JECT. 2014;46:53–59
The Journal of ExtraCorporeal Technology

Predicting Adult Perfusion Practice Trends and the Adoption of Evidence-Based Practice

Margaret A. Relle, BS, CCP; Jennifer M. Hutchinson, RN, BSN; Adam Mattison, CCP; Alicia Sievert, MS, CCP; Anthony G. Shackelford, DHA, MHA, CCT, CCP

Department of Cardiovascular Perfusion, Medical University of South Carolina, Charleston, South Carolina

Presented by Jennifer M. Hutchinson at the 2012 American Society of Extracorporeal Technology International Conference, Orlando, Florida, March 2012.

Abstract: In an effort to provide optimal patient care, perfusionists should rely on information provided by current research. Present statistics, however, document a substantial underuse of evidence-based clinical practice and therapies not only in perfusion, but throughout the entire medical field. This investigation applied a statistical method—binomial proportion analysis—to aid in uncovering the trends in perfusion practice from 2004 to 2011. Through the analysis of national adult perfusion practice surveys, the feasibility of using binomial proportion statistical analysis is assessed in its ability to track adult perfusion practice proportional differentials over time and evaluate the adoption and attitudes toward the compliance of evidence-based practice within the field of perfusion. Surveys conducted in 2004 and 2006 on adult perfusion practice in the United States—although not published—are compared with data obtained by a similar survey distributed in 2011 through an international perfusion network system and perfusion mailing system, Perflist and Perfmail. The increase of perfusionists who practice retrograde and antegrade autologous priming (R/A AP) seen from 2004 to 2006 (35–50%) was statistically significant ($Z_{calc} = -2.30$, $p < .05$) and from 2006 to 2011 ($Z_{calc} = -5.23$; $p < .05$). Although the increase in biocompatible circuit (BC) use by perfusionists from 2004–2006 (53–64%) was not statistically significant ($Z_{calc} = -1.69$, $p < .05$), the use of BCs did continue to increase (86%) significantly from 2006 to 2011 ($Z_{calc} = -9.15$, $p < .05$). Other trends were observed; however, statistical significance was variable. This investigation demonstrates that binomial proportion statistical analysis is an effective method of evaluating perfusion practice trends and adoptions based on increasing or decreasing perfusion population proportion compliance over time. **Keywords:** cardiopulmonary bypass, perfusion practice, evidence-based practice, survey, adoption curve. *JECT. 2014;46:53–59*

In an effort to provide optimal patient care, perfusionists should rely on information provided by current research. Unfortunately, present statistics document a substantial underuse of evidence-based therapies not only in perfusion practice, but throughout the medical profession. The underuse of evidence-based practice has resulted in patients receiving as little as 54% of the treatments recommended by peer-reviewed journals (1). Aberegg (2) concluded in a 2006 study that physicians demonstrate less willingness to adopt these beneficial evidence-based therapies than to abandon their current methods, which they feel most comfortable performing. The correlation between the conclusion of Aberegg on physician mentality may transcend medical practice and apply to the perfusionist community as well or be the very reason evidence-based perfusion practices are limited.

Deploying the resulting evidence in clinical practice is by definition evidence-based practice, which serves as the foundation for the establishment of practice and protocol benchmarking. To appropriately benchmark perfusion practice, it is important to develop a "structured method of measurement" (3). The compilation and interpretation of surveys over time is one research method used to assess the compliance of evidence-based clinical practice throughout a profession. Such structured reviews, specifically in the perfusion practice, have consistently been in the literature suggesting effective changes in clinical practice. However, these surveys are generally focused reviews, honing in on specific aspects of perfusion and neglecting to evaluate the practice as a whole (4). In 2011, the American

Received for publication July 23, 2013; accepted January 9, 2014.
Address correspondence to: Margaret A. Relle, BS, Perfusion, Medical University of South Carolina, 165 Cannon Street #503, Charleston, SC 29403. E-mail: m.anderson.relle@gmail.com
The senior author has stated that the authors have reported no material, financial, or other relationship with any healthcare-related business or other entity whose products or services are discussed in this paper.

