ENHANCING CLINICIAN ADHERENCE TO CARDIAC SURGICAL UNIT-ADVANCED LIFE SUPPORT PROTOCOLS

BROOKE SMITH, MSN, APRN, AGACNP-BC, CNL, CCRN

DOCTOR OF NURSING PRACTICE CANDIDATE

UVA | SCHOOL of NURSING

THE TEAM

Faculty Advisor

Regina DeGennaro

DNP, RN, CNS, AOCN, CNL

Second Reader

Sarah Craig

PhD, RN, CCNS, CCRN-K, CHSE, CNE

Practice Mentor

Michelle Dawson

MSN, RN, AGACNP-BC

Data Specialist

David Martin

PhD

+ CSU-ALS COMMITTEE MEMBERS & TRAINERS

Special thanks to Natalie Lapedota, Taylor Fink, and Joe Hornbrook

THE PRACTICE SETTING

A 24 BED INTENSIVE CARE UNIT CARING FOR CARDIAC, THORACIC, AND VASCULAR SURGERY PATIENTS AT A LARGE ACADEMIC MEDICAL CENTER IN CENTRAL VIRGINIA.

BACKGROUND

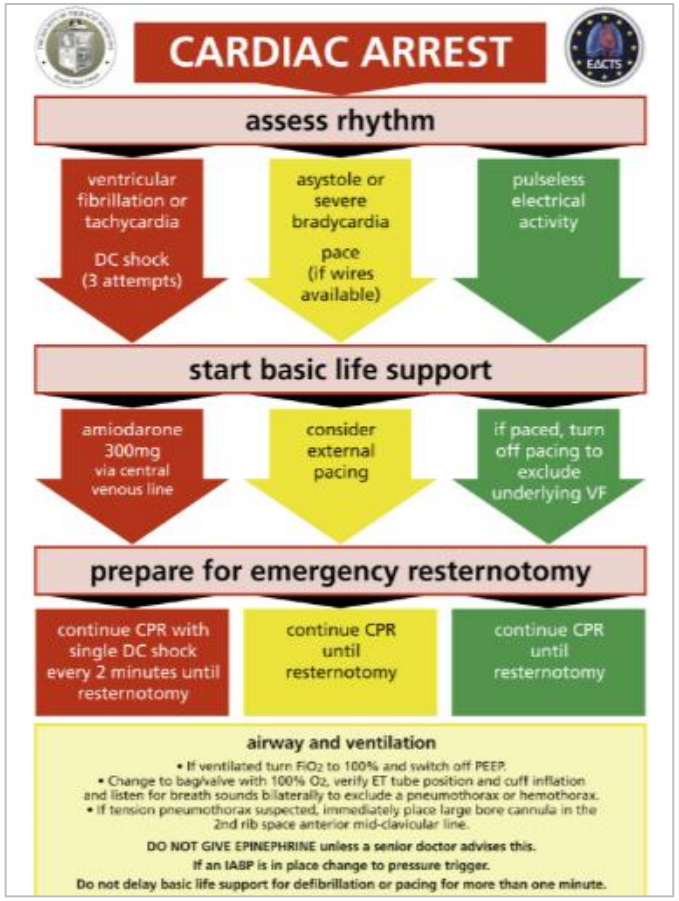
Cardiac surgery presents a set of unique challenges

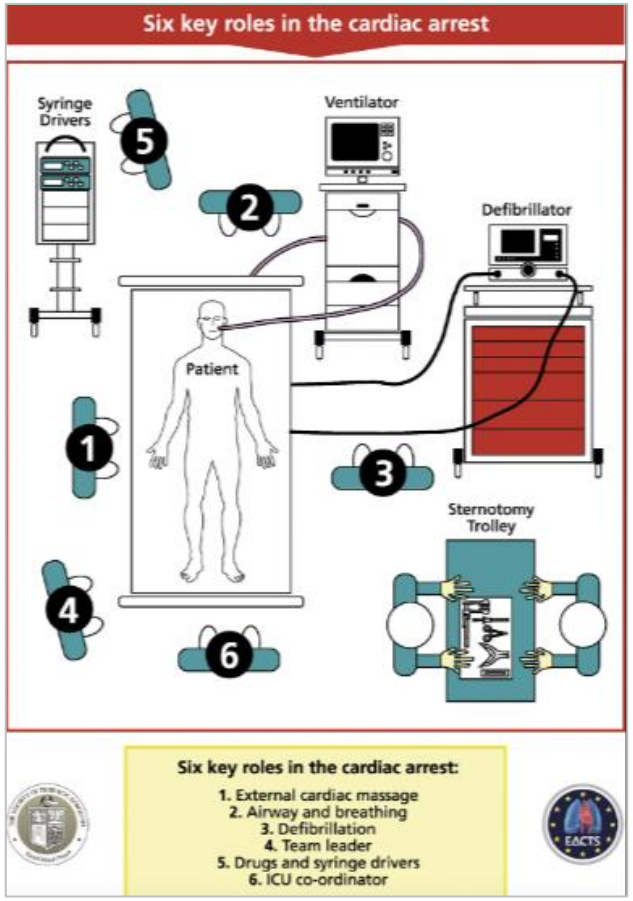
Cardiac arrest following cardiac surgery is different

Practice makes perfect

Fortunately, there's Cardiac Surgical Unit-Advanced Life Support…

INTRODUCTION TO CSU-ALS





SO, WHAT'S THE PROBLEM?

