Resuscitation after cardiac surgery in Australia: a survey of practice and the implementation of a training course

David John Melia, Richard Pieter Ruberti, Kimberley Smith, Sarah Emily Owen

Abstract

***Objective*: To characterise the out-of-hours cover of Cardiac-Surgical Intensive Care Units in Australia, the experience of covering physicians in the training, and management of, cardiac arrest after cardiac surgery, and to describe a novel educational course.**

***Design*: Nighttime phone survey with doctors on public cardiac intensive care units across Australia. Members of nursing, intensive care, and cardiac surgery staff, devised a dedicated half-day course to address the principles of managing a cardiac arrest post-cardiac surgery.**

***Setting*: Tertiary teaching hospital in Sydney, New South Wales, Australia.**

***Patients and Participants*: No patient data used. Qualitative and quantitative feedback from doctors covering intensive care units, and participants, on a pilot course designed to formally train medical and nursing personnel in the management of cardiac arrest after cardiac surgery.**

***Interventions*: Design and implementation of a new training course.**

***Measurements and Results*: We demonstrated wide variation in the availability of training opportunities in Cardiac-surgical Unit-Advanced Life Support, with few units having cardiothoracic surgical doctors on site at night, and the majority of units being covered by a registrar grade, intensive care trainee, out-of-hours. Our pilot course was feasible, well received, and demonstrated improvements in candidates' confidence in managing cardiac arrests, and their ability to perform, or assist with, emergency re-sternotomy.**

***Conclusions*: The experience of doctors covering cardiac intensive care units varies greatly. There is a lack of dedicated guidelines covering the management of cardiac arrest in the post-cardiac surgical population, with wide variability in whether institutions offer training for this emergency, and how frequently these opportunities are available. There is also a lack of trained medical staff on-site, out-of-hours, able to perform emergency re-sternotomy.**

Key words: Cardiac surgery, critical care, resuscitation, training.

Introduction

Between 0.7 and 2.9% of patients undergoing major cardiac surgery will suffer a postoperative cardiac arrest (1) - this accounts for up to 5000 patients per year in the United States. (2) When managed appropriately, up to 79% of patients who experience a cardiac arrest after cardiac surgery, survive to discharge. (3) However, there are significant differences in recommended standards for the management of these patients compared to other groups (**Table 1**). (4)

Cardiac Surgery Unit-Advanced Life Support (CSU-ALS), as it is termed in the United Kingdom, is widely established and embraced by the European Association for Cardio-Thoracic Surgery, whilst Cardiac Advanced Life Support-Surgical (CALS-S) is expanding in the United States, (4) recently receiving endorsement from the Society of Thoracic Surgeons. (5) The Australian College of Critical Care Nurses have also published their recommended guidelines for the management of cardiac arrest after cardiac surgery. (6) The Australian Resuscitation Council make recommendations regarding modifications of their Advanced Life Support algorithm in the cardiac surgical population, (7) but the authors cannot find a dedicated course being offered in Australia.

The use of specific training, and practice, in the management of cardiac arrest in the post-cardiac

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surgery period leads to significant improvements in the speed, and quality, of definitive care. (8) Optimising the delivery of care not only depends upon training, but who can attend the patient in a timely manner, therefore the staffing of units, will play a crucial role. A major determinant of survival in cardiac arrest, not responding to defibrillation or pacing, is chest reopening within ten minutes of cardiac arrest. (9) Thus, it is paramount that all staff working on the cardiac intensive care unit, are trained in the principles of CSU-ALS. (3)

With this in mind, our institution developed and piloted an in-house CSU-ALS course for all members of the multi-disciplinary team, hoping to show improvements in both participants' confidence in managing a cardiac arrest after cardiac surgery, and their ability to perform, or assist with, an emergency re-sternotomy. Similarly, we were keen to find out how intensive care units (ICUs) around Australia are staffed, and prepared, for such situations, and the training opportunities available in this field.

Materials & Methods

As this is a survey, and educational project, involving no patient data or interaction, ethical approval was waived by South East Sydney Local Health District Human Research Ethics Committee.

We contacted the intensive care unit at all twenty-two public centres accredited for Cardiothoracic Surgical Training in Australia. (10) Data collection occurred via telephone between 20:00 on 26th November and 08:00 on 27th November 2016. We sought to speak to the most senior doctor, on-site, covering the intensive care unit, and asked them a list of pre-defined questions (**Table 2**). If the most senior doctor was not available, we asked to speak to the next most senior intensive care doctor present.

