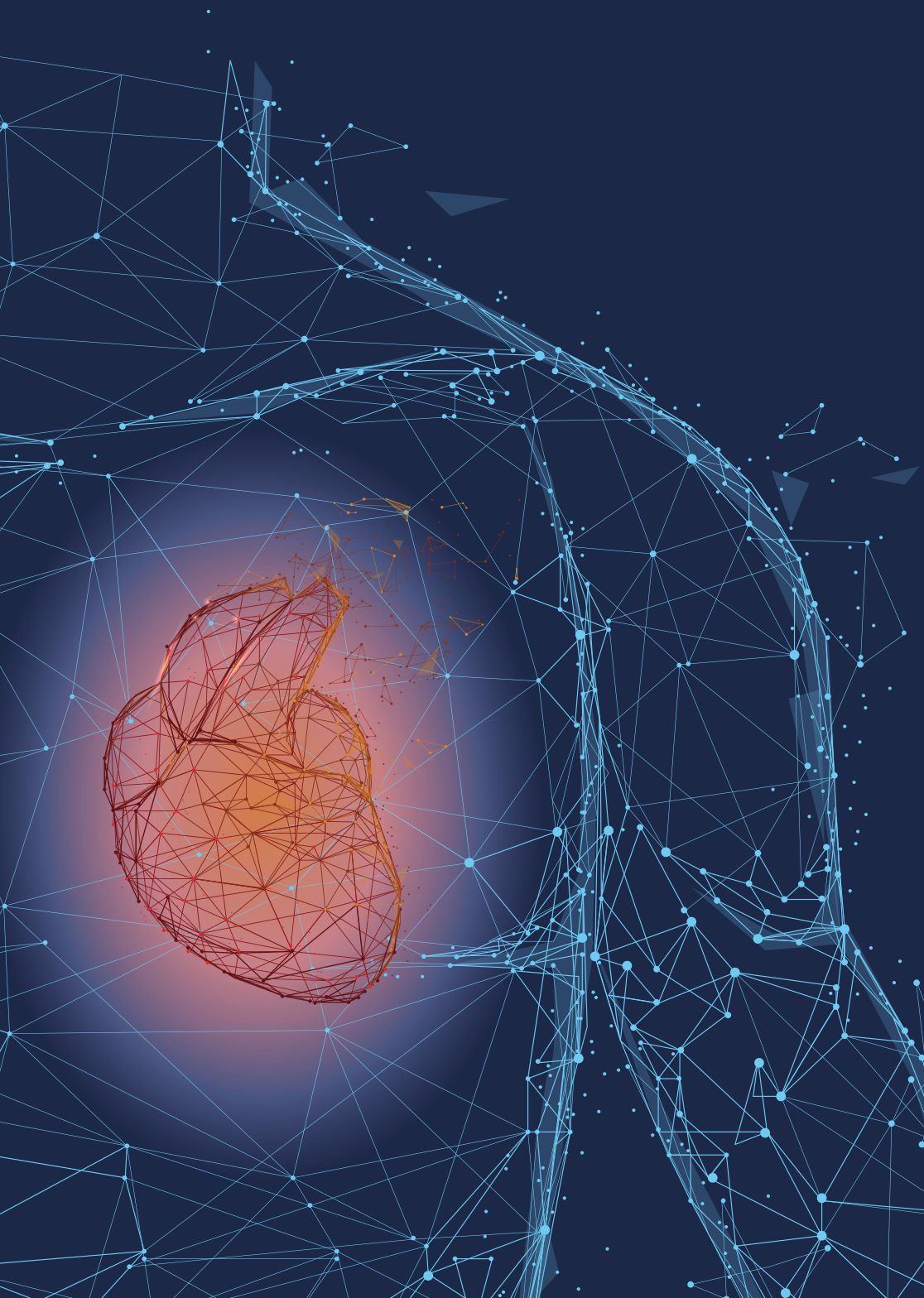
ISSUE 14

PRIME

Perfusion-Related Insights – Management and Evidence



Editorial Letter

It is with immense pleasure that we present the **14th** issue of **PRIME — "Perfusion-Related Insights – Management and Evidence"** — a quarterly scientific newsletter that includes review articles, recently published clinical studies, expert opinion, news, latest guidelines, quizzes and conference calendar on cardiopulmonary bypass (CPB) and perfusion strategies.

