

# A Survey of Practices during Cardiopulmonary Bypass in India: An Indian Association of Cardiovascular and Thoracic Anesthesiologist Endeavor

## Abstract

**Context:** Cardiac anesthesiologists play a key role during the conduct of cardiopulmonary bypass (CPB). There are variations in the practice of CPB among extracorporeal technologists in India. **Aims:** The aim of this survey is to gather information on variations during the conduct of CPB in India. **Settings and Design:** This was an online conducted survey by Indian College of Cardiovascular Thoracic Anaesthesiologists. **Subjects and Methods:** Senior consultants heading cardiac anesthesia departments in both teaching and nonteaching centers (performing at least 15 cases a month) were contacted using an online questionnaire fielded using SurveyMonkey™ software. There were 33 questions focusing on institute information, perfusion practices, blood conservation on CPB; monitoring and anesthesia practices. **Results:** The response rate was 74.2% (187/252). Fifty-one (26%) centers were teaching centers; 18% centers performed more than 1000 cases annually. Crystalloid solution was the most common priming solution used. Twenty-three percent centers used corticosteroids routinely; methylprednisone was the most commonly used agent. The cardioplegia solution used by most responders was the one available commercially containing high potassium St. Thomas solution (55%), followed by Del Nido cardioplegia (33%). Majority of the responders used nasopharyngeal site to monitor intraoperative patient temperature. Antifibrinolytics were commonly used only in patients who were at high risk for bleeding by 51% of responders, while yet, another 39% used them routinely, and 11% never did. About 59% of the centers insist on only fresh blood (<7 days old) when blood transfusion was indicated. The facility to use vaporizer on CPB was available in 62% of the centers. All the teaching centers or high volume centers in India had access to transesophageal echocardiography probe and echo machine, with 51% using them routinely and 38% using them at least sometimes. **Conclusions:** There is a wide heterogeneity in CPB management protocols among various Indian cardiac surgery centers. The survey suggests that adherence to evidence-based and internationally accepted practices appears to be more prevalent in centers that have ongoing teaching programs and/or have high volumes, strengthening the need to devise guidelines by appropriate body to help bring in uniformity in CPB management to ensure patient safety and high quality of clinical care for best outcomes.

**Keywords:** Cardiopulmonary bypass survey, evidence based Best CPB practices, Indian Association of Cardiovascular Thoracic Anaesthesiologists/Indian College of Cardiac Anesthesia

## Introduction

From the first successful use of cardiopulmonary bypass (CPB) on May 6, 1953, to treat a woman with atrial septal defect, the technology of CPB has evolved to support the ever-widening range of cardiac surgery.<sup>[1]</sup> The successful conduct of CPB involves close communication between cardiac surgeon, perfusion technologist (often referred as clinical perfusionists) and anesthesiologist. Cardiac anesthesiologists play a key role in decision-making during various complex procedures during the conduct of CPB.

There are a number of surveys on CPB practices specific to various countries that have been published.<sup>[2-5]</sup> Recently, a global CPB survey on pump priming practices and anticoagulation has also been published.<sup>[6]</sup> Unfortunately, there was no Indian representation in that study. Based on anecdotal evidence, there exist differences in various aspects of CPB practice among Indian centers and no uniform practice guidelines are available for the management of a patient on CPB. The present survey was conducted with an aim to describe these variations and lay the foundation for

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common evidence-based practice guidelines specific to the Indian scenario. This is the survey conducted by the Indian College of Cardiac Anaesthesia (ICCA), which is the Research and Academic wing of the Indian Association of Cardiovascular Thoracic Anaesthesiologists (IACTA).

## Subjects and Methods

The concept of this survey was presented and approved in the executive council meeting of IACTA held in October 2017. The survey was developed by the authors and was tested in a pilot group of 10 participants, before sending the questionnaire to all participants. This survey was targeted at the head of departments/senior consultants (one representative per institute) of various teaching (fellowship in cardiac anesthesia/Diplomat of National Board Super Speciality Training/DM in cardiac anesthesia) as well as nonteaching centers across India who performs at least 15 cases a month. The questionnaire focused on institute infrastructure, perfusion practices, blood conservation during CPB; monitoring and anesthesia practices during CPB.

The questionnaire was fielded using SurveyMonkey™ software, and the link <https://www.surveymonkey.com/r/IACTA-CPB-SURVEY> was sent through E-mail. The E-mail message and questionnaire are appended [Appendix 1]. A follow-up E-mail was sent after 1 week to nonresponders and partial responders. Reminder mail was sent five times alternate day after yet another week; those who still did not respond despite the reminders were contacted on phone by IACTA office, and link was re-forwarded whenever there was technical issue with E-mail. The participation in the survey was voluntary and no incentives were offered to responders.

There were 33 multiple choice questions over 4 pages. The blinded responses were automatically archived by SurveyMonkey database and were retrieved later for analysis. Both complete and incomplete responses were analyzed. Checklist for Reporting Results of Internet E-Surveys was used for reporting the results of the survey.<sup>[7]</sup> The data were analyzed using the Statistical Package for Social Sciences (SPSS Inc., 2007. SPSS for Windows, Version 16.0. Chicago, IL, USA, SPSS Inc.).  $P < 0.05$  was considered statistically significant.

