13th European Conference on Perfusion Education and Training

Saturday, 5th October 2013
9:00 to 17:30
Vienna, Austria

Austria Center Vienna, E1

"Trends in Perfusion"
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Turku, Finland
EBCP, EACTA representative

Leen Vercaemst
Senior Perfusionist,
Leuven, Belgium EBCP
Board Member
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During the advent of the electron microscope, the delicate gel-like lining of all intraluminal blood vessels, called glycocalyx, was first recognized over 46 years ago (1) … long after the creation of Starlings theory of intravascular fluid movement in 1896 (2). We now know that in addition to hydrostatic pressure and colloid osmotic pressure, the glycocalyx lining plays a major role in fluid homeostasis and helps to regulate the movement of fluid between the intravascular and extravascular spaces. In fact, some consider it to be the main structure that provides ionic and colloid osmotic gradients within the vasculature, thereby preventing tissue edema. This membrane bound endothelial cell covering is composed of plasma, proteoglycans and glycoproteins, with many other endothelial and plasma proteins intermeshed. It ranges in thickness between 0.4 µm and 4.5 µm depending on the location/size of the vessel (3, 4, 5).

Glycocalyx is known to be damaged by several mechanisms associated with cardiac surgery, including volume loading, surgical manipulation, ischemia/reperfusion, hyperglycemia, hyperlipidemia and solid/gaseous microemboli (3, 6). Damaged Glycocalyx exposes the underlying endothelial cells, which leads to platelet and neutrophil activation, localized inflammation, tissue edema and increased permeability of both solutes and solvents (6). But how important is the glycocalyx network to the conduct of cardiopulmonary bypass and what should perfusionists know about this ‘double barrier concept’ (glycocalyx and endothelial cells) as it serves to protect our patients from endothelial damage and tissue edema.

In cardiac surgery, the concept of a single embolus causing significant capillary damage has always been discussed in the context of the bubble size, gas composition of the offending embolus and how long it takes for the offending bubble to be absorbed into the surrounding tissue. However, several authors (3, 7, 8, 9) focus more on the destructive nature of microbubbles as they contact, adhere and abrade the delicate vascular endothelial lining.

During in vitro investigations into the damaging effects of microbubbles on endothelial cells, several authors (10, 11) found that bubble contact with endothelial cells initiates and immediate influx of calcium and destruction of mitochondrial membranes in endothelial cells. However, they also acknowledged that similar contact in the in vivo model may be regulated by the presence of an intact glycocalyx layer. Microbubbles are known iatrogenic events and gaseous microemboli are well-documented endothelial irritants that can cause significant brain dysfunction (12, 13). Even the passage of a single embolus through narrow cerebral capillaries can initiate cerebral swelling and intracranial hypertension leading to inflammation, disruption of the blood brain barrier and postoperative dysfunction. However, regardless of the source of intraluminal glycocalyx degradation, the consequences are fluid extravasation (crystalloid and colloid), inflammation, platelet/leukocyte activation (3, 5, 14) and damage to the blood brain barrier. Unfortunately, little is known about the nature and time involved in the reconstruction of the degraded glycocalyx lining (15).
The expanding literature around the presence of glycocalyx and its potential impact on intravascular mechanics may help to explain the damaging effects of gaseous microemboli and allow us to have a better understanding of fluid movement and tissue edema in vivo.

Objectives: To provide a better understanding of the glycocalyx network and thereby enable clinicians to have a more in depth appreciation for GME protection and volume management.

Methods: To review and summarize past and current literature regarding this little known physiological barrier.

Abstract

Introduction of gaseous micro-emboli (GME) into the arterial line of a pediatric cardiopulmonary bypass (CPB) circuit may lead to cognitive decline and adverse outcome of the small patient.

Arterial filters are incorporated into CPB circuits as a safeguard for gross air and to reduce GME in the arterial line. Recently, in two neonatal hollow-fiber membrane oxygenators, the Quadrox-i Neonatal and the Capiox FX05, arterial filters were integrated to reduce volume and foreign surface area.

In this in vitro study a clinical neonatal CPB was simulated. The oxygenators, the corresponding venous reservoirs and the complete CPB circuits were compared in a simulated neonatal CPB on detailed air removal characteristics after introduction of bolus air or GME.

After a constant challenge of GME the Capiox FX05 oxygenator removed a significantly higher volume of GME than the Quadrox-i Neonatal oxygenator (97 vs 86%), although the Capiox FX05 appears to generate a high amount of small GME due to fractionation of larger GME. ‘Improved’ filters may cause more generation of smaller GME.

After a bolus challenge the single components of both brands, oxygenators and venous reservoirs, removed air for 99.9%. During this challenge of the oxygenators significantly more GME were measured in the arterial line of the Capiox FX05, probably also caused by fractionation of bubbles. Both complete CPB circuits showed an air reduction of 99.99%. Overall, we conclude that although significant differences were found, both CPB systems were very adequate in removing GME and gross air and that these differences are probably negligible in a clinical situation. Both systems are considered as a safe and reliable product concerning air removal properties.

Key Words: cardiopulmonary bypass — neonatal extracorporeal circuits —— arterial filter— gaseous microemboli — air— safety.
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09:50-10:10  Gaseous microemboli

Speaker: James D. Ferguson MPS, CCP, CPBMT, MT (ASCP) Chief Perfusionist, Phoenix Perfusion Services, USA
fergy2ccp@q.com

“A comparison of 3 integrated arterial filter oxygenator’s ability to handle GME
James D. Ferguson, Adam Fernandez MPS, CCP

Introduction:
Although there have been many improvements in perfusion and surgical techniques, gaseous microemboli (GME) related concerns are of great concern to the clinician. The incidence of neurocognitive deficits remains a concern and can have detrimental effects on the quality of life of patients after cardiopulmonary bypass (CPB). The causes of GME are multifactorial and the use of CPB lends itself to the possibility of a higher incidence of related GME.

Over the past several years, oxygenators have been developed with integrated arterial filters (IAF) to help decrease the prime volume of the cardiopulmonary bypass circuit improving blood conservation techniques. Yet, the currently available integrated arterial filters have not shown any advantage in GME removal compared to a standalone oxygenator and arterial filter. This experiment compared four currently available IAF models. The Medtronic Fusion® integrated arterial filter will be compared for its GME removal to the Terumo FX25 integrated oxygenator, the Sorin Synthesis integrated oxygenator and the Maquet Quadrox integrated arterial filter.