Article available at https://ject.edpsciences.org or https://doi.org/10.1051/ject/201446053

Society of Extracorporeal Technology (AmSECT) Board of Directors requested these focused surveys be the evidence basis to update—every 2 years or as needed—the "Standards and Guidelines" of perfusion practice to improve "the reliability, safety, and effectiveness" of cardiopulmonary bypass (5). Still, there has yet to be a formal published compilation of overall adult perfusion practice in the United States documenting the compliancy of these guidelines. At the AmSECT International conference in 2012, Shackelford et al. presented data from two adult perfusion practice surveys conducted in 2006 and 2011. It was these surveys and a perfusion practice pilot survey in 2004 that were studied.

This investigation seeks to uncover the trends in perfusion practice based on population proportion compliance from 2004 to 2011 by assessing the feasibility of using binomial proportional statistical analysis hypothesis-testing to track U.S. adult perfusion practice trends, develop trend projections, and evaluate attitudes within the profession toward the adoption of evidence-based practice.

METHODS

Experimental Outline

A 61-question survey was developed by members of the Department of Cardiovascular Perfusion Education at the Medical University of South Carolina (MUSC) and distributed through Perflist and Perfmail during the Fall of 2011. Perflist is an international social networking system for active, retired, and student AmSECT members, perfusion assistants, and blood management technologists. The network allows for members to intercommunicate about perfusion-related topics. Initial results from the 2011 survey were electronically received in nominal, ordinal fashion and compared with a similar survey distributed in 2006 on adult perfusion practice in the United States. A 2004 pilot study concerning the same perfusion practice information was used to project possible trends for 2011.

Survey Development and Distribution

A questionnaire was created using Survey Monkey and distributed to practicing U.S. and international AmSECT members through professional forums: Perflist and Perfmail. The questionnaire was distributed with a cover letter stating the instructions for completing the survey after the approval of the internal review board of MUSC. Completion of the survey by the respondent indicated respondent consent.

Question Content/Mechanics

The decision of which questions to ask on each of the three surveys was based on current evidence in the literature at the time of the survey distribution. Surveys were presented to a focus group for evaluation of question content.

The respondents were asked to answer a series of multiple-choice questions about their perfusion practice. The 61 questions contained categorical information regarding the cardiopulmonary bypass circuit, circuit components, drug use, device use, and general perfusion practice. For some of the questions, skip logics were put in place to streamline and minimize survey time.

Demographics

Perfusionists from all six regions (1, northeast; 2, southeast; 3, north–central; 4, south–central; 5, northwest; and 6, southwest; Figure 1; Table 1) of the United States and from outside of the United States responded to the adult perfusion practice surveys. For the purposes of this investigation, international respondents and those who did not complete the majority of the survey were excluded. A total of 65 perfusionists responded to the 2004 pilot survey; 803 perfusionists responded to the 2006 survey, 122 respondents were excluded (n = 681); and 856 perfusionists

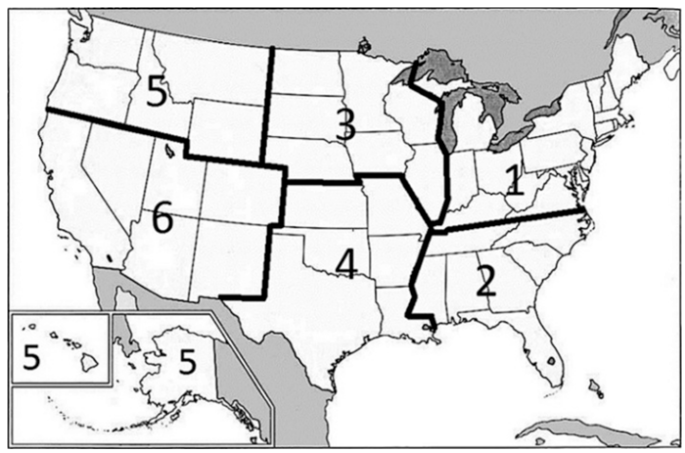

Figure 1. Demographic regional employment distribution.

Table 1. Percentage of 2004, 2006, and 2011 survey respondents used in various geographic regions.*

	2004 (n = 65)	2006 (n = 750)	2011 (n = 751)
	%		
Northeast (1)	31.7	19.5	31.3
Southeast (2)	50.8	21.4	16.5
North–central (3)	3.2	25.7	11.0
South–central (4)	9.5	9.8	13.2
Northwest (5)	0.0	6.4	4.2
Southwest (6)	4.8	9.9	11.7

*Total percentages may not add up to 100% as some respondents chose not to disclose their geographic region of employment.