## Results

Data were collected from December 5, 2017, to January 15, 2018. The authors could obtain a list of 346 cardiac surgery units from India. Ninety-four centers, which reported to perform <15 cases monthly, were excluded as per the exclusion criteria. The survey links were sent through E-mails to 252 members, of which 10 (3.96%) mails did not reach the intended recipient, and seven recipients opted out of the survey. The response rate was 74.2% (187/252) of which 170 (91.90%) complete and 17 (9.1%) were

incomplete responses. The response of 151 respondents was considered statistically adequate for margin of error of 5%. Descriptive analysis was done on the basis of survey questions, and subgroup analysis was done to describe the salient points.

### Institute information

About 18% of responders were from high volume centers (with an annual caseload of more than 1000 cases), 20% from medium volume (annual caseload of 500–1000 cases) and 52% were low volume (annual caseload of 200–500 cases) centers. Fifty-one (26%) centers were teaching centers. The percentage of cases under CPB was low (<25%) in 38% of all cases, intermediate (25%–50% of cases) in 27% of centers, and high (>50% of cases) in 28% of centers.

### Perfusion practices

Crystalloid solution (Normal Saline or Ringers Lactate) was the most commonly used priming solution (45% of the centers) [Figure 1]. The other common additives added in CPB prime are represented in Figure 2. About 23% of centers used corticosteroids routinely, while 56% used them selectively, and methyl prednisolone being the most commonly used corticosteroid (61%) [Figure 3]. About 38% centers routinely administered an additional dose of antibiotics on CPB while 32% gave it only if surgical time exceeded 6 h [Figure 4]. Ultrafiltration was routinely used in 44% centers while other 31% used it selectively in patients with volume overload, heart failure, or chronic kidney disease. The most common cardioplegia used was commercially available high potassium containing St. Thomas solution (55%), followed by Del Nido cardioplegia (33%) [Figure 5]. Mild hypothermia was used by 49% centers; moderate hypothermia in 40% centers; and normothermia was used by 9% centers during CPB. Only a few (12.5%) centers continued to ventilate lungs with low-tidal volume during CPB. Arterial filters were either not available or not used in 18% centers, 24% used them

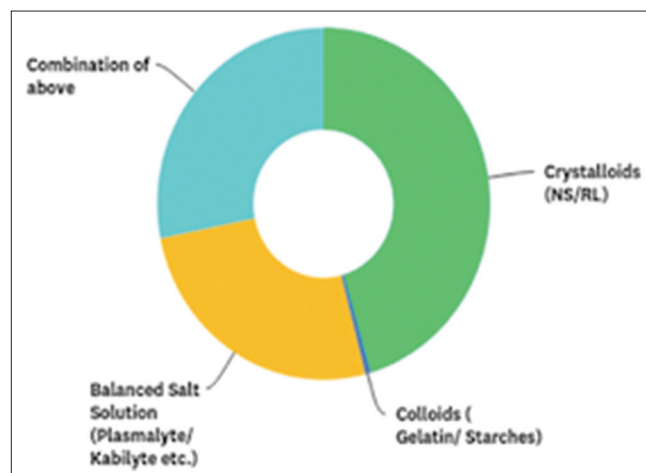


Figure 1: What is the most common priming solution used in your center?

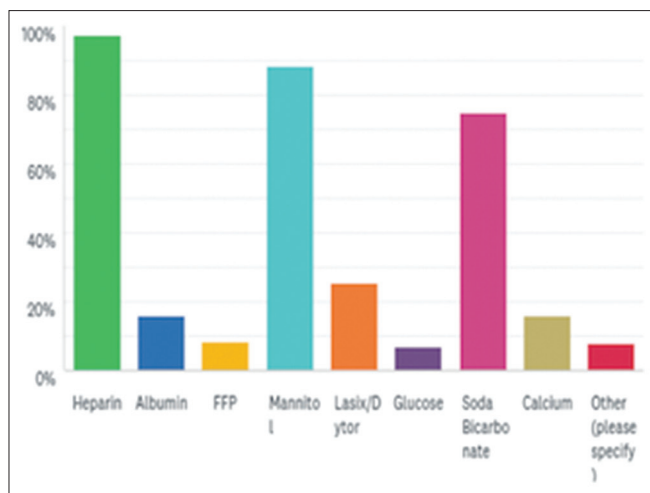


Figure 2: What are the common additives in cardiopulmonary bypass prime?

