturday, 15th September 2007, 09:00 to 17:00
Crown Plaza Hotel, Geneva, Switzerland
Organized by the European Board of Cardiovascular Perfusion

Chairman:

Prof. Dietrich Birnbaum (Germany)

General Secretary:

Mr. Kirk Graves (Switzerland)

Organizing Committee:

Ms. Carole Hamilton (Germany),

Mr. Frank Merkle (Germany)

Mr. Eddy Overdevest (Netherlands)

Mr. Heinz Weitkemper (Germany)

Host Delegate to the EBCP:

Ms. Judith Horisberger (Switzerland)

Moderators:

*Ms. Carole C. Hamilton, CCP, ECCP,
EBCP-Organizing-Committee, Germany*

*Mr. Frank Merkle, ECCP,
EBCP-General-Secretary-Assistant Berlin, Germany*

*Ms. Conny Nielsen, ECCP,
EBCP Accreditation Sub-committee, Denmark*

*Ms. Renate Behr, ECCP,
EBCP-Certification-Sub-Committee*

*Ms. Leen Vercaemst, ECCP, BCCP
Perfusionist UZ Leuven, Belgium*

*Mr. Heinz –H. Weitkemper, ECCP
EBCP-Organizing-Committee*

*Mr. D.Scott Lawson, CPC
Chief Pediatric Perfusion Duke-University, NC, USA*

Program

9:00 – 9:05 Opening of the Scientific Session / Ms. Carole Hamilton

9:05 - 9:30

Keynote Lecture – Mr. Jim MacDonald

„Concept of Teamwork“

Scientific Presentations

1st Morning Session / Moderator: Mr. Frank Merkle & Ms. Conny Nielsen

09:30 – 09:45 Ms. Kate Kingsford Smith

“Simulation in Perfusion; Experience as a training tool”

09:45 – 10:00 Mr. Paul Murphy

“Data management, Perfusion, and the Cardiac Database.”

10:00 – 10:30 MEDOS sponsored Session / Ms.Heidi Goerler M.D.

“Mechanical circulatory support in the pediatric patient population: Technical considerations and clinical aspects”

10:30 – 10:45 Mr. Adrian Bauer

“Follow up after two years using mini bypass systems; experiences with MECC.”

10:45 - 11:15 Maquet Sponsored Session / Mr.Andreas Förster

11:15 – 11:45 Coffee Break

2nd Morning Session

Moderator: Ms. Renate Behr & Ms. Leen Vercaemst

11:45 – 12:00 Ms. Zydre Jurgeliene

“Cardiac surgery with CPB in babies and small children, without blood and its components.”

11:45 – 12:00 Mr. Holger Zorn

“Therapeutic Mild Hypothermia after Cardiac Arrest using a Modified Heart Lung Machine.”

12:00 – 12:15 Mr. Krzysztof Klak

“Hyperthermic isolated limb perfusion with tumour necrosis factor-alpha - the setting up of a new perfusion technique in a university hospital”

12:15 – 12:45 Mr. Harald Keller

“ECMO Concept; University Clinic Frankfurt”

12:45 – 13:15 Terumo Sponsored Session / Mr. Nigel Cross

“Optimisation of the Paediatric Perfusion Circuit”

13:15 – 13:30 Mr. Kirk Graves

“The standby cardiopulmonary bypass circuit: How vulnerable is it to contamination?”

13:30 – 14:15 Lunch

Afternoon Session

Moderator: Mr. Heinz Weitkemper & Mr. D. Scott Lawson

14:15 – 14:30 Dr. Hei Feilong

“Plasma exchange during cardiopulmonary bypass in patients with severe haemolysis in cardiac surgery.”

14:30 – 14:45 Dr. Guan Yulong

“Observation of spinal cord function after descending aorta clamp in chronic porcine model.”

14:45 – 15:15 Medtronic Sponsored Session / Mr. Christiaan Matheve

“Innovation in Progress”

15:15 – 15:30 Mr. Eddy Overdeest

“Antimicrobial Activity of Platelet Gel against Staphylococcus Aureus.”

15:30 – 15:45 Dr. Judita Andrejaitiene

“Retransfusion of Centrifuged Shed Mediastinum Blood in Post- Cardiopulmonary Bypass Patients: Effects on Procalcitonin, C Reactive Protein and Postoperative Outcome”

15:45 – 16:15 Sorin Sponsored Session / Dr. M. Ranucci

“What do we expect from the Future in Cardiac Anaesthesia and CPB?”

16:15 – 16:30 Dr. Peter Tassani

“Management to minimise Systemic Inflammatory Response during Extracorporeal Circulation.”

16:30 – 18:00 Happy Hour Coffee-Break

Keynote Lecture: Exploring The Concept of Teamwork – Personal Observations

Jim MacDonald, CPC, CCP
Chief, Clinical Perfusion Services
Cardiac Care, The London Health Sciences Centre
London, Ontario, Canada

Within the cardiac operating room (OR) the clinical perfusionist must work within a team of individuals who are differentiated by professional status, individual skill sets and specific clinical accountabilities. The OR can be representative of a hierarchical environment, and as such, may make it difficult for people to speak to their individual concerns. While working within the structured domain of the cardiac OR, ones clinical accountabilities require the necessity to communicate concerns effectively. Often, this is while working within a pressured environment where each individual profession has different priorities and constraints. (1) (2) An essential element of teamwork, therefore, would be ones ability to work effectively within a cooperative team environment that would allow individuals the ability to utilize their specific differential skills toward a common purpose; that of efficient and safe patient care.

Ideally, the cardiac OR should represent the clinical setting whereby all members of the team would have the opportunity to invest in a collective synergy of common purpose that would serve to minimize the potential for human error and its associated negative consequence. In his book, "Culture at Work in Aviation and Medicine", Helmreich, et al, provides the reader with similarities between aviation safety and medicine. (2) Similar to aviation, our relationships, interactions and ability to communicate effectively can serve to influence critical decision-making in both elective and emergent cardiac procedures. Leonard, et al, states effective communication and teamwork is aimed at creating a common mental model, or getting the surgical team on the same page". (3) In my concept of teamwork, we would share a communal identity – a common concern for the well being of our patients. My intention is to share the personal experiences and insights of our perfusion team in defining those concepts that have proven to be beneficial in our realization of a cooperative and organized team.