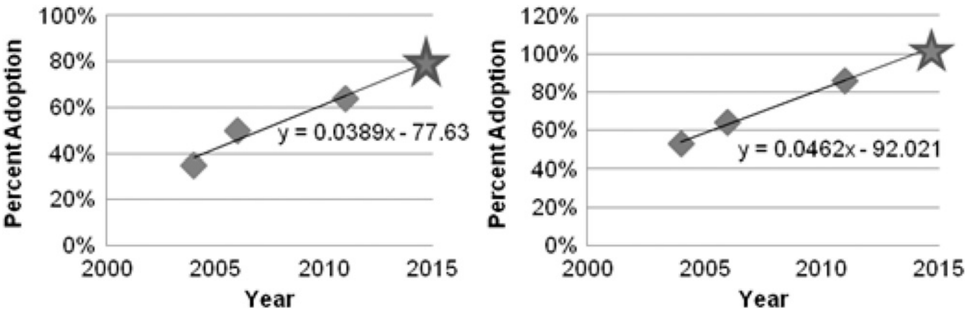

Figure 2. Autologous priming compliance projection and proposed adoption (left); biocompatible circuit compliance projection and proposed adoption (right).

in 2011 responded and reduced to an analyzed population of 751 respondents (Figure 2; Table 1). The majority of the respondents were used in Regions 1 and 2 (eastern) of the United States (2004 = 82.5%; 2006 = 40.9%; 2011 = 46.3%; Figure 2; Table 1).

Data Collection

The data were presented in a nominal, ordinal format, automatically generated by Survey Monkey and auto-collected into Microsoft Excel. Twenty-seven questions transcended all three (2004, 2006, and 2011) surveys. A focus group met to narrow down these 27 questions to 10 questions deemed important to follow through the three studies as significant indicators of practice trends.

Statistics

The results of the 10 questions were analyzed using Microsoft Excel. The hypothesis for this study was developed from binomial proportion analysis of the 2004 pilot study and the 2006 study. Binomial proportion analyses for each question were used to determine proportional significance and, therefore, perfusion population compliance of the questioned practice, technology, or skill for each of the surveyed years. A *p* value of < .05 was considered statistically significant. Significance between the 2006 and 2011 data was determined using binominal proportions in the same fashion and analyzed to see if the previously observed population proportions continued. Linear projections comparing population proportions over time were created using Microsoft Excel.

RESULTS

Binomial Proportions

Answers to four of the 10 questions—autologous priming (AP; 2004, 63 of 65 respondents; 2006, 679 of 681; 2011, 703 of 751), biocompatible circuits (BCs; 2004, 62 of 65; 2006, 679 of 681; 2011, 705 of 751), type of reservoir systems (2004, 63 of 65; 2006, 679 of 681; 2011, 717 of 751), and autologous donations (2004, 62 of 65; 2006, 680 of 681; 2001, 672 of 751)—were shown to have significant trends ($p < .05$). Specifically, the response to the question regarding the practice of AP revealed continued increasing statistically significant trend from 2004 and 2011 (Table 2; $p < .05$). The increase of perfusionists who practice retrograde and antegrade autologous priming (R/A AP) seen from 2004 to 2006 (Table 2; 35–50%) was statistically significant ($Z_{calc} = –2.30$, $p < .05$). The continued increase in practice (2006–2011) of R/A AP (50–64%) was also significant ($Z_{calc} = –5.23$; $p < .05$). Because significance was demonstrated from 2004–2006 and 2006–2011, it can be suggested that this increase is not the result of chance, but that this is a factual population representation.

Table 2. Binomial proportion analysis and changes in proportions from 2004–2006 and 2006–2011 of respondents who answered 'yes' to the use of the questioned perfusion practices.*

Practice	2004–2006	↑↓	Z_{calc}*	2006–2011	↑↓	Z_{calc}*
Autologous priming	0.35–0.50	↑	–2.30	0.50–0.64	↑	–5.23
Bloodless surgery	0.25–0.16	↓	1.81	0.16–0.22	↑	–2.61
Biocompatible circuits	0.53–0.64	↑	–1.69	0.64–0.86	↑	–9.43
CDI-500	0.21–0.47	↑	–3.84	0.47–0.47	↑	–0.100
Vacuum-assisted venous drainage	0.55–0.51	↓	0.540	0.51–0.59	↑	–2.81
Reservoir system	0.016–0.0015	↓	2.11	0.0015–0.017	↑	–2.97
Centrifugal pumps	0.58–0.50	↓	1.09	0.50–0.61	↑	–3.78
Autologous blood donation	0.45–0.21	↓	4.28	0.21–26	↑	–1.98

*Significance of Z_{calc} determined by the Z_{crit} of a two-tailed statistical analysis for $p < .05$ ($Z = \pm 1.96$).

