Practice Patterns after the Therapeutic Hypothermia After Pediatric Cardiac Arrest Out-of-Hospital Trial: A Survey of Pediatric Critical Care Physicians

Marianne R. Gildea¹ Frank W. Moler² Kent Page¹ Victoria L. Pemberton³ Richard Holubkov¹
 Vinay M. Nadkarni⁴ J. Michael Dean¹ Lenora M. Olson¹

¹ Department of Pediatrics, University of Utah, Salt Lake City, Utah, United States

² Department of Pediatrics, University of Michigan Medical School, Ann Arbor, Michigan, United States

³ National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, Maryland, United States

⁴ Department of Anesthesiology and Critical Care Medicine, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania, United States

Address for correspondence Lenora M. Olson, PhD, Department of Pediatrics, University of Utah, 295 Chipeta Way, Salt Lake City, UT 84158, United States (e-mail: Lenora.olson@hsc.utah.edu).

J Pediatr Intensive Care 2019;8:71–77.

Abstract

The Therapeutic Hypothermia After Pediatric Cardiac Arrest Out-of-Hospital (THAPCA-OH) Trial showed therapeutic hypothermia, versus normothermia, did not significantly improve 1-year survival with good neurobehavioral outcome. Our survey of pediatric critical care physicians, designed to assess the use of targeted temperature management (TTM) after publication of the main THAPCA-OH Trial results, found most respondents were aware of trial results, and over 90% agreed THAPCA-OH was well-designed with important clinical outcomes. While most respondents reported TTM usage consistent with THAPCA-OH results in different patient scenarios, 15% did not select TTM for fever management. Since trials prior to THAPCA-OH established that fever is harmful following brain injury, the continued incomplete adoption of TTM warrants further research on challenges and facilitators to the adoption of clinical trial findings.

Keywords

- targeted temperature management
- THAPCA-OH
- survey

Introduction

In 2002, mild therapeutic hypothermia was demonstrated to be superior to usual temperature management in adults sustaining out-of-hospital cardiac arrest (OHCA).^{1,2} A few years later, Shankaran et al³ demonstrated that therapeutic hypothermia reduced death and disability in neonates with hypoxic-ischemic encephalopathy (HIE) compared with neonates maintained at normothermia using overhead warming incubators. Two other neonatal studies failed to demonstrate similar benefit on their primary outcomes, but some beneficial effects were noted on secondary outcomes.^{4,5} These previous studies led to widespread use of therapeutic hypothermia following adult OHCA and neonatal HIE.

The Therapeutic Hypothermia After Pediatric Cardiac Arrest Out-of-Hospital Trial (THAPCA-OH) compared therapeutic hypothermia (hypothermia) with therapeutic normothermia (normothermia) in comatose survivors of pediatric cardiac arrest. The trial was designed with active servo-controlled targeted temperature management (TTM) for both hypothermia and normothermia. THAPCA-OH showed that hypothermia, compared with normothermia, did not confer a statistically significant benefit in terms of survival with good functional outcome at 1 year.⁶ The THAPCA-OH results were consistent with a similar adult trial comparing TTM with hypothermia versus normothermia in 2013.⁷ Based on these results, the 2015 American Heart Association (AHA) consensus treatment guidelines

received

April 2, 2018

accepted after revision

June 24, 2018

published online

August 12, 2018

Copyright © 2019 by Georg Thieme
 Verlag KG, Stuttgart · New York

DOI <https://doi.org/10.1055/s-0038-1667380>
 ISSN 2146-4618.

recommended that fever be aggressively prevented by treatment with either therapeutic hypothermia or therapeutic normothermia for comatose adults or children following out-of-hospital cardiac arrest.⁸

As the findings from future randomized clinical trials are published, there needs to be a greater understanding of how physicians gain their knowledge of trial results and what influences practice change when indicated.⁹ The purpose of this study was to investigate pediatric critical care physicians' knowledge of the use of TTM after publication of the main THAPCA-OH Trial findings. We surveyed practicing pediatric critical care physicians about their awareness of the THAPCA-OH results, ways in which they learned about the results, and whether they considered the THAPCA-OH Trial to be well-designed. Also, using hypothetical clinical scenarios, we assessed whether pediatric critical care physicians' use of TTM was consistent with the THAPCA-OH findings and recent AHA Pediatric Advanced Life Support (PALS) guidelines for aggressive fever management following pediatric cardiac arrest.⁸

Materials and Methods

Instrument

We developed a self-administered 15-item web-based survey based on a previous survey of factors that may influence dissemination and adoption of clinical trial findings.¹⁰ Our survey was revised based on cognitive interviews with practicing pediatric and cardiac critical care physicians (*n* = 9) and field-tested with physicians (*n* = 5) to ensure that questions displayed similarly across different devices, browsers, and platforms. Inclusion criteria were (1) physicians who were board eligible or certified and (2) actively practicing as an attending in an intensive care unit.