1. Lingard L, Espin S et al. Getting teams to talk: development and pilot implementation of a checklist to promote interprofessional communication in the OR. *Qual Saf Health Care* 2005; 14: 340-346
2. Healey AN, Undre S, et al. Defining the technical skills of teamwork in surgery. *Qual Saf Health Care*, 2006; 15: 231-234
3. Leonard M, Graham S, Bonacum D. The human factor; the critical importance of effective teamwork and communication in providing safe care. *Qual. Saf. Health Care*, 2004; 13 (Supp 1) i85-i90.

Simulation in Perfusion; Experience as a training tool

Kate Kingsford Smith BSc. Dip Perf. CCP, Darryl McMillan Dip Perf. CCP, Kieron Potger MNurs. Dip Perf. CCP and Arthur Preovolos BAppSci. Dip Perf. CCP
Sydney Medical Simulation Centre
Royal North Shore Hospital Campus
Sydney, Australia

Introduction:

Simulation has grown into an important training tool for many medical specialities. It gives trainees the opportunity to develop their theoretical lessons into practical skills in real time. By building scenarios based on a group of unique signs, which on their own mean little but together add up to a pending incident, the trainee is able to diagnose, treat and therefore experience potential situations in a non-clinical setting.

Background:

In 1998 the Sydney Medical Simulation Centre (SMSC) developed a prototype Cardio Pulmonary Bypass simulator. This working model was then taken up by Ulco Australia Pty Ltd to produce a commercial model for sale.

The SMSC has been producing perfusion courses that utilize the technology of simulation since 2000, and we have seen attendees from many countries. In 2003 the Australian and New Zealand College of Perfusionists (ANZCP) introduced mandatory simulation training into their curriculum for perfusion training via workshops for students. ANZCP also provides refresher courses for certified perfusionists, and for those re-entering the profession after an absence.

Development:

Like most areas of medicine, the incident rate in perfusion is very low but the consequences can be dire. Simulation allows the participant to become familiar with recognition of 'early warning signs' that may indicate a clinical or technical problem, to gain confidence in their ability to make decisions regarding interventions and then to actually practice emergency protocols. Both the very basic and the most advanced perfusion techniques can be simulated in real time scenarios that allow for reinforcement of knowledge together with refinement of skills.

The risks associated with introducing new technologies and techniques in a clinical environment include potential information overload and distraction during critical stages of the surgical procedure. Perfusion simulation offers a unique capability in the development of and training for new equipment, where risks can be taken and limits tested that would be unacceptable in a real situation. In these scenarios simulated operating theatre conditions are a valuable tool in evaluating and optimizing both equipment and operator performance, and have led to an increased understanding of human factors that contribute to perfusion incidents.

Simulation is becoming a very important training tool in perfusion - as in many other medical specialties - where trainees can practice in real time while in a non-clinical setting, but more importantly it provides perfusionists with the ability to practice emergency protocols for an event that may only occur once in their career.

Taking Data Management to a New Level

Paul Murphy CCP

Manager Perfusion Services

Southlake Regional Health Centre

Newmarket, Ontario, Canada

Past president of the Canadian Society of Clinical Perfusion

“Data management, Perfusion, and the Cardiac Database.”

Our Cardiac program is new and has the advantage of creating a made in Southlake solution in dealing with the innumerable databases that exist within our Regional Cardiac program.

This presentation discusses, briefly, paperless charting for the Perfusionist, Perfusion database management, integrating this data in the patients electronic chart and populating the electronic record with existing information from the electronic chart.

We are partnering with Sorin Biomedica to extend the scope of their Data Management System (DMS in North America) and to allow for full integration of Perfusion data. We anticipate and look forward to the end of isolated silos of information within Cardiac programs.

MEDOS Sponsored Session:

Mechanical circulatory support in the pediatric patient population: Technical considerations and clinical aspects

Heidi Görler MD,

Jörg Optenhövel and Thomas Breymann MD

Division of Pediatric Cardiac Surgery, Department of Cardiac, Thoracic,
Transplantation, and Vascular Surgery.

Hannover Medical School, Hannover, Germany

Circulatory support in the pediatric patient population imposes specific difficulties due to the small size of the patients and the low flow on the device. We report on our experience with ECMO and VAD implantation in neonates and infants for a variety of indications. We address several cannulation techniques and present our postoperative management and anticoagulation protocol. Finally we discuss indications for different devices within different clinical settings.

MEDOS PICTURE

Follow-up after three years using Mini Bypass Systems: Experience with MECC

Adrian Bauer

Chief Perfusionist, Coswig Cardiac Centre, Germany

Bauer Adrian¹, Schnepfershoff S.¹, Ulrich C.¹, Vogt M.², Kohlstedt R.², Eberle T.², Panday G.³, Ali N.³, Schubel J.³, Hausmann H.³

Coswig Cardiac Centre; Department of Perfusion (1), Department of Anaesthesiology (2) and Department of Cardiothoracic and Vascular Surgery (3)

Background: Mini bypass systems are completely closed systems, coated with a surface that is blood-compatible, priming-reduced and haemodynamically less invasive than conventional heart-lung machine systems. The aspirated blood from the operation site goes through a cell saver back to the patient. According to some recent publications patency rates of Off Pump Coronary Artery Bypass Grafting (OPCAB) are inferior to those of coronary artery bypass grafting (CABG) performed with cardiac arrest. Moreover, the benefits of minimal extracorporeal circulation (MECC) in comparison to conventional cardiopulmonary bypass (CCPB) and OPCAB are less postoperative neurocognitive disorders and less use of blood and blood products.

Material and Methods: We have been using the MECC system manufactured by the Maquet® Company in our hospital for over three years now and acquired it in over 200 patients. All patients suffered from end stage coronary heart disease and underwent coronary bypass operation. (One patient of this group received an ECMO, instead of a “classic” MECC because he was admitted in our centre suffering from an acute myocardial infarction and was in low output state after receiving a CABG. This patient was transported to another hospital by helicopter to receive a biventricular assist device.)

Implementation: After a period of observation at The Regensburg Heart Centre, which was the first centre in Germany to use MECC, we carried out the first CABG using MECC in our own centre in 2004 with assistance of an experienced perfusionist.