The current issue brings to you two interesting review articles under its first section, **'Specialty Insights.'** The first article of this section will talk about the **important factors influencing transfusion of red blood cell in coronary artery bypass graft patients undergoing cardiopulmonary bypass** and the second article will focus on **multimodal monitoring approach to manage cerebral function and perfusion during cardiopulmonary bypass.**

The second section, **'Journal Talk'** also includes summaries of two recently published clinical studies. The first study discusses about how **cardiopulmonary bypass flow rate influences renal oxygenation in patients undergoing cardiac operations.** The second study discusses about how to **minimise transfusions and blood loss in patients on dual antiplatelet therapy undergoing CPB.**

The third section, **'Expert Desk',** discusses **about comparative effect of alpha-stat and pH stat strategy during CPB on neurological outcome in children.** The fourth section, **'News Corner,'** presents the latest evidence on how **robotic heart surgery offers promising benefits compared to open heart surgery in intracardiac operations and coronary revascularization and tolvaptan—New Opportunity in fluid management after cardiopulmonary bypass.** The recommendations **on transfusion for foetuses, neonates and older children undergoing cardiac surgery with CPB** have been detailed out in the fifth section, titled **'Practice Pearls.'**

The sixth section, **'Mark Your Calendar',** will update you with the upcoming conferences in the field of cardiovascular medicine and surgery. And finally, get ready to tease your brain through our final section, **'Interactive capsule',** which will test your knowledge on CPB and perfusion.

We hope this newsletter enriches your knowledge with the current practices and research updates in the field of cardiopulmonary bypass and perfusion. Kindly let us know your comments and suggestions to help us improvise based on your feedback.

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PRIME Newsletter invites new authors for their contribution to the perfusion community. If you are interested in volunteering your time writing an article or a topic of your expertise and willingness to share your knowledge with our readers, we certainly encourage you to do so. We invite everyone interested in joining our team, and you can contact us at the email given below. Any amount of time that you can volunteer in adding to our quality of publication will be greatly appreciated. Thank you for your interest in PRIME Newsletter. What are you waiting for?

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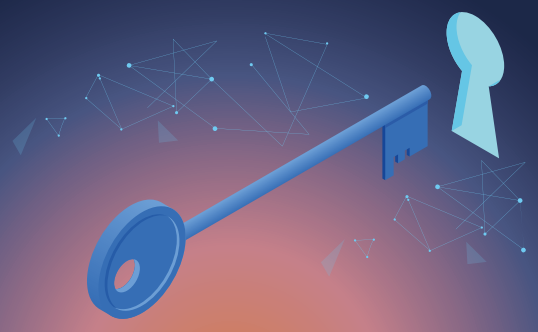
Specialty insights



Determinants of red blood cell transfusion in coronary artery bypass graft patients undergoing cardiopulmonary bypass

Blood management during cardiac surgery

While there are numerous intraoperative blood management interventions that have been studied in patients undergoing cardiac surgery, few have been identified through high-level evidence for incorporation into clinical management plans. Certain methods such as autologous prime (AP), intraoperative autotransfusion (IAT) and ultrafiltration (ULF) have received high-level classification, and others, such as acute normovolaemic haemodilution (ANH), fluid management, transfusion triggers using nadir haematocrit (Hct) both on and off cardiopulmonary bypass (CPB), are supported with strong evidence for their benefits in reducing the risk for transfusion.

Perioperative factors influencing transfusion

Perioperative methodologies have become critically important as first-line defences in blood management and have been extensively studied. Several studies have highlighted certain factors that influence transfusion of red blood cell in coronary artery bypass graft in patients undergoing cardiopulmonary bypass (Fig 1).

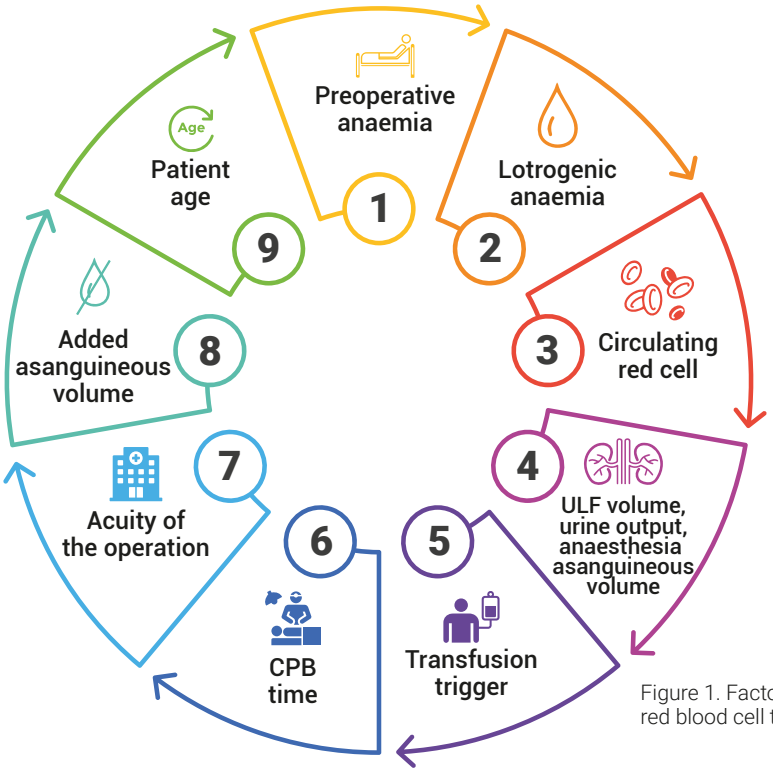


Figure 1. Factors influencing red blood cell transfusion

Results from 1-year survey conducted across 120 hospitals

A recent survey was conducted using data from the SCOPE (SpecialtyCare Operative Procedure Registry™) registry, containing data from over 120 American centers performing open heart surgery between January 2017 and December 2017. The study evaluated the distribution of intraoperative interventions in patients undergoing coronary artery bypass graft surgery with cardiopulmonary bypass.