Although the increase in BC use by perfusionists from 2004 to 2006 (Table 2; 53–64%) was not statistically significant (Z_{calc} = –1.69, $p < .05$), the use of BCs did continue increase (86%) significantly from 2006 to 2011 (Z_{calc} = –9.15, $p < .05$).

In analyzing the type of reservoir system and the practice of autologous blood donations, a significant decrease was determined from 2004 to 2006 (Table 2; 1.6–.15%, Z_{calc} = 2.11, $p < .05$; and 45–21%, Z_{calc} = 4.28, $p < .05$, respectively), whereas a statistically significant increase was seen from 2006 to 2011 (.15–1.7%, Z_{calc} = –2.97, $p < .05$; and 21–26%, Z_{calc} = –1.98, $p < .05$, respectively).

Of the remaining six questions, four of the questioned practices—the practice of bloodless surgery, referring to conservation of the patient's blood while on bypass, rather than the use of banked blood products, the use of the CDI-500, the use of vacuum-assisted venous drainage, and the use of a centrifugal pump—were variable between 2004–2006 and 2006–2011 because they did not continuously increase or decrease. The trends (increases or decreases) for these questioned practices were only calculated to be significant in one time interval (Table 2; Z_{calc} = –2.61, increase 2006–2011; Z_{calc} = –3.84, increase, 2004–2006; Z_{calc} = –2.81, increase, 2006–2011; and Z_{calc} = –3.78, increase, 2006–2011, respectively, at $p < .05$).

DISCUSSION

The results of this study demonstrate significant and consistent trends in the practice of R/A AP during cardiac surgery supported by prior evidence-based publications. Retrograde and antegrade autologous priming was first implemented into cardiopulmonary bypass practice (CPB) in 1959, revised in 1990, and continues to be modified today (6). The efficiency of R/A AP to reduce the need for homologous blood transfusions (7–9), prime volume (10), incidence of postoperative cardiac arrest, and length of stay in the intensive care unit (11,12) has persisted in the literature since implementation of practice with few conflictions (13). Currently little more than half of the reported respondents of Perfmail/Perflist in the United States (Table 2; 64%) use R/A AP.

The lack of significance in the increase in use of BCs from 2004 to 2006 may be attributed to the small sample population of the 2004 pilot survey (n = 65). This may be speculated by the calculated significances (Table 2; Z_{calc} = –1.69, $p < .05$) from 2004 to 2006 being close to achieving statistical significance (Z_{calc} = ±1.96, $p < .05$). Furthermore, evaluation and analysis with another large population is needed to more accurately describe population proportions practicing individual techniques and practices.

Assuming the reported proportions of BC use are increasing, the 2011 survey indicates that 86% of U.S. perfusionist groups implement biocompatible circuits in their practice. Since the 1980s when BCs were first commercially available (14), evidence through research has revealed positive results in BC efficiency in the reduction of inflammatory response, oxidative stress, rate of packed red blood cell transfusions, and decreased in length of stay in the intensive care unit (15,16).

With only 3 years to plot (2004, 2006, and 2011), one (2004) of questionable population size, and with the realization that we are not in a completely controlled environment, the projection of perfusion practice trends for AP and biocompatibility compliance in approximately 2015 is uncertain. However, were all external contributors controlled for and remained as is, future projections can be speculated. It can be predicted that approximately 75% of the perfusion population will be practicing AP, as the disinclined continue to adopt the practice (Figure 3, left). In this hypothetical controlled universe, it can also be expected that 100% of the perfusion community will be implementing the use of BCs into their practice by 2015 (Figure 3, right).