We subsequently devised a half day course, targeted at all members of the multi-disciplinary team who care for post-cardiac surgical patients on the ICU, nurses, ICU doctors, and cardiothoracic surgical doctors, of all grades. We divided the course into an introductory lecture concerning the key differences between Adult Advanced Life Support and Cardiac-Surgical Unit Advanced Life Support, and peoples' different roles within the arrest team, followed by small group skill stations (**Table 3** and **Figure 1**). The participants were subsequently shown videos, shot on our unit, showing the location of key equipment, and demonstrating essential processes, for example, how to set-up our multi-chamber portable suction unit, or the location and set up of the portable overhead lamp. The course finished with multi-disciplinary team moulages (**Figure 2**); concerning both shockable and non-shockable cardiac arrests requiring re-sternotomy, with participants having the opportunity to practice a number of roles within the team. The course has since been run twice, involving 24 participants from ICU nursing, ICU medical, and cardiac surgery staff.

We collected data from candidates via pre-course and post-course questionnaires, asking them to rate their confidence and ability, on a numerical scale, in managing a post-surgical cardiac arrest, and their ability to perform, or assist with, an emergency re-sternotomy on the ICU.

Responses from the phone survey were collated as absolute numbers and percentages. Data collected from pre- and post-course questionnaires were compared using paired Students t-test, with statistical analysis performed using XLSTAT® (New York, USA).

Results

Data were obtained from the most senior ICU doctor on-site, out-of-hours, from 21 institutions in Australia, and from the second most senior doctor on-site from one. Only 6 units reported to have a cardiothoracic surgical doctor on-site at night. Thus, the process of emergency re-sternotomy in the ICU cannot feasibly be undertaken by this person within a ten-minute window.

Of the 22 doctors questioned, 3 had attended a formal CSU-ALS training course. The majority of units were covered by registrar grade doctors at night (20/22), with one covered by a senior resident medical officer, and a single centre having 24-hour consultant cover "on-the-floor".

Fifteen of 22 institutions currently offer drill/simulation training in cardiac arrest after cardiac surgery, however, the frequency of this training varies greatly by institution. (**Figure 3**)

Despite this, of the 22 doctors surveyed, only 59% (13/22) indicated that they would be capable of performing an emergency re-sternotomy in the event of a cardiac arrest that fails to respond to pacing or defibrillation.

Assuming this represents a snapshot of staffing, at night, across Australian public ICUs performing cardiac surgery, and assuming that cardiothoracic surgical trainees would be competent, and comfortable, in the process of re-sternotomy, 14 of 22 (64%) institutions had a doctor on-site that was able, and willing, to perform this procedure.

Our in-house pilot course was extremely well received (**Figure 4**), and is now scheduled to run four times per calendar year. It was simple to exe-

cute with five members of faculty (ICU Fellow, Cardiothoracic Surgical Fellow, Clinical Nurse Consultant for Cardiac Services, Two Clinical Nurse Specialists/Nurse Educators in Intensive Care), accommodating twelve participants on each course, and, although required a significant amount of equipment, the majority we, and probably most other institutions, already own, and thus overhead cost is minimal.

The course proved beneficial to candidates, with all reporting improvements, both in their confidence in managing a cardiac arrest in the post-cardiac surgical population (**Figures 5a** and **5b**, mean [SD] pre-course 2.50 [1.14] vs 4.36 [0.49] post-course, p=<0.0001), and in their ability to perform/assist in the conduct of emergency re-sternotomy (**Figures 6a** and **6b**, mean [SD] pre-course 2.00 [0.97] vs 4.50 [0.60] post-course, p=<0.0001).

Discussion

The most striking finding of the survey is the lack of trained personnel able to perform emergency re-sternotomy in ICUs out-of-hours. This is despite the procedure forming an integral part of resuscitation in a population who have favourable outcomes when managed according to international guidance.

The conduct of arrest management appears to be taught sparsely, with no dedicated course able to be found in Australia, and wide variation in hospitals offering simulation or drill training, with further variation as to how often these opportunities are offered.

The adoption of a formal guideline in Australia and New Zealand, endorsed by the respective colleges and associations, should help address this issue, and lead to standardised education, and the formation of a greater number of dedicated courses.

