'Case report: deep hypothermic ECMO cannula exchange in a child with necrotic pneumonia'

- Alex Robertson, Chief Perfusionist, Great Ormond Street Hospital, London

Necrotizing pneumonia can lead to respiratory failure in previously healthy children. ECMO can be utilised in such cases to provide haemodynamic and respiratory support while lung function recovers. We present such a case in a two year old a child placed initially on veno-arterial ECMO who required conversion to veno-venous support. Her condition, and lack of native gas exchange, precluded re-cannulation at normothernia and she underwent the procedure in the operating theatre under deep hypothermic circulatory arrest. Fluoroscopy and echocardiographic guidance were used for placement of a dual lumen VV ECMO cannula. During cooling to 20oC, volaemia needed to be reduced in order to prevent myocardial distension as the heart rate decreased. Following re-cannulation, ECMO was re-started as veno-veno-arterial circulation due to the lack of native circulation, with the greater proportion of oxygenated blood returning to the systemic circulation. As the patient was rewarmed and the heart rate increased, the previously removed perfusate was returned to the circulation and the proportion of arterial ECMO circulation was reduced gradually until the patient was completely on veno-venous ECMO. The arterial limb of the ECMO circuit was separated and the carotid artery de-cannulated. To our knowledge, this is the first case utilising deep hypothermic circulatory arrest to facilitate an ECMO cannula exchange in a severely ill child.

'Beyond the Protocol – Train for the Unexpected'

- Claire Swift, Senior Perfusionist, John Radcliffe Hospital, Oxford &

Dr Katherine Lamb, Effective Command Practitioner

The employment profile of many Surgical teams has changed dramatically over the last 15 years, with numerous retirements, loss of experienced personnel, part-time working, and changed educational standards, altering the team demographics.

As a consequence, the exposure of individuals to a diverse array of cases has diminished significantly, with a small number of specialist centres focussed on complex cases, leaving the 'run of the mill' to the majority of centres.

However, all Perfusionists must be prepared to deal with the unexpected and demonstrate intuitive decision-making often without any exposure to a similar case or training experience.

Despite efficiency savings, and continual fiscal scrutiny there is a necessity for a professional service 24/7. An organisation which supports and empowers its personnel to make efficient and effective decisions, utilise discretion, apply a risk-based approach and provide the organisation with both competency-based assurance and operational accountability. But how do you ensure that Perfusionists and the teams they work within, can operate safely and effectively, when faced with less frequent, but potentially more complex situations and cases, especially at a time of fiscal restraint or when realistic experience or training is harder to come by. How do you train these individuals to deal with the 'unexpected'?

Understanding the situation, how it is likely to develop especially if it steps outside of a protocol, is essential to the implementation of appropriate tactics and actions.

- What do I need to know?
- What do the answers to my questions mean?
- Can I anticipate how the incident will develop?

I aim to develop Assertive, Effective and Safe autonomous practitioners. An individual who has all these qualities will be dynamic, reactive and balanced, happy to make decisions and be able to dictate the surgical tempo if required. But what makes somebody an effective Perfusionist? How should you develop and nurture those skills? When should you start that development process? How should you measure and re-evaluate this competence?

This paper will examine case-studies from the blue-light practitioners in an attempt to offer solutions to redress this balance.

'Thermal Imaging of the Cardiopulmonary Bypass System In Cardiac Surgery during an Aortic Valve Replacement Procedure'

J Campbell, S.K NaiK

Trent Cardiac Centre Nottingham University Hospitals Trust

Since its inception in the early 2oth century thermal imaging has been widely utilised in the Military, law enforcement, Civil fire & rescue, Sport, Construction and manufacturing. The technology allows the visualisation of temperature that can be measured directly using camera based devices and software.

At the Nottingham University Hospitals Trust (NUHT) we were interested to discover what information thermal images of our working bypass system could provide during a routine cardiac case. Patient informed consent for imaging acquisition was obtained in accordance with NUHT policy.

A protocol was designed to encompass the various aspects of cardiac surgery during and aortic valve replacement procedure. This protocol was divided into two sections one for patient imaging and the second for equipment.

Patient protocol was

1. Heart on bypass (Warm)
2. Cardioplegia administration (Cooling)

Equipment on bypass imaging protocol was

3. Reservoir
4. Oxygenator
5. Arterial filter
6. Cardioplegia device

Images were recorded during an elective Aortic Valve Replacement (AVR) with a FLIR Systems™ (West Malling Kent) Thermacam P640 camera with a FOL38 lens. The images obtained were analysed using the Thermocam™ Quick Report software version 1.1.

This presentation will exhibit the thermal images taken during the AVR procedure. The benefits and limitations of the technology in relation to the clinical assessment of temperature and cardio pulmonary bypass will be discussed.