Distribution

Between June 9, 2016 and July 12, 2016, the American Academy of Pediatrics Section on Critical Care sent three emails to all members inviting and reminding members to participate in the anonymous online survey. The initial email invitation included a hyperlink to the survey with information on the survey content and who was conducting the survey. Two reminder emails with similar information as the invitation, that included the survey link, were sent 2 weeks apart. No incentive was provided to complete the survey. The University of Utah Institutional Review Board approved the study.

Definitions

Hypothermia is active temperature control targeted to 32°C to 34°C, and normothermia is active temperature control targeted to 36°C to 37.5°C. Temperature is controlled with servo-controlled cooling mattresses and central temperature monitoring.

Survey Domains

Respondents were presented with questions regarding their knowledge and mode(s) of learning of the THAPCA-OH results, their impressions of the THAPCA-OH Trial design and study conduct using a Likert scale. Four scenarios were

Table 1 Scenario descriptions

Scenario 1	1-month-old baby found pulseless in the crib
Scenario 2	6-year-old child with asystole drowned in pool
Scenario 3	6-year-old child with ventricular fibrillation drowned in pool
Scenario 4	17-year-old teenager with ventricular fibrillation hit in chest with baseball

developed to assess the use of TTM for OHCA patients. All four scenarios included comatose patients that met enrollment criteria for the THAPCA-OH Trial. The scenarios were designed to assess whether the variations in patient age, presenting rhythm, or arrest etiology would trigger a different temperature management decision. Each scenario had the same information provided on the patient's baseline temperature, ventilation status, motor response, and pupils (► **Supplementary Table S1** (available in online version only) for the full survey tool utilized).

Description of the Four Scenarios

For each scenario, respondents were asked, "How would you manage this patient's temperature following admission to the intensive care unit?" with the following four response options (► **Table 1**):

- (1) Therapeutic hypothermia with central temperature monitoring (i.e., esophageal and rectal), a servo-controlled cooling mattress, sedation, and if required, neuromuscular blockade.
- (2) Therapeutic normothermia with central temperature monitoring (i.e., esophageal and rectal), a servo-controlled cooling mattress, sedation, and if required, neuromuscular blockade.
- (3) Other temperature management (i.e., antipyretics as needed, warm blankets, overhead warmer, and ice packs) with or without a central temperature monitoring device, and without a servo-controlled cooling mattress.
- (4) Other (please specify).

If respondents chose either hypothermia or normothermia, they were given duration choices for how long they would employ the TTM, before rewarming.

We also requested information concerning physician characteristics and practice setting (i.e., type of hospital and number of beds in ICU). Practice change was measured by asking how the THAPCA-OH Trial results affected the respondent's treatment decisions about TTM for future OHCA patients.

Statistical Analyses

Survey respondents were excluded from analyses of individual questions for which they did not provide responses. Respondents' professional characteristics, knowledge of the trial results, and beliefs and practices regarding hypothermia or normothermia were summarized using descriptive statistics. Proportions of respondents choosing TTM were compared by years of board certification, by whether respondents had worked at a THAPCA-OH site, by the number of OHCA patients

cared for in the last 2 years, and by whether the respondents were aware of the trial results. Differences between scenarios in proportions of respondents choosing hypothermia versus normothermia as treatment management were evaluated. All analyses were performed using SAS software, version 9.4 (SAS Institute).