Methods:
An in vitro evaluation of the Terumo FX15 integrated filter/oxygenator (Group I), the Cobe Synthesis integrated arterial filter/oxygenator (Group II), the Maquet Quadrox integrated arterial filter/oxygenator (Group III), and the Medtronic Fusion® integrated arterial filter/oxygenator (Group IV) for GME removal using an EDAC bubble counter. The circuits were identically set up except for the different manufacturer oxygenators and accompanying venous reservoirs. The groups were tested with a 60cc bolus of air introduced over approximately 5 seconds and then measured for GME pre oxygenator (sensor 1), post oxygenator (sensor 2), and post stand alone arterial filter (sensor 3). The sensor location was not changed between each experimental run.

Results:
The means and standard deviation of each difference variable for each manufacturer were calculated for total emboli load (p<.0001), total volume (cc) (p<.0001), total embolic load <40 microns (p .3406), and total embolic load >40 microns (p< .0001). The total embolic load was significant for Group I vs. Group II (p.0003), Group I vs. Group III (p.0013), Group II vs. Group IV (p<.0001), and Group III vs. Group IV (p<.0001). The total volume of emboli was significant for group I vs. group II, (p<.0001), group I vs. group III (p<.0001), and group I vs. group IV (p<.0001), group II vs. group III (ns), group II vs. group IV (ns) and group III vs. group IV (ns). The clearance time in seconds was calculated between manufacturers. The time for clearance was significant for group I vs. group III (p<.0033) and group I vs. group IV (p<.0443).
"Has The Integration Of The Arterial Line Filter Into The Oxygenator Impacted On Filtration Capability?"
S. Allen, J. Unsworth-White, M. Bennett, J. Fitzgerald, L. Holmes. Southwest Cardiothoracic Centre, Plymouth, UK.

Objective.
The transfer of gaseous micro-emboli (GME) through extracorporeal circuits (ECC) is a well described phenomenon in cardiopulmonary bypass procedures.

The drive for more integrated products, although welcomed by many perfusionists, concerns some who see the integration of the previously separate oxygenator and arterial line filter (ALF) as a challenge to the safety profile of the ECC. Our primary objective in conducting these tests was to reassure ourselves locally as to the efficacy of more integrated devices in removing GME.

Methods.
We mapped the occurrence of GME during routine CPB procedures using a GAMPT BCC200 Bubble Counter and applied those typical challenges to four different isolated oxygenators in the laboratory. One with a separate ALF, one with a ‘bolted on’ ALF, one with a fully integrated ALF and one with an integral ALF filtration capability (Compactflo Evo, Sorin / Affinity® ALF, Medtronic; Quadrox-i, Maquet; Capiox® FX25, Terumo; Affinity Fusion®, Medtronic).

The tests were run in two series. Firstly, using a crystalloid solution as the prime and secondly blood. The bubble counter probes were positioned immediately pre oxygenator and post ALF.

Results.
Preliminary results demonstrate a difference across the range of oxygenator blocks tested and an attenuated GME transfer in the integrated devices.

Conclusion.
Although these devices have been tested in isolation from the other major components of a standard ECC, I hope these results will help reassure those who had remained concerned about the integration of an ALF into the oxygenator block.
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Sorin Sponsored Session

Speaker: Sven Maier, MSc. ECCP
University Heart Center Freiburg Bad Krozingen, Freiburg, Germany
sven.maier@universitaets-herzzentrum.de

“First Experience With The New Sorin Lifebox In Interhospital Transport Patients Requiring Extracorporeal Circulatory/Pulmonary Support”
Christoph Benk, Rolf Klemm, Christian Scherer, Georg Trummer, Friedhelm Beyersdorf MD

Objective:
Extracorporeal Membrane Oxygenation (ECMO) and Extracorporeal Life Support (ECLS) systems are used to support pulmonary or circulatory function with an increasing number of operations as rescue technique in cardiopulmonary resuscitation (CPR). Therefore, and favoured by the miniaturization of the devices, interhospital transport of patients with ECMO or ECLS has been increased recently.

Methods:
Since January 2012 the Sorin Lifebox was used to transport n=44 (100%) patients (n= 33 ECMO, n=11 ECLS) with a mean age of 52.5 ± 16.0 years. The patients were transported with special ambulance vehicles (n=25) or helicopter (n=19) over a distance of 5 - 224 kilometers.
During transportation the Sorin Lifebox was connected to the power and oxygen supply of the ambulance vehicle or the helicopter. Upon arrival at the University Hospital in Freiburg the system was switched to a Stoeckert centrifugal pump console (SCPC).

Results:
No complications related to the Sorin Lifebox occurred during the implantation or the transport. The Sorin Lifebox had been securely fastened in all ambulance vehicles and helicopters. Patients with an ECMO were supported for 9.3 ± 8.0 days. 53.1% of the patients survived. In the ECLS-group the support time was 5.6 ± 3.8 days. 45.5% of the patients survived.

Conclusions:
Hospitals beyond a center of maximum care are limited in the treatment of these seriously ill patients with ECMO or ECLS systems. Therefore compact and reliable systems are required to transfer these patients. The Sorin Lifebox provides the opportunity, to transport these patients in a safe way even over a long distance to a center of maximum medical care.
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10:50-11:20
Coffee Break
“Chronic Thromboembolic Pulmonary Hypertension And Treatment With Pulmonary Thromboendarterectomy”

Review of Pathophysiology behind Chronic Thromboembolic Pulmonary Hypertension, and one Center's Experience with Pulmonary Thromboendarterectomy as a treatment modality.

Objective: Review of the literature regarding the incidence of Chronic Thromboembolic Pulmonary Hypertension leads us to the conclusion that the disease is severely underestimated, underdiagnosed, and therefore undertreated. Benotti et al in 1983 estimated that if only .5% of patients with acute pulmonary embolic events develop to chronic disease, approximately 2500 individuals would be diagnosed with Chronic Thromboembolic Pulmonary Hypertension annually in the United States. With the advent of better diagnostic tools, and recognition by the medical community of findings of chronic thromboembolic disease on autopsy not previously diagnosed, more patients are now being diagnosed with this disease.

Methods: A thorough review of the existing literature regarding the incidence and treatment of Chronic Thromboembolic Pulmonary Hypertension was performed. Review of the literature regarding the pathophysiology and contributing factors in the development of Chronic Thromboembolic Pulmonary Hypertension is presented. There are 2 available curative options for treatment of the disease, Pulmonary Endarterectomy and Pulmonary Transplant. Due to the chronic shortage of donor lungs not only in the United States, but worldwide, coupled with the enormous range of complications associated with transplantation, this treatment modality may be unrealistic.

Results: The 30 year experience of the University of California San Diego Medical Centers Pulmonary Thromboendarterectomy program will be reviewed. Specific attention to the policy and procedures for the techniques’ of cardiopulmonary bypass when performing a Pulmonary Thromboendarterectomy are covered due to the technically demanding procedure including cooling the patient to 20 degrees Celsius, two to four periods of twenty minute circulatory arrests, and careful rewarming. A case of history of 1500 plus cases is presented, including the mortality rates for specific patient groups.