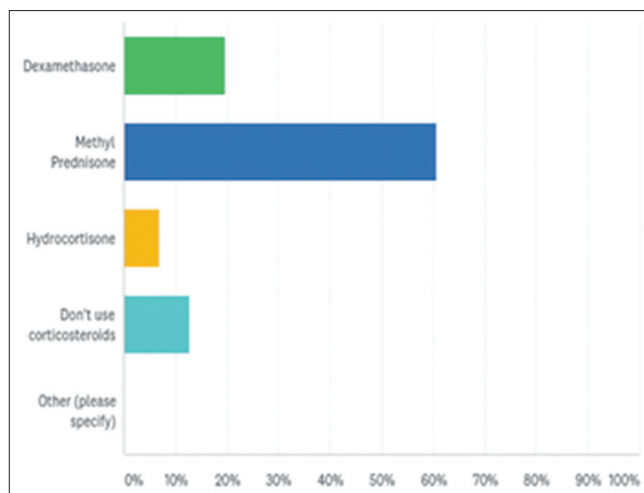


Figure 3: If corticosteroids are used, commonest drug used is

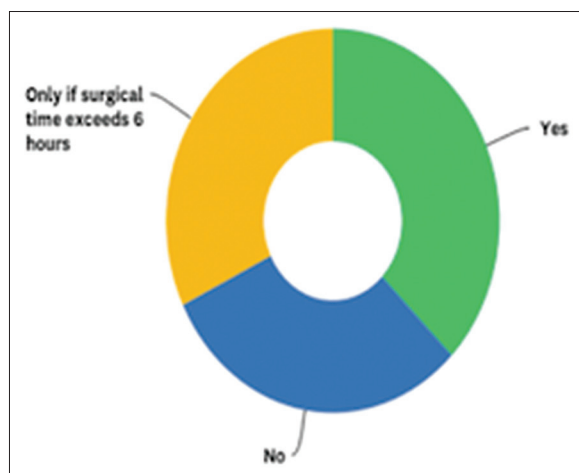


Figure 4: Do you give additional dose of antibiotics on cardiopulmonary bypass?

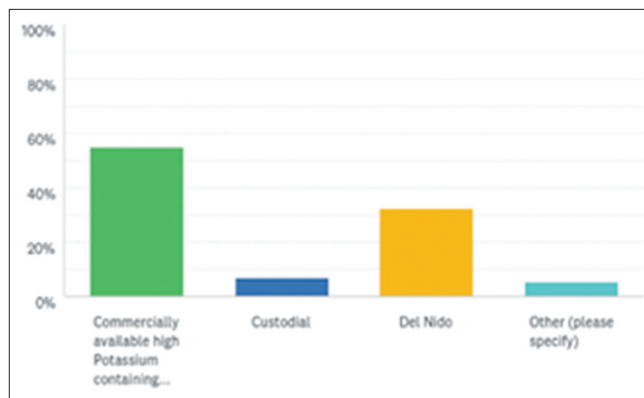


Figure 5: The most common type of cardioplegia used

only in high-risk cases while 58% used them routinely. The differences in perfusion practices existed between teaching and nonteaching centers and are as described in Table 1; as well as the volume of cases as described in Table 2.

### Blood conservation on cardiopulmonary bypass

The transfusion trigger hematocrit (at mild-to-moderate hypothermia) was <20 in 40% centers, 20–25 in 47% centers, and 25–30 in 11% centers. About 61% transfused blood based on the clinical context of the patient while in 38% made this decision on the basis of hemoglobin level alone. A mere 7% of centers routinely used retrograde autologous priming (RAP), whereas 58% of centers used them selectively; 35% of centers reported not using RAP at all [Figure 6]. Twenty-six percent centers practiced preoperative autologous donation of blood. A majority of the respondent centers (51%) used antifibrinolytics agents selectively in patients who were at high risk for bleeding, 39% use them routinely, and 11% avoided their use. The method of use of antifibrinolytic is quite heterogeneous

as demonstrated in Figure 7. As far as duration of packed cells transfused is concerned, 59% of the centers insisted on only packed red cells, those were <7 days old. The most common dosage of protamine: heparin used was 1 mg: 1 mg (65% centers) followed by 1:2 in 20% centers. The cell saver and point of care (POC) platelet tests were available in 41% and 31% centers, respectively. The differences in blood conservation strategies existed among centers based on teaching program and annual caseload [Tables 1 and 2, respectively].

### Monitoring and anesthesia practices

In all most all (97%) of the centers, the anesthesiologist was present all throughout the conduct of CPB and 95% centers reported that their surgical colleagues valued their opinion regarding CPB practices. The depth of anesthesia monitoring was not available in 50% of centers and only 10% used them routinely [Figure 8]. The facility to use vaporizer on CPB was available in 62% of the centers with sevoflurane being commonly used agent followed by isoflurane. Various other drugs administered during the conduct of CPB are shown in Figure 9. Majority of the centers had transesophageal