Data of the first thirteen patients who underwent CABG using the Maquet MECC system were analysed retrospectively and were compared with data of patients who underwent CABG using CCPB in a pilot study. Patient data were comparable regarding baseline characteristics and Euroscore. Aim of this pilot study was to investigate whether MECC was comparable or superior to CCPB. MECC turned out to be superior regarding to the number of blood transfusion during operation and peri-operative, and regarding to neurocognitive disorders and fewer occurrence of arrhythmia. The number of distal anastomoses was equal to the number of distal anastomoses in the CCPB group.

Adaptation: In the course of the following year we adapted the setup of the MECC system and the procedure to the needs of our cardiac surgery department in order to develop a safe procedure with wide application. By means of a series of measurements carried out prospectively on 30 patients in three groups A: conventional cardiopulmonary bypass (CCPB), B: MECC with VBT (venous bubble trap) and C: MECC without VBT, we were able to demonstrate that the use of venous de-airing in the mini system can reduce the amount of Air ($\mu\text{l}/\text{min}$ bypass - time) in the arterial blood to under 3% in comparison to 13% at the group C without VBT ($p < 0,0001$). Today, we use a setup with VBT (venous bubble trap) and an arterial filter: “MECC Set Coswig”.

Follow up: Since January 2005 to May 2007 we re-examined the medical records of 1472 patients who had undergone an isolated CABG operation. Group A: Conventional open CCPB system $n=1143$ patients, B: MECC system $n=220$ patients and C: $n=109$ using the OPCAB technique. Age and concomitant illnesses were comparable in all groups. Operative mortality was respectively 2.0% in the MECC group, 2.3% in the CCPB group and 1.7% in the OPCAB group. The mean number of bypass grafts which were performed in each patient differed significantly. The average reached 3.2 ± 0.6 in the MECC group, 3.4 ± 0.7 in the CCPB group and 1.9 ± 0.8 in the OPCAB group ($p < 0.01$). Arrhythmia was registered in 24.8% in the MECC group, 35.6% in the CCPB group ($p < 0.05$) and 21.7% in the OPCAB group. Neurocognitive disorders occurred in 8 patients (3.6%) of the MECC group, in 74 patients (6.5%) of the CCPB group ($p < 0.05$) and in 3 patients (2.8%) of the OPCAB group. The median number of blood transfusions per patient was 0.8 in the MECC group, 1.8 in the CCPB group and 0.8 in the OPCAB group ($p < 0.0001$).

Conclusions: MECC appears to be superior over CCPB and OPCAB. The implementation of MECC reduces the number of operative and peri-operative blood transfusions and the use of blood products in comparison with CCPB. Moreover the MECC group had less neurocognitive disorders and arrhythmia post-operative. Furthermore the completeness of revascularization favours MECC over OPCAB.

Maquet Sponsored Session

BMS 40 – The new Blood Monitoring System from Maquet

Andreas Förster

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Introduction:

With the new Blood Monitoring System BMS 40, Maquet again provides an increased product portfolio. By listening to our customers and providing them with equipment they were always asking for. In-line blood parameter monitoring is getting more and more state-of-the-art in perfusion during cardiopulmonary bypass. Access to accurate, continuous information is a key advantage for optimum patient management, thus allowing blood parameter management to be more precise. The new BMS 40 gets rid of accuracy drifting caused by temperature changes allowing the user to fully rely on the displayed data.

Product Description: The BMS 40 Blood Monitoring System is used for monitoring important blood values within the extra corporeal circulation. This device provides continuous information of the following parameters:

Arterial side: 1) Partial pressure: p_aO_2 2) Temperature: T_a

Venous side: 1) Oxygen saturation: S_vO_2 , 2) Hemoglobin: Hgb, 3) Hematocrit: Hct 4) Temperature: T_v

Arterial disposable sensors are available in three different sizes: 3/8", 1/4", 3/16"

Venous disposable sensors are available in three different sizes: 1/2", 3/8", 1/4"

The BMS 40 Blood Monitoring System can display the p_aO_2 either at actual temperature or calculate the measured value at 37°C.

Up to 100 cases can be stored on a USB-stick and/or transferred to other systems via RS232.

A printer is available as an accessory for the BMS 40.

With the BMS 40 cumbersome calibration techniques and procedures are something from the past. The integrated 2D bar code scanner is used to calibrate the system. Calibration time for the entire system will be less than one minute.

Another feature of the BMS 40 is the reduced hemolysis due to the use of a contact-free IR-technology through an optical window in the cuvette.

The monitor has a 10.4" high resolution touch screen TFT Display and a rotary-select button for fast, easy and safe use. This screen will be able to show data in all different possible formats. Actual values or trend values in table or graphical format can be displayed. The very intuitive user interface is also an unprecedented step in perfusion by MAQUET.

MAQUET PICTURE

Cardiac Surgery with CPB in Babies and Small Children without Blood and its Components

Zydrė Jurgeliene

University Hospital, Department of Cardiac Surgery Vilnius, Lithuania

Ž. Jurgelienė B. Mockuvienė, V. Maslovas, K. Versockas, V. Tarutis V. Lebetkevičius. Vilnius University Hospital Santariškių clinics.

Cardiac surgery in babies and small children as a rule requires blood and (or) its components. This is related with high hemodilution as we need high priming volumes compare to patient's blood volume. During half a year we analyzed our experience in babies and small children (6,9 to 17,5 kg). We selected children mostly with weight range: ASD, VSD, VSD+PFO, PAS, AoCo. There were few complex cases as well: TOF, PAS + sub aortic stenosis + ASD. Preoperative Hb level was ≥ 120 g/l and patient's weight ≥ 6.9 kg.

We used Dideco Paediatric and Lilliput 2 oxygenators with crystalloid priming volume from 400 ml to 650 ml.

Hb was tested after induction of anaesthesia and placement of the lines. It varied from 148 g/l to 122 g/l. We calculated the lowest Hb levels (between 63 g/l and 76 g/l) during CPB. We checked Hb level at the day of surgery and the next day.

We share our small experience in babies and children cardiac surgery with CPB performed without blood products.

In the future we will try to select smaller children with more complex lesions. There are still more possibilities to reduce the prime volume, length of the CPB lines, smaller oxygenators and arterial filters are available by now.

Our team – surgeons, anaesthesiologists, and perfusionists gain experience and try to save every drop of blood.