Conclusions: Pulmonaryendarterectomy is a curative and relatively low risk procedure for the treatment of Chronic Thromboembolic Hypertension. Mortality rates of 4.4% are reported for a subset of patients most commonly seen.
“Increasing mean arterial pressure during cardiac surgery does not reduce the rate of postoperative acute kidney injury.”

Amélie Azau, Philippe Markowicz, Jean Jacques Corbeau, Christian Cottineau, Xavier Moreau, Christophe Baufreton, Laurent Beydon.

Introduction:
We tested the hypothesis that the optimization of general and renal hemodynamic, by maintaining a high level of mean arterial blood pressure (MAP) during cardiopulmonary bypass (CPB), can reduce the rate of acute kidney injury (AKI).

Methods:
We conducted a randomized study, including patients for elective cardiac surgery performed under CPB, with risk factor of AKI: serum creatinine clearance between 30 and 60 ml/min/1.73m² or two factors among the followings: age > 60 years, diabetes mellitus, diffuse atherosclerosis. After adequate filling, the MAP was maintaining between 80-90 mmHg during CPB in one group, versus 50-60 mmHg in the other group. We conducted CPB with strict normothermia, heparin coated low volume, closed CPB circuits and we routinely processed suffused blood in the operative field with a Cell Saver®. The AKI was defined by a 30% increased of serum creatinine (sCr) level. We also tested others definition for AKI: RIFLE classification, 50% rise of sCr and the need for hemodialysis. The secondary end point was length of hospital stay and, death at day 28 and at 6 month.

Results:
We enrolled 300 patients (145 in the controlled group, 147 in the high pressure group). The pressure endpoints were achieved in the High group (79 ± 6 mm Hg) and Control group (60 ± 6 mm Hg; p<10⁻³). The rate of renal insufficiency, did not differ by group (16.6% vs 17%; p=1), whatever the criteria used. The length of stay in hospital (9.5 days [7.9-11.2] vs. 8.2 [7.1-9.4]), death at day 28 (2.1% vs. 3.4%) and at six month (3.4% vs. 4.8%) did not differ between groups.

Conclusion:
Maintaining a high level of MAP during normothermic CPB does not reduce the risk of postoperative AKI. There were no difference between the groups concerning the length of hospital stay and the mortality rate.
**12:05-12:25  Inflammatory factors**

**Speaker:** Sabrina Meloni  
Perfusionist division of Cardiac surgery master in Health management Hospital policlinico Tor Vergata, Rome, Italy  
sabri_italy@hotmail.com

"Wash Out Of Inflammatory Factors By Modified Ultrafiltration In Adult Cardiac Surgery”

Laura Radomile CP;  
Domenico Chianese CP;  
Pasquale De Vico MD-PhD;  
Dionisio Colella MD-PhD;  
Andrea Farinaccio MD;  
Fabio Bertoldo MD-PhD;  
paolo Nardi MD-PhD

*Perfusionist, division of cardiac surgery, Policlinico Tor Vergata, Rome, Italy;  
Department of anesthesiology, Tor Vergata University hospital, Rome, Italy;  
Division of cardiac surgery, Tor Vergata University hospital, Rome, Italy*

**Objective:** The extracorporeal circulation increases the inflammatory factors, the aim of this pilot study is the possibility to decrease them with the use of Modified Ultrafiltration(MUF).

**Methods:** 24 patients underwent aortic and mitral valve replacement, randomly divided into 2 groups:  
Group 1 (12 patients) underwent Modified Ultrafiltration after CPB with a hemoconcentrator filter.  
Group 2 (12 patients) was the control group.

IL-6, TNF were measured before (T0) and after (T1 T2 T3) CPB. There were no demographic differences between the groups.

In the group 1, MUF technique started after weaning from CPB with Nephral ST200 biocompatible filter with cytokines and endotoxins adsorption capability for 15 minutes at 250ml/min flow, using a specific roller pump.  
The filter was interposed between the arterial line and venous cannula.

**Results:** IL-6, TNF, there were no statistical differences between the groups.

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<tr>
<td>IL-6 T0</td>
<td>38.19±12.4</td>
<td>24.02±9.68</td>
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<tr>
<td>IL-6 T1</td>
<td>291.4±56.3</td>
<td>739.4±250.9</td>
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<td>IL-6 T3</td>
<td>405.2±74</td>
<td>381.3±77.25</td>
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<td>TNF T0</td>
<td>6.967±1.21</td>
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<td>TNF T1</td>
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<td>TNF T3</td>
<td>9.592±3.35</td>
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**Conclusions:** We wanted to test the inflammatory factors removal efficacy of the MUF.  
Even though there were no statistical differences in our data seen between the groups we observed a decrease of inflammatory factors after 24 hours of CPB. We found no differences in mechanical ventilation, postoperative platelet count between the groups.  
The time of stay in the ward was greater in the control group with no statistical significance.  
Only one death occurs in the control group.
“Cardioplexol, A New Cardioplegic Solution For Elective CABG”
L. Ver nieuwe, A. De Bruyn, K. Kaïret, S. Kalantary, and I. Rodrigus, MD, PhD

Objective: Cardioplexol® (Swiss Cardio Technologies) is a hyperkalemic, low-dose, single-shot cardioplegic solution which offers immediate asystole of the heart, maintenance up to 90 minutes and immediate reversal of asystole after release of cross clamp. Intermittent crossclamping with Lidoflazine is the current operative technique used in our center. We investigated if Cardioplexol is an efficient, safe, easy-to-use and worthy alternative to Lidoflazine in elective isolated CABG in low-risk patients. Primary outcomes are heart enzymes (cTnI and CK-MB) and secondary outcomes are operation times, length of stay, major complications and in-hospital mortality.

Methods: From December 2011 to May 2013 40 patients, with LVEF ≥50%, EuroSCORE II <3.5% and no severe systemic disease, underwent elective CABG and were consecutively randomized to intermittent crossclamping (ICC; n=20) or Cardioplexol (CPX; n=20). All were operated on by the same surgeon.

Results: There was no significant difference in age (CPX 71.04±8.54; ICC 67.25±9.90), EuroSCORE II (CPX 1.19±0.63; ICC 1.11±0.46) or number of distal anastomoses (CPX 2.95±0.51; ICC 3.15±0.745). We found no significant difference for maximum cTnI (CPX 3.38±1.50; ICC 4.59±4.23) or maximum CK-MB (CPX 23.99±13.95; ICC 25.50±20.10). ECC time (CPX 57.55±11.93; ICC 67.20±21.78) and cross-clamp time (CPX 24.62±1.31; Lido 22.76±1.49) were not significantly different. Neither length of hospital stay CPX 9.10±2.32; ICC 8.19±1.25) or postoperative complications (CPX 1.25±0.78; ICC 0.85±0.67) showed significant difference. There was no in-hospital mortality.