Results

Surveys were sent to approximately 700 individuals resulting in 140 respondents who were board certified or eligible and were actively practicing as an ICU attending. The majority of respondents were pediatric or cardiac critical care physicians with over 10 years of board eligibility or certification. Most (56%) worked in a freestanding children's hospital. The median number of ICU beds in their ICU unit was 23. Approximately half reported treating 6 to 14 pediatric OHCA patients in the last 2 years, and 47% worked at a hospital where the THAPCA-OH Trial was conducted. Almost all of the respondents were aware of the out-of-hospital trial results (►Table 2). Those who were aware of the results reported learning about the trial results in a variety of ways: the New England Journal of Medicine article (95%), from a colleague (78%), a secondary publication (39%), a newsletter (36%), or website (28%) of a professional organization (not shown in table). Of the 127 respondents who were aware of the trial results, 91% agreed/strongly agreed that the trial was well-

Table 2 Demographics and practice characteristics of healthcare providers completing a survey regarding the THAPCA-OH Trial ($n = 140$), 2016

	Median (IQR) or n (%)
Clinician type	
Pediatric intensivist	128 (91%)
Pediatric cardiac intensivist	11 (8%)
Other	1 (1%)
Board eligible or certified, years	13 (4, 20)
Employment setting	
Freestanding children's hospital	78 (56%)
Children's hospital within an adult hospital	48 (34%)
General hospital/other	14 (10%)
Number of ICU beds	23 (12, 32)
Experience with treating pediatric OHCA in the past 2 years	
0–5 patients	46 (33%)
6–14 patients	71 (51%)
> 14 patients	23 (16%)
Worked at a THAPCA-OH site during THAPCA-OH Trial	66/139 (47%)
Aware of the THAPCA-OH Trial results	127/137 (93%)

Abbreviations: ICU, intensive care unit; IQR, interquartile range; OHCA, out-of-hospital cardiac arrest; THAPCA-OH, Therapeutic Hypothermia After Pediatric Cardiac Arrest Out-of-Hospital.

designed, 97% that the results were clearly presented, 93% that the primary endpoint was relevant, and 78% that the trial enrolled a sufficient sample size. Less than 20% thought that the 12-month follow-up period was too short (►Fig. 1).

Most (85%) respondents chose active TTM (either hypothermia or normothermia) in accordance with the AHA guidelines. The choice of hypothermia versus normothermia did not vary by professional characteristics, employment setting, experience with OHCA pediatric patients or whether respondents worked at a THAPCA-OH Trial site. In addition, these same variables were not statistically different between respondents who selected TTM to those who did not choose TTM (15%). However, the proportion of respondents choosing hypothermia rather than normothermia varied by scenario (►Fig. 2). Respondents were more likely to choose hypothermia for scenarios with ventricular fibrillation compared with those with pulseless arrests and for the teenager with ventricular fibrillation compared with the 6-year-old with ventricular fibrillation. In addition, when prompted about duration of hypothermia, there was considerable variation of opinion (►Fig. 3), with 50% of the respondents choosing 48 hours, which is the duration from the THAPCA-OH Trial in each scenario. More than 30% of respondents selected the duration option of 48 hours for normothermia. About 40% of respondents would maintain normothermia for 72 hours, and only 20% indicated that they would maintain normothermia for 120 hours, which is the duration from the THAPCA-OH Trial (data not shown).

Almost 60% of the respondents said that the results of the THAPCA-OH Trial helped them to change their treatment decisions regarding TTM for OHCA patients. At the end of the survey, an open-ended free response space was provided for respondents to comment on any aspect of the THAPCA-OH Trial. Twenty-three respondents provided responses, and we found comments about the following topics—how the study reinforced the need to prevent fever, a narrow study population limiting the ability to generalize results to individual patients, and that the trial results changed practice from hypothermia to normothermia.

Discussion

This study offers insights into how clinicians, caring for children after out-of-hospital cardiac arrest, became aware of the THAPCA-OH Trial results, how those results were interpreted, and how the findings may be applied to clinical care. Our survey was disseminated a year and a half after the publication of the THAPCA-OH clinical trial findings, and 9 months after AHA treatment guidelines and an international consensus statement were issued.^{6,8,11} Our study revealed that the majority of respondents were aware of and had confidence in the THAPCA-OH Trial results. The patient scenarios showed that TTM use was fairly consistent with trial findings nevertheless being influenced by previous adult hypothermia studies.

Methods for Learning about the THAPCA-OH Trial Results

Both formal and informal means of communication are known to increase a physician's awareness of medical

Fig. 1 Clinician beliefs regarding the THAPCA-OH Trial implementation ($n = 127$), 2016. THAPCA-OH, Therapeutic Hypothermia After Pediatric Cardiac Arrest Out-of-Hospital.