Therapeutic Mild Hypothermia after Cardiac Arrest using a Modified Heart Lung Machine

Holger Zorn

Chief Perfusionist, Martin Luther University Hospital Halle, Germany

Zorn, H. Janusch, M. Silber, R. Werdan, K. Buerke, M.
Department of Cardiothoracic Surgery, *Department of Medicine III
Martin Luther University Hospital Halle, Germany

Background:

Induced, controlled mild hypothermia (32-34°C) increases the survival rate and quality of successfully resuscitated patients after cardiac arrest due to ventricular fibrillation and, since 2003, is part of the ILCOR / AHA guidelines for treatment of unconscious patients after out-of-hospital cardiac arrest.

Methods:

A roller pump (Stöckert Instruments GmbH, Munich, Germany) with pressure and temperature module was combined with a heater-cooler device and mechanically modified in a way that a rotation speed of 25 min⁻¹ cannot be exceeded. A sterile tubing set with a single use heat exchanger (Vision, EuroSets Srl, Medolla, Italy) was connected with an endovascular-cooling catheter (ICY Intravascular Catheter, Alsius Corp., Irvine CA, USA) and filled with sterile isotonic saline solution. The 8.5 French catheter is introduced via the femoral vein using the Seldinger technique and placed into the Inferior Vena Cava. The used ¼" silicon tube and the rotation speed limitation keeps the maximum flow at 300 ml/hour. The patients were cooled to 32 °C; this temperature was kept for 24 hours and controlled by a bladder or pulmonary catheter. Passive rewarming was instituted after removal of the cooling catheter.

Patients:

For this study 17 patients (8 female and 9 male) were cooled. The mean age was 62.1 years ranging from 37 to 86 years. Causes of cardiac arrest were: acute myocardial infarction (n=8), COPD with acute asphyxia (n=2), lung edema due to cardiac decompensation with acute asphyxia (n=1), septic shock (n=2), drug intoxication (n=1) and cardiac arrest without retrospectively specified cause.

Results:

The target temperature was reached within 120 minutes and constantly held over 24 hours. Then the patients were passively rewarmed (37°C) after 3 – 12 hours. Nine patients have showed no or moderate brain damage. Serious hypoxic brain damage resulted in 8 patients. Six patients died as a consequence of cardiac shock or multi organ dysfunction. No serious adverse effects like tachycardia or coagulation dysfunction were observed.

Conclusion:

The combination of an endovascular-cooling catheter with an extracorporeal heat exchanger and a heater-cooler device offers sufficient cooling capacity and avoids volume overload especially in unstable cardiac patients. In contrast to other invasive techniques, the blood contact with foreign surfaces is minimized.

Hyperthermic Isolated Limb Perfusion with Tumour Necrosis Factor-Alpha: The Setting-up of a New Perfusion Technique in a University Hospital

Krzysztof Klak

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Background:

Soft tissue sarcomas are malignant tumours. These sarcomas can arise almost anywhere in the body. About 50 % occur in the extremities (i.e. arms, legs, hands, or feet). Soft tissue sarcomas are relatively uncommon cancers. They account for less than 1 % of all new cancer cases each year. Treatment options for soft tissue sarcomas include surgery, radiation therapy, and chemotherapy. For some subgroups of patients amputation or limb-sparing surgery are necessary, however, these techniques may incur significant morbidity and body disfigurement. The hyperthermic isolated limb perfusion with TNF-alpha is an option in extremity sarcomas for unresectable lesions to preserve limb function and maintain the quality of life.

Method:

The presentation describes the development and the organization of a multidisciplinary isolated limb perfusion programme. Furthermore, the basics of the isolated limb perfusion, the perfusion system and our therapy management will be presented.

Results:

The short-term results of the first 9 patients will be discussed.

Conclusion:

Our example shows that it is possible to establish a project from the borderland of the extracorporeal circulation successfully in a university hospital. Moreover, this endeavour was initiated by the perfusion department which was closely involved in all stages of the programme development. Our project of the isolated limb perfusion gives the subgroup of patients with limb sarcoma a chance to preserve their limbs by avoiding the otherwise inevitable amputation. It also expands our spectrum of activities.

ECMO Concept As A Treatment Option For Refractory Cardiogenic Shock: Data and Results from 45 Patients

Harald Keller

Chief Perfusionist, University Clinic Frankfurt, Germany

Background:

Extracorporeal membrane oxygenation (ECMO) is an established treatment option in patients with Cardiogenic Shock. We retrospectively reviewed early and mid-term outcome as well as predictors of survival during using ECMO. The presentation reviews our experience with this support system from 2003 to 2007.

Methods:

From January 2003 till November 2006, 45 of 5750 (0, 8%) patients undergoing cardiac surgery procedures (Coronary artery bypass grafting (CABG), n=20; implantation of left ventricular assist device (LVAD), n=5; Heart Transplantation, (HTX) n=1, HTX+Lungtransplantation (LTX), n=1; CABG + Repair of post-infarction ventricular septal defect (VSD), n=3; CABG + Mitral valve repair (MVR), n=5; Aortic valve replacement (AVR), n=2; CABG+AVR, n=3; other procedures, n=5). required temporary ECMO support. The ECMO implantation was performed through the femoral vessels, axillary artery or through the right atrium and ascending aorta. Additional intraaortic balloon pump was employed in 30 patients.

Results:

Average patient age was 60, $1 \pm 13, 6$ years. There were 35 male patients. Average duration of ECMO was $6,4 \pm 4,5$ days. 25 patients could be successfully weaned from ECMO. The 30 days mortality was 53% (24 of 45 patients). The In-Hospital mortality was 71% (32 of 45 Patients). 13 patients (29%) could be successfully discharged.

Conclusions:

ECMO offers an acceptable cardiopulmonary support in adults with similar hospital survival rates as other mechanical support. It is versatile and salvages some patients, who may otherwise die. Improvement in intermediate term outcome will require multidisciplinary approach to protect multi organ function and limit organ injury during this support.

TERUMO PICTURE

Terumo Sponsored Session:

Optimisation of the Paediatric Perfusion Circuit

Nigel Cross

Lead Clinical Perfusionist, Great Ormond St. Hospital, London

What is an optimised circuit?