CSU-ALS requires highly skilled and competent clinicians to perform emergent resternotomy within five minutes

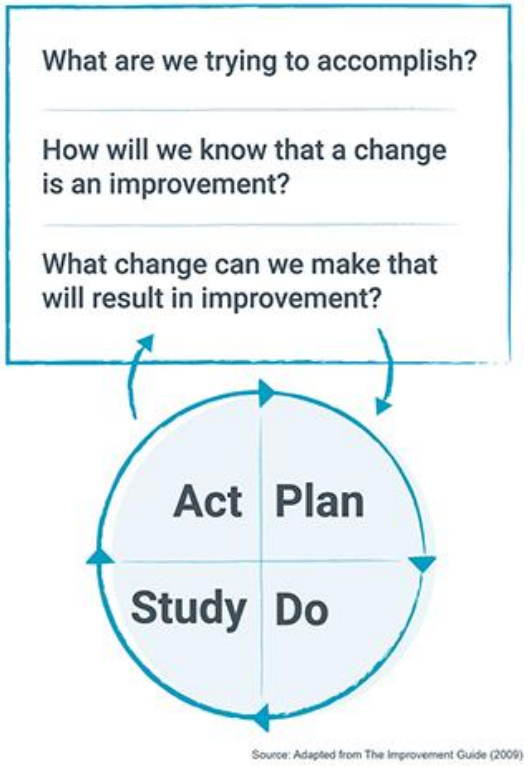
Current competency in CSU-ALS is defined as completion of a one-day course every two years

Cardiac surgery patients are uniquely vulnerable, and require a specialized approach to resuscitation

Low-frequency, high-risk events… Limiting staff exposure to the emergency protocol

Cardiac arrests are scary, and often unexpected… What can we do to minimize the chaos?

THE MODEL FOR IMPROVEMENT & PLAN-DO-STUDY-ACT



What are we trying to accomplish?
Improve patient outcomes through enhanced team performance in responding to cardiac arrests following cardiac surgery.

How will we know that a change is an improvement?
Consistent adherence to CSU-ALS protocol measures.

What change can we make that will result in improvement?
Increase bedside clinician exposure to the CSU-ALS protocol through a multi-modal training approach.

WHAT ARE WE TRYING TO ACCOMPLISH?

HOW DO WE ENHANCE CLINICIAN ADHERENCE TO THE CSU-ALS PROTOCOL AND IMPROVE PERFORMANCE IN RESPONDING TO POST-STERNOTOMY CARDIAC ARRESTS?

UVA | SCHOOL of NURSING

LITERATURE REVIEW

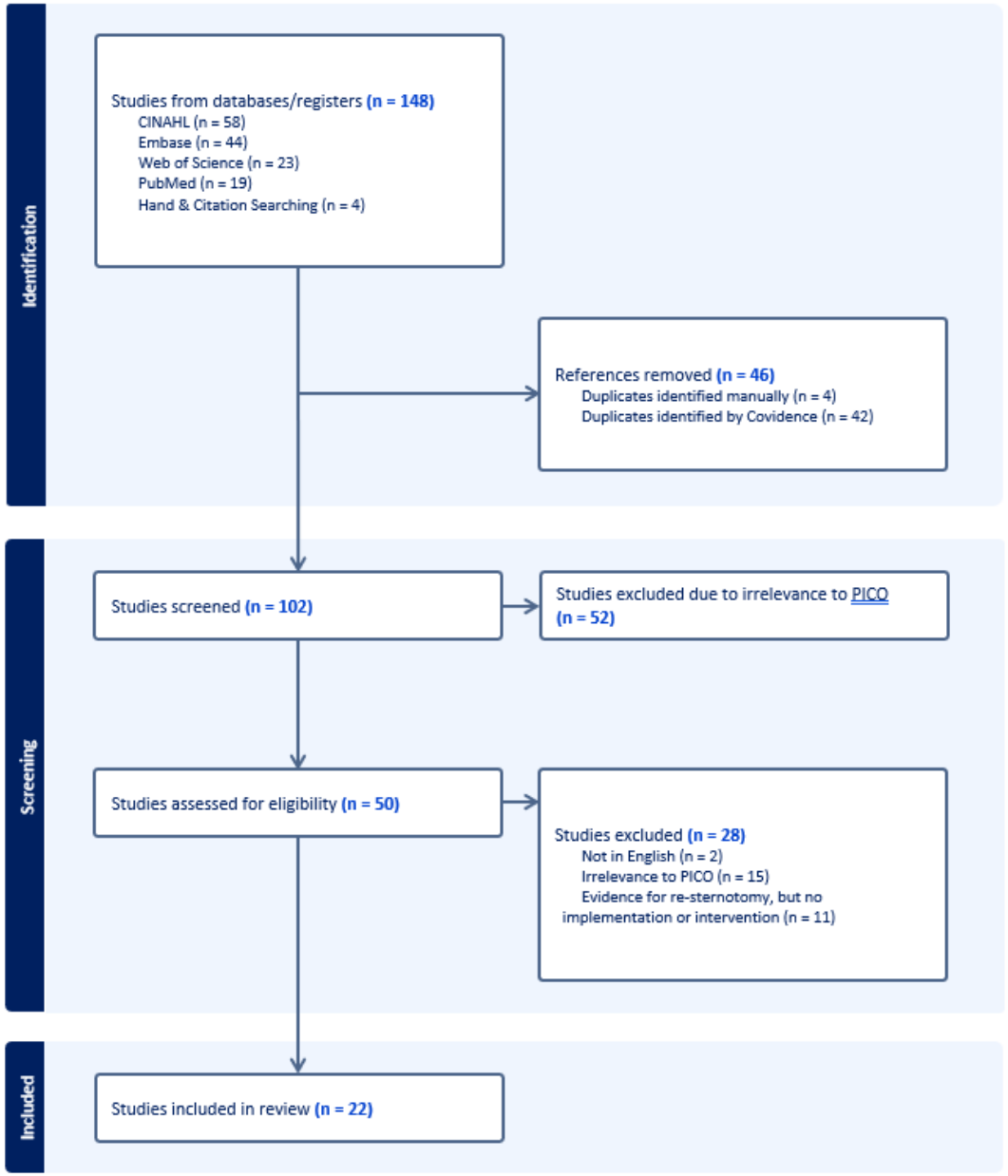
Databases Searched:

- CINAHL
- Embase
- Web of Science
- PubMed

Search Terms: (*cardiac surgery* OR *cardiac surgical*) AND (*cardiac arrest* AND (*resuscitation* OR *life support*)) AND (*resternotomy* OR *re-sternotomy*)

LIMITS: 2000-Present, English

PRISMA


Identification
Studies from databases/registers (n = 148)
CINAHL (n = 58)
Embase (n = 44)
Web of Science (n = 23)
PubMed (n = 19)
Hand & Citation Searching (n = 4)
References removed (n = 46)
Duplicates identified manually (n = 4)
Duplicates identified by Covidence (n = 42)
Screening
Studies screened (n = 102)
Studies excluded due to irrelevance to PICO (n = 52)
Studies assessed for eligibility (n = 50)
Studies excluded (n = 28)
Not in English (n = 2)
Irrelevance to PICO (n = 15)
Evidence for re-sternotomy, but no implementation or intervention (n = 11)
Included
Studies included in review (n = 22)

SYNTHESIS

Conventional Training

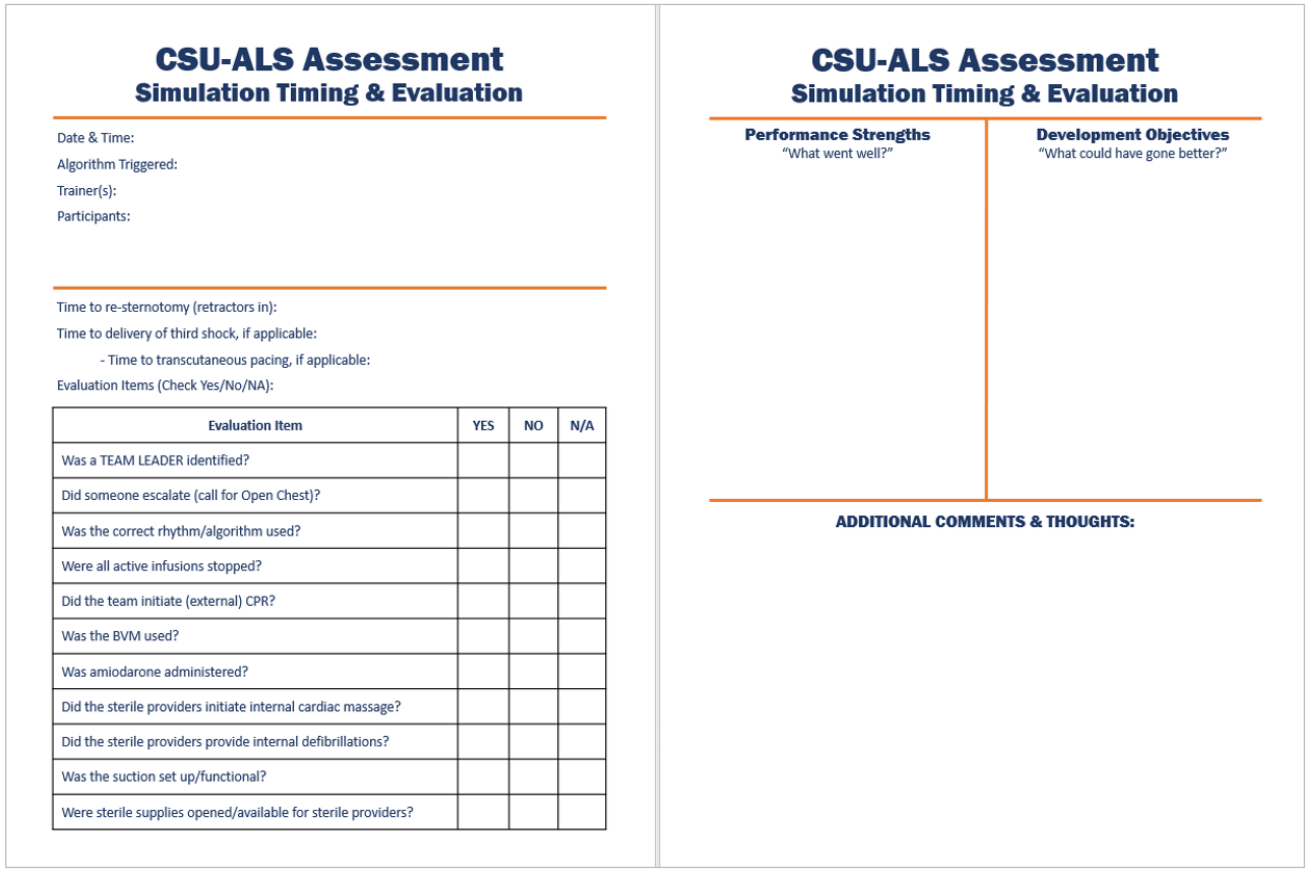
Simulation-Based Training

Virtual Reality

REVISITING THE QUESTIONS:

How will we know that a change is an improvement?

OUTCOMES MEASURES



CSU-ALS Assessment
Simulation Timing & Evaluation

Date & Time:
Algorithm Triggered:
Trainer(s):
Participants:

Time to re-sternotomy (retractors in):
Time to delivery of third shock, if applicable:
- Time to transcutaneous pacing, if applicable:
Evaluation Items (Check Yes/No/NA):

Evaluation Item	YES	NO	N/A
Was a TEAM LEADER identified?			
Did someone escalate (call for Open Chest)?			
Was the correct rhythm/algorithm used?			
Were all active infusions stopped?			
Did the team initiate (external) CPR?			
Was the BVM used?			