'A concept for the future of extracorporeal technologies in UK & Ireland'

- Simon Anderson, Senior Clinical Perfusionist, Royal Papworth Hospital, Cambridge

There is an increased demand for Perfusionists as well as an increase in extra corporeal technology applications. This has led to other healthcare professionals undertaking what has traditionally been seen as Perfusionist roles.

Is there a way to prevent this from happening? Should we prevent this from happening?

This presentation looks into my personal thoughts on a possible future pathway to hopefully get the best of both worlds while provoking thought in the perfusion community on what I personally think is an important topic for the future of our profession.

'An Avoidable Death'

- Gerry Webb, Head of Clinical Perfusion, University Hospitals Plymouth NHS Trust

University Hospitals Plymouth NHS Trust is an adult cardiac surgical unit operating on 1000 patients per annum. Unsurprisingly the use of Intra-Aortic Balloon Pump therapy is not uncommon and we see it used for approximately 80 patients per year. 60% of our IABs are inserted in Cardiology with the full benefit of comprehensive imaging. The remainder are inserted either in the Operating Theatre or in Cardiac Intensive Care where of course the imaging is typically less complete. Of those, roughly a quarter are inserted in theatre after induction and before sternotomy.

Subsequent to one of these post-induction pre-sternotomy IAB insertions, a patient in theatre for coronary artery bypass grafting suffered problems associated with an iatrogenic leak from the IAB. After replacement of the IAB catheter her surgery was completed relatively uneventfully. However, on reducing the sedation postoperatively on intensive care, the patient demonstrated signs of significant cerebral injury including seizures and unequal pupils. A CT scan revealed extensive cerebral infarcts consistent with helium embolization.

Unfortunately, she did not recover and passed away 6 days after surgery. The cause of death was recorded as multiple cerebral infarcts as a result of helium gas embolism.

This presentation will firstly describe the circumstances that led to this incident and then examine the consequential investigation, conclusions and actions. All of which can be pertinent to a broad spectrum of clinical scenarios that perfusionists routinely face.

Guest Speaker

'Peri-operative Physiology and Anaesthetic Management during Delcath Chemosaturation'

- Dr Sanjay Gupta FRCA FICM, Consultant Anaesthetist and Intensivist, University Hospital Southampton

The Hepatic CHEMOSAT® Delivery System is an innovative medical device for the treatment of patients with unresectable primary or metastatic liver tumors. This system is used to perform chemosaturation percutaneous hepatic perfusion (CS-PHP), a procedure in which a high dose of the chemotherapeutic agent melphalan is delivered directly to the liver via the hepatic artery whilst simultaneous filtration of blood from the hepatic venous outflow limits systemic exposure through a veno-venous bypass circuit.

A clinical trial program and subsequent published observational data suggests that CS-PHP with melphalan significantly improves hepatic progression-free survival in patients with un-resectable hepatic metastases from ocular or cutaneous melanoma.

CS-PHP is particularly challenging to the anaesthetist because of the attendant risks associated with total occlusion of the inferior vena cava by the double balloon catheter, establishing the veno-venous extra-corporeal circulation and the unique haematological and cardiovascular effects of the proprietary filter.

Accurate clinical assessment of comorbidities, particularly exclusion of ischaemic heart disease is necessary. Optimized medical therapy of pre-existing coronary artery disease, and the prevention and treatment of perioperative myocardial ischaemia require careful control of the determinants of myocardial oxygen supply and demand.

Patients should discontinue their antihypertensive medication on day of surgery and any ACE inhibitors (or Angiotensin2 antagonists) should be stopped two days before. Peri-operative beta blockade is essential in managing the significant tachycardias including tachyarrhythmias that can arise during the filtration phase.

The pathophysiology of total caval occlusion is complex and varies between patients. The mechanism causing profound hypotension during melphalan filtration for up to 70 minutes is poorly understood. Haemodynamic stability is dependent on the extent of pre-existing coronary artery disease; myocardial dysfunction; intravascular volume; control of the tachycardia with its consequent reduction in diastole and ventricular filling; total occlusion time and anaesthetic technique.

In our experience, infusions of metaraminol and phenylephrine have pronounced bradycardic effects at the doses used, which appears to be due to direct effects on the SA node. The hypotension and resultant diastolic dysfunction is best balanced with the unusually strong constitution of vasopressors (including norepinephrine) and beta blockers.

Perioperative hypothermia is associated with an exacerbation of the expected coagulopathy, which seems to be a consumptive process as blood passes through the charcoal filter. Both thrombocytopenia and a rise in prothrombin time are observed. Aggressive correction of post-operative coagulopathy is essential and early removal of venous catheters is advised.