The results of the survey were as follows:

- Of the hospitals reviewed, 31 hospitals with the lowest transfusion rates fell into the first quartile (low transfusion group, n = 3,186 patients), while 29 hospitals with the highest transfusion rates were in the fourth quartile (high transfusion group, n = 2,561).
- Patients in the low transfusion group had red blood cell transfusion rate of 5.5%, while the high transfusion group was 28.3%.
- Patient age, asanguineous volume added during CPB, and the lowest Hct transfusion trigger were all positively associated with transfusion, whereas, factors to reduce the likelihood for transfusion were the first Hct in the OR, first Hct on CPB, and Nadler estimated blood volume (Fig 2).
- In the low transfusion group, nadir haematocrit on–cardiopulmonary bypass averaged 1.6% lower and 3.0% lower in transfusion post–cardiopulmonary bypass.
- The uses of AP and ANH during cardiac surgery are attractive blood management intervention since they reduce both haemodilution and RBC transfusion.
- Mixed-effects logistic regression identified first in the operating room and first on cardiopulmonary bypass haematocrit, estimated blood volume and nadir haematocrit transfusion trigger as the strongest predictors for red blood cell transfusion.

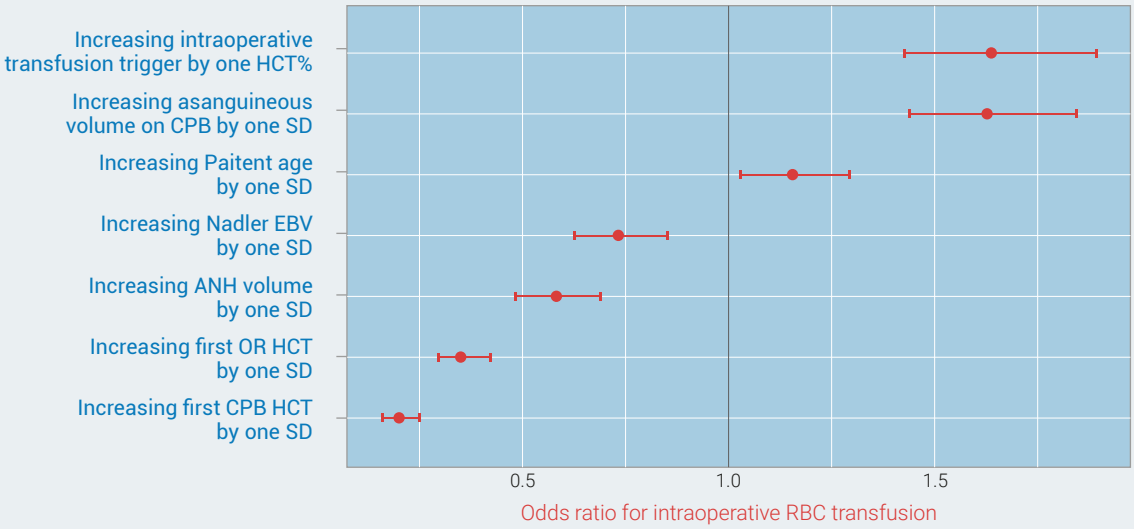


Figure 2. Top seven factors influencing odds of intraoperative RBC transfusion, accounting for 95% of patient/case-level variation.

Conclusion

Most important factors influencing transfusion:

- Risk of transfusion was influenced by the first Hct in the OR and first Hct on CPB
- Likelihood of receiving allogeneic RBCs was influenced by time on CPB and emergent non-elective procedures influence.

Reference
Stammers AH, Tesdahl EA, Mongero LB, et al. The effect of various blood management strategies on intraoperative red blood cell transfusion in first-time coronary artery bypass graft patients. Perfusion. 2019 Aug 21:267659119867004.

Multimodal monitoring approach to manage cerebral function and perfusion during cardiopulmonary bypass

Introduction

Cardiopulmonary bypass poses an increasing challenge for the health care systems due to the risk of neurological complications, particularly cerebral disorders. Pathophysiological processes that lead to cerebral disorders in these patients are mainly, hypoperfusion and embolism. However, in many clinical centres, routine cardiac surgery procedures are still performed without combined or even single mode neuromonitoring. Literature indicates that cerebral function and haemodynamics are too complicated to be managed by single monitoring modality. Hence, intraoperative neuromonitoring with multimodal approach may provide a superior alternative to single mode

neuromonitoring for continuous and non-invasive control of cerebral perfusion and function.

