

8th European Conference on Perfusion Education and Training

Saturday, 13th September 2008, Lisbon, Portugal

**Lisbon Congress Centre
Centro De Congressos De Lisboa (CCL)**



PROGRAMME & ABSTRACTS

"Innovations in Perfusion"

Although literary enthusiasts have studied and defined the meaning of innovation in great depth, the term innovation is simply defined in Webster's Dictionary as *something newly introduced, to make changes, introduce new practices etc. Latin (innovatus): to renew.*

Being innovative is being creative and taking an idea for a new product or improvement of an existing product or system and "successfully" introducing this into practice. Although the end goal is to make "something better", it requires change that can challenge established views on both an individual and institutional level.

Therefore, crucial to the innovation process is the acknowledgment, the exchange of professional experience to learn, the challenge to discuss with our colleagues "innovation" in helping to support technological growth and changes and develop new products and techniques to achieve effective safe advancements in our profession.

Carole Hamilton
Organizing Committee
Member Academic Committee

EBCP Organizing Committee:

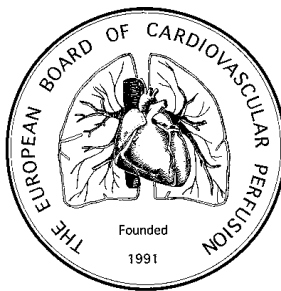
Mr. Charlie Grima, (Malta)
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Ms. Carole Hamilton, (Germany)
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Mr. Eddy Overdevest, (Netherlands)
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8th European Conference on Perfusion Education and Training
Saturday, 13th September 2008, 09:00 to 17:00
Lisbon Congress Centre, Lisbon, Portugal
Organized by the European Board of Cardiovascular Perfusion
www.ebcp.org

Moderators:

Mr. Charlie Grima, (Malta)
Delegate Malta

Ms. Carole Hamilton, (Germany)
Member Academic Committee

Mr. Frank Merkle, (Germany)
EBCP General Secretary

Mr. John Miller (Canada)
Edmonton, Alberta

Mr. Eddy Overdevest, (Netherlands)
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Prof. Alexander Wahba, (Norway)
EBCP Chairman

Mr. Heinz Weitkemper, (Germany)
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Mr. Dalibor Zovko (Croatia)
Delegate Croatia

Programme

Moderators:

Ms. Carole Hamilton (Jettenburg, Germany)

Mr. Dalibor Zovko (Krapinske Toplice, Croatia)

09:00 - 9:15

Mr. Nuno Raposo

Welcome:

Perfusion in Portugal: the Big Picture

09:15 - 9:45

Keynote Speaker:

Mr. Alois Philipp

The Evolution of Rescue: Transport of Critically ill Patients with Extracorporeal Gas Exchange

09:45 - 10:00

Ms. Conny Nielsen

Transportable System: Accidental Hypothermia

10:00 - 10:15

Mr. Bradley Kulat

Optimizing Circuit Design Using a Remote Mounted Perfusion System

10:15 - 10:30

Dr. Emanuela Angeli

New Practice in Pediatric Cardiac Surgery Perfusion: the Experience with Dideco Kids D100 Neonatal Oxygenator

10:30 - 11:00

Dr. Andreas Becker

CAPIOX® FX: A New Generation of Oxygenators

11:00 - 11:30

Coffee Break



Moderators:

Mr. Heinz Weitkemper (Bad Oeynhausen, Germany)

Mr. John Miller (Edmonton, Alberta, Canada)

11:30 - 12:00

Mr. Volker Schmidt

From Stockholm to Lisbon: A two year follow-up of the Dresden EndoVein Harvesting Project

12:00 - 12:15

Dr. Judita Andrejaitiene

Cardiopulmonary Bypass Influence on Intrapulmonary Shunt Value

12:15 - 12:30

Dr. Claus Preusse

An Update of Intraoperative Myocardial Protection

12:30 - 12:45

Mr. Stephen Harwood

Microplegia: Consideration for Best Practice

12:45 - 13:00

Mr. Gábor Szluka

Pharmacotechnological Pitfalls of Priming:

Possible Source of Microembolization during Cardiac Surgery

13:00 - 13:45**Lunch**

Moderators:

Prof. Alexander Wahba (Trondheim, Norway)

Mr. Frank Merkle (Berlin, Germany)

13:45 - 14:00

Mr. Adrian Bauer

MECC - minimized Bypass: more than hemodilution?"

14:00 - 14:20

Dr. Ingo Kutschka

a) Beneficial Effects of Minimized Perfusion Circuits in Aortic Valve and Aortic Root Surgery

b) Minimized Perfusion Circuits for Aortic Valve Replacement in Patients with Severe Liver Cirrhosis

14:20 - 14:35

Mr. Antoine P. Simons

Dynamic Filling Index: A Novel Parameter to Monitor Circulatory Filling During Minimized Extracorporeal Bypass

14:35 - 15:00

Mr. John Mulholland

The IntelliVent - Total miniature cardiopulmonary bypass for all operations and every cardiac team

15:00 - 15:30

Dr. Marco Ranucci

Cardiopulmonary Bypass and Postoperative Outcome: Facts, Dreams and Possibilities

15:30 - 16:00

Coffee Break



Moderators:

Mr. Charlie Grima (G'Mangia, Malta)

Mr. Eddy Overdevest (Eindhoven, Netherlands)

16:00 - 16:15

Ms. Ann Clements

The European Clinical Trial of the CardioPat Split System – Does Post-operative Mediastinal Blood Salvage have a place in Cardiac Surgery?

16:15 - 16:30

Mr. Jeroen W.H. van Hees

The Effect of Peri-operative Plasmapheresis during Cardiac Surgery

16:30 - 17:00

Mr. Christiaan Matheve

Dr. Andreas Koster

Rethinking Blood Conservation Initiative

Nuno Raposo, M.S., ECCP

Chief Perfusionist, Hospital Santa Cruz, Lisbon, Portugal
Co-ordinator of the Cardiopulmonary Technology Program
Portuguese Red Cross Higher School of Health Technologies.

Perfusion in Portugal: the Big Picture

In Portugal, cardiopulmonary bypass (CPB) procedures began in 1967. Since then, this field has developed and grown to meet the needs and demands of cardiac services throughout Portugal. At present there are 7 major centres (> 500 pump cases per year) and 6 minor centres performing cardiac surgery with a total of 41 perfusionists and 3 trainees.

Society name: Portuguese Association of Perfusionists

Webpage: www.apperfusionistas.org

Presentation will discuss briefly:

- the outlook of Portuguese Perfusion over the years, with special relevance to our actual status today.
- statistics on CPB caseload, circulatory assist devices, ECMO and other perfusion related procedures.
- review of the activity of major CPB centres.
- overview of the perfusion education programs

Finally, I will also make a brief presentation on the country itself, looking at its history and major social and economic landmarks.



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Alois Philipp, BS, ECCP

Chief Perfusionist, Cardiovascular Engineering Department,
Department of Cardiothoracic Surgery, University of Regensburg, Germany

“The Evolution of Rescue” Transport of Critically ill Patients with Extracorporeal Gas Exchange

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^b Department of Anaesthesiology, Air medical Service, University Hospital Regensburg

Introduction: Despite advances in mechanical ventilation therapy and critical care, mortality from severe respiratory or cardiopulmonary failure remains high. Transport of patients with severe cardiogenic shock as a result of acute myocardial infarction or unsuccessful cardiological intervention to advanced care referral centre is essential for the patient survival and is also associated with higher risks factors. Another group are patients requiring therapy for refractory acute respiratory distress syndrome (ARDS). Transport of these patients to specialized centres can sometimes only be safely carried out using extracorporeal assist systems, which help to minimize the risk during the unstable phase of transport. System configuration depends on the indication (isolated pulmonary failure versus combined cardiopulmonary failure) according to which a VV-ECMO, VA-ECMO or the arterio-venous pumpless extracorporeal lung assist (AV-PECLA) is necessary.