Was amiodarone administered?			
Did the sterile providers initiate internal cardiac massage?			
Did the sterile providers provide internal defibrillations?			
Was the suction set up/functional?			
Were sterile supplies opened/available for sterile providers?			

CSU-ALS Assessment
Simulation Timing & Evaluation

Performance Strengths "What went well?"	Development Objectives "What could have gone better?"

ADDITIONAL COMMENTS & THOUGHTS:

Primary Outcomes

- Time to resternotomy (<5 minutes)
- Time to delivery of third stacked shock (within 1 minute) OR time to attempted pacing

Secondary Outcomes (Examples)

- Was a team leader identified?
- Was the correct algorithm used?
- Were all active infusions stopped?
- Did the team initiate external CPR?
- Was the BVM used?

Practice Measures

- Volume of staff participating in mini-mocks
- Volume of staff maintaining CSU-ALS certification
- Program costs (e.g., sterile gloves, gowns)

REVISITING THE QUESTIONS:

What change can we make that will result in improvement?

THE PRACTICE CHANGE: “MINI-MOCKS”

The project intervention is the implementation of “mini-mocks,” a marriage between conventional classroom-based training on CSU-ALS and in-situ simulation events. The mini-mocks will be hosted with individual staff members, or potentially small groups, to capture more staff in training dedicated to the CSU-ALS protocol.

Evaluate competency and knowledge gaps

Establish sense of “muscle memory,” and familiarize staff with protocol

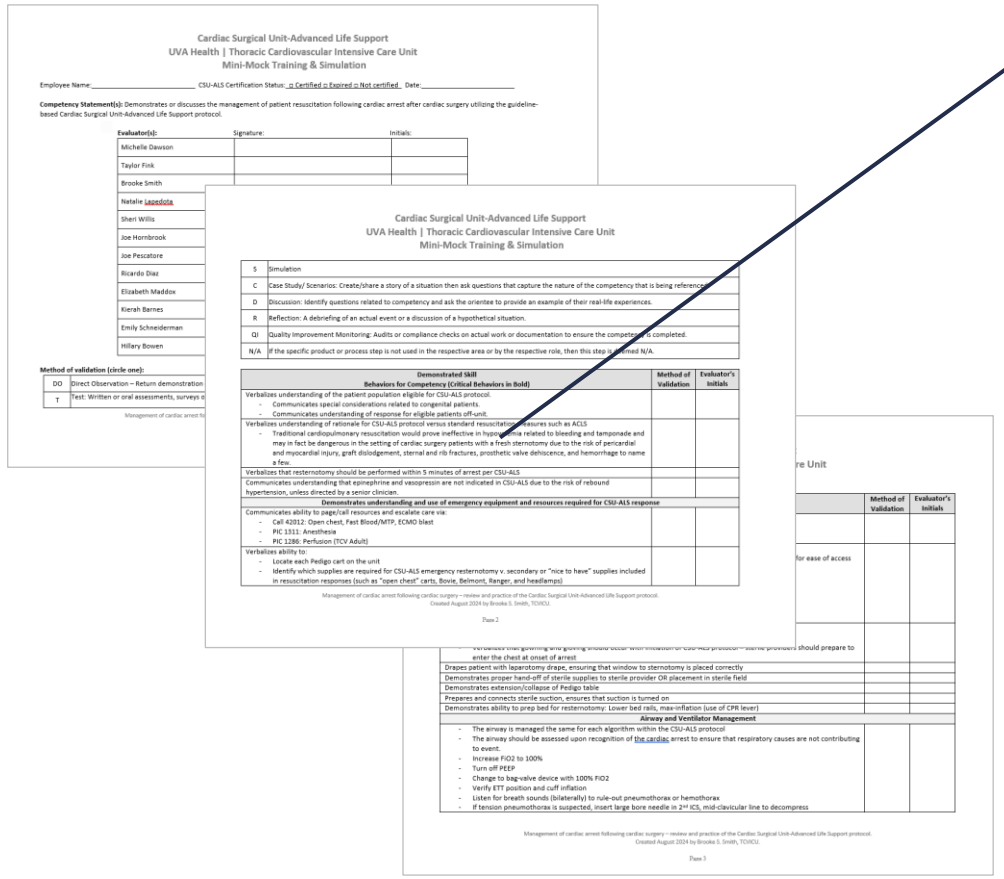
Enhance team exposure to CSU-ALS protocol, promote teamwork