Neuromonitoring modalities

Thudium M, *et al.* in an observational study compared the advantages and limitations of some of the routine monitoring tools such as Near Infrared Spectroscopy (NIRS), Bispectral Index (BIS) and transcranial Doppler (TCD) sonography that are generally used for the detection of cerebral function and perfusion deficits during cardiopulmonary bypass in a regular clinical setting.

NIRS

- **Advantages:** Monitoring of cerebral oxygenation and metabolism
- **Limitation:** Low spatial resolution

BIS

- **Advantages:** Monitoring of electrophysiological and functional aspects of the brain
- May allow the detection of cerebral hypoperfusion
- **Limitation:** Interaction with anesthetics

TCD

- **Advantages:** Used to determine the limits of cerebral autoregulation in combination with NIRS as well as EEG
- **Limitation:** High interindividual variability

The observational study included 32 patients of age group 41-82 years who had undergone elective on-pump open heart surgery. In total, NIRS, BIS, and TCD values from 229 different time points were collected with 32 consecutive patients being monitored and recorded.

Compared to NIRS as well as BIS monitoring, relative MCAV (middle cerebral artery flow velocity) values showed a wide interindividual variability (range 0.39-2.19). Out of total 229 measurements, large number of BIS values (82) compared to only 30 NIRS and 12 TCD values were lying outside these predefined limits (Figure). TCD monitoring identified two patients with disturbed cerebral autoregulation, whereas NIRS was significantly associated with systemic haemoglobin levels. Also, patients with relative MCAV values >1.0 had a higher risk of developing postoperative delirium.

Conclusion

Each of the individual monitoring components have their own limitations. Hence multimodal neuromonitoring approach may help to integrate various qualities and adequately cover important aspects of cerebral oxygenation, haemodynamics, and electrophysiology. Such an approach may help to reduce these limitations and provide more patient safety during cardiopulmonary bypass.

The predefined threshold levels of each monitoring modality:TCD, decrease from baseline MCAV by more than 50% oran increase by more than two-fold or absolute values below 20 cm/s; NIRS, >20% decrease in rSO_2 from baseline values or absolute values below 50%; BIS, absolute values below 40.

Reference
Thudium M, Heinze I, Ellerkmann RK, et al.Cerebral Function and Perfusion during Cardiopulmonary Bypass: A Plea for a Multimodal Monitoring Approach.Heart Surg Forum. 2018 Jan 31;21(1): E028-E035.

Journal talk

Cardiopulmonary Bypass Flow rate influences Renal Oxygenation in Patients undergoing Cardiac Operations

Aim: A study by Lannemyr L, *et. al.* evaluated the impact of CPB flow rates on renal oxygenation in patients undergoing cardiac operations.

P Population / Patient

The study included 17 patients with normal serum creatinine undergoing normothermic CPB. The patients included were men of:

- Age 69+10 years
- Had Left ventricular ejection fraction 0.58+0.04
- Preoperative serum creatinine 86+12 mmol/l
- Body surface area, 1.95+0.22 m^2

I Intervention/ Indicator

The CPB circuit consisted of an Inspire 8 oxygenator and an Inspire hard-shell venous reservoir. Three levels of CPB flow rate, 2.4, 2.7 and 3.0 $l.min^{-1}.m^{-2}$ were tested consecutively in all patients in a randomly determined order.

C Comparator/ Control

CPB was initiated at a baseline flow rate of 2.4 $l.min^{-1}.m^{-2}$ in all patients.

O Outcome

Systemic variables

- At CPB flow rate of 2.4 L. $min^{-1}.m^{-2}$, CVP, serum hemoglobin, and SVRI decreased, whereas DO_2I increased compared to pre-CPB level.
- At CPB flow rates of 2.7 and 3.0 L $min^{-1}.m^{-2}$, MAP (6% to 9%, *P*= 0.003), renal perfusion pressure (7% to 9%, *P* = 0.007), SvO_2 (4% to 7%, *P* < 0.001), and DO_2I (16% to 28%, *P* <0.001) increased, whereas SVRI (−4to−12%, *P* < 0.001) decreased compared with CPB flow rate of 2.4 L. $min^{-1}.m^{-2}$

Renal variables

- At CPB flow rate of 2.4 L. $min^{-1}.m^{-2}$, renal oxygen extraction increased by 30% versus pre-CPB (*P* < 0.05) whereas at 2.7 and 3.0 L $min^{-1}.m^{-2}$ renal oxygen extraction was 12% (*P* < 0.05) and 23% (*P* < 0.01) lower, respectively, compared with 2.4 L. $min^{-1}.m^{-2}$.
- This corresponds to 14% and 30% improvement respectively of renal oxygen supply/demand relationship.

Conclusion

Higher CPB flow rates improve renal oxygenation, due to increased renal oxygen delivery with maintained or reduced oxygen consumption compared to conventionally used CPB flow rate.