'Case study of accidental hypothermia as a result of water submersion, and an update on recent published evidence for best practice in treatment"

Elizabeth Stevens, University Hospital of Wales, Cardiff

A case is presented where a 20 year old male drowned after getting into difficulties in a river. He was submerged for approximately 30 minutes before he was able to receive medical attention, and then admitted to UHW in cardiac arrest with a core temperature of 29.2°C. The patient was transferred to theatres and received cardiopulmonary bypass via femoral cannulation to rewarm the patient, but after 107 mins bypass the patient was declared dead. This presentation aims to address whether anything could have been done differently to potentially achieve a different outcome. Accidental hypothermia cases are relatively unusual, and this infrequency of incidence can lead to uncertainty in how to approach treatment using extracorporeal circulation. In published studies there is considerable variation in approach; In particular, there appears to be no clear consensus regarding the optimal rate of rewarming. This presentation will lay out recently published literature in order to clarify the current best practice in treatment where extracorporeal circulation is used.

'The Utility of Aortic Valve Leaflet Reconstruction Techniques in Children and Young Adults'

Luke M. Wiggins, MD[1], Branko Mimic MD, PhD[3] , **Richard Issitt PhD[4,5,6]**, Slobodan Ilic MD, PhD[7], Beatrice Bonello, MD[2], Jan Marek, MD[2], Martin Kostolny, MD[1]

[1]Division of Cardiothoracic Surgery, [2]Division of Cardiology, Great Ormond Street Hospital, London, England, [3] East Midlands Congenital Heart Centre, University Hospitals of Leicester, Leicester, United Kingdom, [4] Digital Research Environment, Great Ormond Street Hospital, London, England, [5] Perfusion Department, Great Ormond Street Hospital, London, England, [6]British Heart Foundation Research [7]Department of Pediatric Cardiac Surgery, University Children's Hospital, Belgrade, Serbia

Objectives: The treatment of aortic valve disease in children and adolescents requires an individualized approach to provide a long-term solution with optimal hemodynamic profile. The role of aortic leaflet reconstruction techniques is evolving.

Methods: We retrospectively reviewed the charts of 58 patients who underwent aortic valve tri-cuspidalization either by an Ozaki procedure (neo-tricuspidalisation) or single leaflet reconstruction (SLR) between 2015 and 2019. Immediate operative results as well as hospital and short-term outpatient follow-up data were evaluated.

Results: Fifty-eight patients underwent leaflets reconstruction with 40 (69%) receiving a neo-tricuspidalisation and 18 (31%) having a SLR, using either a glutaraldehyde fixed autologous pericardium or tissue engineered bovine pericardium (CardioCel®). The median age at the time of surgery was 14.8 (interquartile range 10.6-16.8) years. Twenty-three (40%) patients had an isolated aortic regurgitation. The gradient across the aortic valve decreased from 3.4 ± 1.2 m/s preoperatively to 2.0 ± 0.4 m/s ($p < 0.001$) after surgery and remained stable (2.2 ± 0.7 m/s) during a median echocardiographic follow-up of 14.1 (7.2 – 20.1) months for the whole cohort. Freedom from reoperation or moderate and greater aortic regurgitation at 1, 2 and 3 years was 94.2±3.3%, 85.0±5.8% and 79.0±8.0% respectively with no difference between the neo-tricuspidalization and SLR groups (p=0.635).

There were 6 (10%) late reoperations of which 3 due to endocarditis.

Conclusions: Aortic leaflet reconstruction surgery provides acceptable short-term hemodynamic outcomes and proves the utility of this technique as an adjunctive strategy for surgical treatment of aortic valve disease in children and young adults.

' "Is 300 enough?" A practical insight into aortic root venting and effective de-airing'

- Nicholas Trafford (MSc, ACP, LCCP) - Essex Cardio-Thoracic Centre

Background:

Gaseous macro-embolism during open heart surgery is a known risk and one that can be minimised yet never fully avoided. Embolic events are strongly linked to end-organ ischemia and postoperative neurological complications, such as cerebral injury, CVA and TIA, and possible myocardial dysfunction and dysrhythmias.

Effective de-airing techniques are crucial in removing gaseous emboli, both micro and macro, from the heart and aorta during and after closure of the myocardium and/or great vessels. There is no standardised approach and ambiguity exists within the surgical community over which techniques are more effective. Techniques deployed are wholly centred on venting via the aortic root and/or superior pulmonary vein/left ventricular vent. The effectiveness of these venting sites are dependent on variable factors such as vent flow, patient positioning, systemic pressures and flow output during cardio-pulmonary bypass (CPB) along with carbon dioxide insufflation.