**Table 1: Differences in various cardiopulmonary bypass practices between teaching and nonteaching centers**

	All centers (187) (%)	Teaching centers; 51 (28%) (%)	Nonteaching centers; 136 (72%) (%)	P
Perfusion practices				
Corticosteroids use				
Routinely	44 (22)	7 (14)	27 (20)	<0.01
Selectively	104 (53)	34 (67)	69 (53)	
Never	38 (19)	9 (19)	37 (27)	
Ultrafiltration				
Yes	82 (42)	29 (57)	41 (34)	<0.01
No	40 (18)	7 (14)	41 (34)	
Selectively	58 (30)	15 (29)	40 (32)	
Target temperature				
Mild hypothermia	88 (45)	21 (41)	67 (49)	<0.01
Moderate hypothermia	75 (38)	21 (41)	53 (39)	
Low tidal volume ventilation during CPB	22 (11)	9 (18)	13 (10)	<0.01
Blood conservation on CPB				
Transfusion trigger				
<20	74 (38)	13 (26)	61 (45)	<0.01
20-25	87 (44)	31 (62)	56 (41)	
25-30	22 (12)	7 (14)	13 (10)	
Retrograde autologous priming				
Never	66 (34)	13 (26)	53 (39)	<0.01
Selectively	106 (54)	33 (65)	71 (52)	
Routinely	14 (7)	5 (9)	9 (7)	
Anti-fibrinolytic usage				
Never	19 (10)	3 (6)	16 (12)	<0.01
Selectively	97 (50)	30 (60)	65 (48)	
Routinely	70 (36)	18 (34)	52 (40)	
Cell saver availability	77 (39)	34 (67)	42 (31)	<0.01
POC platelet tests availability	57 (29)	25 (50)	29 (21.3)	<0.01
Monitoring/anesthesia practices				
TEE				
Not available/no	16 (8)	0	16 (12)	<0.01
Routinely	97 (47)	38 (76)	57 (42)	
Sometimes	69 (35)	12 (24)	58 (44)	
Depth of anesthesia monitoring				
Never/not available	93 (47)	13 (26)	80 (60)	<0.01
Routinely	18 (9)	7 (14)	11 (8)	
Selectively	76 (38)	31 (62)	42 (32)	
BSL monitoring				
All patients	149 (76)	43 (86)	103 (75)	<0.01
Only diabetics	37 (19)	8 (16)	29 (22)	

CPB: Cardiopulmonary bypass, POC: Point of care, TEE: Trans esophageal echocardiography, BSL: Blood sugar level

echocardiography (TEE) probe available for monitoring during a CPB case with 51% using them routinely and 38% using them at least once or based on clinical condition [Figure 10]. The vast majority of centers (79%) monitor online aortic line pressure. The most usual core temperature-monitoring site was nasopharynx (87%), followed by rectum (8%) and esophagus (5%). Eighty

percent of the centers monitor blood glucose during CPB in all cases irrespective of whether the patient is diabetic or not while remaining 20% monitored blood glucose only in diabetics. Nearly, all respondents (97%) suggested IACTA to generate evidence-based guidelines/recommendations, which would be unique and pertinent to the cardiac anesthesiologist in India for better patient

**Table 2: Differences in various cardiopulmonary bypass practices as per center volume**

	All centers (187) (%)	Low-volume centers; 101 (52%) (%)	Medium volume centers; 40 (20%) (%)	High-volume centers; 37 (18%) (%)	P
Perfusion practices					
Corticosteroids use					
Routinely	44 (22)	28 (28)	10 (25)	4 (10)	0.45
Selectively	104 (53)	53 (53)	22 (55)	25 (68)	
Never	38 (19)	19 (19)	8 (20)	7 (19)	
Ultrafiltration					
Yes	82 (42)	38 (38)	22 (55)	19 (52)	0.11
No	40 (18)	32 (32)	4 (10)	7 (19)	
Selectively	58 (30)	30 (30)	14 (35)	10 (27)	
Target temperature					
Mild hypothermia	88 (45)	52 (52)	19 (48)	14 (38)	0.49
Moderate hypothermia	75 (38)	37 (37)	16 (40)	16 (43)	
Low-tidal volume ventilation during CPB	22 (11)	11 (11)	6 (15)	5 (14)	0.62
Arterial line filters					
No/not available	33 (17)	20 (20)	7 (18)	5 (14)	0.71
Routinely	109 (56)	56 (56)	22 (55)	25 (68)	
Only in high risk cases	45 (23)	24 (24)	11 (28)	6 (16)	
Blood conservation on CPB					
Transfusion trigger					
<20	74 (38)	47 (47)	15 (38)	10 (27)	0.11
20-25	87 (44)	44 (44)	18 (45)	21 (57)	
25-30	22 (12)	9 (9)	4 (10)	4 (11)	
RAP					
Never	66 (34)	41 (41)	12 (30)	11 (30)	0.34
Selectively	106 (54)	54 (54)	24 (60)	21 (57)	
Routinely	14 (7)	5 (5)	4 (10)	3 (9)	
Anti-fibrinolytic usage					
Never	19 (10)	12 (12)	4 (10)	2 (5)	0.46
Selectively	97 (50)	48 (48)	22 (55)	18 (49)	
Routinely	70 (36)	40 (40)	14 (35)	14 (41)	
Cell saver availability	77 (39)	30 (30)	18 (45)	35 (68)	<0.01
POC platelet tests availability	57 (29)	20 (20)	19 (47)	14 (38)	<0.01
Monitoring/anesthesia practices					
TEE					
Not available/No	16 (8)	14 (14)	2 (5)	0	0.01
Routinely	97 (47)	43 (43)	22 (55)	26 (70)	
Sometimes	69 (35)	42 (42)	14 (35)	9 (24)	
Depth of anesthesia monitor					
Never/not available	93 (47)	64 (64)	17 (42)	7 (19)	<0.01
Routinely	18 (9)	10 (10)	4 (10)	4 (11)	
Selectively	76 (38)	26 (26)	19 (48)	24 (65)	
BSL monitoring					
All patients	149 (76)	79 (79)	31 (78)	28 (76)	0.65
Only diabetics	37 (19)	21 (21)	8 (20)	7 (19)	

CPB: Cardiopulmonary bypass, POC: Point of care, TEE: Transesophageal echocardiography, BSL: Blood sugar level, RAP: Retrograde autologous priming

care. There were differences in anesthesia practices among teaching or nonteaching centers and between centers based on caseload as demonstrated in Tables 1 and 2, respectively.