RO_2Ex – Renal oxygen extraction DO_2I – systemic oxygen delivery index; SVRI – systemic vascular resistance index SvO_2 – mixed venous oxygen saturation MAP – Mean arterial pressure CVP – Central venous pressure CPB – Cardiopulmonary bypass FF – Renal filtration fraction

Reference

Lannemyr L, Bragadottir G, Hjärpe A, *et al.* Impact of Cardiopulmonary Bypass Flow on Renal Oxygenation in Patients Undergoing Cardiac Operations. *Ann Thorac Surg.* 2019 Feb;107(2):505-511.

A strategy to minimise transfusions and blood loss in patients on dual antiplatelet therapy undergoing CPB

Aim: A study by Karlsson M, *et al.* evaluated the use of heparin-coated CPB adjunct to low-dose systemic heparin and cell salvage in coronary artery bypass surgical patients preoperatively treated with ticagrelor and aspirin.

Population / Patient

The study included 60 patients scheduled for urgent coronary artery bypass surgery who were prospectively randomised into study group (N=30) and control group (N=30). The patients included were:

- Of age <80 years
- On DAPT with ticagrelor (90 mg × 2) and aspirin (75 mg)
- Ticagrelor was withdrawn <96 hours prior to surgery

Intervention/ Indicator

In study group, CPB combined a closed Cortiva® heparin-coated circuit with low systemic heparinisation (activated clotting time < 250 seconds) and intraoperative cell salvage. Total heparin dose during CPB: 14,245 ± 3,203 IU

Comparator/ Control

The control group used a Balance® coated open circuit, full systemic heparinisation (activated clotting time > 480 seconds) and conventional cardiotomy suction. Total heparin dose during CPB40, 117 ± 7,631 IU in the control group ($p < 0.001$).

Outcome

- Postoperative blood loss was reduced by about 50% in the study group compared to control group (554 ± 224 ml vs. 1,100 ± 989 ml, $p < 0.001$)
- Number of patients receiving packed red transfusions reduced by 88% in the study group compared to control group (7% vs 53%, $p < 0.001$)
- Haemoglobin plasma concentrations decreased more among control than study group patients (-28 ± 15 versus -40 ± 14 g/l ($p = 0.004$).
- Reduction in the platelet count was more among control than study group patients (-35 ± 36 versus -82 ± 67 × 10 /l ($p< 0.01$).
- Indices of rotational thromboelastometry showed shorter clotting times within internal and external pathway in the study group compared to control group.
- ROTEM and Multiplate analysis confirmed that platelet function was inhibited by aspirin and not by ticagrelor and showed no intergroup differences.

Conclusion

In patients taking DAPT preoperatively, the study protocol reduced post operative blood loss and transfusions without changing platelet function.

DAPT – Dual antiplatelet therapy CPB – Cardiopulmonary bypass ROTEM – Rotational thromboelastometry

Reference

Karlsson M, Hannuksela M, Appelblad M, *et al.* Cardiopulmonary bypass and dual antiplatelet therapy: a strategy to minimise transfusions and blood loss. Perfusion. 2019 Aug 24:267659119867005.

Expert Desk

Effect of alpha-stat or pH stat strategy during CPB on neurological outcome in children

Contributed by Nair R, Sir Gangaram Hospital, New Delhi

Currently, alpha-stat or pH stat strategy is used to manage blood acid-base during hypothermic CPB. A study aimed to compare perioperative neurologic outcome in children undergoing cardiac operations using alpha-stat and pH stat strategies during hypothermic cardio-pulmonary bypass.

Materials and Methods

The study included 493 children below 14 years of age who were undergoing a variety of open-heart procedures. Children who were associated with extra cardiac defects were excluded.

Discussion

In the alpha stat method, arterial CO_2 tension (PCO_2) is maintained at 40 mmHg when the sample is measured at 37°C and is not corrected for the patient's temperature. In the pH stat method, arterial PCO_2 is maintained at 40mmHg and is corrected to a patient's hypothermic temperature to maintain a pH of 7.40. Because the pH of blood becomes more alkalotic during hypothermia, CO_2 must be added to the blood during the cooling phase on CPB.

The alpha-stat strategy of pH management during hypothermia is based on the premise that cellular functions is best preserved by maintaining neutral pH appropriate to the temperature of the cell. To achieve this, the pH is allowed to rise naturally with cooling so that, at 20°C the pH measured is approximately 7.70 and at 37°C, the pH measured will always be 7.40 when the alpha-stat method is used. This strategy also results in a constant ratio (alpha) of dissociated to non-dissociated imidazole groups of histidine, an essential component of the protein buffer system- hence the term "alpha-stat".

The pH stat strategy is achieved by the addition of CO_2 to the oxygenator gas mixture during cooling, which results in a pH and PCO_2 profile. This is adjusted in such manner so as to remain unchanged at patient temperature. The more acidic pH-stat strategy shifts the oxy-haemoglobin dissociation curve to the right, increasing the availability of oxygen at the tissue level and balancing the shift to the left caused by hypothermia. The relative acidosis produced by the pH stat strategy also serves as a stimulus for cerebral vasodilation, resulting in a 1.5 to 2 times increase in cerebral blood flow at 26°C as compared to alpha stat strategy.