Especially within the context of a neonatal / paediatric circuit. The adult world of perfusion has seen radical changes recently with the introduction of “Mini bypass” circuits. These have reduced static priming volumes dramatically, almost to the same value as the average paediatric circuit, and users are able to choose circuits where the oxygenator, arterial filter and pump are integrated into one unit.

Such options are, as yet, not available to the neonatal/paediatric perfusionist. Is it possible, given the range of hardware and consumables available, to “optimise” these circuits any further? Small/micro oxygenators, hardware that moves your circuit as close to the operating field as possible, assisted drainage.....what would be on your wish list?

The Standby Cardiopulmonary Bypass Circuit: How Vulnerable Is It To Contamination?

Kirk Graves

Chief Perfusionist, City Hospital Triemli, Zurich, Switzerland

Graves K, Behr R, Costabile S, Reuthebuch O, Genoni M.
City Hospital Triemli, Zurich, Switzerland

Introduction:

The objective of this current investigation is to confirm the sterility of pre-assembled CPB circuits maintained in standby for off-pump procedures for more than 24 hours. Included are dry circuits, circuits which are partially primed with lactated Ringers (reservoir only), and pre-primed circuits where prime is circulated.

Methods:

A sterile CPB circuit (Sorin AVANTE) is mounted on a standard heart lung machine (Stöckert CAPS). 5 groups are created: 3 control circuits (A), 6 dry exposure circuits (B), 5 primed, but prime not circulated circuits (C), 6 circuit filled, primed, and circulated (D), and 2 prolonged NaCl 0.9% primed and circulated circuits (E). After standby time limits are reached in the non-primed or circulated groups (A-C), prime is circulated at 2-3 L/min for a minimum of two hours before prime samples are obtained for analysis. For all circuits, three 10 ml samples are drawn from each circuit for microbiological and sediment analysis.

Results:

One positive analysis was provoked and confirmed in one of the three control circuits to substantiate the sensitivity of the method of analysis. Otherwise, no positive microbiological results were found in any of the circuit prime for all groups (B-C) in time periods up to 11 to 14 days. In Group D, no positive microbiological results were found. Sediment analysis was positive in one circuit in this group which was circulated for 11 days. Sediment analysis revealed oxidation, although microbiological analysis remained negative. This circuit had been primed with additional NaCl 0.9%. Visual analysis confirmed a slight oxidation process in the stainless steel heat exchanger. An extra group (E) was at this point added to compare prolonged exposure of NaCl 0.9% prime to the stainless steel heat exchanger. An oxidation process could not be repeated over a period of 14 days for either circuit.

Conclusion:

Routinely assembled and prime CPB circuits maintained in standby support for cardiac surgery remained sterile under normal conditions for at least 14 days. From our findings, we have extended the safety limit to 10 days for dry circuits and 7 days for reservoir primed circuits which are prepared under normal conditions. Due to a potential oxidation process where prime containing higher levels of chloride ions remains in prolonged contact with stainless steel heat exchangers, we recommend that when circuits are primed and circulated in standby status, the circuits be left un-circulated and used within 3 days. Otherwise by using oxygenators with non-metal heat exchangers in the same situation, we leave the prime un-circulated and use the circuit within 5 days. Finally, we recommend using a circuit assembly checklist, confirming when a circuit is prepared and whether it was set up under normal conditions.

Plasma Exchange During Cardiopulmonary Bypass in Patients with Severe Haemolysis

Hei Feilong

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Feilong HEI MD, Shu yi LV MD, Cun LONG MD, Jian Ma MD
Department of CPB Cardiovascular Institute and Fuwai Hospital, CAMS and PUMS,
Beijing 100037 China

Objective:

To summarize the clinical experience of plasma exchange (PE) during cardiopulmonary bypass (CPB) in patients with severe haemolysis in cardiac surgery.

Methods:

Between January 2001 and December 2005, five patients in Fuwai Hospital required PE for severe haemolysis after cardiac surgery. Three patients had peri-prosthetic valve leakage and infective endocarditis, 1 patient with congenital heart disease of pulmonary artery stenosis with unsatisfied right ventricular outflow tract patching and 1 patient had thrombosis during extracorporeal membrane oxygenation (ECMO). They all required blood purification to avoid acute renal failure.

Results:

Five patients were successfully treated with PE during CPB without major complications. The average amount of plasma and blood transfused in the five patients were respectively $2.2 \pm 0.8L$ and $0.6 \pm 0.3L$. The volume of plasma exchange and ultrafiltrate were $3.9 \pm 1.8L$ and $2.4 \pm 1.3L$ respectively. The electrolytes and blood-gas analysis in all the patients were maintained at the normal levels. The hemodynamics was stable. After heart resuscitation the CPB stopped smoothly. Echocardiograms after the operation indicated disappearance of peri-prosthetic leakage and satisfied right ventricular outflow tract patching. They were extubated 24h after the operation and were discharged 12 - 53d after the operation after fully recovered. The urine was clear and the body temperature was normal. Before they left the hospital, the concentration of free hemoglobin was tested in 3 patients. The concentration of free hemoglobin was slightly high in 1 patients ($68mg/L$), and it was normal in the other two patients $< 40mg/L$.

Conclusion:

PE during CPB in severe haemolysis is a safe technique which can effectively prevent acute renal failure caused by severe mechanical haemolysis after cardiac surgery.

OBSERVATION OF SPINAL CORD FUNCTION AFTER DESCENDING AORTA CLAMP IN CHRONIC PORCINE MODEL

Guan Yulong

MD, Department of Extracorporeal Circulation, Fuwai Hospital, Beijing, China

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Department of Extracorporeal Circulation, Fuwai Hospital, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, 100037, People's Republic of China

Objective:

In this study, chronic animal models were established using piglets. The spinal cord function was monitored with somatosensory evoked potentials (SEP) and outcomes was compared between single clamp and left heart bypass.

Methods:

12 piglets were used in the chronic models. Spinal cord ischemia was established by 30 minutes of descending aorta clamp. Single clamp and left heart bypass was two different intervenes during the procedure. SEP was recorded to monitor the function of spinal cord. The behavior outcomes were observed postoperatively. The changes of ultrastructure were observed with electron microscope.

