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CRASH 2016:

Update in Cardiothoracic Anesthesia

The 2016-year promises to be another exciting and challenging one for practitioners in perioperative cardiac medicine. The objective of this lecture is to provide a snapshot of critical literature in the field of cardiothoracic anesthesia. As with last years presentation, I am taking a perioperative approach to this as I think it is critical that we as anesthesiology providers have an understanding of the issues our surgical, intensivist, and cardiology colleagues are focused on as well as our specific anesthesiology perspective in order to best plan for our patients.

It is clearly impossible to provide an in depth review of such a big topic – so I have tried to select a series of topics and will review the highlights of literature in each area. An overview of our topic choices is as follows:

- ECMO
- TAVR
- VAD
- Aortic Surgery
- Coagulation
    - Major Hemorrhage and appropriate transfusion
    - Red Cell storage
    - Point of Care Testing
    - Fibrinogen supplementation
- Patient Safety – FOCUS
- Cardiac revascularization

ECMO:

Extracorporeal membrane oxygenation (ECMO) has continued to increase in use and the number of programs reportedly implementing ECMO is rapidly expanding. Improvements in circuit design, oxygenator function, and cannulation strategies have opened up increasing clinical pathways to utilize ECMO. Increasing number of institutions have developed ECMO services or teams to use this modality to treat patients with severe respiratory failure, but also for cardiac failure, and to use in select CPR scenarios. Although a randomized controlled trial has not been performed to date, the updated 2015 AHA/ACC guidelines for CPR and ECC now state that E-CPR may be considered as an alternative to standard CPR in select patients with reversible causes of arrest [1]. Evidence for E-CPR is growing [2,3], with the CHEER trial publication this year

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demonstrating reasonable survival benefits in a protocolized application of E-CPR along with hypothermia. Although this observational trial only included 26 patients, the authors reported a survival with full neurologic recovery of 54% of patients. Additional concepts from this year include use of ECMO in the setting of myocarditits[4] as well as prediction of survival in settings of heart failure[2]. Finally, there remains debate about the best method to deal with LV distension that occurs following institution of veno-arterial ECMO, and the concept of using an intra-aortic balloon pump to offload the LV was explored [5].

TAVR / VAD:

Following the theme of cardiac technology, both TAVR and Ventricular Assist device (VAD) therapy have seen some important updates for in 2015. In a recent review for Seminars in Cardiothoracic and Vascular Anesthesiology, Dr. Cleveland summarized critical updates for both of these areas[6]. The Society of Thoracic Surgeons (STS) and American College of Cardiology (ACC) Transcatheter Valve Registry has become operational and it provides valuable insights into several aspects of TAVR. Most noteworthy is the data contained within this registry will be used for quality improvement and bench marking of TAVR centers. Important trends in TAVR growth are evident in the latest report of the TVT registry [7]. This latest TVT registry report demonstrates that the median age of patients in 2014 is 83 – compared to 84 in 2012. The risk factors remain similar – the typical TAVR patient is over 80, has several co-morbid conditions, and 80% have at least one frailty component present. Other interesting trends in this TVT report include a decrease in procedural mortality from 5.54% to 4.38%. 5 year data is now available from the Placement of Aortic Transcatheter Valves (PARTNER – I) - which is the only randomized trial comparing TAVR to surgically inoperable patients.[8] This particular arm compared TAVR to patients who were treated medically with balloon aortic valvuloplasty (BAV). The resultant mortality in the medical arm was 93.6% - confirming the dismal 5-year survival of untreated symptomatic, severe aortic stenosis. While the mortality in the TAVR group at 5 years was 71.8%, many died of their co-morbid conditions. The second arm of the PARTNER 1 study randomized 699 patients who were at high risk for Surgical AVR (SAVR) to either TAVR or SAVR. The 5-year data from this arm showed no difference in risk of death, 62% in surgical group versus 67% in the TAVR group[9].

Major advances in VAD therapy include CE Mark approval for the Heartmate 3 pump, which is a fully magnetically levitated pump eliminating the need for mechanical

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bearings. This has been a major design concern for longevity with previous pump systems as wear and tear on the bearings is thoguht to become a nidus for thrombosis. Increased blood flow within this pump reduces blood trauma, and there is now the ability for an artifical pulse. Approval was based on results of a 50 patient trial comparing outcomes with INTERMACs registry data [10]. The Heartware HVAD is another device approved for bridge to tranplant, and outcomes from the ADVANCE (Evaluation of the Heartware Left Ventricular Assist Device for the Treatment of Advanced Heart Failure) clinical trial became available with particular emphasis towards reducing the neurological events associated with this pump[11].

Aortic Surgery:

Aortic surgery remains a major surgical and anesthestic challenge, especially in cases involving the Thoracic Aorta and Aortic Arch. Optimal temperature management continues to be debated during arch surgery as techniques of antegrade cerebral perfusion continue to allow surgeons to improve cerebral protection. Angeloni et al completed a metanalysis looking at bilateral vs unilateral antegrade cerebral perfusion during the circulatory arrest period for total arch reconstruction[12]. The only difference that could be teased out between these groups was that longer circulatory arrest times affected mortality with unilateral cerebral perfusion but not bilateral. They concluded that unilateral was sufficient for constructions requiring<40 minutes, but that bilateral perfusion was optimal for longer cerebral perfusion times. These studies utilized surgeries with temperature at 24 C, however the question remains as to what temperature is acceptable. Two publications from Emory explore this topic looking at complex aortic repairs, as well as emergent dissection cases and they were able to demonstrate comparable outcomes using warmer temperatures (25-26 C) [13,14].