Reduce overall time to response, accelerate “reaction time”

How do we measure impact?

Compliance against outcomes measures in full-scale simulation events.

THE PRACTICE CHANGE: “MINI-MOCKS”


Cardiac Surgical Unit-Advanced Life Support
UVA Health | Thoracic Cardiovascular Intensive Care Unit
Mini-Mock Training & Simulation

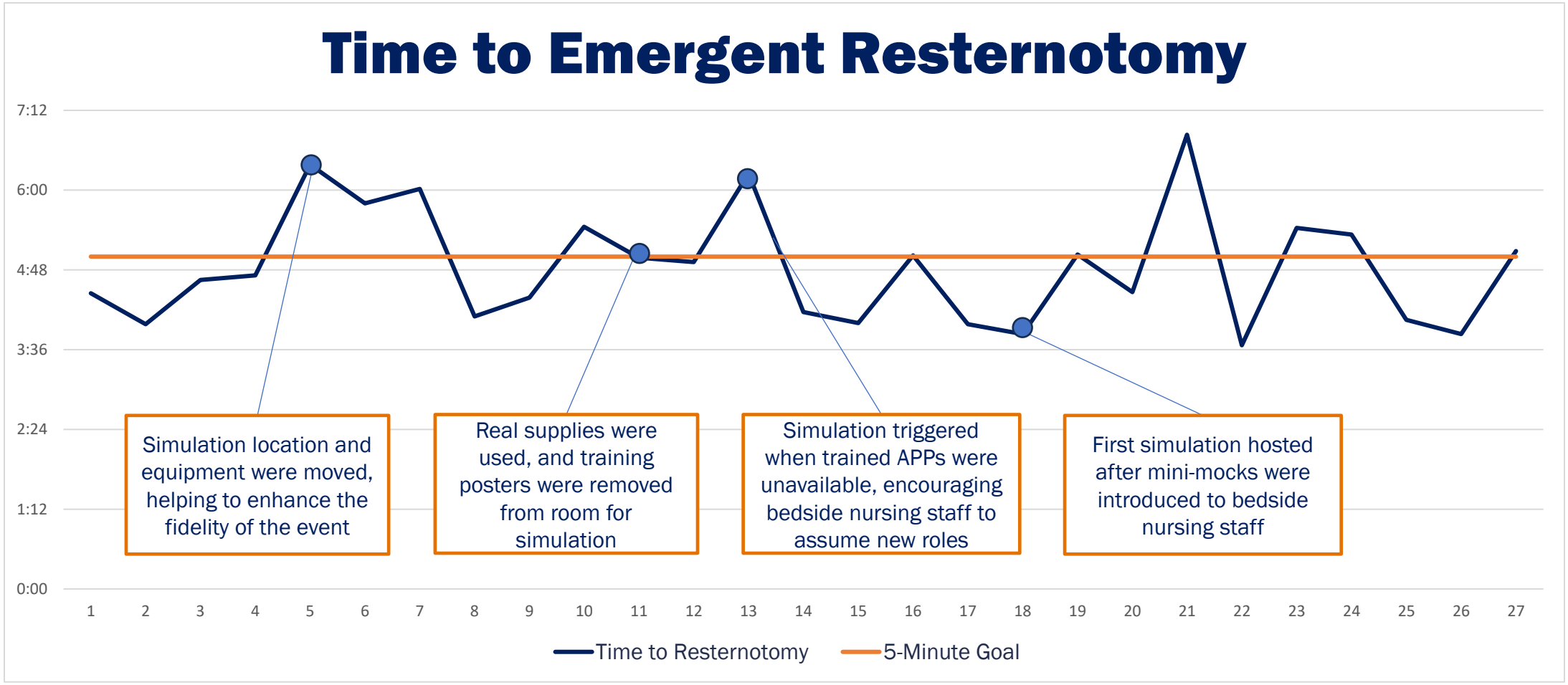
Cardiac Surgical Unit-Advanced Life Support
UVA Health | Thoracic Cardiovascular Intensive Care Unit
Mini-Mock Training & Simulation