The vent rate of 300mls/min is often used when de-airing the heart from the aortic root, and is often the preferred rate by many surgeons, yet the clinical reasoning behind this value is somewhat unsubstantiated with limited supporting evidence. The aim of this study is to assess the efficacy of different vent flows at set flow outputs and to what extent Trendelenburg positioning affects the de- airing process.

Method:

A volplex primed circuit to simulate the de-airing process was constructed using components of a bypass circuit including a reservoir and silicone pump boot. The aorta was simulated using an inner tube measuring 4cm in diameter that provided similar compliance, diameter and wall thickness of that of the aortic root.

A 'non-vented' aortic root cannula was inserted at the highest point of the inner tube for de-airing. A venous gate clamp was used to allow sufficient control to occlude the circuit return, so line pressures could be maintained at 100mmHg throughout.

Pressure and flow were generated using a roller pump, set at 3, 4 and 5 litre per minute flow.

Macro emboli within the aorta were simulated using a set of syringe drivers, delivering set volumes of air into circuit, ranging from 20mls to 70mls at fixed rates (10ml/s).

Air was evacuated via the root vent and could be captured in a separate 'soft shell' reservoir. The air evacuated could be offset from the volumes of air injected into the circuit at different flows.

The inner-tube position could be manipulated into a 20° angle to simulate Trendelenburg positioning (head down)

Results could be collated running variable flows (3, 4 and 5 litres/min), variable vent flow rates from 200ml-500ml/min and variable air bolus volumes ranging from 20ml-70ml, given at 10ml/s.

Results:

There was a significant correlation between vent efficiency when using higher vent flow rates at lower flow outputs. Venting at 500ml/min was effective in removing 92.8% of air at 5ltr/min flow, compared to 63.3% of air when venting at 200ml/min. Venting efficacy improved when flow output was reduced.

When a 20° incline was applied, venting efficacy improved across all parameters, more so at lower vent flow rates. Venting at 300ml/min at 5ltrs/min flow output saw an average increase of 5.3% in air evacuation when the largest air bolus (70ml) was delivered.

Conclusion:

Venting at higher flow rates does show an improvement in gaseous evacuation. However there needs to be an appreciation that when venting at higher rates, this will diminish patient systemic flow and increase haemolysis during cardio-pulmonary bypass.

Provisional results imply that effective vent flow should be proportional to the patient flow and therefore be increased in patients with higher body surface areas and resultant higher flows. Based on the pilot study, an initial hypothesis can be drawn which infers that the vent rate should be 10% of the patient flow rate.

Though the results strongly suggest that inverted patient positioning and aortic manipulation significantly improves aortic root de-airing efficiency, the caveat is that the modelling lacks sophistication. An immediate limitation is the simulation of complex fluid dynamics seen during bypass, as this model study looks purely at aspects of de-airing from a unidirectional flow of gaseous macro-emboli in fluid. In reality, the flow would be multidirectional, due to the position of the aortic cannula and the subsequent retrograde flow of blood towards the heart, which would dramatically alter the dynamics of gaseous emboli entering the aortic root. More advanced modelling would be required to simulate such dynamics.

'Case Study: A Patient with cold agglutinin disease'

- Karolina Peszko, Clinical Perfusionist, Freeman Hospital, Newcastle upon Tyne

Introduction

Cold agglutinin disease usually develops as a result of the production of a specific immunoglobulin M auto-antibody directed against the I/i and H antigens, precursors of the ABH and Lewis blood group substances, on red blood cells. Autoimmune and lymphoproliferative disorders, other infections can be associated with the production of cold agglutinins. In its classic presentation with haemolytic anaemia and Raynaud's syndrome, cold agglutinin disease is usually idiopathic. Several factors play a role in determining the ability of a cold agglutinin to induce a haemolytic anaemia such as antibody concentration and temperature range.

Case presentation

A 64-year-old man with LAD disease and aortic stenosis (moderate stenosis with mild aortic regurgitation). Breathless on exertion with good left and right ventricular function. Chronic cold agglutinin diagnosed in 2016 after complication from right total hip replacement (pulmonary embolism).

Cardiopulmonary Bypass

The aorta was cannulated with an armoured size 24 EOPA cannula after systemic heparisation. An armoured three stage venous cannula was placed in the right atrium through the appendage. Cardiopulmonary bypass was then commenced at normothermia (not less than 35.5 degrees of Celsius). A vent was placed via the main pulmonary artery. After aortic clamping, warm blood cardioplegia was administered into the aortic root which lead to prompt diastolic arrest. Cardioplegia was repeated every 15-20 min during the cross-clamp period. Total cross-clamp time 60min. Cardiopulmonary bypass was then discontinued smoothly without inotropic support after 77min. Total cardioplegia - 3300mls.