Conclusions: In this elective CABG population with low risk, Cardioplexol offered good myocardial protection, with comparable primary and secondary outcomes. Further studies are needed to expand its use.
Objective:
The aim of our study was the evaluation of a new LANDING Monitor produced by Eurossets S.r.l. located in Medolla (MO) Italy and the analysis of DO$_2$, SvO$_2$, O$_2$ER and DO$_2$/VCO$_2$ as an effective predictor to evaluate the adequacy of perfusion in our patients in order to tailor the CPB.

Methods:
49 patients scheduled for CABG and Valve Replacement were enrolled. CPB was conducted using continuous blood flow and moderate hypothermia (min 30.3°C).

Blood samples were taken at the beginning of CPB, after the second dose of cardioplegic solution, at the rewarming (33°C), at end of rewarming and after aortic clamp removal.

Results:
In 22 patients (45% of total) the mean flow during CPB was lower than theoretical flow (C.I=2.4).
In 1 patient (2% of total) the mean flow during CPB was equal to theoretical flow (C.I=2.4)
In 26 patients (53% of total) the mean flow during CPB was higher than theoretical flow (C.I=2.4).

Our results showed the following values: DO$_2$ > 276 ml/min/m$^2$, SvO$_2$ > 74.5%, lactates < 1.30 mmol/l, and haemoglobin > 8.4 g/L.
Consequently the DO$_2$ and SvO$_2$ were adequate for the patient’s metabolic needs. All patients were weaned from CPB and survived the operation without major complications.

Conclusions:
The complete management of DO$_2$, SvO$_2$%, Hb and pump flow, offer the new perspective of a “tailored” perfusion concept, for each Patient.
Considering the appropriate value of hematocrit, when it was necessary to increase the flow of the pump, we tried not to increase volemia expanding the “stressed volume” with addition of external volume, but have instead tried to mobilize “the unstressed volume” from the splanchnic department using a certain vasoconstrictor. It was useful knowing the values of the peripheral resistance of the patient to optimize the dose of vasoconstrictor without side effect on peripheral perfusion.
As we have been working in this way for the last five years, we firmly believe that the introduction of the in-line device (LANDING) would be desirable because it allows the continuous reading of the values of DO$_2$, SvO$_2$ and O$_2$ER during CPB.
13:00-14:00
LUNCH

1400 – 14.30 Poster session
Speaker: M. Kaluza
Department Cardiothoracic Surgery Friedrich-Schiller-University Jena, Germany
Life Systems Medizintechnik Service GmbH, Germany
mirko.kaluza@med.uni-jena.de

“Less hemodilution by integration of the arterial filter into the oxygenator with or without retrograde autologous priming (RAP)”
M. Kaluza¹,², S. Boog¹,², D. Bösemann¹,², B. Runge¹,², R. Ostermann¹,², T. Burgter¹,², T. Doenst¹
¹Department of Cardiothoracic Surgery, Friedrich-Schiller-University of Jena, Germany
²Life Systems Medizintechnik Service GmbH, Mönchengladbach, Germany

Objective:
New, second generation oxygenators combine oxygenation and arterial filtration in one single housing. This new technology enables optimized circuit designs with shorter tubing, less connection sites and significantly reduced total circuit priming volume. The present study was undertaken to examine the effect of a condensed perfusion circuit utilizing an oxygenator with fully integrated arterial filter and total circuit priming volume of 1050 ml on hemodilution of cardiac surgery patients.

Methods:
After obtaining ethics approval, we included 352 operations performed with two different ECC setups. Extracorporeal circulation in group 1 was established with a conventional extracorporeal circuit containing an oxygenator and separate arterial filter (Avant, D734, Sorin). Group 2 had a circuit using an oxygenator with integrated arterial filter (Capiox FX25, Terumo). The drop in hemoglobin concentration at the initiation of bypass was used as an indicator of hemodilution in both groups. The groups were divided in two subgroups depending on whether retrograde autologous priming (RAP) was performed. Both groups included patients with a wide range of different surgical interventions. Patients undergoing re-operations, emergency or very complex procedures were excluded.

Results:
Patient groups did not differ in demographic data and surgical procedures performed. RAP was possible in 68% of patients in group 1 and 72% of patients in group 2. Dynamic priming volume after system setup was 1550 ml in group 1 and 1050 ml in group 2. RAP removed 356 ml ± 182 in group 1 and 365 ml ± 128 in group 2 (n.s.). The figure shows the fractional decrease in hemoglobin concentration with the initiation of ECC. Integration of the arterial filter into the oxygenator significantly reduced hemodilution as measured by the drop in hemoglobin (p<0.001). This effect was even larger in the RAP subgroups.

Conclusion:
Integration of the arterial filter into the oxygenator housing reduces hemodilution and improves the efficiency of retrograde autologous priming (RAP)
3 reasons why to use CAPIOX® FX Oxygenators

Reduces blood transfusion requirements
JECCT 2009; 41:220

Effective De-Airing
Perfusio 2012; 27:235

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JECCT 2009; 41:220; Perfusio 2009; 24:107

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Oxygenators with Integrated Arterial Filter

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**Introduction**: The use of blood products (BP), although sometimes unavoidable, involves losses both for the institution, due to the inherent financial cost, and for the patient due to the adverse effects that have been associated with them. Thus, it is necessary to rationalize the transfusion therapy in the surgical setting. This study focuses on the analysis of the evolution of the use of blood products in the period 2000-2010 depending on the different techniques and pharmacological strategies applied in the cardiothoracic surgery department of a central public hospital in the Lisbon region.

**Methods**: Data of 749 adult patients undergoing cardiac surgery under cardiopulmonary bypass (CPB) in 2000, 2005 and 2010 were retrospectively studied. The variables included age, gender, body mass index (BMI), type of surgery, ECC time and aortic clamping time (ACT). The technical strategies were analyzed using the variables: priming, myocardial protection, and fluid therapy and ultrafiltration, whereas the pharmacological strategies were studied using the variables vasoconstrictor drugs, antifibrinolytic agents (aprotinine) and anaesthesia volume. Finally we analyzed the consumption of blood products, including erythrocyte concentrate (EC), fresh frozen plasma (FFP) and platelet concentrates (PC), distinguishing intraoperative, postoperative and overall consumption (i.e. the sum of the intraoperative and postoperative consumption.)