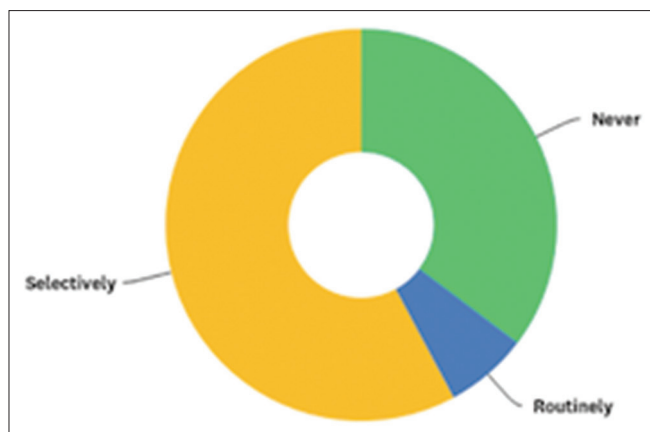


Figure 6: Do you use retrograde autologous priming?

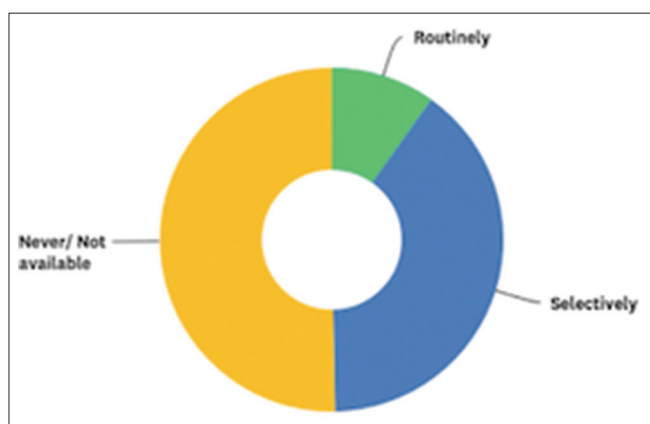


Figure 8: Do you routinely monitor the depth of anesthesia by bispectral index or similar monitoring (near infrared technology) on cardiopulmonary bypass?

## Discussion

This was a survey by IACTA/ICCA to understand the Indian practice pattern of various CPB-related management strategies. Overall, the teaching centers and high volume centers appear to be better equipped (TEE, cell savers, POC platelet function tests, arterial filters, and depth of anesthesia monitoring devices) and follow evidence-based best practices during CPB.

The aim of this survey by IACTA/ICCA was, to gather the information from Indian cardiac anesthesiologists about the various aspects of CPB practices, and to generate guidelines/evidence-based recommendations, which would be relevant to the Indian scenario. The cardiac anesthesiologist, as a part of the team, plays an important part in the decision-making regarding CPB practices. Their opinion is valued by their surgical and perfusion colleagues (as reported by 95% of the respondents); which can favorably affect patient care and outcome. Thus, this survey and subsequent guidelines may have a positive impact on patient care.

Off-pump coronary artery bypass grafting is a very common operation performed in India. Indeed, 38%

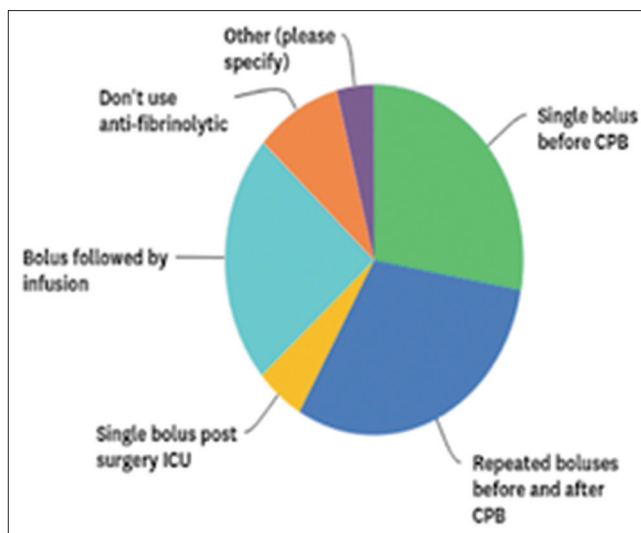


Figure 7: What is the method for the use of antifibrinolytic?