In 1995, Everett M. Rogers developed a model to classify innovation/practice adopters (17), dividing them into various categories based on the idea that certain individuals are more open to change than others. The significant trends seen in the practice of R/A AP and the use of BCs

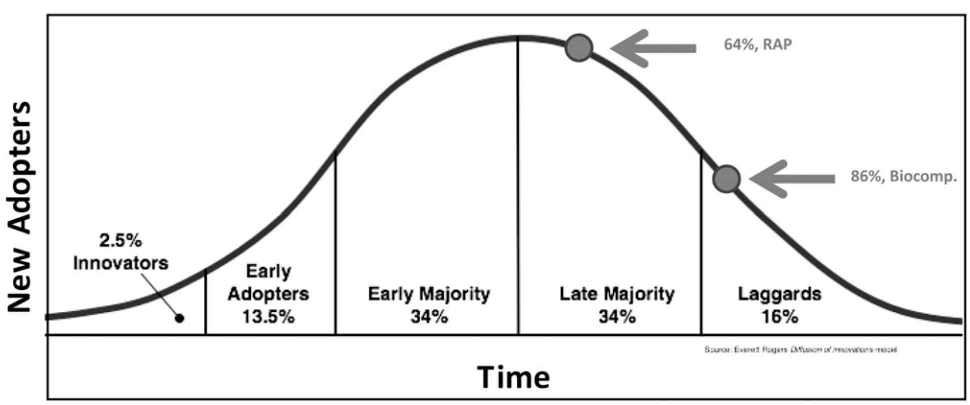

Figure 3. Relationship between types of adopters classified by innovativeness and their location on the adoptive curve. Source: Rogers EM. *Diffusion of Innovations,* 3rd ed. New York: Free Press; 1963:247.

can be analyzed in reference to the Rogers model. Now, 56 years after its introduction into perfusion practice, only 64% of U.S. perfusionist groups practice R/A AP despite evidence of the beneficial and safe outcomes. For this practice, the profession has reached the "early majority phase" and is beginning to move into the "late majority phase" of adoption, meaning the more cautious, although thoughtful, perfusionist groups (early majority) have adopted the practice and the skeptical perfusionist groups (late majority) are starting to consider the positive and beneficial effects of R/A AP. In the future, the profession should see a continued increase in R/A AP practice, as the "laggards," traditional perfusionist groups caring for the old ways, reluctantly begin to accept these changes.

In analyzing the adoption of BCs in perfusion practice, the innovation was adopted much quicker than that of R/A AP (86% use in approximately 31 years) compared with 64% compliance of the profession in 52 years, raising the question: what evidence has been more compelling to perfusionists/perfusion groups to accelerate the adoption of this practice compared with the adoption of R/A AP? The answer is unclear and cannot be found in current research. It can be speculated that perhaps changing technologies are more widely accepted than changing techniques. With technologies, the advantages are more easily seen because practitioners are not blinded by their comfort level as they are with changes in practice. Changes in technique require new skills to learn, whereas changes in technology maintain the same skills just with different materials, shapes, or sizes.

It must be understood that there are many external contributors to the adoption of technologies and techniques. In regard to the adoption of technologies, the perfusion community has little control over what the manufacturers choose to produce and, therefore, must change with the manufacturers. This may be the reason for a more rapid adoption of BCs in comparison with the adoption of AP. As manufacturers phase out the older product and increase production of the newer one, adoption is inevitable. Additional influential factors include the competition among manufacturers, technological advancements, and the changes in healthcare costs and reimbursement. Likewise, individual perfusionists/perfusion groups often have little influence on the overall surgical protocol, which is more often than not dictated by the surgeon. Therefore, perfusion practice and used perfusion technologies and techniques are based on the comfort level of the surgeon.

The key to the acceptance of techniques and technologies within the profession comes down to a matter of available research. The International Consortium of Evidence-Based Practice is an organization comprised of 17 international perfusion societies, which aims to incorporate evidence-based principles into perfusion practice (18). In their evaluation of research, they classify techniques and technologies from a must-use (Class Ia) to a do-not-use (Class III) in the perfusion practice rating. The rating can increase with increased research proving the technique or technology is beneficial. This may explain why the rate of adoption of a technique is hindered. In the two practices this investigation has analyzed, BC technology is rated a Class Ib, whereas AP is rated a Class IIb because more studies have been done with the experimentation of BCs proving it beneficial. Despite the overwhelming evidence in research that AP is beneficial, there is not enough literature to increase the rating. More perfusion research is needed to support the use of techniques such as R/A AP. It therefore becomes exceedingly important that perfusionists participate in research and publish literature so their evidence can impact clinical practice, provide better patient optimal care, and persuade others to adapt as well.