**Results**: There was a significant increase in female patients \( (p = 0.000) \), age \( (p = 0.001) \), CPB time \( (p = 0.002) \) and aortic clamping time \( (p = 0.000) \), associated with an increase of the complexity of the surgery and the volume of fluid administered and the volume of crystalloid filtered MUF (MUF) \( (p = 0.000 \) and \( p = 0.002 \) respectively). The levels of pre- and postoperative hemoglobin (Hb) decreased significantly \( (p = 0.000 \) and \( p = 0.022 \) over the decade, as did the volume of total filtrate by conventional ultrafiltration (CUF) and MUF \( (p = 0.007) \), the priming mix volumes \( (p = 0.000) \), the volume of vasoconstrictor drugs \( (p = 0.002) \) and anaesthesia volume \( (p = 0.000) \). The technical and pharmacological strategies and techniques analyzed showed no significant or strong correlation with the use of blood products (HD), although there has been an overall reduction of blood products over the decade (15% EC and 20% PFC).
Conclusions: The significant effect for the variables - females, age, duration of CPB and aortic clamping time - suggest, according to several studies, an increase in the consumption of blood products due to the resulting increased risk associated with transfusion. Thus, the decrease in the consumption of HD observed in the present suggests that the strategies implemented were effective in reducing consumption.

Key-Words: Blood Products, extracorporeal circulation, cardiac surgery, erythrocyte concentrate, fresh frozen plasma, platelets.
“Minimization Of Circuit The Cardiopulmonary Bypass And The CPB Console To Improve Outcomes”

U. Borelli ECCP 4, M. Detroux MD 1, R. Nottin MD 2, N. Al-Attar MD 3, S. Mercurio 4

1 Department of Cardiovascular Surgery, Grand Hôpital de Charleroi, Gilly, Belgium
2 Department of Cardiac Surgery, Center Surgical Marie Lannelongue, Paris, France
3 Department of Cardiac Surgery, Golden Jubilee Hospital, Glasgow, UK
4 Department of Perfusion, Grand Hôpital de Charleroi, Gilly, Belgium

Introduction
My objective, since 1995, is to create an extracorporeal circulation (ECC) with a particular holder system, that makes it possible to install the oxygenator and VAVD reservoir together with the external pumps, at a distance from the ECC console and this at the same height of the shoulder of the patient. We have tried to lessen the effects of cardiopulmonary bypass (CPB) by reducing the surface of contact air/blood and blood/materials, introducing hemocompatible treatments and using an ECC compact, with assisted venous drainage (VAVD) and autologous retrograde priming.

Material And Methods
As from 1999, three groups of patients who underwent CABG were compared with ECC systems, so the contact surface air / blood, the blood / materials have been gradually reduced from group to group.

The choice of the oxygenator and venous reservoir is made according to body surface. So for a body surface equal or inferior to 1.9 m², the residual priming of ECC is 250 ml, while for a body surface superior to 1.9 m², residual priming of ECC is 350 ml.

In parallel we have sought to reduce our ECC console and created a holder system with the external pumps, to minimize the totality of our ECC circuit.

Results
We observed a reduction of postoperative ventilation time, blood loss, duration of stay in intensive care, need for blood transfusion and levels of lactate dehydrogenase .

Conclusions
The minimization of CPB and its use have a direct impact on the postoperative outcome of the patient.
Since September 2007, our objective is reached through the creation of a support that affords to manage the entire system, being at the same level of the shoulder of the patient. It allows calibrating the console ECC in relation to the CPB circuit to optimize its performance. This means a reduction of tubing length of the aspiration line around ± 50 %. This new concept of ECC makes it possible to have a different approach to heart valves, paediatric surgery and more fragile and more complicated patients. From 6 years, we have realized more than 1600 cardio-thoracic surgeries with this new concept of ECC.
**Speaker:** Dr Erich Gygax ECCP  
Inselspital University Hospital Berne, Switzerland, Germany  
Erich.gygax@insel.ch

“A new minimized extracorporeal perfusion system. First clinical results”  
E.Gygax, Hj. Jenni, A.Kadner, T.Carrel MD  
Clinic of Cardiovascular Surgery, University Hospital, Bern, Switzerland

**Objective:**  
Minimized extracorporeal perfusion systems (MECC) are quite similar to ECMO-Systems. The only difference for MECC-Systems is the opportunity for volume transfusion and the handling of suction blood. The use of one console for MECC- and ECMO-perfusion requirements can be an attractive option for clinics regarding economic and safety aspects. The deltastream® MDC offers different applications such as MECC-and ECMO-perfusions for pediatrics and adults. Due to the modular positioning the deltastream® MDC can be equipped with different components and allows patient tailored perfusion set-ups. In addition to the established ECMO-program with the deltastream® MDC we started a new MECC-program in our clinic for adults and pediatrics by using the deltastream® MDC with different components.

**Methods:**  
The MECC-adult set-up consists of the new s.pump® (MEDOS AG;Stolberg;Germany) and the oxygenator HILITE 7000 (MEDOS AG;Stolberg;Germany) and an integrated suction device (Cardiosmart;Muri;Germany). The MECC-adult system was used for coronary artery bypass grafting (AcB).  
The MECC-pediatric set-up consists of the s.pump® or DP III (MEDOS AG;Stolberg;Germany) and the oxygenator Affinity Pixie (Medtronic;Minneapolis;USA). The MECC-pediatric set-up offers the opportunity of a change to an open-system. The MECC-pediatric was used for VSD-closure, BT-Shunts and Glenn anastomosis.  
For all cases following intraoperative postoperative data were collected and analysed:  
Average blood loss, transfusion requirements, hemodynamic parameters and an evaluation of safety and feasibility.

**Results:**  
No critical incidence for the whole collective. Every case could be perfused with the new set up without changing to a conventional perfusion system.

**Summary:**  
The deltastream® MDC perfusion system allows safe perfusion strategies for adults and pediatrics. Due to the flexible positioning of the components, the system allows an optimal placement of the system in the theatre with the consequence of maximal reduced priming volume.
s.pump® and mini.systems™

medos®
cardiopulmonary solutions

S.PUMP®
The s.pump® offers a new solution for perfusionists and cardiac surgeons seeking a safe and reliable alternative to existing blood pumps for all cardiac surgical procedures.

- Real and accurate control especially at low flow rates
- Designed to be controlled by deltaxstream® MDC console
- Complements and optimizes miniaturized circuits, e.g. medos® mini.systems™
- With 17 ml minimal priming volume ideal for pediatrics, infants and adults

MINI.SYSTEMS™
Medos® offers miniaturized circuits which can be completely individualized according to distinct needs.