With less than 28% of units providing on-site cardiothoracic surgical cover, out-of-hours, the responsibility to perform emergency re-sternotomy within the time critical window will increasingly fall to the intensive care doctors and nursing staff present. Regular education and simulation training should lead to increased familiarity and adherence to guidelines, with improved outcomes. (11)

We have demonstrated that a dedicated in-house course, employing lectures, small-group hands-on skill stations, simple to produce videos, and multi-disciplinary moulages/simulations, is both feasible and effective. The actual cost to run the course will vary by institution depending upon the equipment and facilities they already possess, the cost of disposables, and availability of faculty; we estimate that at our institution it costs approximately $170.62 in disposable equipment items per course run. Faculty continue to give up their time for free, and by utilising our simulation suite and seminar room on-site, we have no direct facilities fee. We recognise a faculty to candidate ratio of 1:2.4 is high, but this is similar to other resuscitation courses offered internationally. (12) We suggest that this could be ameliorated by running two courses in one day.

There are numerous limitations to this project. It constitutes a very small data set, and is largely opinion, and it is feasible that institutions are providing more training opportunities than those questioned are aware of. However, in sampling the most experienced grade of doctor, on the floor, during a twelve-hour window, this is a realistic snap-shot of night-cover in Australia. Also, we have not been able to demonstrate a true clinical benefit of running a CSU-ALS course, with our pre, and post, course data collection addressing candidate-focused end-points. However, in better educating and enabling those at the sharp end of this critical situation, we hypothesise that we will see improvements in performance at our institution.

Though a small survey, and educational project, the results demonstrated have significant implications for both clinicians, and policy-makers alike; regarding the adoption of guidelines, and standardised training in the conduct of CSU-ALS in Australia.

Our audit of nighttime cover of cardiac-surgical ICU patients reveals wide variation in the experience of resident staff. There appears to be a need for a specific consensus guideline, covering cardiac arrest in the post-cardiac-surgical population, and adjunctive standardised training courses will help in the provision of optimal care for patients suffering a post-operative cardiac arrest. The design and subsequent execution of such courses is simple, feasible and effective.

Acknowledgements

There was no conflicts of interest, funding and sponsorship.

We would like to thank A. Armstrong RIBA, of AA & D Design Studio, for his help with the figures within this article, Roy Gutierrez, at The Glenn McEnally Simulation and Learning Centre, Prince of Wales Hospital, for his enduring hard work and flexibility, and Dr. Jee-Young Leong, Genevieve Gardner RN, and the rest of the faculty who helped designed and run the course.

Table 1. Comparison of CSU-ALS Guideline versus ANZCOR ALS Guideline

CSU-ALS 2009 Guideline	ANZCOR ALS 2016 Guideline
Ventricular fibrillation/pulseless ventricular tachycardia	
- 3 successive shocks prior to chest compressions	- Immediate chest compressions - Single shock every 2 minute cycle
Asystole/pulseless electrical activity	
- Attempt pacing - use epicardial wires if present, external pads if not - Delay chest compressions if feasible to achieve within 1 minute - Atropine 3 mg IV	- Immediate chest compressions - No atropine
Ventricular fibrillation/pulsesless ventricular tachycardia/asystole/pulseless electrical activity	
- No adrenaline unless directed by senior clinician - Re-sternotomy after failure of initial rescue strategies	- 1 mg 1:10,000 adrenaline every 3-5 minutes - Not applicable

Legend: CSU-ALS=Cardiac Surgery Unit Advanced Life Support; ANZCOR ALS=Australia and New Zealand Committee on Resuscitation Advanced Life Support; IV=intravenous

Table 2. Questions asked via phone survey

What is your grade?				
Does your unit have a cardiothoracic surgical doctor on-site at night?	Yes		No	
Does your unit offer simulation/drill training in cardiac arrest after cardiac surgery/emergency re-sternotomy on the ICU?	Yes		No	
- If yes, how many times per year?	1-2	3-6	7-12	>12
Would you be able to perform an emergency re-sternotomy on a post-cardiac surgery patient in the context of a cardiac arrest?	Yes		No	

Table 3. List of skill stations

Conduct of re-sternotomy
Orientation and opening of chest opening pack
Internal cardiac massage and defibrillation
Scrubbing and draping aseptically