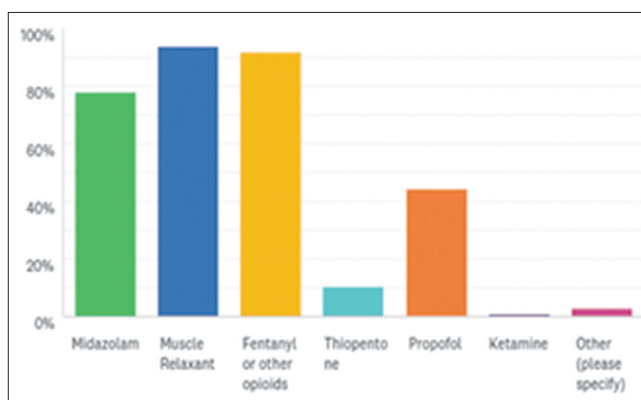
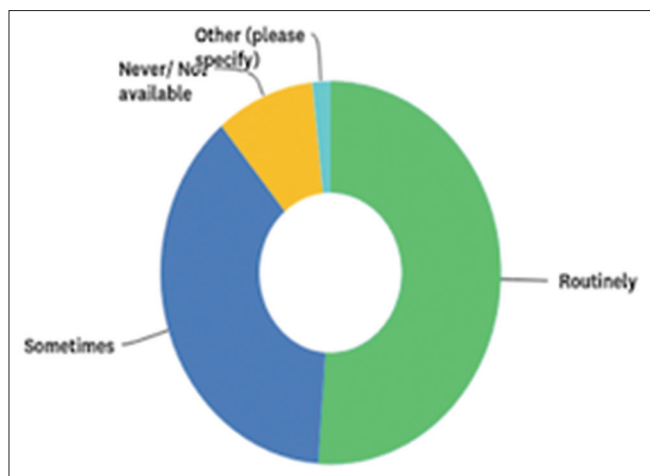


Figure 9: Which of these drugs you usually administer during the conduct of cardiopulmonary bypass?

of centers performed <25% of their total cardiac cases with CPB. The Indian practices of priming solutions on CPB are in consensus with global practices. The use of crystalloid as the commonest priming fluid (45%), with very rare use of colloid as priming solution (<1%) and use of RAP (58% selectively and 7% routinely) are similar to the global trends use of crystalloid as commonest priming solution (38%), use of colloid for priming in <1% of centers, and use of RAP (31% in North American and 16% Australian and New Zealand centers).<sup>[6]</sup> The use of Del Nido cardioplegia is gaining popularity even in India as evidenced by one-third Indian centers using it. Single center reports of propensity score-matched comparisons of del Nido cardioplegia to conventional cardioplegia solutions in various cardiac surgical procedures have yielded similar postoperative outcomes. These studies have demonstrated that the use of del Nido cardioplegia for myocardial preservation can lead to lower total volume and number of cardioplegia infusions, lower CPB, aortic cross-clamp, and operative times improved glucose management, and perhaps cost savings when compared to other solutions.<sup>[8]</sup> Still, there



**Figure 10: Do you use transesophageal echocardiography for cardiopulmonary bypass cases?**

is a need for more evidence to support the routine use of Del Nido cardioplegia.

The use of corticosteroid to reduce the inflammatory response to CPB is subject of various clinical trials in recent time, with most studies demonstrating no added advantage of corticosteroids.<sup>[9,10]</sup> Only 23% of Indian centers presently use corticosteroids routinely and 56% use them selectively, most common drug used being methylprednisone. Fewer teaching centers use corticosteroids routinely and even selectively as shown in Table 1. This issue could be an important point to be discussed when IACTA/ICCA guidelines are developed.

The most common site for monitoring the patient temperature was nasopharynx. In this survey, 49% centers used mild hypothermia and 39% used moderate hypothermia, while only 9% of centers use normothermia. This target temperature was similar irrespective of center volume as shown in Table 2. These monitoring sites were in accordance with recent Canadian survey on temperature monitoring and management practices.<sup>[11]</sup>

Postoperative pulmonary complications still are a leading cause of morbidity and mortality in cardiac surgery, with 25% patients experiencing them from fever with a cough to frank acute respiratory distress syndrome.<sup>[12]</sup> No one single therapy or procedure is proven to prevent or eliminate the incidence of lung injury after CPB. Evidence suggests that ventilation does play a key role,<sup>[13,14]</sup> and that, general consensus, ventilation or CPAP ought to be considered better than no ventilation at all. Fewer Indian centers (12.5%) use ventilation during CPB, with teaching centers using it more frequently (18%) than nonteaching institute (10%). It may be prudent for the committee recommending the standard practice of CPB to include ventilatory strategies during cardiac surgery.

Arterial line filters are important safety feature of CPB circuit, which prevent micro embolism and subsequent

end-organ damage.<sup>[15]</sup> About 58% of Indian centers use it routinely while 24% use it selectively; the use seems to be more prevalent in teaching and high volume centers [Tables 1 and 2]. Most probable reason for infrequent use appears to be economical.

In 2017, European associations of cardiac surgery and cardiac anesthesiology published guidelines on patient blood management for adult cardiac surgery.<sup>[16]</sup> It is recommended that transfusion should be based on clinical context rather than hemoglobin levels alone. Majority of (71%) of Indian centers seem to be practicing it. As far as duration of packed cells transfused is concerned, there is recent evidence that packed cells of any age do not have any impact on outcomes in cardiac surgery;<sup>[17,18]</sup> but still 60% of Indian centers seem to be insisting on fresh (<7 days old) packed red cells during cardiac surgery. This was similar across various volumes and teaching status of centers. Expectedly, the cell saver and POC platelet function tests were more prevalent in teaching and high volume centers [Tables 1 and 2]. The European on blood conservation during cardiac surgery recommend routine use of antifibrinolytics.<sup>[15]</sup> About 38% of Indian centers use them routinely and 51% centers use them selectively in patients who are at high risk of bleeding. The teaching centers seem to use antifibrinolytics more selectively [Table 1]. The method of antifibrinolytics administration is quite heterogeneous. This is significantly different from recent Canadian survey of tranexamic acid administration during cardiac surgery<sup>[19]</sup> where 86% administer it to all patients and most (68%) administer infusion followed by bolus. The European guidelines<sup>[14]</sup> recommend that it should be considered to restrict protamine: heparin ratio <1; 75% of Indian centers seem to be practicing it.