- Proven in years of clinical routine
- Unique combination of safety, flexibility and ease of use
- Clear benefits in terms of patient benefit, outcome and costs
- Pre-connected circuits designed for simplicity and ready for priming

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15:55-16:15
Coffee Break
“Could you survive a Clinical Practice Audit?”

There are two facets to this question:

First: Do you have the mind-set that will allow you to accept the results of such an audit, and make appropriate changes? Audits are not necessarily about right or wrong, but are about showing where either process or practice or both can be improved to have a positive effect on outcome. While audits seem to have the greatest effect when initial performance is low, even small changes can be of potentially important benefit. Audits can be performed by you yourself, or by someone else. Most effective change occurs when the feedback is from a colleague or supervisor.

Second: How would your clinical practice stand up under scrutiny? Two of the types of clinical audits are: process, which looks at how we do our job, and outcomes, which look at the end result. Processes can affect outcomes, so there is some overlap, but there is a clear division. With the real time acquisition of data now available, audits can be more in-depth. The steps of an audit are: understand the question, define the criteria, select the data points and/or specific process to be reviewed, decide on the scope of the audit, design the collecting tool, collect the data, analyze the data, decide what changes may be indicated, implement changes, re-audit.

An audit does not mean we all have to march in lock step. There is room for individual variation in some processes. The key is to have a set process with defined outcomes, and to periodically look at these through audits. This will make sure you are actually meeting your stated goals. Simply having an audit or designing an audit will serve to improve practice.

Finally, audits are not research. Research is the search for new knowledge through proven scientific principles. Audits simply look at how well we meet criteria supported by research.
"Simulation training for routine application of CPB for perfusion students"

Training and education for perfusion involves basic scientific knowledge, materials science and pathophysiology as well as profound knowledge on operative procedures and on the use of extracorporeal circulation for cardiac surgery. Team management and communication skills are necessary adjuncts.

At the Berlin Academy for Perfusion, a high fidelity perfusion simulator (Orpheus), installed at a dedicated Simulation Operation Room, is in use since March 2009. Perfusion students as well as students from other disciplines are trained in this realistic environment. Perfusion students are subjected to different stages in Simulation. Initially, demonstration of perfusion-related technology and training of basic skills are offered. Thereafter, more complex perfusion scenarios are organized in order to train students for both routine and emergency situations.

The development of professional behaviour was studied on a group of 20 perfusion students. 4 teams with 5 participants each were subjected to a standard perfusion scenario. Team members were assigned to act as surgeon, anaesthesiologist, perfusionist, or to another team role. Key findings were that the team was able to arrange and re-arrange relevant procedural information, but that unexpected situations led to problems with team leadership.

Simulation is a useful tool for educating perfusionists, interdisciplinary team training and development of professional ethos and behaviour. It is hypothesized that patient outcome may be positively influenced by team training interventions in the future.
**Speaker:** Maite Mata MS, ECCP  
Perfusionist, Hospital Clinic, Barcelona, Spain  
Instructor School of Perfusion, Barcelona  
mata@clinic.ub.es

**“Training the Cardiac Team With Simulators”**  
Martin Romero, Lourdes; Gahete Santiago, Francesc; Mata Forcadas, MªTeresa; Ayats Vallverdú MC; González Escrivà M; Román Vázquez X; Rovira I, Matute P, Gomar Sancho C;

**Introduction.**  
Since 1996 up to now the University of Barcelona is responsible for training perfusionists through the Master "Tecnicas de Perfusión y Oxigenación Extracorporal". In 2010, the University of Barcelona acquired the extracorporeal circulation simulator Orpheus and a CPB machine so students may complete their practical training, simulating real situations both conventional CPB, as other procedures such as ECMO, Circulatory Support, MECC and hyperthermic perfusion in a Lab. This simulation system has also been used for the team interaction in CPB crisis for the European Congress of Cardiothoracic Anesthesia (EACTA) held in Barcelona in June 2013. The Orpheus, is composed of a complex hydraulic system, controlled by computer, which mimics the behavior of the circulatory system and can connect to any heart-lung machgine and hemodynamic monitoring systems. We also have incorporated a Beating Heart mannequin, which can be synchronized with Orpheus in order to have a more realistic behavior of real situations during simulated sessions. There are not experiences published with this system in the literature.

**Methods.**  
We organized an international workshop on critical situations during cardiac surgery under CPB for anesthesiologists. It consisted in four critical scenarios: allergic reaction to protamine, massive air embolism, ruptured iliac vein after femoral cannulation and aortic dissection after aortic valve replacement. It took place in the Operating Theater and each case were documented and recorded had a duration of 15 minutes. The participants were real professionals instead of actors and were: one anesthesia nurse, two surgical nurses, one anesthesiologist, two surgeons and two perfusionists and all procedures were recorded. Two other anesthesiologists assessed performance by a checklist. Participants were distributed in groups of two anesthesiologists and cases were randomly distributed. According to the possible responses of anesthesiologists an algorithm of actions by the team was previously established. After the cases a debriefing with participants and members of the simulation team watching the video recordings was held.

**Conclusion.**  
This new Simulation Era training is better and safer both for patients and students. Simulation allows not only teaching the technical and clinical bases to perfusionist students but also is useful for certified perfusionists to check their knowledge and team interaction under critical situations. Our simulation system developed for perfusionists allows also other professionals to check their knowledge and attitudes in front of standard or critical procedures during cardiac surgery under CPB. Finally, the simulation sessions permit a better behavior and interaction of the cardiac team.
Tahir Heart Institute, Department of Cardiac Surgery, Rabwah, Pakistan
ranafaisalshehzad@gmail.com

“Use of blood microplegia technique and inclusion of lidocaine in cardioplegic solution in adult patients undergoing coronary revascularization; an audit of 200 consecutive cases”

Objectives
Myocardial protection is of paramount concern during coronary revascularization. The use of systemic hypothermia, ventricular unloading and the use of cardioplegia can reduce basal metabolic consumption during electromechanical arrest by ninety percent. The composition, temperature, route of administration of cardioplegia is subject to considerable variation. Since the classical description of Buckberg, cold blood cardioplegia in a 4:1 dilution has become the standard in the United States. Interest in warm cardioplegia (37°C) was renewed due to its superior ability to reduce myocardial lactate production and early restoration of cardiac rhythm. However, investigators (Martin et al) noted an increasing incidence of neurologic events in the warm cardioplegia group which led to the impetus of tepid (28°C) cardioplegia by Hayashida N et al. Theoretically, combination of tepid cardioplegia and minimal dilution cardioplegia (mini cardioplegia as described by Calafiore et al) offers minimal dilution and maximal oxygen delivery. Inclusion of Lidocaine in Cardioplegic solution provides additional Mayocardial protection. Lidocaine inhibits depolarization by blocking sodium and calcium influx and potassium release, abolishing the action potentials of cells in the Hiss-Purkinje system and myocit cells. As it can directly influence cardiac electric and mechanical activities.