Also, the rate of brain oxygen depletion during DHCA is considerably slower with pH stat than the alpha stat management. The pH stat management was found to substantially prolong the interval between onset of arrest and exhaustion of brain oxygen stores. At profound hypothermia (17°C), pH-stat management reduces brain oxygen consumption by 30-40% compared to alpha stat management.

The pH-stat strategy during CPB may protect the immature brain from hypoxic-ischemic damage by several mechanisms. Through increase in pH-stat CO_2, there is an increase in cerebral blood flow and cerebral oxygen delivery. This may prevent cerebral hypoperfusion during CPB.

The pH-stat strategy improves brain cooling efficiency during CPB by allowing all brain regions to cool more rapidly and homogeneously. It also increases cortical oxygen consumption, thereby slowing cerebral deoxygenation during DHCA. Improved cerebral hypothermia confers better brain protection.

Conclusion

pH-stat strategy may be a superior strategy for blood gas management during hypothermic CPB in Infants and children.

NEWS CORNER

Tolvaptan—New opportunity in fluid management after cardiopulmonary bypass

Patients undergoing cardiac surgery with the support of cardiopulmonary bypass (CPB) are generally prone to exaggerated positive fluid balance. This may increase the risk of postoperative morbidity, including acute kidney injury (AKI) and mortality.

Currently, patients who suffer from massive fluid retention after cardiac surgery are mainly treated with high doses of loop diuretics, aldosterone antagonists, and natriuretic peptides. However, these treatment options may cause adverse effects such as deterioration of renal function, hyperkalaemia, or arterial hypotension.

Evidence suggests that tolvaptan can be considered as one of the promising treatment options in the management of these patients. Tolvaptan, an orally administered selective competitive antagonist of the arginine-vasopressin receptor 2, was developed in Japan about 20 years ago.

Bellos and colleagues through meta-analysis evaluated the effects of tolvaptan compared to conventional diuretic treatment from 3 randomized controlled trials (RCTs) and 7 observational studies. Out of 795 patients included in the analysis, 397 received tolvaptan postoperatively and 398 received convention aldiuretic treatment (furosemide or spironolactone). The study revealed that patients receiving tolvaptan can return to preoperative body weight much faster and had a shorter length of hospital stay (mean difference, -1.48 days; 95% CI, -1.92 to -1.03; 520 patients). Also, the incidence of postoperative AKI was found to be significantly lower in patients treated with tolvaptan (odds ratio, 0.34; 95% CI, 0.16 to 0.69). In addition, tolvaptan increased sodium levels (mean difference, 2.85 mEq/l; 95% CI, 1.90 to 3.80) and ameliorated congestion symptoms in patients with acute and chronic CHF.

Conclusion

Tolvaptan is a safe and effective alternative or supplement to conventional treatment for fluid retention in patients after cardiac surgery.

Reference

Hollinger A, Bolliger D. Tolvaptan-New Opportunity in Fluid Management After Cardiopulmonary Bypass. *J CardiothoracVascAnesth.* 2019 Aug;33(8):2180-2182.

Robotic heart surgery offers promising benefits vs. open heart surgery in intracardiac operations and coronary revascularization

Robotic surgery has seen major positive developments in cardiac surgery over the last two decades. Currently, the application of robotic cardiac surgery extends to the therapeutic areas of intracardiac operations and coronary revascularization. Robotic cardiac surgery offers promising benefits vs. traditional approaches in these areas with its good tolerability and efficacy data. Some of its procedures are associated with shorter hospital stays and reductions in complications like major cardiac or cerebrovascular complications when compared to traditional approaches, despite needing longer operative time. These advantages of robotic surgery have led to the conduction of robotic cardiac surgery programs across the globe.

Robotic techniques for coronary revascularisation include Arrested Heart Totally Endoscopic Coronary Bypass (AHTECAB), Beating Heart TECAB and minimally invasive direct coronary artery bypass graft (MIDCABG), which involves endoscopically harvesting the left internal mammary artery (LIMA). Single-bypass robotic surgery has been shown to be associated with lower postoperative stroke rates and requirements for blood transfusions. Although several reports have demonstrated TECAB with high conversion rates, analysis of 164 consecutive cases of beating heart TECAB not requiring any conversion suggest that detailed preoperative planning, well-executed surgical steps, and maintaining good communication with the operating team may prevent open conversions. MIDCAB and TECAB have similar outcomes in terms of perioperative analysis and mid-term follow-up; however, evidence shows that TECAB carries low operative risks and offers good early vessel patency. Also, lower rates of cerebrovascular or cardiac events have been found with TECAB as compared to conventional CABG. On the other hand, the use of robotic CABG has been shown to reduce operative durations, need for blood transfusions, and shorter post-operative stay.