Fig. 2 Clinician reported practices regarding targeted temperature management ($n = 120$), 2016. V Fib, ventricular fibrillation.

developments.¹² The primary formal method of learning about the THAPCA-OH Trial results identified by respondents was the New England Journal of Medicine article. It is not surprising that nearly all the respondents had access to the results since they were published in a widely circulated

journal. Many respondents learned of the results from a colleague. This dissemination method has been described as the greatest influence to increase awareness of medical advances, when a well-respected colleague endorses change.¹² Over half of respondents familiar with the results

Fig. 3 Clinician reported practice for duration of therapeutic hypothermia by scenario, 2016. V Fib, ventricular fibrillation.

also reported learning about the trial results from secondary publications, newsletters, and websites from professional organizations. As all National Institutes of Health (NIH)-funded clinical trials require a dissemination plan, deploying several methods could contribute effectively to a comprehensive plan for disseminating study results.

Trial Results and Their Use in Guiding Clinical Care of OHCA Patients

We do not have a reliable source for how respondents practiced TTM prior to the THAPCA-OH Trial, but almost two-thirds of respondents said the THAPCA-OH results helped them change their treatment decisions. When presented with four scenarios of patients who would have been eligible for the THAPCA-OH Trial, nearly all respondents reported they would employ some type of TTM, but clearly favored normothermia for most cases. We were surprised that there remained 15% of respondents who did not select TTM. Deployment of TTM may be burdensome at hospitals without the infrastructure to implement a cooling/warming device, close monitoring, paralytics, and sedatives. In 2005, Abella et al¹³ found that almost a quarter of physicians reported technical constraints in using induced hypothermia after cardiac arrests in adults. Studies have shown that introducing new skills and increased complexity are barriers to adopting new recommendations.¹⁴

Variation of Management in Different Hypothetical Scenarios

Respondents were less likely to choose hypothermia on a pulseless infant post arrest, despite the historical precedent of using hypothermia in neonates with mild or moderate

HIE secondary to birth asphyxia.^{3,4} The practice of extrapolating results from one pediatric population to another is often required, due to lack of evidence—fewer than 250 randomized trials in pediatric critical care were published in the past 30 years.¹⁵ But clearly clinicians are differentiating between HIE patients and post cardiac arrest patients and were more likely to employ normothermia in this scenario. Conversely, more clinicians were likely to use hypothermia on a teenager with ventricular fibrillation. Hypothermia usage in teenagers may have been extrapolated from earlier studies of adults experiencing OHCA with ventricular fibrillation.^{1,2} Since previous adult studies, along with the AHA guidelines and international consensus statements,^{16,17} supported the use of hypothermia in adults with shockable ventricular fibrillation, it is not surprising that scenarios with ventricular fibrillation led more physicians to select hypothermia, compared with the asystole or the pulseless scenarios. It was also not surprising that clinicians chose hypothermia more often for the 17-year-old ventricular fibrillation scenario than for the 6-year-old with ventricular fibrillation. These patterns suggest that despite the THAPCA-OH results indicating neither hypothermia or normothermia TTM to be superior, the earlier adult studies influenced pediatric clinician behavior in the older pediatric patient.

The 2010 AHA PALS guidelines stated that hypothermia is reasonable for adolescents resuscitated from witnessed out-of-hospital ventricular fibrillation arrest.¹⁸ However, the 2015 AHA PALS guidelines recommend *either* hypothermia or normothermia for children post arrest and did not specify hypothermia in adolescents as the previous guidelines did.⁸ Because the Moler et al⁶ and Nielsen et al⁷ studies did not show superiority for either approach in children or adults,

respectively; the determination to use one over the other may be based on other factors. For example, many institutions may still have a cooling protocol in place that they continue to follow.

At the time of our survey, approximately 85% of physicians reported using TTM, with the largest practice variation noted in the *duration* of temperature management. The 2015 AHA guidelines, based on the THAPCA-OH Trial findings, recommended that it is reasonable to either maintain continuous normothermia for 5 days or 2 days of hypothermia followed by 3 days of normothermia.⁸ Yet just half of our respondents reported following the hypothermia duration guidelines of 48 hours and 20% following the normothermia guidelines of 120 hours. (Our survey did not address rewarming duration choices.) Most chose to cool for 12 to 48 hours prior to rewarming, although the proportion that chose a shorter time frame of 12 to 24 hours was substantial. When respondents chose normothermia as the preferred treatment modality, most opted to maintain normothermia for 48 to 120 hours and a substantial proportion (30–40%) opted for 48 hours. Less than 5% of respondents selected a shorter duration of normothermia (12–24 h), a time frame that has not been studied.