Methods: A total of 200 consecutive patients undergoing coronary revascularization at Tahir Heart Institute, Chenab Nagar were studied from January 2011 to June 2012. All patients received tepid minimally diluted blood cardioplegia with lidocaine 2mg/kg (temp.10-28°C) using antegrade and retrograde administration, with selective graft perfusion. The early mortality (hospital discharge) was 3% and IABP was required in 5% of patient with prolonged ionotropic support. There was no incidence of any neurological event or renal insufficiency requiring dialysis.

Conclusions: These results demonstrate that the use of microplegia and lidocaine as an additive to microplegia is safe in adult patients who are undergoing coronary revascularization and significantly reduces the incidence of ventricular fibrillation after aortic unclamping and results in good in-hospital morbidity and mortality.

Key Words: Microplegia; Cardioplegia; Lidocaine; Myocardial protection; Morbidity; Mortality
Poster Presentations

A new evolving method to meet today's perfusion needs

Objectives
The purpose of this investigation was to present the Tor Vergata experience about a new method to calculate the effective blood flow during Extra Corporeal Circulation.

Methods
Between December 2011 and March 2013, 750 patients required ECC during open heart surgery in Tor Vergata Hospital. Terumo Advanced Perfusion System 1 (Terumo, Ann Arbour-USA) is our Heart Lung Machine.

The System 1 is provided by a Central Control Monitor; it's a high resolution touch screen computer that serves as a safety monitor and can be used as the central area for controlling the system components and current perfusion parameters.

Normally we can see the calculate blood flow directly in the front panel displays of the roller pump and the cardiac index in the Central Control Monitor. Even we can see the effective blood flow by the use of a non invasive flow sensor that use a Doppler technology to measurement the blood flow in the arterial line with an operating range between -9.9l/min and 9.9 l/min.

Results
We analyzed the internal and external diameters of the silicone tubes and we have verified that there are important differences that are the cause of the flow difference that can be detected only by using a Doppler flow sensor.

We have measured the internal diameter sizes and wall thickness of the 5 samples of silastic tube from a different company. We have used a plug gauge to measure the ID and a slide vernier gauge to measure the wall thickness. Dimensions are given to 1 place of decimals only due to the equipment used cannot guarantee anything more accurate. Nominal sizes for 1/2" ID x 3/32" wall in mm are 12.69mm x 2.34mm. The results are:

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<th>Sample</th>
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<th>Internal Diameter(mm)</th>
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Conclusion
We have verified that during the CPB there is a difference between calculated and effective blood flow greater and less than 200-300ml/min respect the calculated flow; this is only depending on the type of silastic that you use. To reach an optimal perfusion is important to use all that technology and the research available for the patients. It's very important for the perfusionist using the blood flow sensor so to understand the effective blood flow during CPB for maintaining high quality standards.

In our experience, we could see that there is a difference between the calculated flow and the effective flow.
"Weaning From Veno-Arterial Extracorporeal Life Support Using An Arterio-Venous Shunt"
Y.M. Ganushchak, MD, PhD; D.W. Donker, MD, PhD; A.P. Simons, PhD; J.G. Maessen, MD, PhD; P.W. Weerwind, CCP, PhD

Objective:
Weaning from extracorporeal life support (ELS) after partial or full cardiac recovery remains scarcely described. Incorporation of an arterio-venous (AV) shunt in the circuit during weaning may facilitate gradual cardiac loading/unloading without additional anticoagulation to maintain circuit integrity. This report describes the use of an AV shunt to wean patients from veno-arterial ELS.

Methods
From 2007 to present, 60 patients suffering from severe refractory cardiogenic shock were assisted by veno-arterial ELS. Echocardiography and hemodynamic monitoring were used to assess cardiac load-responsiveness. Upon partial or full cardiac recovery, and after a successful weaning trial, an AV shunt was added to the circuit and weaning was initiated. Support flow was reduced stepwise by 10-15% every 4 to 10 hours. The circuit flow was maintained at 4-5 L/min and adjustments of AV shunt flow allowed gradual cardiac loading.

Results
In 29 patients, stepwise weaning was unsuccessful because of incurable heart disease or other concomitant conditions, and ELS was discontinued. Out of 31 successfully weaned patients, 10 died after 7.8 ± 4.2 days. All other patients were discharged and remain on follow-up. Weaning duration depended on cardiac recovery and varied from hours to days. A mean arterial blood pressure of 70 mmHg was kept during weaning with or without inotropes and/or balloon pump support. Activated partial thromboplastin time was 60±10 s without increasing systemic heparinization. No thromboembolic oxygenator events were observed during weaning.

Conclusion
Stepwise weaning from veno-arterial ELS by gradual cardiac loading can safely be accomplished using an AV shunt while maintaining circuit integrity.
Dmitry Yamgurov, Sergey Shefer, Ludmila Malih.
Department of Cardiosurgery ICU. Childrens’ hospital #1. St. Petersburg, Russia
jamgourov@mail.ru

“Our experience used oxygenator Affinity Pixie in the different pediatric group”.

Objective: The aim of the study was to present our experience used oxygenator Affinity Pixie in the different pediatric groups.

Material and methods
Between November 2010 and December 2012, 220 pediatric patients underwent open heart surgery for the correction of congenital heart disease with the use of the Affinity Pixie oxygenator.

Patient age was 2 days to 7 years. The weight varied between 2.8 kg and 23 kg. The CPB time was 92+/−56.2 min. The ACC time was 44+/−26.2 min. An arterial filter was not used.

The patients were divided in four groups.

- In first group (n=62) the weight was 2.8 to 4.0 kg. Maximum blood flow was 0.7 l/min; the circuit priming was 200 ml. A-V loop was 3/16-3/16. Deep hypothermia (18-25 degrees) and pH-stat strategy were used.
- In the second group (n=58) the weight was 4.1 to 6.0 kg. Maximum blood flow was 1.0 l/min; the circuit priming was 230 ml. A-V loop was 3/16-1/4. Same temperature and pH strategy was used.
- In the third group (n=65) the weight was between 6.1 and 12.0 kg. Maximum blood flow was 1.5 l/min; the circuit priming was 250 ml. A-V loop was 1/4-1/4. In this group mild hypothermia (up to 32 degrees) and alpha stat strategy was applied.
- The fourth group (n=35) weight was 12.0 to 25.0 kg. Maximum blood flow was 2.5 l/min; the circuit priming was 300 ml. A-V loop was 1/4-3/8. Temperature and pH strategy were identical as in group 3.