Methods: Between 10/2000 and 3/2007 PECLA was used in twenty patients suffering from severe ARDS (FiO_2 0.97 ± 0.01 and pCO_2 80 ± 15 mmHg). Between 3/2006 and 4/2008 the new mobile Extracorporeal Life Support system (ELS-System, Maquet Cardiopulmonary, Hechingen, Germany) was used in eighteen patients (Table.1). Four patients were in cardiogenic shock ($\text{MAP} < 60$ mmHg and Norepinephrine ≥ 1.0 $\mu\text{g/kg/min}$). Fourteen patients had both cardiac and pulmonary failure (pO_2/FiO_2 65 ± 14 and Norepinephrine ≥ 0.8 $\mu\text{g/kg/min}$). Percutaneous cannulation using Seldinger technique was performed without problems in all cases.

ELS (Extracorporeal Life Support): For the therapy of acute life-threatening diseases and transport of patients with severe refractory cardiopulmonary failure we developed a mobile hand-held extracorporeal assist system, known as the ELS-System. This is based on the Minimal Extracorporeal Circulation (MECC) system by Maquet and can be employed effectively and safely for transport via helicopter or ambulance. One of the system components is a multifunction carrying device which contains the oxygenator, a Rotaflow pump drive and a two liter oxygen gas cylinder with flow meter (FM 41L: 0-15 l/min, Dräger AG, Lübeck, Germany) as a gas supply for the oxygenator. The weight of the assembled multifunction carrying device is approximately 11 kg. The second component consists of a base plate with shoulder strap for carrying the centrifugal pump control system (16 kg). The complete system can be carried by one person and can be fixed easily to every standard stretcher in the helicopter or intensive care ambulance.

Alois Philipp, BS, ECCP

Chief Perfusionist, Cardiovascular Engineering Department,
Department of Cardiothoracic Surgery, University of Regensburg, Germany

Group	N	Age [years]	Sex m/f	Transport distance [km]	Transport mode air/ground
PECLA (iLA)	20	36 ± 15	17/3	227 ± 161	14/6
VA ECMO	9	51 ± 10	8/1	77 ± 23	7/2
VV ECMO	9	41 ± 20	5/4	105 ± 59	7/2

Table 1: Patient number (n), age, sex, transport distance between outlying hospital and referral centre and transport mode. Twenty-eight patients were transported by helicopter and 10 by intensive care ambulance. Interventional lung assist (iLA)

Results: Transport was uneventful in all cases, no technical problem occurred. In the PECLA-Group the assist time was 5.1 ± 3.0 days. Nine patients (45 %) survived. Patients with VA-ECMO were assisted for 3.9 ± 2.9 days with a hospital mortality rate of 44 %. The supported patients with VV-ECMO had a survival rate of 56 %. Assist time in this group was 7.3 ± 5.8 days. In four patients moderate complications (ischemia of lower limb, bleeding) occurred).

Conclusion: Hospitals lacking highly specialized extracorporeal gas exchange technology and experienced personal are limited in the treatment of these seriously ill patients. Our miniaturized extracorporeal assist system opens up the possibility of a safe interhospital transport to centres of advanced medical care.

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****Alois Philipp: 2008
Recipient of the Innovation Prize
from the Bavarian prime minister,
Dr. Günther Beckstein, for their
transportable Emergency Life
Support (ELS) System.*

Conny Nielsen, ECCP, CCP

Perfusionist, Aalborg Hospital, Denmark

European Board delegate to Denmark and Secretary Accreditation Sub Committee

A Portable System for the Treatment of Accidental Hypothermia

Department of Cardiothoracic surgery, Center of Cardiovascular Research. Aalborg Hospital, Aarhus University Hospital. Denmark.

Hypothermia may be dangerous. It costs 700 lives per year in the United States of America and 300 lives in the United Kingdom. In Denmark, approximately 20 persons die from hypothermia per year, but the numbers are very uncertain.

Denmark is a country surrounded by water, most of the year cold water. Ten years ago we became aware of the need for a mobile system for treating an accidental hypothermic victim. The idea was to make a team capable of turning out to other hospitals bringing the equipment needed to treat the patient in cases where transferral of the patient is considered to risky.

In 1999 we started to develop a mobile ECC system together with the Royal Danish Air Force (RDAF) using pigs as our volunteers. From 2003 we offered a turn out service in a close cooperation with Falck's rescue service and RDAF. In the meantime we developed the system and we described systematic methods for helping the hypothermic patient. Our knowledge is based both on experiences with real patients and with pigs in our laboratory.

Today we have all equipment packed and ready for turn out immediately. The team is a perfusionist and a surgeon. Falck and RDAF make the transportation of the team using ambulances, helicopter or both. We have demonstrated the system for many hospitals in Denmark during lectures and during real episodes.

When reaching the hypothermic patient our first job is to decide the best way to treat him. If ECC is indicated, the surgeon will start with the patient puncturing the femoral artery and vein either percutaneously or after surgical cut down. In the meantime the perfusionist will prime the ECC system, and they can make the cannulation as teamwork. It may now be possible to warm the patient using equipment already available at the hospital or we can transfer the patient, if needed even on ECC.

- The system consists of a Jostra Rotaflow pump, Quadrox Diffusion Membrane Oxygenator and the tubing set is custom-made to reduce the priming volume.

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Optimizing Circuit Design Using a Remote Mounted Perfusion System

There is a considerable amount of literature published on the detrimental effects of banked blood exposure in cardiac surgery. Likewise, in an effort to minimize blood exposure, many of these articles involve modifications to the heart lung machine.

The purpose of this study is to compare blood usage and priming volumes before and after employing a remote mounted perfusion system. Using Terumo's System 1 Advanced Heart/Lung machine, all pump heads were remotely mounted off the pump base closer to the patient. This method also allowed all pump components to be closer together, for example cardioplegia, ultrafiltration unit, vent and cardiotomy lines were now closer to the oxygenator and patient thereby minimizing any excess tubing length. This goal was attained by using the manufacturer's remote mounting plates for the pump heads; however, some creative adaptations were employed for example, modified holders and masts were utilized to mount disposables closely to the remotely mounted circuit.

CPB blood usage and priming volumes in 400 similar weight class patients were then compared before and after changing to a remote mounted perfusion system. Since this remote mounted system was being used in a pediatric institution, there were differences of pump prime and CPB blood usage in four weight classes. One weight class (2-7kg) was eliminated from the study due to tubing size difference not utilized before remote mounting. In all of the weight classes studied, it was documented that by using the remote mounted system blood usage and pump prime were cut considerably. There was reduced CPB blood usage by 40 % and priming volume by 52% in the 8-12kg patients, reduced CPB blood usage by 44% and priming volumes by 43% in the 13-20kg patients, reduced CPB blood usage by 43% and priming volumes by 28% in the 21-40kg patients, and lastly, there was reduced CPB blood usage by 74% and priming volumes by 33% in the 40kg+ patients. In addition, there was a cost analysis of the savings in using less banked blood which showed considerable savings for the hospital.

Weight in Kg.	Blood in units		% Change	Prime in mls.		% Change
	Fixed	Remote		Fixed	Remote	
8-12 kg	1.84 ± 0.55	1.10 ± 0.36	-40	751.2 ± 68.4	360.4 ± 51.70	-52
13-20 kg	1.80 ± 0.42	1.04 ± 0.28	-44	829.6 ± 69.6	476.0 ± 8.14	-43
21-40 kg	1.60 ± 0.57	0.92 ± 0.49	-43	994.0 ± 137.2	713.6 ± 121.80	-28
≥ 41 kg	1.62 ± 0.88	0.42 ± 0.54	-74	1306.3±112.9	875.5 ± 96.60	-33

In **conclusion**, switching to a remote mounted perfusion system not only reduced priming volumes but also sharply decreased the need for banked blood subsequently saving the hospital money and the patients excessive exposure to banked blood.