Barriers to following clinical practice guidelines include lack of agreement with the guidelines (differences in interpretation/applicability to patients), perception of the results as invalid, not remembering to use the treatment out of habit or routine, and external barriers (patient preferences/lack of time).¹⁹ These and other factors may be contributing to the self-reported practice variations found in our survey. Results of controlled trials may be persuasive, but a physician has to decide if the rule applies to a particular patient.¹² Comments from respondents showed that some thought the inclusion and exclusion criteria for the trial were so narrow that it ultimately applied to only comatose patients. In addition, some pediatric critical care physicians may not be convinced of the THAPCA-OH Trial results and think the subsequent AHA consensus treatment guidelines do not apply to their specific types of patients. A study conducted in Canada found that emergency department physicians were not using a highly validated rule to assess head injury in adults even though clinicians were familiar with the rule and strongly believed in its benefits. The use of the rule varied, however, with atypical patients or during busy times in the emergency department.²⁰ Similarly, despite positive clinical trial findings and published consensus guidelines for adults after OHCA, hypothermia utilization by practicing physicians remained low due to lack of awareness of supporting data, not enough evidence, and resource and technical difficulties related to cooling methods.^{13,21}

Our study has several limitations. First, this is a cross-sectional survey that reflects TTM self-reported versus actual observed practice at one point in time. Second, our response rate of 20% may not completely reflect the viewpoints and practice patterns of all pediatric critical care physicians caring for pediatric cardiac arrest patients, which may limit the generalizability of our findings. While surveys are considered an important tool for obtaining information

on physicians' knowledge and attitudes related to healthcare delivery, physicians typically have low response rates (less than 20% is not uncommon), and our survey was no different.^{22,23} The survey was sent via a non-personalized email with a hyperlink, from the American Academy of Pediatrics, to the members of the Section on Critical Care that included retired physicians, fellows, and Advanced Practice providers, not eligible to participate in the survey. Since we were not able to identify ineligible participants a priori, they were included in the denominator while calculating our response rate. Email invitations and reminders may have been identified as "spam mail," which may have also limited our response rate. Third, a public survey does not track individuals by an identifier limiting our ability to compare characteristics and practice setting information of non-respondents to respondents. However, the characteristics of our respondents were similar to those who participated in a critical care workforce survey²⁴ in terms of working at children's hospitals and in ICU with at least 13 beds suggesting that our sample may reflect overall pediatric critical care physicians. Lastly, the incorporation of practice change may take longer than the time covered by our survey. The duration of time from publication of the THAPCA-OH results to the administration of the survey was likely too short to note significant changes in practice. Some estimates say that there is a 17-year gap for clinicians to adopt new practices after the results of a clinical trial.²⁵

Conclusions

We surveyed pediatric critical care physicians, using a web-based public survey, with questions regarding mode(s) of learning about the THAPCA-OH results, opinion of trial design, and clinical scenarios assessing self-reported TTM usage. Despite knowledge of and reported confidence in the THAPCA-OH Trial findings, 15% of the respondents did not select TTM for prevention of fever when responding to the patient scenarios. In addition, the majority of respondents did not select TTM durations consistent with trial findings and published guidelines. Further research is warranted on barriers and facilitators to implementation of TTM following pediatric cardiac arrest.

Conflict of Interest

None declared.

Acknowledgments

This work is supported by grants from the National Heart, Lung, and Blood Institute (HL094345 to Dr. Moler and HL094339 to Dr. Dean). Content of this article is solely the responsibility of the authors and should not be construed as the official position or policy of, nor should any endorsements be inferred by NIH or the US government. The authors would like to thank Linda Herrera, data manager at the University of Utah, Sue Tellez at the American Academy of Pediatrics, who helped with survey deployment, and the pediatric critical care physicians who participated in the cognitive interviews and final survey testing.