LIMITATIONS

Data in the study were limited by the small sample population of the 2004 pilot study and by collecting an interim analysis of the 2006 practice survey. Likewise, question wording was not maintained throughout all three surveys, making data analysis difficult because it may have led to varied respondent interpretation. Results were impaired as a result of the ability of respondents to voluntarily answer or skip any question and the liberty of the respondents to end the survey at any time. Lastly, online surveys present inherent biases in responses—those being the more technologically savvy of the population and those who care most about the survey topic will be the ones most willing to respond. More specifically, the survey respondents for this investigation were limited to active AmSECT members—possibly taking into account retired members commenting on their past institutes, which may have adapted their practices since their employment.

CONCLUSION

This investigation suggested that binomial proportion statistical analysis is an effective method for evaluating perfusion practices within the U.S. population and possibly predicting the adoption of these practices into the mainstream profession. However, the time in which it takes a practice to be adopted, despite its beneficial evidence, should be further researched, because it remains relatively unclear. Healthcare professionals should consider the evidence when constructing the standards of care for the benefit of the patient and not for the comfort of the professional. This investigation proposes a multifaceted approach for optimal patient care: 1) understand current practice; 2) identify and evaluate areas of improvement; 3) encourage proactive attitudes towards research in those areas; and 4) encourage compliance of and communication among the surgical community.

ACKNOWLEDGMENTS

Appreciation is expressed to our perfusion colleagues as well as the all the respondents of the three perfusion practice surveys. Extreme thanks are extended to Dr. Anthony Shackelford for his encouragement and enthusiasm and for his assistance and guidance throughout this investigation. Gratitude is also expressed to Alicia Sievert for her assistance in data analysis and Jeff Acsell for his assistance with computer programming. Thank you to the entire Cardiovascular Perfusion Department of the College of Heath Professions at the Medical University of South Carolina for the use of their facilities.

REFERENCES

1. McGlynn EA, Asch SM, Adams J, et al. The quality of healthcare delivered to adults in the United States. N Engl J Med. 2003;348: 2635–45.
2. Aberegg SK. Failure to adopt beneficial therapies caused by bias in medical evidence evaluation. Med Decis Making. 2006;26:575–82.
3. Baker RA, Newland RF, Fenton C, et al. Developing a benchmarking process in perfusion: A report of Perfusion Downunder Collaboration. J Extra Corpor Technol. 2012;44:26–33.
4. Guidelines and indications for coronary artery bypass graft surgery. A report of the American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures (Subcommittee on Coronary Artery Bypass Graft Surgery). J Am Coll Cardiol. 1991;17: 543–89.
5. American Society of Extracorporeal Technology Standards and Guidelines for Perfusion Practice. AmSECT; 2013.
6. Severdija EE. Extracorporeal circuit prime reduces blood transfusion requirements in coronary artery surgery. NeSECC. 2007;2: 9–16.
7. Balachandran S, Cross MH, Karthikeyan S, et al. Retrograde autologous priming of the cardiopulmonary bypass circuit reduces blood transfusion after coronary artery surgery. Ann Thorac Surg. 2002;73: 1912–8.
8. Saczkowski RS, Bernier PL, Tchervenkov CI, et al. Retrograde autologous priming and allogeneic blood transfusions in adults: A meta-analysis. Interact Cardiovasc Thorac Surg. 2009;8:373.
9. Hou X, Yang F, Liu R, et al. Retrograde autologous priming of the cardiopulmonary bypass circuit reduces blood transfusion in small adults: A prospective, randomized trial. Eur J Anaesthesiol. 2009;26: 1061–6.
10. Rosengart TK, DeBois W, O'Hara M, et al. Retrograde autologous priming for cardiopulmonary bypass: A safe and effective means of decreasing hemodilution and transfusion requirements. J Thorac Cardiovasc Surg. 1998;115:426–42.
11. Eising GP, Pfauder M, Neimeyer M, et al. Retrograde autologous priming: Is it useful in elective on-pump coronary artery bypass surgery? Ann Thorac Surg. 2003;75:23–7.
12. Murphy GS, Szokol JW, Nitsun M, et al. Retrograde autologous priming of the cardiopulmonary bypass circuit: Safety and impact on postoperative outcomes. J Cardiothorac Vasc Anesth. 2006;20: 156–61.
13. Murphy GS, Szokol JW, Nitsun M, et al. The failure of retrograde autologous priming of the cardiopulmonary bypass circuit to reduce blood use after cardiac surgical procedures. Anesth Analg. 2004;98: 1201–7.
14. Ranucci M, Balduini A, Ditta A, et al. A systemic review of biocompatible cardiopulmonary bypass circuits and clinical outcomes. Ann Thorac Surg. 2009;87:1311–9.
15. Sohn N, Marcoux J, Mycyk T, et al. The impact of different biocompatible coated cardiopulmonary bypass circuits on inflammatory response and oxidative stress. Perfusion. 2009;24:231–7.
16. Ovrum E, Tangen G, Tollofsrud S, et al. Heparinized cardiopulmonary bypass circuits and low systemic anticoagulation: An analysis of nearly 6000 patients undergoing coronary artery bypass grafting. J Thorac Cardiovasc Surg. 2011;141:1145–9.
17. Rogers EM. Diffusion of Innovations, 3rd ed. New York, NY: Free Press; 1963:247.
18. Likosky DS. Integrating evidence-based perfusion into practices: The International Consortium for Evidence-Based Perfusion. J Extra Corpor Technol. 2006;38:297–301.