New Practice in Paediatric Cardiac Perfusion: Experience with Dideco Kids D100 Neonatal Oxygenator

E.Angeli MD, C.Pace Napoleone MD, G.Oppido MD, N.Shekho MD, E.De Toni*, F. Bruzzi*, G.Gargiulo MD. Pediatric Cardiac Surgery Unit, S.Orsola-Malpighi Hospital, University of Bologna, Bologna Italy

Introduction:

Surgical strategy in paediatric cardiac surgery has completely changed in the last years. The reduction of palliative procedures in favour of a definitive correction in the neonatal period led to the increased usage of cardio-pulmonary bypass (CPB) in neonatal surgery. Conventional neonatal CPB requires the use of relatively large volumes of allogeneic blood to prevent unacceptable hemodilution. The reduction of priming volume and surface coatings, are great advances that minimize the impact of CPB on the patient, limiting the adverse effects such as fluid balance and organ dysfunction, systemic inflammatory response syndrome and coagulopathy.

The Dideco Kids D100 (Sorin Group Italia, Mirandola, Italy) is a newly developed hollow fibre membrane oxygenator with characteristics that seem particularly suitable for neonatal patients.

Priming volume is optimized at 31 ml and membrane surface area is 0.22m².

Maximum blood flow rate is 700ml /min and this leads to a spectrum of utilization for patients up to 5 kg weights.

Material and methods:

Since March 2007 we used Dideco Kids D100 to treat 35 patients with a mean age of 40 ± 55 days (min. 4-max 251days) and with a mean weight of 3.35 ± 1 kg.

We routinely used a phosphorylcholine-coated circuit with 3/16" calibre in the arterial line and 1/4" in the venous line, and dedicated arterial filter Dideco Kids D130 with a priming volume of 16ml.

The priming volume was prepared with blood, plasma and 14% bicarbonate. The mean volume of priming was 217 ± 27ml, prepared with 70 ± 24ml blood, 109 ± 36ml plasma and 46 ± 11 ml of 14% bicarbonate.

All the operations were performed under moderate hypothermia, with a mean temperature during CPB of 28.5 ± 2.1C°.

The mean CPB time was 113± 41minutes.

Continuous blood gas measurement was obtained with the Terumo CDI500 monitoring system (Terumo, Ann Arbor, MI).

In the cooling period we maintained a mean value of hematocrit of 29.2 ± 2.4 .

During rewarming period of CPB the hematocrit was maintained at a mean value of 32.9 ± 2.9 %.

In the same period, a group of 35 patients with similar characteristics underwent CPB operation with Dideco D901 Lilliput 1 oxygenator (Sorin Group Italia, Mirandola, Italy). A Capiiox Cx-BT05 arterial filter was used with a priming volume of 40 ml. The priming volume was prepared with blood, plasma and bicarbonates.

The Dideco D901 Lilliput 1 oxygenator required a mean priming volume of 402 ± 53 ml, with 180 ± 27 ml blood, 160 ± 42 ml plasma and 62 ± 4 ml of 14% bicarbonate.

All patients received continuous ultrafiltration with a Jostra BC20 plus blood concentrator filter (Bioline Jostra AG, Hirrlingen, Germany).

Results:

The data regarding CPB settings and conduction of the two groups were retrospectively compared.

The priming volume used in the Kids group resulted significantly lower than that used in the D901 Lilliput 1 (217 ± 27 ml vs. 402 ± 53 ml).

The analysis of priming component showed that a significantly smaller amount of blood was used in the Kids D100 group (99 ± 41 ml vs. 183 ± 24 ml).

During the CPB a smaller amount of blood was used in the Kids D100 group (98 ± 73 ml vs. 150 ± 91 ml).

Conclusion:

The Dideco Kids D100 oxygenator revealed to be very effective in reducing blood usage in neonatal CPB. Its biocompatibility is improved from the reduction of membrane surface area and from the coating of all the blood contact surfaces.

We reduced the degree of hemodilution and the amount of exogenous blood transfusions that is the goal in the conduct of the CPB in neonates. Other possible favourable effects of this perfusion strategy may be the reduction of the incidence of transfusion reaction and infection, as well as the decrease in severity of perioperative inflammation.

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Dr. Andreas Becker, PhD

European Marketing Manager Perfusion, Terumo-Europe, Leuven, Belgium

Capiox FX: A New Generation of Oxygenators

The reduction of priming volume is a constant goal in the development of products for extracorporeal perfusion. Especially in neonates and infants, the priming volume of the perfusion circuit causes significant hemodilution resulting in greater need for blood transfusion. Both hemodilution and blood transfusion induce inflammatory response and increase myocardial and pulmonary dysfunction.

To further reduce these adverse effects of extracorporeal perfusion, Terumo has developed a new generation of oxygenators, the Capiox FX series.

FX oxygenators feature an integrated arterial filter and offer significantly reduced priming volume and foreign surface area compared to a set up with oxygenator and a separate arterial filter.

The reduction in priming volume was achieved by incorporating the filter membrane into the oxygenator housing surrounding the hollow fiber bundle. This design does not increase the priming volume and pressure drop of the oxygenator and does not affect the gas and heat exchange performance of the oxygenator. Furthermore, the filter foreign surface area is significantly reduced because no separate housing is used; yet the active filter area is similar to stand-alone arterial filters.

Unlike conventional arterial filters, FX oxygenators eliminate air via the inner lumen of the hollow fibers and through the gas outlet of the oxygenator. This patented self-venting technology allows easier priming and de-airing, while particulate and gaseous emboli are trapped or removed as effectively as with a separate arterial filter.

An FX oxygenator for neonates and infants with 0.5 m² fiber surface area will be introduced first since the new technology is particularly beneficial for small patients. A mid-size FX oxygenator with 1.5 m² for pediatric and small adult patients and an adult version with 2.5 m² will follow in the near future.

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CAPIOX® FX05 Oxygenator

Pediatric oxygenator with integrated arterial filter



- *Integrated arterial filter with no additional priming volume*
- *Self-venting technology*
- *Less foreign surface area, lower pressure drop**

*Compared to CAPIOX® FX05 oxygenator plus stand alone arterial filter

www.terumo-europe.com

Volker Schmidt, Chief Perfusionist
Department of Cardiac Surgery, Heart Centre Dresden, Germany

From Stockholm to Lisbon: A two year follow-up of the Dresden EndoVein Harvesting Project

Volker Schmidt, Chief Perfusionist, Department of Cardiac Surgery,
B.B. Scholz, (Dipl.Ing.), H.Raziq (MD), O. Allham (MD), K.Matschke (MD)
Heart Center Dresden University Hospital Dresden, Germany

Background:

Perfusionists in Germany today are dealing with some of the following situations:

- There are very good training and education possibilities – but no official government legalization to work as a perfusionist
- There are over 500 members in the German Society for Cardiovascular Engineering – but no consensus for educational programs
- A growing number of hospital groups, where people work for less money – especially when “training on the job” is possible
- Off-pump-procedures in many cases are the daily routine where perfusionists are only in “standby”
- More hospitals are beginning with endovascular valve replacements that require a co-operation with the cardiologists
- The health care system in Germany is changing rapidly as hospitals are forced to save money reducing their staff costs leading to flexible work hours and necessitating employees to have variable, so called multitasking abilities

Our Solution: In our cardiac center we started with Endoscopic Vein Harvesting (EVH) 3.5 years ago that was part establishing a surgical assistance program within the perfusion department.

EVH is not a very new technique but new in the approach in which hospitals are evolving with the change in practice.

Two years ago we presented our primary results at the 6th European Conference on Perfusion Education held in Stockholm on “Training Endoscopic Vessel Harvesting - the Perfusionist’s Point of View”. We were able to show a relatively rapid learning curve with a specific training concept. This included a senior surgeon sponsored by Guidant with their Vasoview 4 system. The first few days of training started with an artificial leg, and after two weeks – and every day two cases – we were able to do the procedures on our own.