Figure 1. Skill station

Figure 2. Moulage

Figure 3. Frequency of training per year as varies by institution

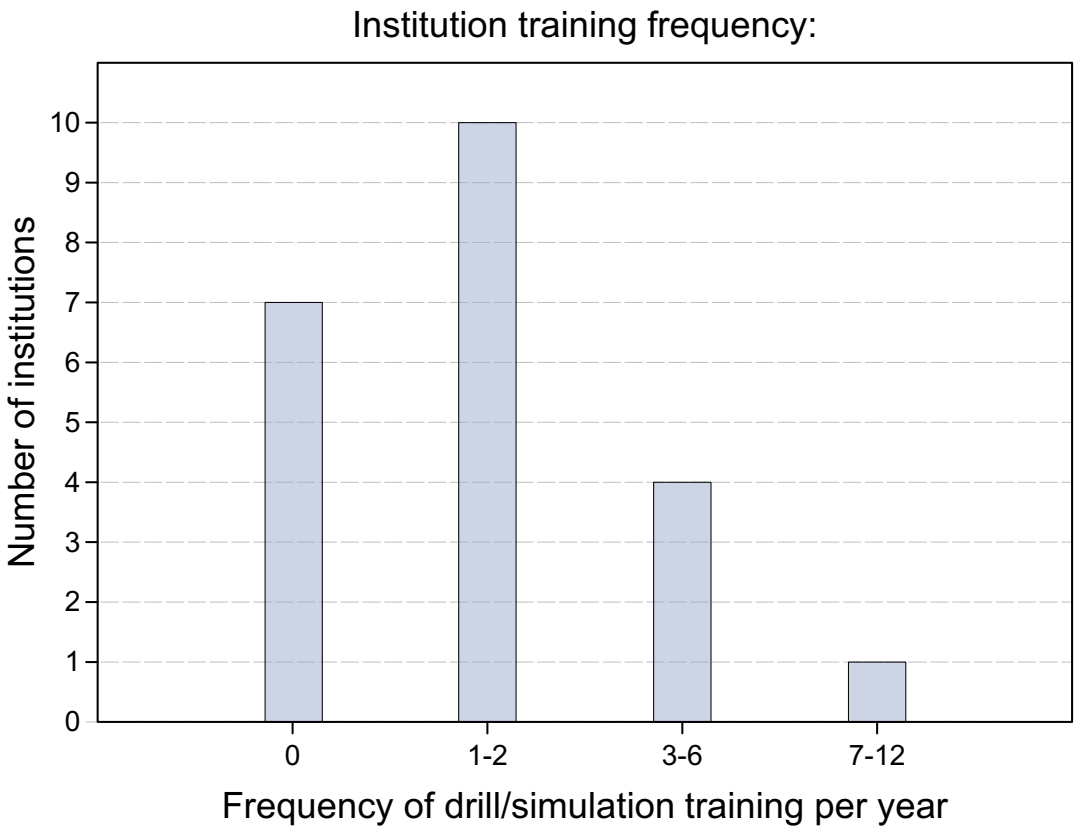


Figure 4. Participants' post-course satisfaction

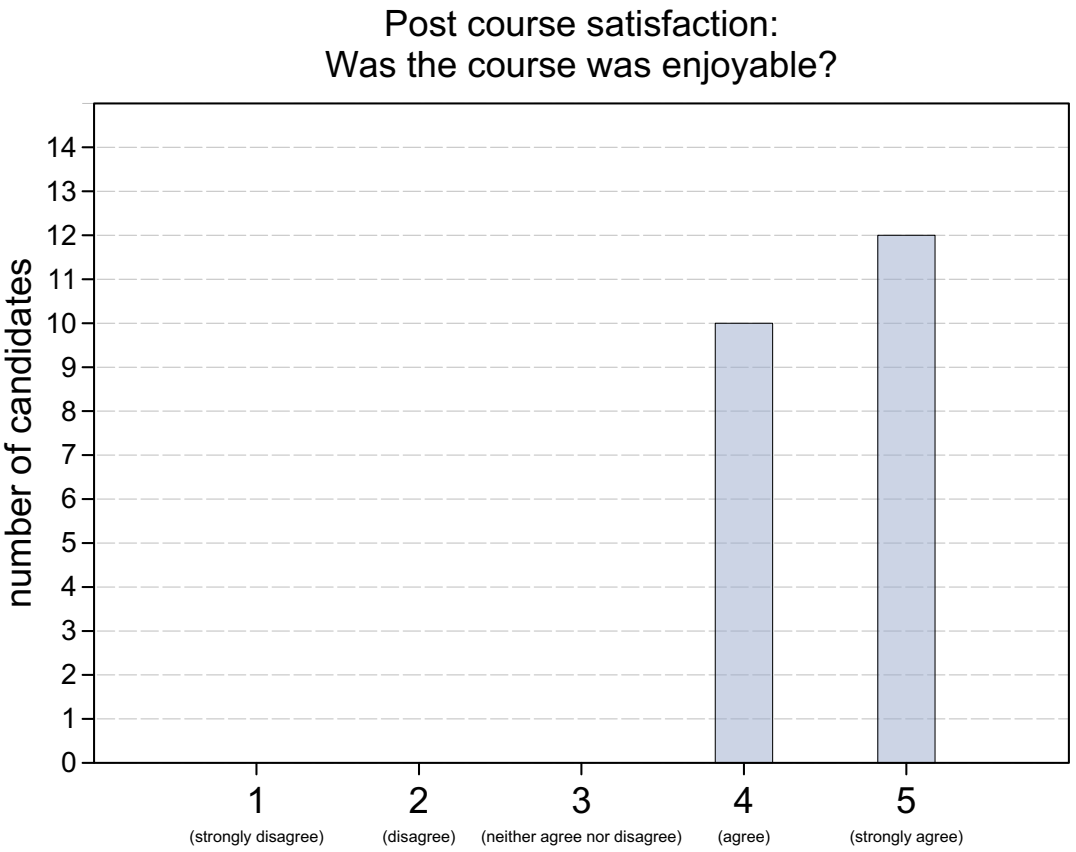