Conclusion

Patient was discharged home after 5 days.

'Time to wake-up? Circadian rhythms in cardiac surgery & the future of cardiovascular research'

- Murray, A.J.

Perfusion Department, Liverpool Heart & Chest Hospital, Liverpool

Translational Health Sciences, Bristol Medical School, University of Bristol, Bristol

Circadian rhythms are biological processes that display endogenous oscillations over a period of approximately 24-hours. Recent evidence shows that circadian rhythms influence many physiological processes as well as cardiovascular diseases. Circadian rhythmicity is evident in terms of heart rate and blood pressure, circulating catecholamines, blood coagulation profile, endothelial function, platelet aggregation and inflammation as well as many other processes. There also appears to be daytime variations in onset of acute disease such as arrythmias, MI, stroke and sudden cardiac death as well as affecting the efficacy of medications such as anti-hypertensives. Better long-term control of hypertension has been demonstrated when these medications are taken prior to sleep compared to morning-time. A similar effect has been shown with aspirin and platelet reactivity. Time-of-day variations in MI incidence as well as infarct sizes have been demonstrated in recent years. In addition, circadian rhythms have been implicated in cardiac surgery with patients undergoing aortic valve replacements in the morning having an increased risk of perioperative MI and MACE. The circadian clock appears to represent a novel target for future research in cardiac surgery and cardiovascular research. In experimental work, circadian rhythms and time of day should be considered as a confounding variable. Clinically, the circadian clock could present opportunities for intervention such as timing of surgery and administration of medications. It could also expose novel molecular targets to improve outcomes in patients experiencing adverse cardiovascular events and those undergoing cardiac surgery.

'Pulsatile versus non-pulsatile flow during cardiopulmonary bypass: effects on haemolysis and renal function'

- Newey, C.N.

Cambridge Perfusion Services, Royal Papworth Hospital, Cambridge

Translational Health Sciences, Bristol Medical School, University of Bristol, Bristol

Acute kidney injury is a common complication following cardiac surgery with cardiopulmonary bypass (CPB). Roller pumps produce non-pulsatile flow (NPF) by default, however it is now possible to produce pulsatile flow (PF), which mimics the flow produced by a beating heart. This may maintain microcirculatory flow and improve renal perfusion during CPB, however clinical trials have not demonstrated any consistent improvements in renal outcomes with PF modalities. There is ongoing concern that the action of the roller pump during PF may increase shear stress damage to red blood cells. Release of free haemoglobin into the circulation may cause renal damage through oxidative and inflammatory tissue damage and by reducing renal blood flow. Previous studies which examined whether PF increases haemolysis were inconclusive. This study aimed to determine whether PF causes increased haemolysis by comparing levels of free haem and globin in 30 patients receiving PF and 30 receiving NPF. The effect on renal function was assessed by changes in serum creatinine as a secondary outcome. Globin in the PF group was higher than in the NPF group at 30 minutes ($p=0.03$) and 60 minutes ($p=0.04$). There were no significant differences in haem levels between the groups. Postoperative increases in creatinine were statistically similar between the two groups. Increased haemolysis in the PF group may be due to increased blood velocity through the arterial cannula and the action of the roller pump. However, other sources of haemolysis such as transfused and cardiotomy suction blood cannot be excluded. The study was also limited by small sample size and the lack of randomisation and blinding. Optimising the CPB circuit may increase the benefits of PF and minimise the risks. Future work should address these areas to answer the question of whether PF can prevent AKI during cardiac surgery.

'Does lipid and leukocyte depletion during coronary artery bypass graft surgery reduce the risk of postoperative cognitive dysfunction? Proposal for a randomised controlled trial'

- Rynne, K

John Radcliffe Hospital, Oxford

Translational Health Sciences, Bristol Medical School, University of Bristol, Bristol

Introduction: Coronary artery bypass (CABG) surgery with cardiopulmonary bypass (CPB) is associated with a high risk of postoperative cognitive dysfunction (POCD). Physiological disturbances occurring during CPB contribute to POCD. During CPB shed-blood from the chest cavities is collected via cardiotomy suction and returned to the CPB circuit. Shed-blood is flooded with lipid-microemboli (LME), leukocytes and inflammatory mediators and re-infusion of shed-blood into the systemic circulation may contribute to neurological injury. POCD is associated with adverse patient outcomes and preventative strategies are needed. The main objective of this study is to determine the effect of lipid and leukocyte filtration on the incidence of POCD.