Bleeding and Coagulopathy:

Cardiac surgery continues to represent one of the major perioperative areas of blood product use besides trauma and liver transplant. As such, review of recent updates in the area of coagulation management is critical and constantly changing. Hot topics from 2015 include appropriate ratio use of blood products in massive transfusion, use of point of care testing, transfusion thresholds, and factor concentrates. Holcomb et al published the long anticipated results of the Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) Trial which incited a large number of editorial responses.[15] This trial reported

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that in patients with severe trauma and major bleeding, early administration of plasma, platelets, and red blood cells in a 1:1:1 ratio compared with a 1:1:2 ratio did not result in significant differences in mortality at 24 hours or at 30 days. However, more patients in the 1:1:1 group achieved hemostasis and fewer experienced death due to exsanguination by 24 hours. Two other major publications looked at the issue of transfusion triggers in the setting of cardiac disease and surgery. Murphy et al published results of the TITRe2 trial (2000 patients) and reported A restrictive transfusion threshold after cardiac surgery was not superior to a liberal threshold with respect to morbidity or health care costs.[16] Carson et al reported on results from the FOCUS trial looking at over 2000 patients with cardiac disease, and having hip surgery for outcome related to liberal vs restrictive transfusion strategies. They reported Liberal blood transfusion did not affect mortality compared with a restrictive transfusion strategy in a high-risk group of elderly patients with underlying cardiovascular disease or risk factors. The underlying causes of death did not differ between the trial groups. These findings do not support hypotheses that blood transfusion leads to long-term immunosuppression that is severe enough to affect long-term mortality rate by more than 20-25% or cause of death.[17] Finally – specific to RBC transfusions, debate has continued on age of PRBC and outcomes. Steiner et al published results of their trial looking at this question in NEJM and reported that the duration of red-cell storage was not associated with significant differences in the change in MODS. We did not find that the transfusion of red cells stored for 10 days or less was superior to the transfusion of red cells stored for 21 days or more among patients 12 years of age or older who were undergoing complex cardiac surgery.[18]

Point of Care testing is a frequent topic for coagulation management and cardiac surgery. Corredor et al published a review and meta-analysis looking at over 30 observational and 9 randomized studies examining the utility of POC testing in 4000+ patients. [19] Overall conclusions support incorporation of point-of-care platelet function tests into transfusion management algorithms is associated with a reduction in blood loss and transfusion requirements in cardiac surgery patients. Karkouti et al published a similar trial this year in Anesthesiology with a similar conclusion regarding use of a ROTEM based algorithm.[20] One of the interesting things we are learning about coagulation is the importance of various factors in the cascade and fibrinogen is gaining a lot of attention. With the availability of fibrinogen concentrate- there were two interesting publications

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from 2015 worth looking at. Rannucci et al published a "Randomized, double-blinded, placebo-controlled trial of fibrinogen concentrate supplementation after complex cardiac surgery" [21] which was a single-center, prospective, randomized, placebo-controlled, double-blinded study in one-hundred sixteen patients undergoing heart surgery with an expected cardiopulmonary bypass duration >90 minutes. They were able to demonstrate that fibrinogen concentrate limits postoperative bleeding after complex heart surgery, leading to a significant reduction in allogeneic blood products transfusions. The second trial by Jeppson et al, "Preoperative supplementation with fibrinogen concentrate in cardiac surgery: A randomized controlled study performed in 48 low-risk, coronary artery bypass grafting patients.[22] Findings in this study were that there was not an effect of Fibrinogen concentrate when given to this group of low risk patients with normal Fibrinogen, but the authors do suggest that further work should be done focused on patients with hypofibrinogenemia. Finally – regarding platelet activation and CPB, Kertai and colleagues published a study in over 4000 patients looking at the post-operative nadir platelet count with kidney injury. [23]They demonstrated that for every 30 x 10/l decrease in platelet counts, the risk for postoperative AKI increased by 14%.

In the past two years I have mentioned the issue of percutaneous cardiac interventions with coronary artery stenting and how it compares to CABG. This year brings a NEJM publication by Bangalore et al comparing registry outcomes between PCI using everolimus stents and CABG[24]. They report the risk of death associated with PCI with everolimus-eluting stents was similar to that associated with CABG. PCI was associated with a higher risk of myocardial infarction (among patients with incomplete revascularization) and repeat revascularization but a lower risk of stroke. The concepts of revascularization and choice of conduit choice has also been debated for years. This year, Guadino et al published results of a nice meta-analysis that details the current state of the various options for arterial grafts, as well as proposing a patient choice algorithm. [25] Critical for the anesthesiologist in this regard are positioning details, as well as pharmacologic therapy options if multiple arterial grafts are used[26].

The last section for this year is on patient safety initiatives. Beginning in 1999 the Institute of Medicine published a number of patient safety articles including their Seminal publication, "To Err Is Human" (1999) which reported 44,000 and 98,000 hospitalized people died each year from preventable medical errors. "Crossing the Quality Chasm" was

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published in 2001and highlighted deficiencies in quality in the American health care system and called for a complete system redesign. In response to this, the Society of Cardiovascular Anesthesiologists initiated a program named "FOCUS" (Flawless Operative Cardiovascular Unified Systems) to develop a funding mechanism for novel methodology in addressing patient safety issues in the cardiac OR. We are now seeing some of the fruits of this initiative with important publications coming out as a result of this funding. We will discuss two articles, one from Paulus et al, and the other from Thomson et al that are recent publications in this area and briefly explore the methodology that they have used to approach patient safety concerns in the OR. [27,28]

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