Figure 5a. Difference in candidates' confidence in managing a cardiac arrest before the course

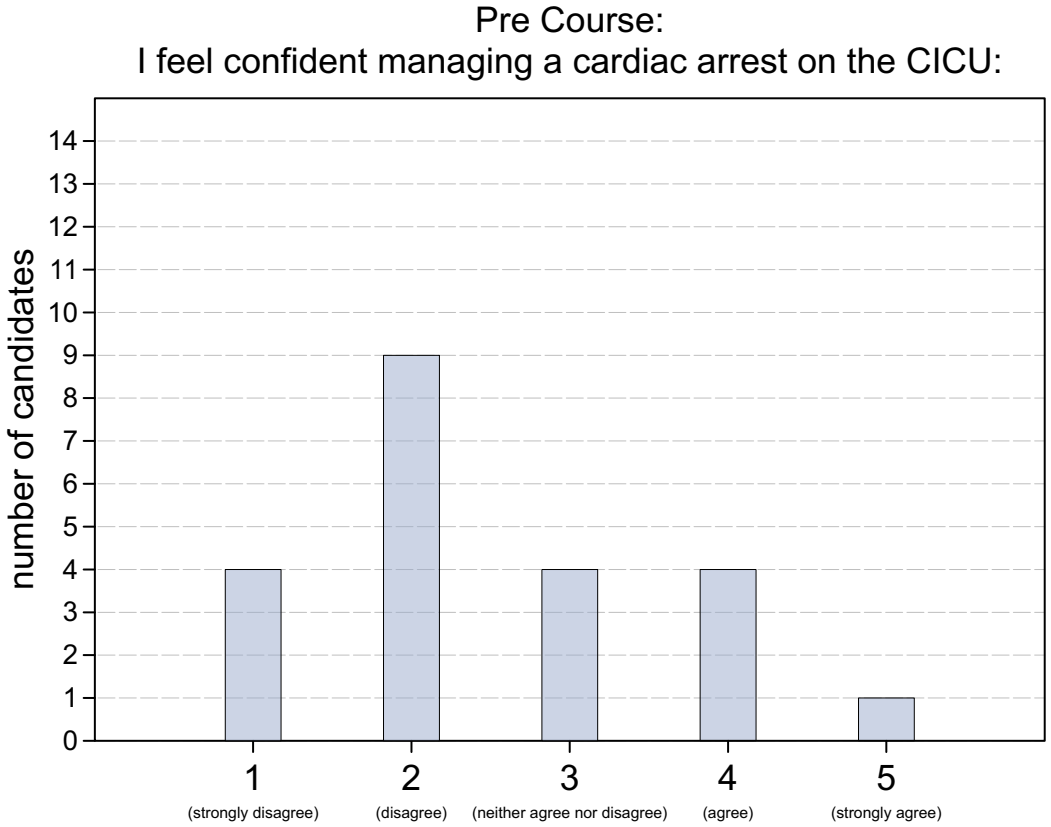


Figure 5b. Difference in candidates' confidence in managing a cardiac arrest after the course