To date; the Surgical assistance program is more and more accepted with almost 500 EVH completed procedures.

A new system is now introduced, the Vasoview 6 system from Maquet. We will present our data comparing the advantageous of this new system.

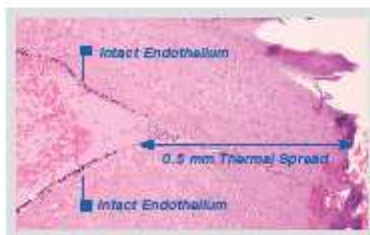
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MAQUET

MAQUET

VASOVIEW HEMOPRO OPTIMIZES CONDUIT QUALITY

CARDIOVASCULAR



Minimize Thermal Spread: Precise thermostatic action ensures hemostasis yet has minimal thermal effect on surrounding tissues.¹

1. Data on file, MAQUET Cardiovascular; 2006.

Refer to the Instructions for Use (IFU) for detailed information on device description, instructions, contraindications, warnings, and precautions.

Minimize thermal spread with the simultaneous cut-and-seal action of the VASOVIEW™ HemoPro™ Endoscopic Vessel Harvesting System. The unique thermostatic tip maximizes hemostasis with minimal thermal effect on surrounding tissues. Sensitive fingertip controls allow confident maneuverability. VASOVIEW HemoPro is the most advanced EVH system currently offered by MAQUET. With 800,000 procedures performed to date, VASOVIEW has helped make minimally invasive vessel harvesting the standard of care.

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Cardiopulmonary Bypass influence on Intrapulmonary Shunt Value

Judita Andrejaitiene, Edmundas Sirvinskas. Institute for Biomedical Research Kaunas
University of Medicine, Kaunas, Lithuania

Objectives:

The aim of the study was to determine the influence of CPB on pulmonary function by evaluating intrapulmonary shunt in early postoperative period.

Methods:

We have analysed the data of 90 patients who had undergone coronary artery bypass graph (CABG) surgery. There were 49 patients in Group I, who underwent CABG on CPB and 41 patients in Group II, who underwent CABG without CPB. Intrapulmonary shunt (Qs/Qt) was calculated in 20 minutes after the induction and after 4 hours from the end of surgery. Statistical significance was accepted at a level of $p < 0.05$.

Results:

The volume balance during the surgical procedure was significantly more in Group I than Group II (1754.54 ± 1006.09 vs. 195 ± 170 mL, after 24 hours postoperatively 954.54 ± 567.37 vs. 188.89 ± 79.67 mL. Patients in the Group I had shown significantly more affects by chest X-ray than Group II: atelectasis was revealed 81.8% vs. 20%. Arterial hypoxemia was specific cause to pulmonary dysfunction in both groups 37.3% vs. 20%. Qs/Qt baseline significantly increased after 4 hours from the end of surgery in the Group I: from 8.64 ± 5.22 to $16.85 \pm 8.26\%$. The difference of Qs/Qt between the groups was significant after 4 hours from the end of surgery (16.85 ± 8.26 vs. $6.8 \pm 2.1\%$), there was a higher number of atelectasis diagnosed by chest X-ray and arterial hypoxemia. Length of postoperative hospital stay in patients after on-pump CABG surgery was longer than II days (16.4 ± 4.3 vs. 7.3 ± 2.6 days).

Conclusions:

Our data suggest that pulmonary dysfunction is more common after on-pump CABG surgery, when patients establish atelectasis, which leads to arterial hypoxemia and increases intrapulmonary shunt fraction.

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Dr. Claus J. Preusse, M.D.

Anesthesiologist, University of Bonn, Germany

An Update of Intraoperative Myocardial Protection

Increased morbidity of cardiac patients due to older age and changes in cardiosurgical techniques, demand optimized intraoperative myocardial protection.

Today crystalloid and blood based cardioplegic solutions are routinely used world wide. However, nearly all cardioplegia solutions must be re-administered every 15 to 30 minutes to keep the myocardium cold. Particularly in complex procedures and in mitral reconstructions cardioplegia reperfusion is often time-consuming and laborious. Even with the use of retrograde cardioplegia, the risk of inadequate perfusion to the right ventricle is well known. Retrograde cardioplegia catheters may be malpositioned and there is an increased risk of coronary sinus injury.

Considering all risk factors of ante- and retrograde cardioplegia delivery, it may be concluded, that one single, initial cardioplegia perfusion without mandatory reperfusion(s) would be optimum. Therefore the question rises; why are cardioplegia reperfusions necessary?

It has been thought for a long time that myocardial energy charge potential is the most significant limiting factor during ischemia. But it has been recently shown that energy charge potential is not as important as the degree of myocardial acidosis. To reduce the sequelae of an acidotic injury, either the cardioplegia solution is readministered at regular intervals or a highly buffered cardioplegia solution is applied. Additionally, myocardial temperature will no longer be significant even with long aortic clamp times.

High buffer concentrations can only be added to the intracellular type of cardioplegia solutions (low sodium) without exceeding the physiological limit of osmolarity.

Furthermore, the choice of buffer substances distinctly influence the protective power of the solution that will be used.

Experimental and clinical results will be presented that demonstrate the progress that has been achieved over the last decades.

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Stephen Harwood, CCP, CPC, BA

Manager, Cardiopulmonary Specialties, Coordinator, Mechanical Circulatory Support,
Toronto General Hospital, Toronto, Ontario, Canada

“Microplegia” – Consideration for Best Practice

There are a variety of perioperative techniques aimed at protecting the myocardium (mild hypothermia, inhaled anesthetic agents during CPB), but one of the most common and effective techniques is that of cardioplegia. This is the injection of a temperature controlled, hyperkalemic solution that produces a prolonged diastolic arrest, reduces metabolic requirements of the heart, as well as providing nutrients to the resting myocardium. Regardless of the actual solution utilized, and there are many different crystalloid based solutions currently available, the goal remains the same.

During CPB and cardioplegia delivery, the heart is flaccid and quiet, and as such, it is easy to make the mistake of assuming it is protected during this time. Interestingly, and of concern, more than 65% deaths following cardiac surgery are attributed to cardiac failure, and this can be directly related to poor or incomplete protection of the myocardium intraoperatively. Recent studies further illustrate that hearts may not be as well protected during surgery as we initially thought. The GUARDIAN trial showed that 20% of patients undergoing cardiac surgery had CPK-MB 5 to 10 time's normal post operatively. The ARTS trial showed similar results in 60% of that patient group. These types of data make a compelling argument to re-evaluate how we protect the myocardium, and improve our patient outcomes. This is especially important as the adequacy of protection is only assessed *after the fact*.

Myocardial edema is a particularly deleterious effect that can result from hemodilution caused by both cardiopulmonary bypass as well as cardioplegia that is further diluted with a crystalloid base. Hypothermia & ischemic stresses compromise the normal myocardial cell membrane, particularly its ability to remain physiologically stable. Introducing large amounts of dilute cardioplegia in this setting results in myocardial edema. It has been shown repeatedly that even small changes in myocardial water content are associated with substantial changes in LV geometry, and subsequent diminished LV function and even cellular apoptosis. The platform for our cardioplegic administration (Quest MPS) allows for the delivery of whole blood from the CPB circuit, and the direct addition of drugs to this blood, avoiding any additional crystalloid, and thereby reducing the harmful effects seen with myocardial edema. This is known as '*microplegia*'

Myocardial protection has evolved considerably over the life of cardiac surgery. Our Institution has found Microplegia to be of great advantage to our patient group. The incidence of arrhythmias is decreased, and functional recovery appears improved over our past cardioplegic interventions.

The Quest MPS is an ideal platform for the adoption of Microplegia with specific substrate addition. It is easy to use, offers complete control over all parameters, and provides the flexibility that is paramount in the clinician's attempts to align cardioplegic intervention to specific underlying patient conditions. Cardioplegia is no longer a “one size fits all” approach, but rather a clearly defined strategy which complements other myocardial protection strategies, and the surgical procedure in general.