APPENDIX

Data Collection

Binomial proportion calculation:

$$p = \text{same proportion}$$
$$x = \text{number of success}$$
$$n = \text{total number of cases}$$
$$p_1 = x_1/n_1$$
$$p_2 = x_2/n_2$$
$$p' = x_1 + x_2/n_1 + n_2$$
$$q' = 1 - p'$$
$$SE(p_1 - p_2) = \sqrt{\frac{p'q'}{n_1} + \frac{p'q'}{n_2}}$$
$$Z_{calc} = p_1 - p_2/SE(p_1 - p_2)$$
$$Z_{crit} = 1.96(p < .05)$$

Questions

Questions represented numerically:

1. Do you antegrade/retrograde prime (AAP/RAP) your circuit? (yes/no)
2. Does your hospital/group participate in a "bloodless surgery" program? (yes/no)
3. Do you use a biocompatible circuit on routine cardiac surgeries? (2004/2006)/Do you use a coated circuit (heparin or other biocompatible circuit)? What kind of coating? (2011) (yes/no)
4. Do you use a Terumo CDI 500 Blood Parameter Monitoring System? (2004/2006)/Do you use an inline blood gas monitor? Do you use the Terumo CDI Blood Parameter Monitoring System? (2011) (yes/no)
5. Do you use VAVD? (2004; yes/no)/Do you use vacuum-assisted venous drainage? (2006; yes/no)/Do you use assisted venous drainage (e.g., kinetic or vacuum)? What method of assisted drainage do you use? (2011) *(VAVD = yes, kinetic/other = no)

6. Which type of reservoir system do you use? (2004/2006/2011) (open/closed/neither)
7. Do you use a centrifugal pump for open heart surgery? (2004)/What percentage of your open heart cases do you use a centrifugal pump? *0% = no/all other percents = yes (2006)/Do you use a centrifugal pump? Approximately what percentage of your open heart cases do you use a centrifugal pump? (2011) (yes/no)
8. Do you divert shed blood during cardiopulmonary bypass (CPB) to the cell saver (rather than the venous reservoir)? (2004)/Do you divert shed blood during CPB to the cell saver rather than the venous cardiotomy/reservoir? (2006) During CPB, where do you divert shed blood? (cell saver = yes/other = no)
9. Do you practice intraoperative autologous donation pre-CPB? (2004)/Do you routinely practice intraoperative autologous donation pre-CPB? (2006/2011) (yes/no)
10. How do you determine the initial heparin dose in adult open heart procedures? (2004)/Primarily, how do you determine the initial heparin dose in on-pump adult open heart procedures? (2006)/Primarily, how do you determine the heparin loading dose for on-pump adult open heart procedures? (2011) (weight/dose–response curve automated/dose–respo nse curve manual/body surface area/blood volume/other please specify)