Verbalizes ability to:
- Locate each Pedigo cart on the unit
- Identify which supplies are required for CSU-ALS emergency resternotomy v. secondary or “nice to have” supplies included in resuscitation responses (such as “open chest” carts, Bovie, Belmont, Ranger, and headlamps)
- List contents of quick-pack, resternotomy tray, and internal paddle pack
- Describe order in which to open CSU-ALS supplies (consider sterile field)
- Find Zoll defibrillators and associated supplies in each patient room within the unit

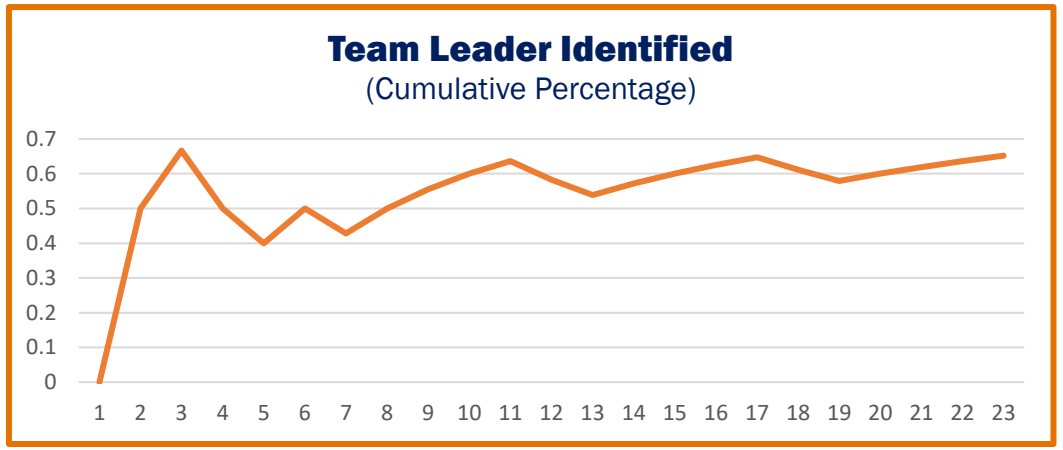
Demonstrates ability to use Zoll defibrillator:
- Removes defibrillator pads from packet and applies to patient, being careful to leave sternotomy clear for ease of access and sterile draping
- Performs a “shock test,” if required to reset defibrillator
- Demonstrates ability to use defibrillation, synchronized cardioversion, and pacing functions on Zoll
- Demonstrates ability to adjust the joules (increase and decrease) on Zoll
- Disconnects external pads and reconnects internal defibrillator cable
- Verbalizes importance of clearing patient prior to defibrillation

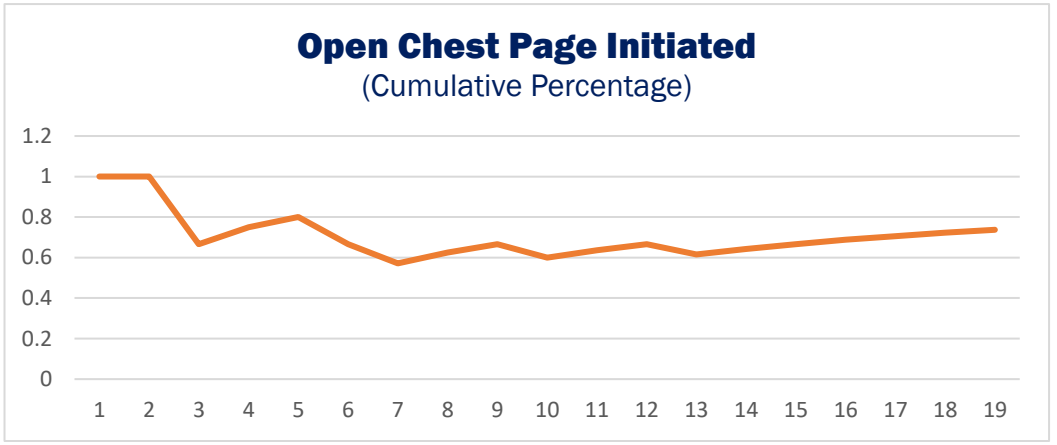
Mini-mocks were completed with 69 of 76 (91%) bedside RNs initially targeted for intervention