As far as monitoring and anesthesia practices during the conduct of CPB are concerned the continuous presence of anesthesiologist all throughout cannot be overemphasized. Vast majority of centers (97%) reported that anesthesiologist is present all throughout the conduct of CPB. The delivery and maintenance of anesthesia during CPB pose unique challenges. Monitors of anesthetic depth – assessment of clinical signs, hemodynamic indicators, the bispectral index monitor, end-tidal anesthetic concentration, or twitch monitoring – are often absent, unreliable, or directly impacted by the unique pathophysiology (non pulsatility) associated with CPB.<sup>[20]</sup> The use of these monitoring can be expensive, and that may be play a vital role in Indian scenario, preventing its routine usage. In present survey, depth of anesthesia monitoring device was more frequently employed by teaching centers and high volume centers [Tables 1 and 2]. The future guidelines should recommend specific high-risk patients or surgeries in which these modalities can be selectively used. Various anesthesia medications administered during CPB are demonstrated in Figure 9, with opioid, neuromuscular blocking agent and benzodiazepines being most common. There seems to be a need to make vaporizers on CPB, universally available.

TEE plays important role in monitoring and preventing complications related to CPB. Various uses of TEE are to assist cannulation and feasibility, examining the aorta for atheromas, early identification of iatrogenic complications like aortic dissection, or assist de-airing after releasing the aortic cross-clamp, etc.,. Previously, in an IACTA survey,<sup>[21]</sup> it was reported that 76% IACTA members have access to TEE probe and echo machine, which is dedicated to cardiac operation theaters. In the present survey, it was demonstrated that 51% of centers use TEE routinely, 38% of centers use them at least sometimes. It is heartening to know that all the teaching centers or high volume centers in India had access to TEE probe and echo machine. This is in contrast to China, where only 41% of the intraoperative echoes are done by cardiac anesthesiologist.<sup>[22]</sup>

Based on these findings of various CPB-related practices, IACTA/ICCA could have a committee to formulate guidelines/recommendation/evidence-based suggestions to improve CPB practices relevant to practicing cardiac anesthesiologists in India. The authors suggest few pertinent points for the same as mentioned in Table 3.

There are certain limitations to this survey. To improve the response rate for the survey, there were limitations on the number of questions asked. Although authors have tried to cover most aspects of CPB practices, authors have missed questions such as details of antifibrinolytics agents (names and dosage regimens), addition of blood in prime, use of retrograde cardioplegia, mean arterial pressure management, method of cardioplegia delivery (by perfusionists or by anesthetist), and mode of drug administration (central line or venous reservoir of CPB machine). Perhaps these details would have added more information, but the response to very large survey is usually suboptimal. Usually, a short sharp survey attracts more response in contrast to lengthy ones. It is possible that different surgical teams from the same institute may follow different protocols for CPB and opinions given by representative may not represent them fully. The responders were anesthesiologists; they may have under-represented the opinion of their perfusionists colleagues. However, the authors tried contacting chief consultants of various centers to get the best possible responses. Bias inherent to surveys exist, the analysis implies only the respondents and favors the respondent population only.

## Conclusions

The survey helps us to understand a wide heterogeneity in CPB management protocols among various Indian cardiac surgery centers. The survey also suggests that adherence to evidence based and internationally accepted practices appears to be more prevalent in centers that have ongoing teaching programs and/or have high volumes, further strengthening the need to devise guidelines by appropriate body to help bring in uniformity in CPB management to ensure patient safety and high quality of clinical care for best outcomes.

**Table 3: Potential issues for expert recommendations specific to Indian context**

Minimum monitoring standards during conduct of CPB (e.g., temperature monitoring, depth of anesthesia monitoring, POF platelet function and coagulation monitoring, blood glucose monitoring and maintenance, TEE monitoring)
Best anesthesia practices during conduct of CPB (e.g., use of various anesthesia drugs like opioids, inhalational agents, dexmedetomidine etc.)
Best practices to reduce inflammatory response to CPB (e.g., use of corticosteroids, modifications in CPB circuits like heparin coating etc.)
Best practices to reduce myocardial injury after CPB (e.g., use of cardioplegia-type, additives, mode of delivery, and other pharmacological interventions like inotrope use)
Best practices to reduce pulmonary complications after CPB (e.g., ventilatory strategies during and after cardiac surgery)
Best Practices to reduce neurological complications after CPB (e.g., identification of high risk patients, monitoring CNS during CPB like cerebral oximetry, use of arterial filters, pharmacological interventions)
Best practices to reduce renal complications after CPB
Blood conservation during CPB (e.g., transfusion trigger, antifibrinolytics, modifications in CPB circuits, and blood product usage)
Managing CPB related major accidents (e.g., iatrogenic aortic dissection, accidental decannulation, and massive air embolism)-role of anesthesiologist in the heart team
Promotion of research related to CPB by academic wing of IACTA-ICCA

ICCA: Indian College of Cardiac Anesthesia, IACTA: Indian Association of Cardiovascular Thoracic Anaesthesiologists, CNS: Central nervous system, CPB: Cardiopulmonary bypass, TEE: Trans esophageal echocardiography, POF: Point of care

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## Conflicts of interest

There are no conflicts of interest.