In all cases we used roller pump, ultrafiltration during CPB and modified ultrafiltration. Anesthetic management was performed according to a standardized protocol. For anesthesia continuation during perfusion we introduced Sevorane in the oxygenator with a vaporizing device fixed on the CPB in all group. The mean preoperative hemoglobin level was 11.7 mg/dl, during bypass 9.0 mg/dl and postoperative 10.7 mg/dl. Transmembrane pressure drop was not measured.

Results: All patients survived after surgery. No complications during and after CPB was found in any off the cases. In two cases we found thrombosis of cardiotomy reservoir before CPB. Those cases were associated with violation of the conditions of storage of RBC.

Minimum rectal temperature was 16 degrees, maximum rectal temperature was 38 degrees.

Minimum blood flow was 0.1 l/min and maximum blood flow was 2.5 l/min.

In all cases, we have had good oxygen transfer and CO2 removal at all temperatures. The oxygen delivery was between 520-720 ml/min/m2 in the whole group. The mean use of RBC in priming volume was 120 +/- 43 ml.

Conclusion: Oxygenator Affinity Pixie is universal for children weighing from 3 to 20 kg. The use of volatile anesthetics can maintain adequate anesthesia. However, for children less than 3 kilograms a neonatal oxygenator is preferable.
“Comparison of 3 Intra Aortic Balloons With Different Balloon Design Made For IABP In 3 Different Kinds Of A Mock Circuit In Respect Of Augmentation Efficiency “

Objective:
Two years ago the idea of a short balloon coming from Japan, was to enter the market in Europe. Since then the Zeon Medical Inc. from Tokyo sells it in Asia. These IABP catheters with short balloon design have been well tested and used. Because we did not believe that a 35 cc balloon could be effective in European patients with average height, we designed an in vitro trial. The objective was to show how much augmentation such a specially designed balloon could produce. We also looked for the reason how a smaller balloon can create the same or more augmentation as a normal 40 cc and additionally we looked at which other factors over all have significant influence for augmentation.

Material and Methods:
We compared the Zeon Xemex 35 cc Short Balloon, Zeon Xemex 40 cc and the Maquet Sensation 40 cc in a 4.5 l mock circuit in 3 different setups to simulate different kinds of circulation conditions. Compared data are: augmentation peak, augmentation curve surface, increasing pressure of the balloon and ratio of increasing pressure. Additionally we filmed the flow manner with a high-speed camera to find reasons for the above findings.

Results:
The Xemex 35 cc short balloon shows the best augmentation, especially in a poor circulation. The relation between tube diameter and balloon diameter is very important, but without a systemic pressure, there is no proper augmentation.

Conclusion:
A bigger balloon is not necessarily a better balloon. The right design is important!
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« Is Smaller Better? The New Sorin Inspire 6 Compared To Oxygenators With Larger Surfaces »

**Background:**
The Inspire 6 (Inspire 6M, Sorin, Italy) oxygenator is an oxygenator with a small surface area and approved for a maximum flow of 6 liters/minute. We retrospectively examined its performance and compared it to other oxygenators (Quadrox, Maquet, Germany; Avant, Sorin, Italy) with larger surface areas.

**Methods:**
92 patients were assigned to three groups (Avant-Group (AV) n=30, Quadrox-Group (QU) n=30 and Inspire-Group (IN), n=32). We examined: oxygen transfer ($vO_2$), shunt fraction, oxygen delivery ($DO_2$), pressure drop, arterial oxygen content ($CaO_2$), venous oxygen content ($CvO_2$), hemoglobin (Hb), platelet count, C-reactive protein (CRP), leucocyte count, serum creatinine, lactate, creatinine kinase and the overall consumption of Packed Red Blood Cells (PRBC).

**Results:**
There were no significant differences between the groups with regard to age, gender, EuroScore (ES), Body Mass Index (BMI), volume of cardioplegic solution (ml) and ECC time.
Significant differences were found in the following parameters: priming volume (AV: 1532.6±164.0 ml, QU: 1560±114.7 ml, IN: 1050±222.0 ml; p=<0.001), minimal Hb on ECC (AV: 8.3±1.5 g/dl, QU: 7.8±1.3 g/dl, IN: 9.9±2.1 g/dl; p=<0.001), $CaO_2$ (AV: 127.0±23.6 ml/min/m$^2$, QU: 118.8±19.9 ml/min/m$^2$, IN: 105.2±26.5 ml/min/m$^2$; p=0.005) and $CvO_2$ (AV: 93.6±22.8 ml/min/m$^2$, QU: 89.0±18.8 ml/min/m$^2$, IN: 137.0±26.5 ml/min/m$^2$; p=0.03). No differences were found in $DO_2$, $VO_2$ and pressure drop.
Overall PRBC consumption was: Inspire Group: 23 units, Avant-Group: 69 units, Quadrox-Group: 65 units.

**Conclusion:**
The Inspire 6M-oxygenator is safe and efficient, suitable for nearly all patients and low prime circuits. The oxygenator may contribute to a better patient outcome.
Fat removal during cell salvage – An optimized program in the XTRA\textsuperscript{®} autotransfusion device

**Objective:**
Fat in wound blood seen in orthopedic or cardiac surgery might pose a risk for fat embolism during blood salvage. Fat removal was optimized in the washing process of the autotransfusion device XTRA\textsuperscript{®} (Sorin, Italy) and tested in an experimental study.

**Methods:**
ABO-matched blood from fresh volunteer donations was adjusted to an hematocrit of 25% and an admixture of 1.25% human tissue fat. Volumetric quantification of fat was performed after centrifugation in Pasteur pipettes (according to Engstrom) with a sensitivity of 0.04 vol%. From the volumes, the Hcts and the concentrations of fat and other parameters RBC recovery and elimination rates were calculated.

**Results:**
Fat elimination rates for the 225ml-bowl increased from 69.2 ±2.5% in the standard program Pstd to 89.2 ±4.3% with the (for Hct) optimized program Popt, and to 98.5 ±2.3% with the Fat removal program Pfat. The product had a mean Hct of 49% and a RBC recovery rate of 93.5%. The program achieved the high elimination rates for albumin, heparin, potassium and free plasma hemoglobin as Popt (98.8%, 99.3%, 95.3% and 94.9%, respectively). Similar high fat removal was also seen with bowls of smaller size (98.1% for the 175ml bowl, and 98.2% for the 125ml-bowl). With test blood of Hct 10% a mean fat elimination of 99.6% was observed.

**Conclusions:**
A special program modification Pfat involving extra washing and RBC concentration steps significantly improves fat removal by the Latham bowl based autotransfusion device XTRA\textsuperscript{®}, thus yielding results equivalent to the continuous cell salvage system (CATS).
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