Results:

All animals underwent the procedure steadily. The animals in single clamp group developed 1 incomplete paralysis and 5 paraplegia. The animals in left heart bypass recovered unevenly and there was no paraplegia/ paralysis. The record of SEP showed amplitude decreased to below 50% of baseline and prolong of latency was beyond 10% of baseline in single clamp group but not in left heart bypass group. The measurement with electron microscope indicated serious damage of layers in spinal cord in single clamp group while the morphology was almost normal in left heart bypass group.

Conclusion:

(1) Serious spinal injury would take place if 30 minutes of single clamp was used during descending aorta surgery; (2) Compared to single clamp, left heart bypass may provide superior spinal protection; (3) From this chronic model, SEP may provide useful information of spinal cord.

Medtronic Sponsored Session:

Innovation in Progress

Christiaan Matheve

Medtronic

Extracorporeal circulation (ECC) in heart surgery is still regarded as one of the main contributors of the systemic inflammatory response syndrome (SIRS).

The aim of both the clinical world and the industry is to provide answers to decrease the side-effects of ECC.

Because the causes of SIRS are multi-factorial, the approach must be multi-disciplinary as well.

Medtronic has recently invested substantially in both designing new products/procedures and educational programs in order to assist the clinical world.

The tendency of producing small, powerful, safe and reliable ECC-systems is reflected in the Resting Heart™ System leading to interesting and promising improvements in patients outcome.

Because of the need for multi-disciplinary approach, OR's become more crowded than ever before, so smaller and more versatile hardware becomes a necessity in the modern operating theater.

The PERFORMER® Cardiopulmonary Bypass (PCPB) offers a limited-size-platform with which multiple therapies can be delivered in or outside the OR.

At the same time, training and educational programs have been developed and delivered to the clinical community in order to fully guarantee the safe and reliable handling of the new techniques and technologies available today.

The presentation will highlight the recent achievements in terms of technology and clinical experience in all these area's.

MEDTRONIC PICTURE

Antimicrobial Activity of Platelet Gel against *Staphylococcus Aureus*

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Introduction:

The use of platelet gel (PG), a mixture of platelet rich plasma (PRP) and thrombin, to stimulate bone formation and wound healing by the release of platelet growth factors has been investigated extensively. However, it has been suggested that PG might also have antimicrobial properties. In addition to several growth factors also platelets antimicrobial peptides are present in the platelet α -granules, which released their content upon activation with thrombin. PG also contains a high concentration of leukocytes, which play an important role in the normal host defense against infections. It has been shown that myeloperoxidase (MPO), mainly present in the monocytes and neutrophilic granulocytes, is the most important mediator in this process. In the current study, we investigated the *in vitro* antibacterial activity of PG against *Staphylococcus aureus*.

Materials and Methods

Production of PRP: Blood was obtained from 6 healthy donors (3 male, 3 female; age 22-45). Two 60 ml syringes were pre-filled with 7 ml of anticoagulant citrate dextrose A solution and 53 ml of whole blood was slowly drawn via an intravenous catheter. PRP was prepared, using the Angel Whole Blood Processing System™ (AWBPS; Sorin Group, Mirandola, Italy). The AWBPS is a semi-automated tabletop centrifuge system using a flat-disc, with a variable blood volume ranging from 60 to 180 ml. Following a 19 min spin at 3.200 rpm, platelet-poor plasma (PPP) was removed and platelet rich plasma (PRP) was collected. 12 ml of PPP was isolated to produce autologous thrombin (AT), using activAT (Sorin Group, Mirandola, Italy). The red blood cells were collected separately, but were discarded. PRP was mixed with AT in a 10:1 ratio to create PG. As an alternative to AT, PRP was also activated with bovine thrombin (500 U/ml; Jones Pharma Inc, St Louis, MO, USA) in a ratio 10:1. Platelet and leukocyte counts were measured in samples of whole blood, PRP and PPP as a quality control of the PRP separation process.

Bacterial kill assay: Phosphate buffered saline (control), 20% v/v PG activated with autologous thrombin, PG activated with bovine thrombin, PRP or PPP were added to sterile tubes containing *Staphylococcus aureus* Wood 46 (ATCC 10832) at a final concentration of 1×10^6 colony-forming units (CFU)/ml in Müller-Hinton broth. After 1, 4, 8, 12 and 24 hours, a 50 μ l sample was taken from each tube and antibacterial activity of MPO was inactivated by adding excess catalase. Serial 10-fold dilutions were made and plated on blood agar plates. After an overnight incubation at 37°C the number of viable bacteria were counted (10^{\log} CFU/ml).

Statistical analysis: Analysis was performed using repeated measures analysis and Tukey-HSD post hoc-testing. $P < 0.05$ was considered significant.

Results:

Quality control of PRP: An average of 4.5 ml concentrated PRP was obtained from the whole blood samples. This volume was diluted with PPP to obtain a total PRP volume of 10 ml. Analysis of the samples showed that the leukocyte content increased from 5.7 ± 0.4 ($10^9/l$) in whole blood to 18.0 ± 1.2 in PRP. The platelet concentration increased from 262 ± 11 ($10^9/l$) in whole blood to 1688 ± 130 in PRP. In PPP only a few platelets were present, as expected.

Bacterial kill: Cultures showed a rapid decrease in the number of bacteria for both PG activated with autologous thrombin and with bovine thrombin. The maximum decrease was seen after 4 hours when $0.35 \pm 0.07\%$ and $1.03 \pm 0.44\%$ of the number of bacteria present in the control group were left for PG autologous and bovine, respectively. Because the bacterial kill was not complete in any of the groups, the number of bacteria increased at later time points, when growth rates exceeded bacterial kill. After 24 hours, bacterial growth had reached the stationary phase in all groups. Although PG, PRP and PPP all induced a significant decrease in the number of bacteria compared to the control ($p < 0.001$), the effect of PG activated by autologous thrombin appeared to be largest ($p = 0.093$ vs. PG bovine activated; $p = 0.004$ vs. PRP and $p < 0.001$ vs. PPP).

Discussion:

This experiment showed that platelet gel has a significant antimicrobial activity against *S. aureus*. Although it did not result in a total kill using the current set-up, it did reduce the absolute number of bacteria to less than 1% of the control up to 8 hours. Strikingly, also non-activated PRP and even PPP decreased bacterial growth. This may be explained by the presence of lower amounts of antimicrobial agents in these groups as well.