Methods: Proposal for a multicentre, double blinded randomised controlled trial (RCT), including 848 patients undergoing CABG surgery. Exclusion criteria are: previous cardiac surgery, diabetes, >80-years, emergency surgery and cognitive dysfunction at baseline. Participants will be randomised to receive lipid and leukocyte filtration (intervention) or standard-filtration (control) during CPB. A validated cognitive test battery will be administered preoperatively and postoperatively at 1-month and 6-months. POCD will be determined using the Reliable Change Index. During surgery, blood samples will be taken for: LME quantification, leukocyte-analysis (total count, differentiation and activation) and neuron-specific enolase (NSE). NSE will be used as a biochemical marker of neurological injury. Retinal fluorescein angiographs (RFA) will be obtained intraoperatively to detect evidence of retinal-microembolic-induced vascular damage.

Discussion: The incidence of POCD is expected to be significantly less in the intervention group compared to the control group. LME, leukocytes, NSE-release and evidence of retinal microembolic-induced vascular damage are also expected to be significantly less in the intervention group. Results may advance perfusion practice and improve patient outcomes. Reducing the risk of POCD would be a major benefit of this study. Future work should include patients with an increased risk of neurological injury.

'A Randomised, Triple-Blind Study to Assess the Impact of Cell Salvage on ROTEM Analysis and Allogeneic Transfusions in Elective Cardiac Surgery: Is the Volume of Autologous Transfusion Associated With Coagulopathy'

- Rothwell, O.R.

Perfusion Department, Lancashire Cardiac Centre, Blackpool Teaching Hospital, Blackpool

Translational Health Sciences, Bristol Medical School, University of Bristol, Bristol

Excessive postoperative blood loss and allogeneic blood transfusions (ABT) are common complications of cardiac surgery requiring cardiopulmonary bypass (CPB). Cell savers (CS) are a popular blood conservation tool; however, their effectiveness in reducing allogeneic red blood cell (RBC) transfusions remains controversial, whilst it may even contribute to both increased transfusion of non-RBC allogeneic blood products and increased postoperative bleeding. Furthermore, these risks may be exacerbated with increased CS volumes. We hypothesize that clotting deficiencies will be observed in patients receiving CS blood, and these deficiencies will be associated with CS volumes. To test this hypothesis, 1144 elective cardiac surgery patients will be randomised in a triple-blind study to CS or no-CS treatment groups, with no-CS group receiving whole blood transfusion of the residual volume within the CPB circuit. Between-group comparisons to be assessed include: the proportion of patients receiving ABT; the number of units of ABT; coagulation time (CT), clot formation time (CFT), maximal clot firmness (MCF) using rotational thromboelastometry (ROTEM), and platelet count; and finally, chest tube drainage, length of stay on intensive care unit (ICU), and 30-day mortality. In addition, we will conduct a within-group analysis of the CS group, investigating the impact of different volumes of CS blood on ROTEM parameters. This research aims to contribute to current evidence regarding CS use in routine cardiac surgery, however addressing the many methodological limitations identified in previous studies. If expected outcomes are observed, we encourage careful consideration for appropriate CS use, with its utility judged on a case-by-case basis, based on the individual patient requirements. This may not only result in improved patient safety and reduced adverse events; but may also result in significant financial savings.

'A retrospective analysis and prospective survey to evaluate if clinical parameters show a trend that may predict an ECMO circuit change'

- Cheriyan, R[1,2], Pardoe, B. A.[2], Patel, B.V.[1,3]

1. Royal Brompton and Harefield NHS Foundation Trust, London; 2. Translational Health Sciences, Bristol Medical School, University of Bristol, Bristol 3. Faculty of Medicine, Department of Surgery & Cancer, Imperial College, London

Background: Circuit failure related to thrombosis is common in patients on extra corporeal membrane oxygenation (ECMO) support requiring a circuit change (CC). This study aims to audit assessment strategies employed by ECMO intensivists to justify need for CC and evaluate if clinical parameters show trends that may predict a CC.

Method: The first part of the study involved a prospective survey among ECMO intensivists at Royal Brompton Hospital. The second part involved a retrospective study in patients ≥16 years of age (n=109) who had at least one CC. The subgroup were patients with veno-arterial (VA-ECMO(n=21)) or veno-venous ECMO (VV-ECMO(n=88)) support. The VV-ECMO group included patients with single CC (n=27) and multiple CC(n=61).

Results: Values are presented as counts and frequency or median (interquartile range). The prospective survey shows that D-dimer (76.5%), fibrinogen (47.1%) and transmembrane pressure (TMP, (47.1%)) were commonly considered as indicators for CC. Others being post-oxygenator PO_2 (29.4%), arterial PO_2 (11.8%), plasma-free haemoglobin (17.6%), platelets (11.8%), blood-products usage (5.9%) and time on ECMO (5.9%).