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Pharmacotechnological Pitfalls of Priming:**Possible Source of Microembolization during Cardiac Surgery**

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In spite of low mortality and morbidity rates of cardiac surgery, cognitive dysfunction associated with cardiopulmonary bypass (CPB) became important according to medical and social expectations. Short-term cognitive impairment is observed in more than 50 % of patients. The possible reasons are cerebral hypoperfusion, micro- and macroembolisation, systemic inflammatory response, and metabolic disorders. Recent interest in the prevention of systemic embolization related to cardiac surgery has led us to study the prime as a source of microembolization.

The aim of this investigation is the analysis of the priming solution as determined by the crystallogenesis as a function of composition, pH, temperature and storage, inspired by our observation that the prime sometimes becomes opalescent on pre-bypass circulation. Lactated Ringer and Ringerfundin based prime solutions were tested adding Mannitol B, NaHCO₃, Heparin and Trasylol in the operating room. The oxygenator is blown through with compressed medical air. Samples were taken for analysis with Malvern Zeta-Sizer by dynamic light scattering: opalescent solutions contained 100-4800 nm while clear solutions contained 20-473 nm particles. The priming was modelled in the laboratory by mixing the components and then blowing the mixture through by compressed air (0.1 bar, 10 minutes).

Continuous pH measurement showed pH ranges from 6.4-7.4 after mixing the prime components together. With the addition of gas flow the pH increased to 7.2-8.0, followed by opalescence with lactated Ringer based prime.

The pH of the prime may be stabilized by the addition of ascorbic acid (100-200 mg/ml), and also the opalescence may be prevented. Ringerfundin showed no opalescence, and has a stable pH for 3 hours but not at 72 hours, when it shifted to pH 8.07-9.62 depending on temperature (15-35 °C).

Therefore the proposed apothecary preparation and storage of the priming solution is not feasible. Blowing air through the lactated Ringer based prime after blending is not allowable because its pH alkalizes and opalescence, crystallogenesis begins. Ascorbic acid stabilizes the pH and prevents crystallogenesis. Pre-bypass filtration (200 nm) is recommended.

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MECC – Minimized Bypass: more than Hemodilution?

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Background: The use of minimized extracorporeal circulation (MECC) is an established procedure to perform coronary revascularisation. Some studies showed positive effects of MECC compared to conventional cardiopulmonary bypass (CCPB) procedures in terms of transfusion requirements, less inflammation reactions and neurological impairments (1-4). According to a retrospective data analysis, a higher mean arterial pressure (MAP) and a lower frequency of vasoactive drug administration in MECC-patients compared to CCPB-patients was found by Wiesenack et al.(1).

Retrospective data analysis done by our workgroup found very similar results in terms of higher MAPs and less norepinephrine consumption. This current study addressed this observation in more detail with particular attention on major organ systems.

Material and Methods: This was a prospective, controlled, randomized trial with 40 patients (assigned to a MECC and CCPB group) undergoing coronary bypass grafting. (minimized system: MECCTM Maquet with venous bubble trap and arterial filter QuartTM, conventional Bypass: same oxygenator [QuadroxTM] rollerpump and open venous reservoir) Primary endpoints were the peri-operative course of mean arterial pressure, system vascular resistance and the consumption of norepinephrine. Secondary endpoints were the measurement of regional oxygen saturation of cerebral and renal tissue as an assessment of the perfusion at these areas. Furthermore blood samples during the peri- and postoperative course were collected to determine the injury on the major organ systems in both groups.

Both, CCPB and MECC were performed at normothermia. Cardiac arrest was achieved with antegrade administration of Calafiore's cardioplegia. MECC provided a completely empty heart for CABG surgery during cardiac arrest.

Results: Eighteen patients were randomized to group 1 (MECC) and 22 patients to group 2 (CCPB). Clinical and demographic characteristics did not differ significantly between the groups under consideration of age, body surface area, and left ventricular function. Thirty-day mortality was 0%.

MAP and Vasopressor consumption: At four of five time points during extracorporeal circulation (ECC) the MAP values were significantly higher in the MECC group compared to CCPB patients (highest differences occurred after starting the ECC 60 mmHg \pm 11 vs. 48 mmHg \pm 10 p=0.002). MECC patients received significantly less norepinephrine (MECC after start ECC: MECC 0.56 μ g \pm 1.6 vs. CCPB 5.2 μ g \pm 9 p=0.038). The lactate dehydrogenase increased significantly in the CCPB group. (T2: 1h post ECC 3.6 \pm 0.8 vs. 2.1 \pm 0.5 <0.001; T3: 24 h p.o. 3,6 \pm 0.6 vs. 3.0 \pm 0,6 p=0.016).

Regional saturation: The rSO₂ measured at right and left forehead and the renal area (dorsal lateral) was similar for both groups during ECC and significantly higher in the CCPB Group, one and four hours after termination of ECC.

Brain: Cerebral injury assessed by S100 and neuronal specific enolase release was significantly better in MECC patients, one hour after ECC compared with CCPB group (S100: 0.56 µg/l ±0.31 vs. 1.27 µg/l ± 0.85 p=0.02, NSE: 9 µg/l ±4.6 vs. 19 µg/l ±9 p<0.001).

Renal: Renal function estimated by the calculation of glomerular filtration rate did not show significant differences between both groups.

Heart: Significant higher values in the CCPB group were observed for serum CK-MB and troponin T one hour after ECC conclusion, (CK-MB - MECC 0.38 µmol/l ±0.1 vs. CCPB 0.66 µmol/l ±.21 p<0.001 and for troponin T MECC 0.08 µmol/l ±0.05 vs. CCPB 0.22 µmol/l ±0.15 p<0.001).

Blood: The hematocrit decreased by 70 % from baseline in the CCPB and by 80 % in the MECC group. The peri-operative transfusion requirement was lower in the MECC group peri-operatively and up to 8 days post-operatively (MECC 8/18 vs. CCPB 14/22 p=0.56).

Liver: The laboratory values (GPT, GGT, GOT) for liver function and coagulation parameter (PTT, Quick; INR; Fibrinogen; ATIII; Factor XIII) were similar for both groups.

Inflammation: C-reactive protein, procalcitonin and Interleukin-6 did not differ between both groups, but the serum level for the tumor necrosis factor alpha peaked one hour after ECC in the CCPB group (MECC 11.6±6 ng/l vs. CCPB 40.9 ng/l ±57 p=0.029).

Conclusion: The results of our study support the theory that MECC procedures provide a higher mean arterial pressure during ECC. A critical issue still remains the interpretation of MAP in context with vasopressor administration. However, with respect to major organ injury, particularly heart and brain, our results indicate positive effects of MECC and promising advantages seem to be existent.

In our opinion the use of MECC is less harmful to the major organ systems and very easy to perform. Further investigations considering hemodynamic effects of MECC remain to be elucidated.

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Beneficial Effects of Minimized Perfusion Circuits in Aortic Valve and Aortic Root Surgery

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Objectives:

Minimized perfusion circuits (MPC) were found to reduce side effects of standard extracorporeal circulation (ECC). We evaluated the safety and efficacy of the ROCsafe™-MPC for aortic valve- and aortic root surgery.

Methods:

170 patients were randomized for surgery using either MPC [n=85, 30 female/55 male, mean age: 69.8±11.8 years, AVR: n=40, AVR+CABG: n=31, David operation: n=3, aortic root replacement (ARR): n=11] or ECC [n=85, 29 female/56 male, mean age: 67.7±9.5 years, AVR: n=39, AVR+CABG: n=35, David operation: n=2, ARR: n=9]. Neurological status, length of ICU-stay, C-reactive-protein (CRP), blood count, transfusion requirements and bleeding volume were analyzed.