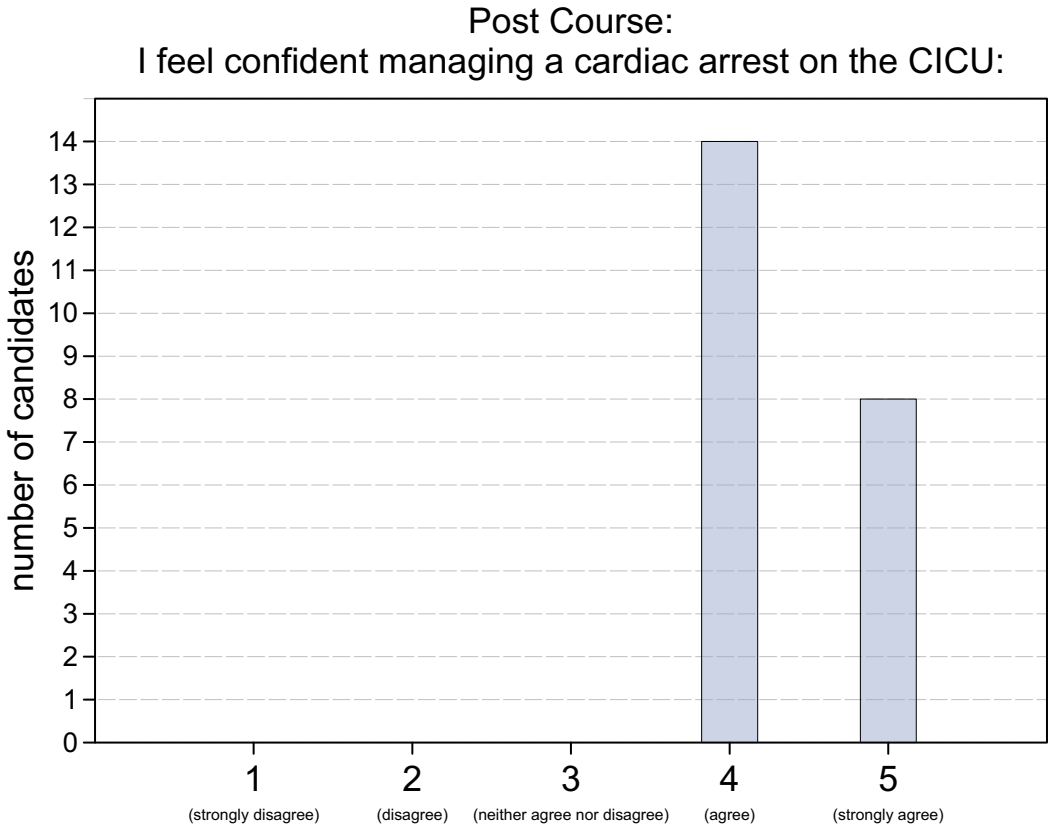


Figure 6a. Difference in candidates' perceived ability to assist with/perform emergency re-sternotomy before the course