The heart port system adopted for mitral valve surgeries since 1990 offers minimally invasive procedure with smaller incisions. It has been perceived as the one which is more beneficial for patients in terms of shorter hospital length of stay, cosmesis, and shorter time until return to preoperative level of function, when compared to a sternotomy approach. Five incisions of 1–2 cm in length together with femoral cannulation are used to operate on the mitral valve with positive outcomes. A totally endoscopic robot-assisted mitral valve repair technique in 127 patients observed a 94% success rate. Furthermore, the largest study in 2012 with the same technique done in 540 patients yielded high successful repair rates as well as low conversion rates to sternotomy.

For the past 30 years, there have been multiple versions of the Cox-Maze procedure which is the gold standard surgical treatment for atrial fibrillation (AF). The 'mini maze' procedure is, in fact, a minimally invasive variant of the same. Robotics in AF ablations with their safety and efficacy have shown been to offer encouraging success rates and minimal complication rates.

Left ventricular lead implantation is an important part of cardiac resynchronisation therapy. Long-term follow-up studies with the use of robotics in this area have demonstrated good implant performance at 12 months and significant improvements in left ventricular ejection fraction (LVEF). Percutaneous device closure is currently the preferred approach for atrial septal defects (ASD). Many ASD closures are performed on young candidates, thus the benefits of smaller incisions required for robot assisted surgery and faster recovery time are particularly most welcomed in this patient group. Robotic ASD closures offer the advantages of shorter ICU and total hospital length of stays, as well as the lower requirement for blood transfusions when compared to a traditional sternotomy.

Conclusion

Robotic heart surgery offers greater potential as compared to open heart surgery with respect to decreasing the risk of intra- and post-operative complications and duration of stay, particularly in a certain subset of patients. Hence, appropriate choice of patients along with well-trained cardiac surgeons play a major role in establishing robotic surgery as the standard preferred option to the traditional approach. For this, there is an imminent need to improve training programs, establish specialized robotic theatre teams and design randomized trials, to compare robotic and traditional operative approaches, which will facilitate better outcomes with robotic surgery.

Reference

Harky A, Chaplin G, Chan JS, *et al.* The future of open-heart surgery in the era of robotic and minimal surgical interventions. *Heart, Lung and Circulation.* 2019 May.

Practice Pearls

Guidelines on transfusion for foetuses, neonates and older children undergoing cardiac surgery with CPB.

About 13% of red cell transfusions for children in the UK are done to support cardiac surgery. Some of the factors that contribute to this high blood use include the nature of the surgery and the coagulopathy associated with cardiopulmonary bypass (CPB). The guideline provides clear guidance to healthcare professionals on the management of transfusion in foetuses, neonates and older children. The guideline is a revision of the 2004 British Committee for Standards in Haematology (BCSH) guideline on transfusion in neonates and older children (BCSH, 2004).

Recommendations

Red blood cells

- A restrictive transfusion threshold of 70 g/l following CPB is recommended for stable children with non-cyanotic heart disease.
- In neonates (both cyanotic and non-cyanotic) or actively bleeding or unstable children following CPB, a higher Hb threshold may be appropriate, and signs of inadequate oxygen delivery can provide additional information to support transfusion.
- Blood used for cardiac surgery in neonates and infants should be used before the end of Day 5.
- Potassium concentrations should be checked in the bypass fluid before connecting to the patient to ensure that they are within the normal range. Individual paediatric cardiac surgery units should have their own internal guidance on the maximum acceptable potassium concentration in the circuit prior to commencing CPB, and measures to adjust the level if necessary, such as washing or ultrafiltration of the prime. If the bypass circuit potassium levels are noted to be unusually high such that they cannot be adjusted by normal procedures, an alternative red cell unit should be requested (with appropriate specification dependent on availability if the situation is urgent).

Cell salvage

- Red cell salvage is recommended for all neonates and children undergoing cardiac surgery with CPB.

Antifibrinolytics

- Antifibrinolytic therapy should be considered in neonates and children undergoing cardiac surgery who are at high risk of significant bleeding.

Haemostasis

- For clinically significant bleeding following CPB and platelet count <100x10^9/l, PT or APTT >1.5 times midpoint of normal range, fibrinogen <1.5 g/l specific component replacement may be warranted.

Reference

New HV, Berryman J, Bolton-Maggs PH, *et al.* Guidelines on transfusion for fetuses, neonates and older children. *Br J Haematol.* 2016 Dec;175(5):784-828.

Mark your calendar

13th Annual Conference of Venous Association of India

16th-19th January 2020

The Lalit, Mumbai, India

International Conference on IACS-India section meeting

21st-23rd February 2020

Delhi Pharmaceutical Sciences and Research University, New Delhi, India

26th International Conference on Cardiovascular and Thoracic Surgery

16th-17th March 2020

Hong Kong, China

Society for Cardiothoracic surgery in Great Britain and Ireland Annual meeting 2020

22th-24th March 2020

Newport, United Kingdom

2nd World Congress on Cardiac Sciences 2020

16th-17th April 2020

International Conference on Cardiology, Indian Institute of Science, Bengaluru, India