The MPC system provided ultrasound controlled deairing. A small roller pump and a flexible reservoir were used for LV-venting. As a control we used a standard ECC with cardiomy suction and hard shell reservoir.

Results:

Cross clamp time (MPC: 76.5±29.5; ECC: 79.0±34.0 min) and bypass time (MPC: 103.0±37.9; ECC: 106.9±44.9 min) were comparable between groups. Transfusion requirements (Red blood cells: MPC: 1.5±1.5 vs. ECC: 2.2±2.1 units [p=0.05], frozen plasma: MPC: 1.2±1.8 vs. ECC: 1.9±2.4 units [p=0.03]), postoperative bleeding (MPC: 521±283 vs. ECC: 615±326 ml/24h, p=0.09) were lower using MPC. ICU-stay was shorter with MPC (1.6±1.6 days) compared to ECC (2.4±2.8 days, p=0.001). One stroke occurred in each group. Postoperative psychosyndromes were reduced with MPC (n=7) compared to ECC (n=14).

Conclusions:

The ROCsafe™-MPC provides safe circulatory support for a wide range of aortic valve surgery. Transfusion requirements, postoperative bleeding and length of ICU-stay were markedly reduced compared to standard extracorporeal perfusion.

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Minimized Perfusion Circuits for Aortic Valve Replacement in Patients with Severe Liver Cirrhosis

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Background: Cardiopulmonary bypass is associated with severe complications and high mortality in patients with severe liver cirrhosis (>50%) (Child B/C). Therefore coronary surgery should be performed with off pump techniques. If valve surgery is required, the use of minimized perfusion circuits (MPC) might have some advantages compared to conventional bypass systems.

Methods and Patients:

We used MPC for aortic valve surgery in 2 patients (male, both 59 years old). Patient 1 had a severe aortic valve insufficiency based on an endocarditis 6 months before. He suffered from liver cirrhosis CHILD C, renal failure and ascites, which required daily drainage.

Patient 2 had severe aortic valve stenosis and coronary artery disease. He underwent CABG in 2003 with still sufficient bypass grafts. He had severe pulmonary artery hypertension, left heart failure, renal insufficiency and liver cirrhosis CHILD B. He recovered from acute liver and renal failure 10 months before. Both patients had been considered for liver transplantation before. We used the ROCsafe™ MPC (Terumo) with pulsatile flow, normothermic conditions and Calafiore cardioplegia for extracorporeal bypass during aortic valve replacement. Both patients received biological valves. To reduce the risk of peritonitis, selective bowel decontamination was done 2 days before surgery.

Results:

Pat. 1: The postoperative course was uneventful (Extubation on day 1, ICU stay 3 days, total hospital stay 18 days). Ascites drainage was required daily in ICU and then weekly. Transfusion requirements were moderate (12 FFP, 2 PRB). After complete cardiac recovery (6 weeks postoperative) further ascites drainage was unnecessary.

Pat. 2: Recovery was normal (Extubation on day 1, ICU stay 1 day, total hospital stay 14 days). Ascites drainage was only required on day 1 and 2 postoperatively. Transfusion requirements were moderate (4 FFP, 5 PRB, 4 units platelets).

Renal and liver function remained stable in both patients. Inflammatory parameters (leucocytes, CRP) showed a normal postoperative course. Administration of noradrenalin was necessary on ICU to compensate initially low vascular resistance.

Conclusion:

We observed a favourable postoperative course in two multi-morbid patients with aortic valve disease and severe liver cirrhosis, which underwent aortic valve replacement using a minimized perfusion circuit. Liver failure improved with cardiac recovery. MPC might help to reduce bleeding and perioperative inflammation in these high risk patients with markedly impaired liver function.

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Dynamic Filling Index: A Novel Parameter to Monitor Circulatory Filling During Minimized Extracorporeal Bypass

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Objective:

To evaluate the dynamic filling index, a novel parameter to monitor changes in intravascular volume, in patients on minimized extracorporeal circulatory bypass (MECC).

Rationale:

MECC systems are used in acute and post-cardiotomy cardiac failure, high-risk percutaneous interventions, and respiratory failure. Generally, MEC systems lack volume buffering capacity, demanding tight control of drainable intravascular volume (IVV) to maintain bypass flow. Therefore, quantitative assessment and monitoring of drainable IVV are crucial in managing patients on MEC.

Measurements and main results:

Seven patients (age 64 ± 8 years, weight 82 ± 14 kg) underwent MEC-supported coronary artery bypass surgery. We utilized the luxation of the heart to induce a reduction in drainable IVV. The MEC system incorporated a centrifugal pump of which the pump speed was transiently and periodically reduced to monitor resultant changes in bypass flow. The DFI, a measure of drainable IVV, was calculated as $\Delta\text{bypass flow}/\Delta\text{pump speed}$ (1). Routinely recorded parameters included pump inlet and arterial line pressures, and bypass flow.

With luxation of the heart, the DFI was significantly reduced (-0.4 ml/rotation, $p=0.001$). In contrast, bypass flow, pump inlet pressure and arterial line pressure did not change significantly (Table 1), suggesting the ability of this parameter to monitor drainable IVV in patients.

Table 1

		luxation	no luxation	*p-value
		mean \pm SD	mean \pm SD	
bypass flow	l/min	4.72 ± 0.37	4.64 ± 0.38	0.503
pump speed	rpm	3031 ± 172	3071 ± 142	0.232
DFI	ml/rotation	2.0 ± 0.2	2.4 ± 0.2	0.001
pump inlet pressure	mmHg	-49 ± 9	-50 ± 11	0.845
arterial line pressure	mmHg	155 ± 12	161 ± 14	0.147

Values represent mean \pm standard deviation over 7 patients.

*Luxation compared to no luxation; paired Student t-test.

Conclusion:

The dynamic filling index can detect small changes in drainable IVV which remained unrevealed by routinely recorded parameters. The dynamic filling index could be a valuable tool to monitor and control circulatory filling in MEC-supported patients.

Reference :

1) Artificial Organs, Vol. 31, No. 2, 2007, pp. 154-159

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The IntelliVent - Total Miniature Cardiopulmonary Bypass for all Operations and Every Cardiac Team

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Over the past four years miniature bypass has grown in stature but it is still considered a 'niche' technology. Reports in the literature involve many different systems and an enormous variation in its utilisation and results. This said, two recurring themes are evident:

- Perfusion management of this technology is integral to its success.
- The technique is not regularly used for open chamber operations.

These two points are intrinsically linked. Good perfusion management of any MCPB system involves understanding the strengths of MCPB, how to maximise these strengths and how the system interacts with the patient. Literature review reveals that research teams who demonstrate good perfusion management of the system yield good results and vice versa.

One of the key differences identified by our Perfusion team between conventional and miniature bypass is the management of "vent" blood, especially during open chamber surgery. During conventional CPB this is poorly managed by the circuit, with excessive air exposure and the safety net of a large non-specific systemic circulating volume. With miniature systems, air must be manually removed by the Perfusionist. The Perfusionists "vent" management must also balance the loss of volume via the "vent" from an accurate systemic circulating volume (1932 ± 391 ml per case over 50 open chamber case). This is a time consuming and distracting task, that whilst manageable in the straightforward case can introduce a risk during more complex surgery. At our institution the only "difficult" cases are operations where there is a large amount of vent blood to manage. This is the principle reason that miniature bypass is still considered a 'niche' technology.

Total Miniaturized Cardiopulmonary Bypass (tMCPB) involves all the generic attributes of MCPB combined with a reduced surface area, good perfusion management and the IntelliVent Automatic Venting System. The presentation gives an overview of our multi-disciplinary experience of tMCPB with a focus on the IntelliVent system - designed and tested at the Hammersmith Hospital.