As platelet gel is a safe to use autologous blood product, which can be easily prepared during surgery, it appears to be a potentially useful prophylactic strategy against postoperative infections, for example as a coating on uncemented implants. However, further research should prove its efficacy in combination with implants and in the *in vivo* situation.

Retransfusion of Centrifuged Shed Mediastinal Blood in Post-Cardiopulmonary Bypass Patients: Effects on Procalcitonin, C Reactive Protein and Postoperative Outcome

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OBJECTIVE: Cardiac surgery with cardiopulmonary bypass (CPB) is associated with number of adverse effects due to systemic inflammatory response syndrome (SIRS). The aim of this study was to evaluate effects of shed mediastinal blood (SMB) on predictors of SIRS and postoperative outcome in patients during the early period following cardiac surgery.

METHODS: Two groups of patients who underwent cardiac surgery with CPB were examined. Group I consisted of 41 patients who received centrifuged autologous SMB collected during the four hours following surgery. In the Group II (49 patients) all SMB was discarded (control group). Haemoglobin, haematocrit values, C reactive protein (CRP) and procalcitonin (PCT) concentration were compared before the surgery (baseline), at 4 and 20 hours after surgery and at the fifth postoperative day.

RESULTS: Requirement for allogeneic blood transfusion was significantly lower in Group I (14.6% vs 38.8%). CRP concentration was increased during postoperative period in both groups without differences. Augmentation of PCT concentration (0.5 – 2 ng/ml) was more often observed in Group II (58.3% vs 33.3%). The rate of postoperative infection in Group I was lower in comparison with that of Group II (2.4% and 10.2% respectively). Hospital length of stay in Group I was shorter than in Group II (9.32 ± 2.55 days vs 14.38 ± 4.27 days, $p < 0.05$).

CONCLUSION: Early retransfusion of autologous centrifuged shed mediastinal blood did not increase bleeding, reduced requirement for allogeneic blood transfusion, showed lower PCT concentration, reduced the rate of postoperative infection, significant shortened hospital length of stay.

Sorin Sponsored Session:

What do we expect from the Future in Cardiac Anaesthesia and CPB.

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Three different research areas are presently offering promising results in the field of cardiac anesthesia and CPB: new mini-invasive CPB systems, coagulation monitoring, and perfusion adequacy monitoring.

Minimally invasive CPB circuits

Many innovative cardiopulmonary bypass (CPB) systems have been recently proposed by the industry. With few differences, they all share a philosophy based on priming volume reduction, closed circuit with separation of the surgical field suction, centrifugal pump and biocompatible circuit and oxygenator. These minimally invasive CPB (MICPB) systems are intended to limit the deleterious effects of a conventional CPB. However, no evidence exists with respect to their effectiveness in improving the postoperative outcome in a large patient population. We recently published a study aimed to verify the clinical impact of a MICPB in a large population of patients undergone coronary artery revascularization. In a retrospective analysis on 1,663 patients treated with a MICPB; the control group (conventional CPB) was extracted from a series of 2,877 patients according to a propensity score analysis. Results: the two groups were homogeneous for pre and intraoperative variables. Patients receiving a MICPB had a shorter intensive care unit (ICU) stay, a lower peak postoperative serum creatinine and bilirubin level, and suffered less postoperative blood loss. They had a lower rate of intra-aortic balloon pump support (relative risk 0.56, 95% confidence interval 0.35-0.9), and demonstrated a lower rate of atrial fibrillation (relative risk 0.83, 95% confidence interval 0.69-0.99) and ventricular arrhythmias (relative risk 0.43, 95% confidence interval 0.27-0.69). Rates of early extubation and early discharge from the ICU and the Hospital were significantly higher in MICPB group. Hospital mortality did not differ between groups. Conclusions: MICPBs are effective in reducing morbidity but do not affect mortality.

Hemostasis and coagulation monitoring

The clinical profile of the cardiac patient has greatly changed during the last two decades. The increasing effectiveness of percutaneous procedures for coronary disease, the advancing age of the general population, and the presence of more and more redo patients created an environment where a "normal" cardiac patient is almost impossible to be found, and where the presence of comorbidities and pharmacological treatments are the rule.

From this point of view, the preoperative pharmacological approach to hemostasis and coagulation has greatly changed as well. If 20 years ago the only preoperative treatments were salicylates, subcutaneous unfractionated heparin, and warfarin, nowadays we have a wide spectrum of possible pre-treatments: besides the already mentioned, patients can reach the operating theater under subcutaneous LMWH, ADP-dependent platelet function inhibitors (ticlopidine, clopidogrel), GPIIb/IIIa – dependent platelet function inhibitors (eptifibatide, tirofiban, abciximab), and various combinations of different drugs (double or triple antiaggregation). Novel drugs

recently appeared, belonging to new categories (i.e. the direct thrombin inhibitor bivalirudin), and will rapidly become a part of the pharmacological strategies during percutaneous cardiological procedures.

The absolutely surprising information is that this overwhelming amount of different preoperative strategies did not result in any change in the routine preoperative assessment of the patient by the anesthesiologists. 20 years ago we had the routine preoperative central lab assays: PT, aPTT, platelet count, fibrinogen level; and as intraoperative monitoring, the standard ACT.

Nowadays, in routine cases, we don't have any more, yet. A recent EACTA European Survey (data on file), revealing that 70% of the European Institutions are still working on this set of laboratory information. About 30% added a routine assessment of antithrombin (AT) activity before and after the operation. No more than 20% of the Institutions has available bedside coagulation monitoring tools like TEG or platelet function analyzers.

However, bleeding after cardiac surgery is still a reality, and transfusional issues are very important, to this respect. Just to demonstrate the feeling of the clinicians with respect to haemostasis and transfusions, we can quote the fact that in the next EACTA congress 15% of the free presentations are dealing with these problems; the rate was 8% in 2005, 10% in 2004, 13% in 2003..

It is therefore clear that we cannot go on addressing perioperative hemostasis and coagulation with the standard tools. The following part will be therefore dedicated to a brief overview of what is available as point-of-care assessment. The perioperative coagulation lab and Heparin responsiveness

The standard monitoring is traditionally based on celite or kaolin ACT response to a standard dose of intravenous unfractionated heparin. However, many factors may decrease or increase patients responsiveness to heparin.