The retrospective study shows that VV-ECMO group had longer ECMO support (11.6 (8.8-14.40) days) and longer stay in adult intensive care unit (34.4(26.8-48) days). The baseline values of alkaline phosphatase, platelet count, C-reactive protein, PCO_2 , and fibrinogen was higher and PO_2 was lower in the VV-ECMO group.

In the VA-ECMO groups, PCO_2 increased pre-CC and decreased post-CC. D-dimer and fibrinogen increased pre-CC but stabilised post-CC.

In VV-ECMO group platelets, haemoglobin and fibrinogen decreased pre-CC but stabilised post-CC. Serum calcium levels and TMP increased pre-CC. D-dimer level and PCO_2 increased pre-CC and decreased post-CC.

Conclusion: RBH ECMO CC protocol recommends PO_2, PCO_2, TMP and D-dimers as indicators of CC. This study shows that serum calcium level, fibrinogen, platelet and haemoglobin could be possible predictors of CC. Further research is required to establish their validity as predictors of CC.

'Chalice Medical Ltd. Paratherm - Update'
- Richard Hartshorne, Clinical Specialist, Chalice Medical

The presentation will update the Perfusion community on the status of the Chalice Medical Ltd. small ECMO heater Cooler, The Paratherm in terms of Mycobacterium Chimaera but also:

Public Health England.

Tests carried by Public Health England with regards to the Paratherm.

Environmental Concerns.

Concerns about cleaning agents entering the waste water system and the environmental impact. Trying to reduce the requirement for extra disposables or third-party components.

CE marking.

UK and Europe moving away from Medical Device Directive [MDD] to the more stringent Medical Device Regulation [MDR].

MDSAP

Medical Device Single Audit Program has been created to find a global approach to medical device regulation. At present MDSAP covers Australia, Brazil, Argentina, Venezuela, Santiago, Canada, Japan, and the World Health Organisation [WHO]. Other countries will join moving forward.

'Update Concerning MDR Implementation and Continuing Impact on Cardiac Surgery'

- Mike van Driel, Business Director Extracorporeal Technologies, Europe Middle East and Africa, Medtronic International

The Medical Device Requirements (MDR) are poised to enter into enforcement at the start of the coming calendar year in the European Union and will have a significant impact to perfusion and cardiac surgery, most specifically concerning device availability and new device development. The MDR has re classified a number of products used in Extracorporeal circulation including cannula and bioactive coated products and is driving significant resources and re investment by the industry partners that supply tubing packs, coagulation systems, cell savers and cannula to the market. This presentation will review the scope of these changes as enforcement by the European Union comes into being, how this affects the perfusion community in the United Kingdom and Ireland, and what we can expect in the future.

'Reservoir empty? Burnout, overload and moral fatigue in perfusion'

- Rosie Smith, Lead Perfusionist, Royal Brompton & Harefield NHS Foundation Trust

Perfusion is a high-stress profession often with long periods of intense concentration and occasionally emotionally or physically stressful situations, involving complex or emergent cases.

There is a growing understanding of how stress impacts the cognitive and technical performance of both the individual clinician and wider MDT.

The concept of 'overload' in theories of human factors is when there is a mismatch between capacity, load and state leading to an increased risk of errors in the clinical environment.

Perfusionists can be at risk of becoming overloaded as the 'load of task' i.e operating the heart-lung bypass machine is naturally complex and additional external factors such as fatigue and personal or environmental stress can quickly cause capacity to think to become compromised. Increased human factors training and lessons in recognising signs of overload, such as becoming overly task-focused, can help reduce mistakes.

Occupational burnout is a term used to describe a chronic state of mental, physical and emotional distress resulting from prolonged exposure to work demands and subsequent response to the organisational tasks, colleagues and clients. This concept is becoming more implicated in safety and outcomes with acute or chronic occupational stress having direct and indirect consequences on safety and quality of care.

Burning out is a real risk for perfusionist working in high-stress environments, experiencing emotional and physical exhaustion often under organisational pressures.

In order to mitigate the risks to the individual perfusionist and perfusion teams throughout the profession, we must first recognise and appreciate the effects of stress, overload and burnout. It is important to foster an environment of open communication regarding the subject, in order to reduce the stigma surrounding individuals feeling stressed or burnt out.

Continuing training on human factors, emotional resilience and recognition of the symptoms should be encouraged throughout the profession. Additionally, a focus should be put on the development of the team environment which has been continuously shown to have a major impact on the management of stress and burnout at an individual level.

'Perfusion in the Digital Age: The role of the Perfusion Bioinformatician'

- **Richard Issitt PhD[1,2,3]**

[1]Perfusion Department, Great Ormond Street Hospital, London, England

[2]Digital Research Environment, Great Ormond Street Hospital, London, England,

[3]British Heart Foundation Research Fellow

Following the publication of the Topol Review, it is clear that the emphasis within the NHS is shifting. Using digital technologies in combination with genomic and biosensor data to identify treatments tailored towards the individual will become routine. As part of this process, there are implications for the changing skill requirements of professionals providing care to patients, and the emerging subspecialties providing expertise in data science and bioinformatics as well as their own disciplines.