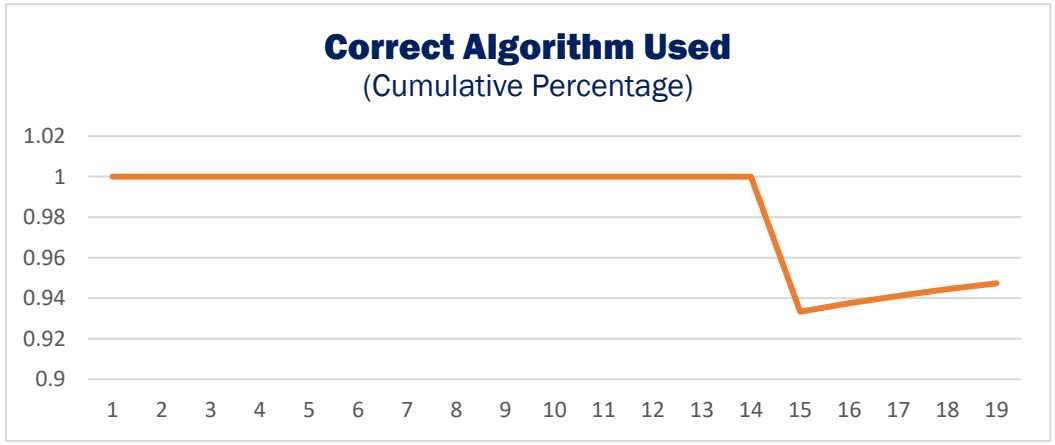
RESULTS

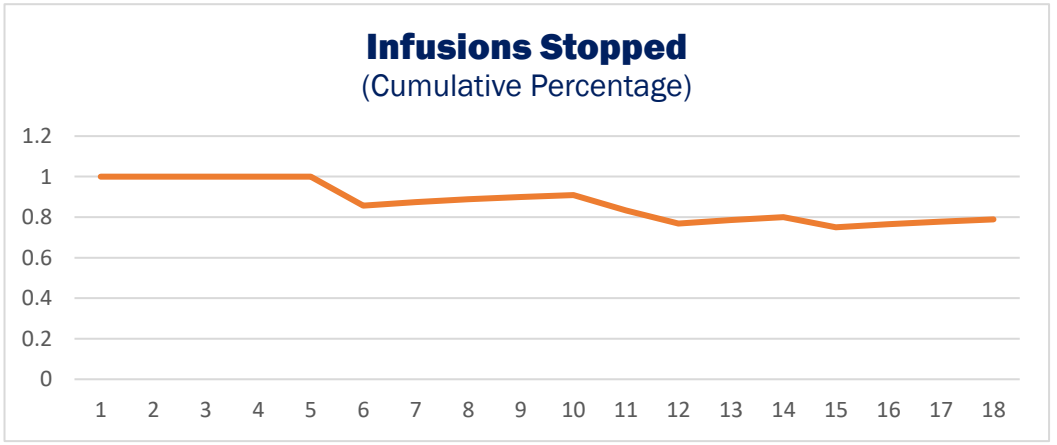

Time to Emergent Resternotomy
7:12
6:00
4:48
3:36
2:24
1:12
0:00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
Simulation location and equipment were moved, helping to enhance the fidelity of the event
Real supplies were used, and training posters were removed from room for simulation
Simulation triggered when trained APPs were unavailable, encouraging bedside nursing staff to assume new roles
First simulation hosted after mini-mocks were introduced to bedside nursing staff
Time to Resternotomy
5-Minute Goal

RESULTS

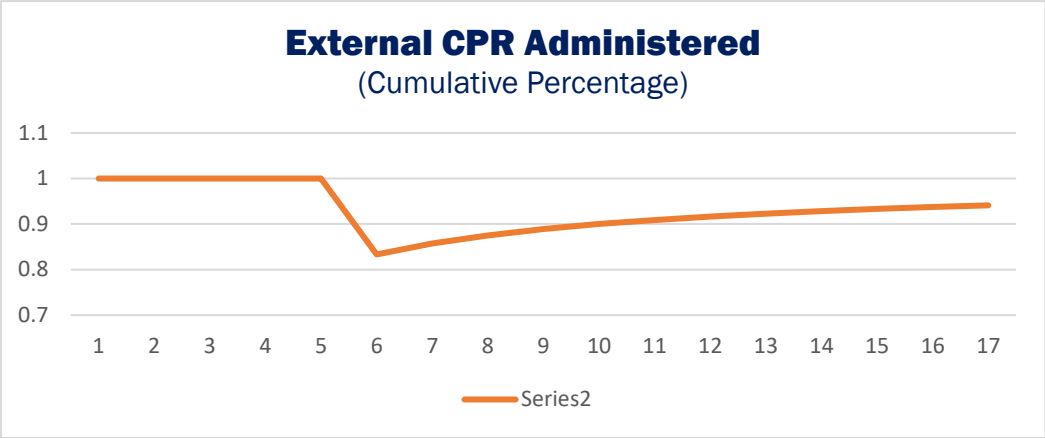

Team Leader Identified
(Cumulative Percentage)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

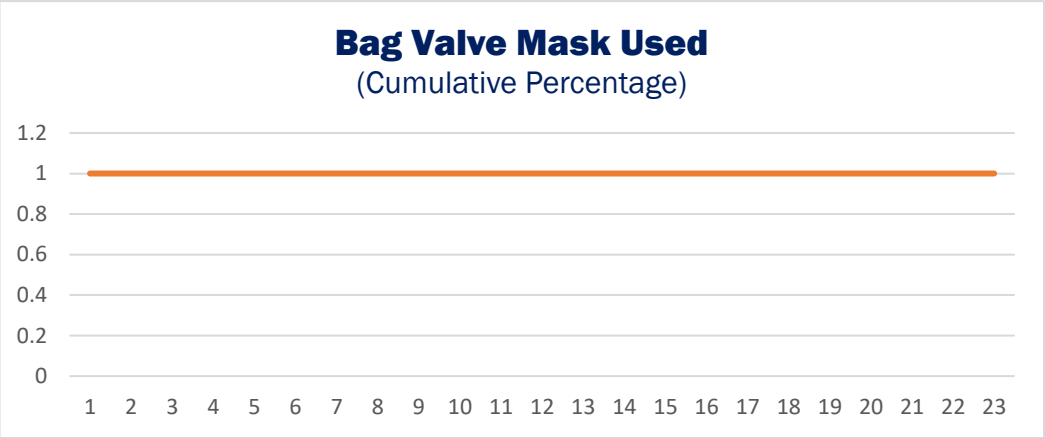

Open Chest Page Initiated
(Cumulative Percentage)
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