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## Appendix

### Appendix 1

Invitation mail

Dear colleague,

Greetings from IACTA!

There is significant heterogeneity within India regarding cardiopulmonary bypass (CPB) practices. To understand these, IACTA is conducting IACTA cardiopulmonary bypass Survey. Below is the link to the survey. You are being requested to complete this anonymous survey in an effort to assist us in obtaining this information. After giving your institute details, survey has three components (10 questions each)-Perfusion Practices, Blood Conservation on cardiopulmonary bypass and Monitoring/Anaesthesia Practices on cardiopulmonary bypass. Your participation is entirely voluntary. Participation will constitute your implied consent. It is estimated that it will take not more than 10 min to complete the survey.

The results of the survey will be presented in IACTA meeting to be held in Hyderabad from 1-4 February 2018. Survey results will be summarized in manuscript form and submitted to a peer-reviewed journal for publication. In addition, results may be used to construct guidelines/evidence-based recommendations, which are unique to cardiac anesthesiologists in India.

Thanks in advance for your time and valuable opinions!

IACTA cardiopulmonary bypass Survey Team.

#### Institute details

1. Total number of annual cardiac surgical cases; 200–500, 500–1000, 1000–2000, >2000
2. Proportion of cases performed under cardiopulmonary bypass – <25%; 25%–50%; 50%–75%; >75%
3. Is your center a teaching institute for cardiac anesthesia (Fellowship in cardiac anesthesia/FNB/DM Cardiac Anesthesia) – Y/N.

#### Perfusion practices

1. What is the most common priming solution used in your institute: Crystalloid (NS/RL); Colloid (Gelatin/Hetastarch) or Balanced salt solution (Plasmalyte/Kabilyte, etc.) or combined crystalloid colloid
2. What are the common additives in cardiopulmonary bypass prime (Can answer more than one): Heparin/FFP/Albumin/Mannitol/Sodium Bicarbonate/Glucose/Calcium Any Other
3. Corticosteroids are used: Never/Routinely/Selectively; Commonest corticosteroid used: Dexamethasone/Methyl Prednisone/Hydrocortisone
4. Do you give an additional dose of antibiotics on cardiopulmonary bypass: Y/N/Only if the surgical time exceeds 6 h.

5. Do you use ultrafiltration: Y/N
6. The most common type of Cardioplegia – commercially available high Potassium containing solution (St. Thomas)/Del Nido cardioplegia/Custodial/Any Other
7. Do you use Cold/Warm Cardioplegia?
8. What is target temperature during cardiopulmonary bypass -Normothermia (>35)/Mild Hypothermia/Moderate Hypothermia (<32)
9. Do you ventilate lungs with low tidal volume when on cardiopulmonary bypass?: Y/N
10. Do you use arterial line filters? – Never/Always/High-risk cases.

#### Blood conservation

1. What is the routine transfusion trigger (at mild-to-moderate hypothermia)-<20/20-25%/25-30%, >30%
2. Decision to transfuse PRBCs is based on Hemoglobin levels alone/clinical context
3. Do you use Retrograde Autologous Priming: Routinely/Never/Selectively
4. Do you practice preoperative autologous donation (PAD)? Y/N
5. Do you insist using only fresh (<7 days old) blood during cardiac surgical cases?
6. What is the usual dose of protamine you administer? <1:1, 1:2, >1:2
7. Is anti-fibrinolytic used: Never/Routinely/Selectively
8. It is given as single bolus/repeated boluses/Bolus followed by Infusion
9. Do you have cell saver facility available in your center? No/Yes. If yes in how many % of cases you use it<10; 10-25; 25-50; 50-75; all cases
10. Do you have point-of-care platelet function tests like TEG/ROTEM/aggregometry available: Y/N In how many cases you use it?: <25%; 25-50%; >50%.

#### Monitoring/anesthesia practices

1. Is an anesthesiologist present all throughout the conduct of CPB? Y/N
2. What is the most common temperature monitoring site: Nasopharynx/Esophagus/Rectum/Tympanic membrane/Bladder
3. Do you routinely monitor the depth of anesthesia by BIS or similar monitoring (near infrared technology) on CPB – Routinely/Never/selectively
4. Do you use inhaled anesthetic agents on CPB – Y/N. If yes, please specify agent: Isoflurane/Sevoflurane/Desflurane
5. Which of these drugs you usually administer during conduct of CPB (may answer more than one) Midazolam, Muscle relaxant, Fentanyl or other opioids, Thiopentone, Propofol, Ketamine, Others
6. Do you monitor and maintain blood glucose <200 mg/dL during CPB: All patients/Only Diabetics
7. Do you use Transesophageal echocardiography for CPB cases: Routinely/Sometimes/Never

8. Do you monitor Aortic line pressure online – Y/N
9. Do you recommend to IACTA to generate guidelines/evidence-based recommendations, which are unique and pertinent to cardiac anesthesiologists in India for better patient care?
10. Do your surgical colleagues value your opinion as Cardiac Anesthesiologist regarding CPB practices? Y/N.