Over the last decade there has been a global move to ensure Perfusion records are electronically recorded. This has many benefits, but of greatest interest is the far higher fidelity of parameter recording. However, when this increase in recording results in repeated measures every few seconds, the ability of use standard statistical methodology for analysis is reduced. Furthermore, to utilise such information in a clinical setting, the integration of machine learning and artificial intelligence is required. Arise the role of the Perfusion Bioinformatician.

Here we discuss the relevance of genomic data and data science in Perfusion as well as how we can implement machine learning and artificial intelligence algorithms to identify key parameters in predicting outcomes. We'll briefly demonstrate how best to train and test these models across national and international databases. Finally, we'll discuss the creation of a new UK Perfusion Academic Network to facilitate national research and training as well as support Perfusionists wishing to pursue careers in academia and bioinformatics.

'3T Heater cooler management challenges 2003 to 2019'

- John Campbell, Chief Perfusionist, Trent Cardiac Centre, Nottingham University Hospitals Trust

The Stockert 3T has been the workhorse heater cooler in cardiac surgery both nationally, throughout Europe and the World. The tragic report of patients being diagnosed with Mycobacterium Chimaera infections following cardiac surgical procedures has required a concerted response from the manufacturer, government agencies and the Perfusion teams.

I would like to describe management of the reported outbreak and the subsequent steps taken to protect patients in our unit. These steps are based on the published guidance and the Field Safety Notices issued. This unprecedented situation has had catastrophic consequences for some patients and new cases are still being identified. Mycobacterium Chimaera has presented an opportunity to review how we safely work with water as a medium for temperature control during cardiopulmonary bypass.

The recommended manufacturer's interventions together with those of National Health Service England and Public Health England have had substantial implications. Compliance with the required interventions has been both costly in time and consumables.

There are valuable lessons to be learnt from the management of the outbreak. Communication is vital; the enormity of this situation may have led to some key information on testing methods not being clear at the time of the initial alert. Given the scale of the situation as a group we were looking for direction from our government agencies. Hopefully by examining the resulting response to the outbreak if a similar unfortunate event was to occur, we may have the necessary procedures in place to respond in a co-ordinated manner.

'Is there a population of adults who would benefit from Modified ultrafiltration'

- Sarah Goring, Clinical Perfusionist, Royal Brompton Hospital

Modified ultrafiltration is a technique commonly used in paediatric cardiac surgery to remove inflammatory mediators and excess fluid and is purported to improve organ function and reduce bleeding. In contrast, this technique is occasionally used on adult populations and could have potential benefits on outcomes. This literature review examines the evidence for modified ultrafiltration in adults, investigates how it may provide a benefit through inflammatory marker or volume removal and whether modified ultrafiltration should be routinely performed on populations of adults. Studies have shown that modified ultrafiltration can remove large volumes of fluid safely over short time periods although revision of Starling' law has cast questions over how this volume is removed. The evidence suggests that modified ultrafiltration has limited capacity to remove inflammatory markers although inflammatory moderation is implicated some studies. Individual differences in inflammatory response and different sampling techniques may be in part responsible for the heterogeneity of results in this area. Modified ultrafiltration reduces bleeding via an unknown mechanism in adults but is most likely to improve clinical outcomes in high-risk groups where severe bleeding is expected, and other comorbidities are present. Future research should focus on the testing the feasibility of modified ultrafiltration in complex high-risk cases in multi-centre trials.

'ECMO CPR at Wythenshawe'

- Alexandra Sheardown, Clinical Perfusionist, Manchester University Foundation Trust

Guest Speaker

'Cardiac surgery and extracorporeal circulation – Some moments in history'

- Colin Green

Sir James Mackenzie was a cardiologist at The London Hospital. In 1913 as a comment to the discussion on the possible treatment of babies and children with congenital heart disease, he stated "If the heart maintains the circulation well, no treatment is required. In more serious cases, beyond attending to the child's comfort and nutrition, special treatment of the heart is of little benefit"

The smallest baby known to have had an arterial switch and survive the procedure was Jerrick de Leon who, at the time of surgery on 6th February 2005 weighed 680 grams. He was born 13 weeks prematurely.

In the 92 years between these two events, both cardiac surgery and extracorporeal circulation have developed side by side resulting in techniques and equipment that make todays surgical procedures and extracorporeal circulation both appropriate and safe.

This presentation will mention some relevant moments in history as chosen by the author.