The IntelliVent (figure 1) reduces non-physiological surface exposure (0.07m^2 reduction), manages vent blood with a minimum air interface ($9.11 \times 10^{-5}\text{m}^2$), automatically removes vent entrained air and automatically replaces the volume to the systemic circulation. Our principle finding during the first 20 cases was that the system assumes some of the increased management responsibility that tMCPB puts upon the Perfusionist. This allows them to focus on other aspects of the heart and lung support, essential during open chamber or complex surgery.

It is the opinion of our Cardiac team that the IntelliVent evolves miniature CPB beyond a 'niche' technology to a technique applicable for all operations and every cardiac team.

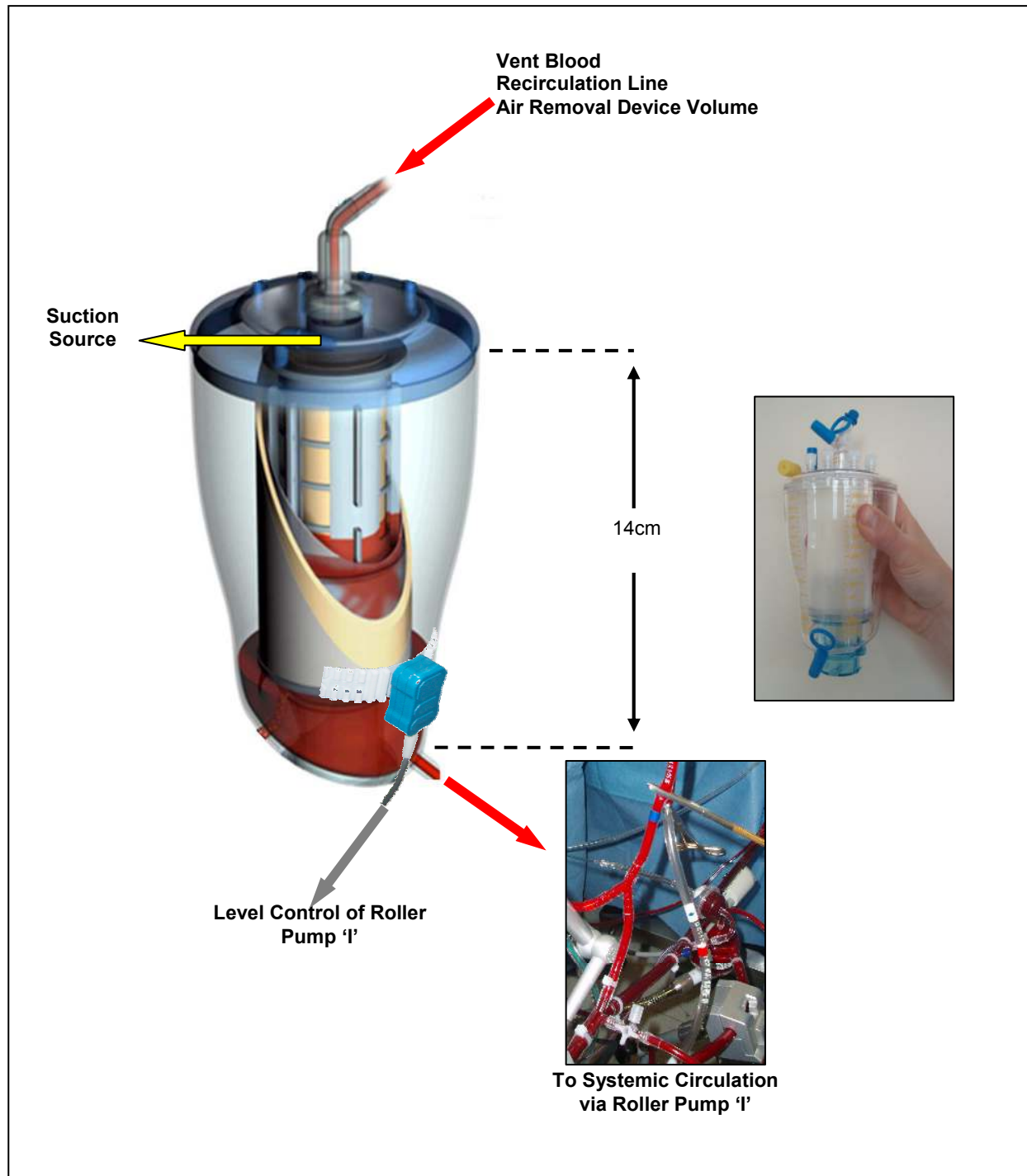


Figure 1 – The IntelliVent

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Cardiopulmonary Bypass and Postoperative Outcome: Facts, Dreams and Possibilities

For many years cardiopulmonary bypass (CPB) has been considered one of the main determinants of postoperative complications in cardiac surgery. Many aspects of CPB may lead to adverse reactions: the inflammatory response to foreign materials; the adhesion of proteins and cells to the surface of the circuit; the activation of the hemostatic system; the exhaustion of the natural properties of the endothelium, and others.

Actually, it is still unclear to which extent the above mentioned mechanisms contribute in determining the postoperative complications; and certainly other non-CPB mediated mechanisms may have a crucial role. As a matter of fact, it is still debated if the off-pump coronary revascularization technique may really improve the early postoperative outcome, and recent data suggest that the benefits may be limited to a lower transfusion rate (1), and that the need for subsequent revascularization is higher in patients treated with off-pump vs. on-pump techniques (1,2).

One information that is constantly found in almost all the relevant literature, is that CPB duration is an independent risk factor for morbidity and mortality. From our Institutional data base, a CPB duration higher than 80 minutes is predictive for mortality with a sensitivity of 61% and a specificity of 70%. However, very little information is available, with respect to the exact mechanisms leading to CPB-associated morbidity and mortality. Many attempts have been done to limit the deleterious effects of CPB. However, the results have been often disappointing. Improving the biocompatibility of the CPB circuit through heparin-coating has provided limited beneficial effects, as observed in a recent meta-analysis (3), and the new-generations of biocompatible treatments seem to offer little advantages.

In recent years, some new information became available with respect to the possible role of CPB as a risk factor. Many Authors (4-8) could demonstrate that severe hemodilution during CPB is accompanied by increased morbidity and mortality. Recent data suggest that the reason is a low oxygen delivery, and that by maintaining high pump flows, hemodilution may be sufficiently compensated (9,10).

Another important observation is that hyperlactatemia during or early after CPB is predictive for bad outcome (11,12), although it is not yet totally established through which mechanism. However, a low oxygen delivery during CPB is still one of the the main determinants of hyperlactatemia (13).

Recently, the use of a comprehensive strategy, inclusive of biocompatible surfaces, low priming volume, separation of blood suction from the surgical field, and centrifugal pumps, has been proposed as a “minimally invasive” CPB. The results of this approach seems encouraging in terms of morbidity reduction, but still without impact on mortality (15-18).

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The Effect of Peri-operative Plasmapheresis during Cardiac Surgery

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Background:

Patients undergoing cardiopulmonary bypass (CPB) are at risk for haemostatic changes such as structural and biochemical alterations of platelets. In prolonged CPB times, this might lead to an increased risk of post-operative bleeding and transfusion of allogeneic blood components. In order to minimize the haemostatic disorders, peri-operative plasmapheresis can be effective. This prospective randomized study was performed to determine whether patients with a minimum CPB duration of 120 minutes might benefit from peri-operative plasmapheresis prior to CPB.

Methods:

The predonated whole blood was sequestered into platelet-poor plasma (PPP), platelet-rich plasma (PRP) and erythrocyte-concentrate (ERY). After heparin reversal with protamin to baseline ACT-value, PPP was reinfused followed by PRP

Haemostatic changes in coagulation screens and viscoelastic whole blood monitoring were performed with thromboelastography (TEG). During five specific intervals (baseline, pre-heparin, post-protamine, 1-hour and 4-hours post-CPB) platelet count, fibrinogen, D-dimers, thrombin time, and TEG-parameters (R-time, K-time, angle, MA (tissue-factor, tissue factor/abciximab and LY30)) were measured.