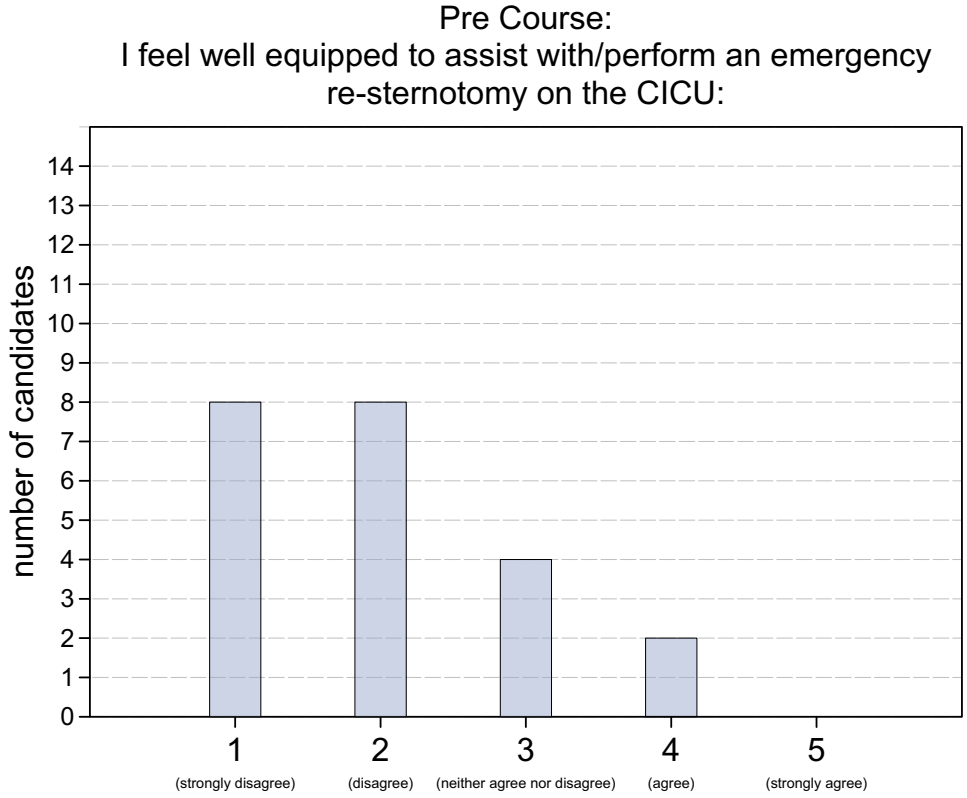
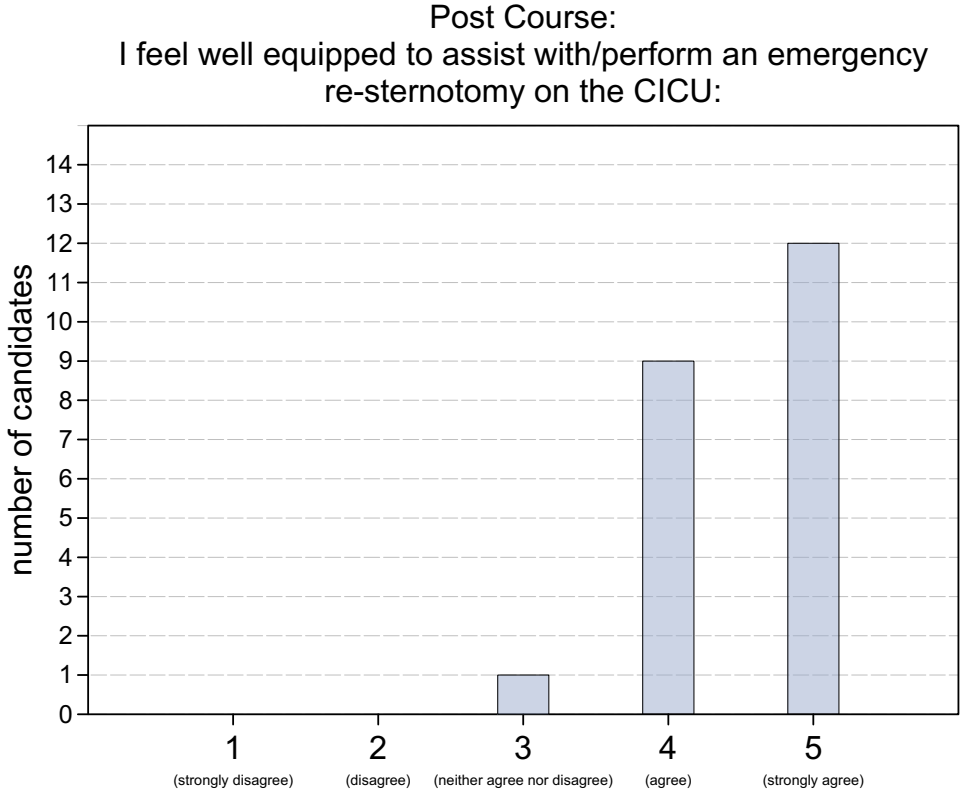


Figure 6b. Difference in candidates' perceived ability to assist with/perform emergency re-sternotomy after the course



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