The need for an adequate heparin dose during the operation has been addressed by many articles. In case of "heparin resistance" thrombin is extensively formed and not adequately suppressed. On the other side, unneeded heparin dose may create the environment for a wide consumption of natural anticoagulants (AT, TFPI). In both the situations, postoperative hemorrhagic or thrombotic complications are most likely to occur.

To this respect, particular attention should be dedicated to the preoperative AT activity. This measurement allows to distinguish between "AT dependent heparin resistance" (to be treated with AT supplementation using FFP or AT concentrates), and "AT independent heparin resistance (to be treated with increased doses of heparin).

Many authors have stressed the need for a more strict control of heparin responsiveness.

A possible monitoring of heparin response is achievable using dedicated heparin monitoring systems (HMS), which determine an "in vitro" response to various heparin concentrations.

Using this technique, a dose-response function is determined, and the slope of the linear relationship is a useful indicator of heparin responsiveness (figure 1). Patients with a low heparin response are in the range of 30-40 seconds/U/mL; increased heparin response is present if the value exceeds 100.

Thromboelastography (TEG)

TEG is the graphical representation of a dynamic phenomenon: the thrombus formation.

Basically, it allows to determine the kinetic of thrombus formation, by activating blood with kaolin. The different phases of thrombus formation may be addressed in terms of

time to the beginning of thrombus formation, speed of clotting, force of the clot, and lysis of the clot.

TEG may have many applications during a cardiac operation. Before the operation, an increased R time may be found in case of hepatic dysfunction, warfarin treatment, coagulopathy, or heparin pre-treatment. Using heparinase-TEG, it is possible to determine if there is active heparin in the patient. This allows a correct protamine administration at the end of the procedure.

A decreased MA is present in case of low platelet count. Conversely, less information is available in case of platelet dysfunction. For this reason, recent modified TEGs have been proposed (platelet mapping). At the end of the operation, TEG may correctly guide a pharmacological therapy (protamine, tranexamic acid), or a transfusional approach (FFP-Platelets), but most of all may help in detecting surgical bleeding.

Platelet function

Bleeding after cardiac surgery is a problem of platelet function in the majority of the cases. Platelet function may be addressed using some bedside devices.

The ULTEGRA has been used for determining GPIIb/IIIa dependent platelet aggregation. Other techniques include the HMS haemostatus and the PFA-100. This last device is easy and practical, and through the use of different activators (collagen-epinephrine, collagen-ADP), allows to discriminate the action of salicylates or other antiaggregants. Its response is however dependent on the HCT and the platelet count. Its sensitivity for salicylates-induced antiaggregation is high, while clopidogrel therapy may be detected less easily.

Of course, not all the patients require a sophisticated hemostasis/coagulation assessment during a cardiac surgery procedure. However, whenever a problem may be present (preoperative use of new generation antiaggregants; hepatic dysfunction; warfarin treatment; unexpected bleeding), only a comprehensive assessment of the coagulation profile may guide a selective therapy and save time, resources, finally leading to an improved outcome.

Pump flow adequacy

Hyperlactatemia during cardiopulmonary bypass (CPB) is a common event and is associated to a high morbidity and mortality following cardiac operations. We recently published a study aimed to identify the possible predictors of hyperlactatemia during CPB among a series of oxygen and carbon dioxide derived parameters measured during CPB.

Methods: Prospective observational study on 54 patients undergoing cardiac surgery with CPB. Hyperlactatemia was defined as an arterial lactate concentration higher than 3 mMol/L. Serial blood lactate assays have been performed during CPB, and their association to a number of oxygen and carbon dioxide derived parameters was explored.

Results: Arterial blood lactate concentration was positively correlated to the CPB duration, the carbon dioxide elimination, the respiratory quotient, and negatively correlated to the presence of the aortic cross-clamping, the body surface area, the ratio between the oxygen delivery and the carbon dioxide production, and the arterial oxygen saturation. Predictors of hyperlactatemia during CPB, are a carbon dioxide production higher than $60 \text{ mL} \cdot \text{min}^{-1} \cdot \text{m}^{-2}$, a respiratory quotient higher than 0.9, and a ratio between oxygen delivery and carbon dioxide production lower than 5.

Conclusions: Carbon dioxide derived parameters are representative of hyperlactatemia during CPB

SORIN PICTURE

Management to Minimize Systemic Inflammatory Response during Extracorporeal Circulation

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Intraoperative management to minimize systemic inflammatory response can be stratified in mechanical methods dealing with modifications of the cardiopulmonary bypass circuit, such as conventional and modified ultrafiltration, heparin coating, the use of a roller pump in comparison to a centrifugal pump, bilateral perfusion, and circulatory arrest to minimize the CPB-time and by pharmacological agents like corticosteroids, complement inhibitors, and aprotinin.

Corticosteroids:

Methylprednisolone was given as early as 1966 to reduce vasoconstriction during cardiopulmonary bypass (CPB) and to prevent low output syndrome thereafter. The use of methylprednisolone attenuates the systemic inflammatory response during cardiopulmonary bypass significantly which has been shown in many investigations. However, improvement of clinical outcome parameters has been shown only slightly and not consistently throughout the literature.

Aprotinin:

The pro-inflammatory IL-6 has been shown to be significantly reduced in the aprotinin treated patients, whereas the anti-inflammatory reaction was enhanced. Clinical parameters – similar to corticosteroids – seem to be influenced very little.

Ultrafiltration:

Conventional ultrafiltration is performed during CPB. It has been shown to remove inflammatory mediators to some degree. The effect on reducing these small molecules is very limited. Modified ultrafiltration in contrast, is performed after CPB. Modified ultrafiltration has been proven to be effective in reducing the elevation in total body water from 11% to 4% and improving systemic arterial pressure and cardiac index in children undergoing various cardiac procedures.

Capillary leak study:

The conclusion drawn from this investigation is that capillary leak is not the result of systemic inflammatory response. Colloid osmotic pressure seems to be of utmost importance.

In summary it seems highly questionable, if the systemic inflammatory reaction during cardiac surgical procedures should at all be “modified”. The outcome data as yet available do strongly recommend ultrafiltration and modified ultrafiltration – methods which only slightly modify the inflammatory response. Pharmacological drugs to reduce inflammation are not recommended.

NOTES