References

- 1 Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *N Engl J Med* 2002;346(08):549–556
- 2 Bernard SA, Gray TW, Buist MD, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. *N Engl J Med* 2002;346(08):557–563
- 3 Shankaran S, Laptook AR, Ehrenkranz RA, et al; National Institute of Child Health and Human Development Neonatal Research Network. Whole-body hypothermia for neonates with hypoxic-ischemic encephalopathy. *N Engl J Med* 2005;353(15):1574–1584
- 4 Gluckman PD, Wyatt JS, Azzopardi D, et al. Selective head cooling with mild systemic hypothermia after neonatal encephalopathy: multicentre randomised trial. *Lancet* 2005;365(9460):663–670
- 5 Azzopardi DV, Strohm B, Edwards AD, et al; TOBY Study Group. Moderate hypothermia to treat perinatal asphyxial encephalopathy. *N Engl J Med* 2009;361(14):1349–1358
- 6 Moler FW, Silverstein FS, Holubkov R, et al; THAPCA Trial Investigators. Therapeutic hypothermia after out-of-hospital cardiac arrest in children. *N Engl J Med* 2015;372(20):1898–1908
- 7 Nielsen N, Wetterslev J, Cronberg T, et al; TTM Trial Investigators. Targeted temperature management at 33°C versus 36°C after cardiac arrest. *N Engl J Med* 2013;369(23):2197–2206
- 8 de Caen AR, Berg MD, Chameides L, et al. Part 12: Pediatric advanced life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2015;132(18, Suppl 2):S526–S542
- 9 Avron J, Fischer M. 'Bench to behavior': translating comparative effectiveness research into improved clinical practice. *Health Aff* 2010;29(10):1891–1900
- 10 Zak V, Hsu DT, Pemberton VL, et al; Pediatric Heart Network Investigators. Translating clinical trials into clinical practice: a survey assessing the potential impact of the Pediatric Heart Network Infant Single Ventricle Trial. *Cardiol Young* 2017;27(07):1265–1270
- 11 de Caen AR, Maconochie IK, Aickin R, et al; Pediatric Basic Life Support and Pediatric Advanced Life Support Chapter Collaborators. Part 6: Pediatric basic life support and pediatric advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Circulation* 2015;132(16, Suppl 1):S177–S203
- 12 Winkler JD, Lohr KN, Brook RH. Persuasive communication and medical technology assessment. *Arch Intern Med* 1985;145(02):314–317
- 13 Abella BS, Rhee JW, Huang KN, Vanden Hoek TL, Becker LB. Induced hypothermia is underused after resuscitation from cardiac arrest: a current practice survey. *Resuscitation* 2005;64(02):181–186
- 14 Burgers JS, Grol RP, Zaat JO, Spies TH, van der Bij AK, Mokkink HG. Characteristics of effective clinical guidelines for general practice. *Br J Gen Pract* 2003;53(486):15–19
- 15 Duffett M, Choong K, Hartling L, Menon K, Thabane L, Cook DJ. Randomized controlled trials in pediatric critical care: a scoping review. *Crit Care* 2013;17(05):R256
- 16 Field JM, Hazinski MF, Sayre MR, et al. Part 1: executive summary: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010;122(18, Suppl 3):S640–S656
- 17 Hazinski MF, Nolan JP, Billi JE, et al. Part 1: Executive summary: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation* 2010;122(16, Suppl 2):S250–S275
- 18 Kleinman ME, Chameides L, Schexnayder SM, et al. Part 14: pediatric advanced life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010;122(18, Suppl 3):S876–S908
- 19 Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA* 1999;282(15):1458–1465
- 20 Curran JA, Brehaut J, Patey AM, Osmond M, Stiell I, Grimshaw JM. Understanding the Canadian adult CT head rule trial: use of the theoretical domains framework for process evaluation. *Implement Sci* 2013;8:25
- 21 Laver SR, Padkin A, Atalla A, Nolan JP. Therapeutic hypothermia after cardiac arrest: a survey of practice in intensive care units in the United Kingdom. *Anaesthesia* 2006;61(09):873–877
- 22 Dykema J, Jones NR, Piché T, Stevenson J. Surveying clinicians by web: current issues in design and administration. *Eval Health Prof* 2013;36(03):352–381
- 23 Cho YI, Johnson TP, Vangeest JB. Enhancing surveys of health care professionals: a meta-analysis of techniques to improve response. *Eval Health Prof* 2013;36(03):382–407
- 24 Radabaugh CL, Ruch-Ross HS, Riley CL, et al. Practice patterns in pediatric critical care medicine: results of a workforce survey. *Pediatr Crit Care Med* 2015;16(08):e308–e312
- 25 Morris ZS, Wooding S, Grant J. The answer is 17 years, what is the question: understanding time lags in translational research. *J R Soc Med* 2011;104(12):510–520