Interactive Capsule

1. At what point during CPB is it appropriate to turn off ventilation of the lungs?

a. After cardioplegic solution is begun by the perfusionist
b. Following clamping of the aorta
c. Following insertion of the SVC cannula
d. Following administration of heparin

Reference: Cheung AT, Smith MS, Heath M. Cardiopulmonary bypass: Preparations and initiation. Available from uptodate.com/contents/cardiopulmonary- bypass-preparations-and-initiation. Accessed on September 6th, 2019

2. A patient is being reviewed after cardiac surgery and his cardiac monitor is showing atrial fibrillation at a rate of 160 beats/ minute. The patient suddenly begins complaining of chest pain. What is the best treatment?

a. Administration of digoxin
b. Defibrillation
c. Cardioversion
d. Administration of flecainide

Reference: Hernández-Madrid A, Svendsen JH. Cardioversion for atrial fibrillation in current European practice: Results of the European Heart Rhythm Association survey. Europace. 2013;15(6):915-8.

3. Surgical valve repair is considered in chronic asymptomatic severe mitral regurgitation (MR) when left ventricular end systolic dimension is

a. ≥ 45 mm
b. < 40 mm
c. < 60 mm
d. None of the above

Reference: Otto CM. Timing of surgery in mitral regurgitation.Heart. 2003; 89(1):100–105.

4. The mottled-appearing purplish discoloura- tion of the skin on the toes seen in this patient after CABG is diagnostic of:

a. Cholesterol embolisation syndrome
b. Contrast nephropathy
c. Xanthomas
d. Gangrene

Reference: Devy L, Brunet-Possenti F. Cholesterol embolization after transcatheter aortic-valve replacement.N Engl J Med. 2016; 375:e25.

5. Which of the following is not part of the treatment of massive air embolism during cardiopulmonary bypass?

a. Continue CPB to flush out the air via the aortic root vent
b. Trendelenburg position
c. Vent aorta
d. Retrograde perfusion of SVC

Reference: Mills NL, Ochsner JL. Massive air embolism during cardiopulmonary bypass.Causes, prevention, and management. J ThoracCardiovasc Surg. 1980Nov;80(5):708-17.

6. During cardiopulmonary bypass, the risk of air embolism is greatest during:

a. Initiation of bypass
b. Termination of bypass
c. During intracardiac procedure
d. During flushing of vein grafts with cardioplegia

Reference: Sarkar M, Prabhu V. Basics of cardiopulmonary bypass. Indian J Anaesth. 2017;61(9):760–767.

7. Which of the following leads to the greatest reduction in myocardial oxygen requirement during cardiopulmonary bypass?

a. Fibrillating heart
b. Hyperkalaemic cardiac arrest
c. Hypothermic arrest
d. Empty beating heart

Reference: Ismail A, Miskolczi SY. Cardiopulmonary Bypass. [Updated 2019 Feb 24]. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2019 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482190/. Accessed November 21, 2019.

8. Which of the following about perfusion during cardiopulmonary bypass (CPB) is FALSE?

a. Venous flows are maintained between 2-2.5 liters/min/m^2
b. Perfusion pressure is maintained between 50-70 mmHg
c. Complement is activated and consumed and thus complement factor C3a is decreased during CPB
d. Sole antegrade cardioplegia is adequate for coronary bypass surgery

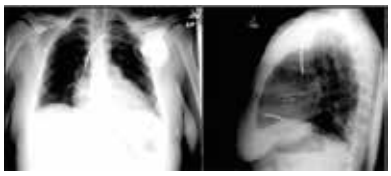
Reference: Ismail A, Miskolczi SY. Cardiopulmonary Bypass. [Updated 2019 Feb 24]. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2019 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482190/. Accessed November 21, 2019.

9. A 67-year-old man is admitted with an acute inferior wall MI. He is taken directly to the catheterization laboratory and is found to have an occluded RCA at coronary angiography. He has minor disease in the LAD. The most likely preexisting culprit lesion that precipitated the acute coronary occlusion is:

a. The highest-grade stenosis
b. The most proximal stenosis
c. A non-flow limiting (<50%) stenosis
d. A coronary aneurysm

Reference: Kim CX. *Myocardial infarction. In: Mayo Clinic Cardiology: Board Review Questions and Answers.* 1st ed. Canada: Mayo Clinic Scientific Press; 2018:109.

10. A 34-year-old woman underwent dual-chamber ICD implantation. She had a history of a VSD closure at birth with a persistent non-ischemic dilated cardiomyopathy with a reduced LVEF. After the device was implanted, the following chest X-ray was obtained.



a. Lead dislodgement
b. Pneumothorax
c. Cardiac perforation
d. Lead fracture

Reference: Bunch TJ. Cardiac electrophysiology. In: *Mayo Clinic Cardiology: Board Review Questions and Answers.* 1st ed. Canada: Mayo Clinic Scientific Press; 2018:33.

Answer: 1 - b, 2 - c, 3 - a, 4 - a, 5 - a, 6 - a, 7 - b, 8 - c, 9 - c, 10 - a

Designed and developed by

havas life sorento