Results:

Seventeen patients had $21.4 \pm 1.8\%$ of their circulating blood volume predonated in citrate prior to heparinization and yielded a mean platelet count of $174 \pm 56 \times 10^9/\text{liter}$ per patient. The control group, not exposed to the plasmapheresis procedure consisted of twenty patients. There were no significant differences between treatment and control patients with regard to pre- and peri-operative CPB and surgical parameters. The treatment group had a significantly improved platelet function, qualified by TEG-measurement, four hours post-CPB ($P=0.04$) compared to the control group.

Conclusion:

The use of peri-operative plasmapheresis is a technique to improve platelet function post-CPB.

Keywords: Plasmapheresis, Thromboelastography, Platelets, Cardiac Surgery

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The European Clinical Trial of the CardioPat Split System – Does Post-operative Mediastinal Blood Salvage have a place in Cardiac Surgery?

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Purpose: Peri-operative mechanical blood conservation is a well established technique for collecting, processing and returning the patients own blood during cardiac surgery. Despite the success of this technique for reducing the requirement for donor blood, it remains underused during the post-operative period. The aim of the first clinical trial in Europe was to use an audit of practice to examine the safety, applicability and cost effectiveness of the CardioPat Split System (CPSS) within the post-operative environment.

Description: The CardioPat is a mechanical cell salvage device designed specifically for the post-operative period. Until now the cost of the CardioPat integrated system (including a collection reservoir and integrated wash kit) has limited its use to patients that are identified as having a high risk of bleeding post-op. Accurately indentifying these high risk patients is difficult due to the multiple variables involved. As a result, patients who do bleed can be missed and patients who do receive the technology may not bleed enough. The CardioPat Split System (CPSS) was designed with a separate, more cost effective reservoir and a wash kit that can be incorporated if the patient bleeds (figure 1).

Evaluation: As well as looking at safety and the application of the technology, we focused on identifying the ‘trigger volume’ to clinically and financially justify the use of the more expensive component, the dynamic wash kit. Three patient specific trigger volumes were assessed using equation 1, (608g, 486g and 365g of haemoglobin - 15 patients in each group) with regard to the volume of processed autologous blood returned to the patient and the effect of this processed blood on the patients haemoglobin. The CPSS was also assessed from both a donor blood transfusion and a financial perspective.

Results: As a drain the CardioPat is a safer and more effective mediastinal drainage system than convention under water drains. This is due to the following design modifications:

- The active monitoring of air leak rate.
- The 2-way pressure release valve.
- The one way valve on the chest drain line prevented retrograde contamination.
- The integrated suction source and battery back-up facilitates continuous suction during patient transfer, reducing the risk of blood collection and removing this phenomenon from the decision making process if the patient is bleeding.
- The graphical trend display of mediastinal blood loss with total volume spilt.

In terms of cell salvage, the device was invaluable in the bleeding patient. The optimum patient specific trigger volume was 486g of haemoglobin. The cost effectiveness of the split system allowed us to offer the technology to all patients. This combined with the use of the patient specific trigger volume meant that no bleeding patients were missed in this group. The impact of CardioPat blood on the patients circulating Hb was similar to a unit of donor red cells ($0.64 \pm 0.08\text{g/dl}$ vs. $0.75 \pm 0.21\text{g/dl}$) - both were surprisingly low.

There is definitely a place for cell salvage in the post-operative environment. The presentation highlights the influencing factors compared with peri-operative cell salvage.

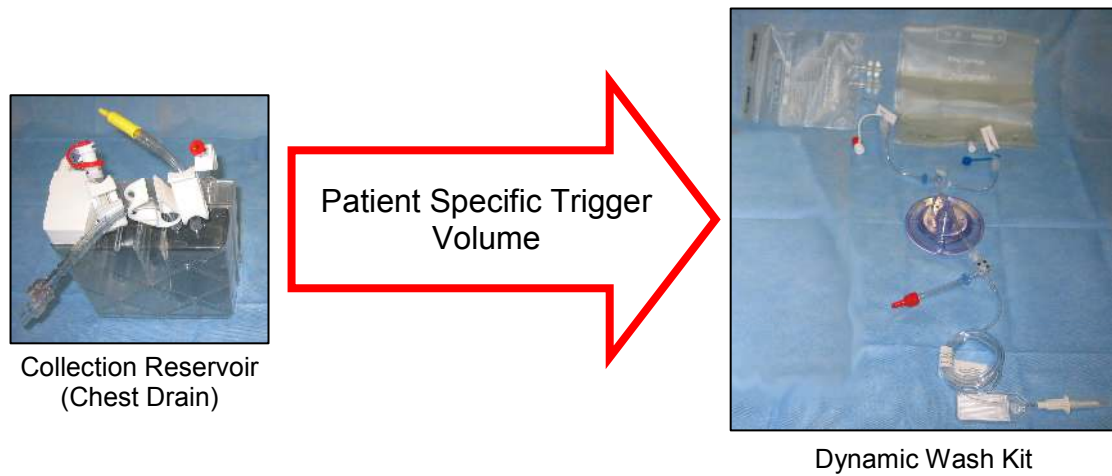


Figure 1 – The CardioPat Split System showing the separate collection reservoir and dynamic wash kit

$$TV_{ps} = \left(\frac{(Av_{Hb} \times 10)}{Pt_{Hb}} \right) + V_{ACDA}$$

Equation 1 – Trigger volume equation, where TV_{ps} is the patient specific trigger volume, AV_{Hb} is the target mass of haemoglobin, Pt_{Hb} is the patients haemoglobin on return to the unit and V_{ACDA} is the volume of anticoagulant used

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RBC Initiative: Rethinking Blood Conservation Initiative

The need for blood conservation in cardiac surgery is driven by 3 key factors: blood shortage, cost and patient safety.

Increasing complex surgery combined with low donation rate can cause blood shortages.

Additional safety measures will add cost to the units of blood being screened and used. Finally increasing risk for the patient has been proven to be associated with donation of blood such as increased viral and bacterial infection, increased length of stay (LOS) and adverse reactions such as ARDS (Adult respiratory distress syndrome), infections, atrial fibrillation and kidney/liver function complications.

The Medtronic Rethinking Blood Conservation Initiative (RBC Initiative) advocates a multi-modality approach to blood conservation to improve patient outcomes and reduce financial burden of blood use-related complications. The right advance technology is a key component for effective blood conservation.

Some recently published data strongly support the direct correlation between transfusion- rates and morbidity/mortality of patients following cardiac surgery.

During the presentation we will cover the rational of multi-factorial approach and discuss the latest published data on transfusion issues with respect to patient outcome.

THE NEW REALITIES

Cardiac transfusions utilise about 13% of the U.K.

blood.¹ Blood use and blood conservation are issues that hospital administrators and medical professionals must urgently address. The effects of mismanaged blood cascade into real consequences that affect both patient outcomes and hospital costs.

¹ <http://www.blood.co.uk/pages/e18used.html>

**Blood
Matters**

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Alleviating Pain · Restoring Health · Extending Life

Blood Matters



Proper blood management during cardiovascular surgery contributes to more positive patient outcomes, decreased post-operative morbidity, and earlier ICU and hospital discharge.² That's why Medtronic developed the RBCSM Initiative.

The Rethinking Blood Conservation Initiative is an evidence-based education program that advocates a multi-modality approach to blood conservation, applying strategies and tactics designed to improve patient outcomes and reduce the financial impact of blood use-related complications.

Find out how the Medtronic RBCSM Initiative can help your institution become more cost effective through improved patient outcomes and reduced blood use-related complications: RBCI@medtronic.com

Because now more than ever before ...
BLOOD MATTERS.

¹ Speks BD. Transfusion and outcome in heart surgery. *Ann Thorac Surg*. 2002;74(4):966-7.

² Ranucci R, Giuseppe L. Minimally invasive cardiopulmonary bypass: does it really change the outcome? *Crit Care*. 2007;11:R45.

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