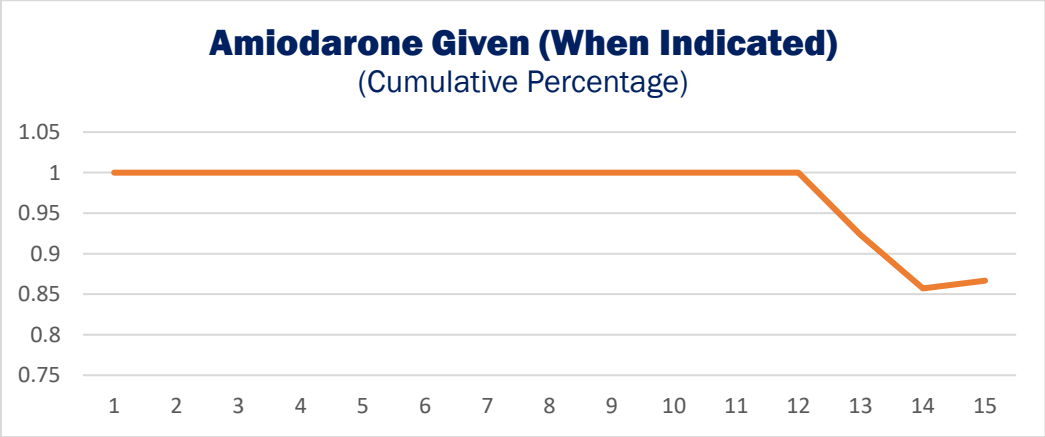

Correct Algorithm Used
(Cumulative Percentage)
1.02
1
0.98
0.96
0.94
0.92
0.9
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

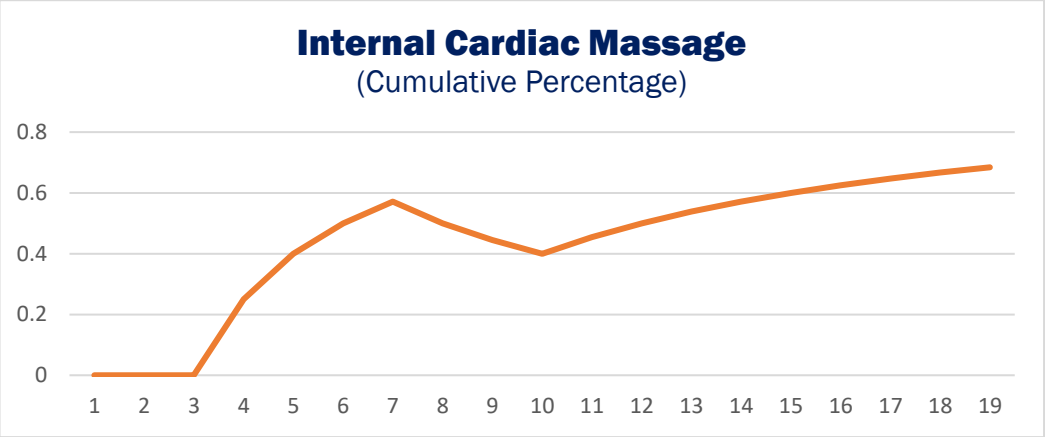

Infusions Stopped
(Cumulative Percentage)
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

RESULTS

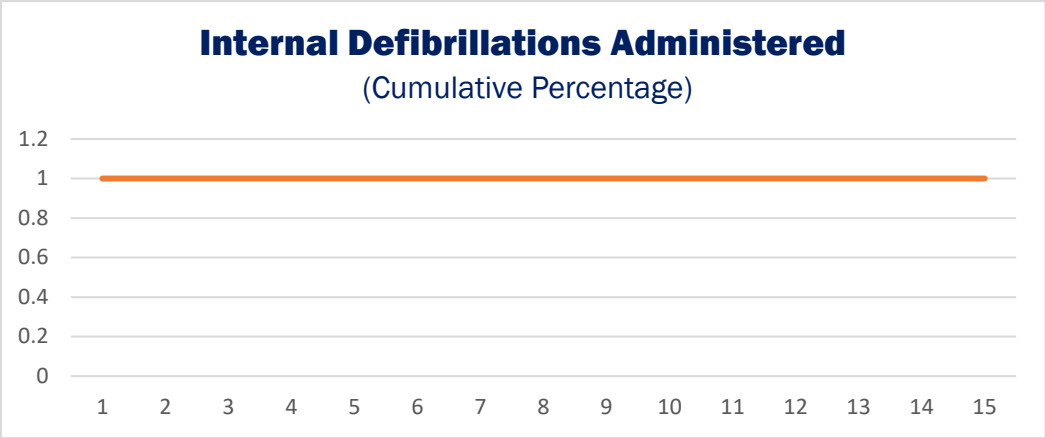

External CPR Administered
(Cumulative Percentage)
1.1
1
0.9
0.8
0.7
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
Series2

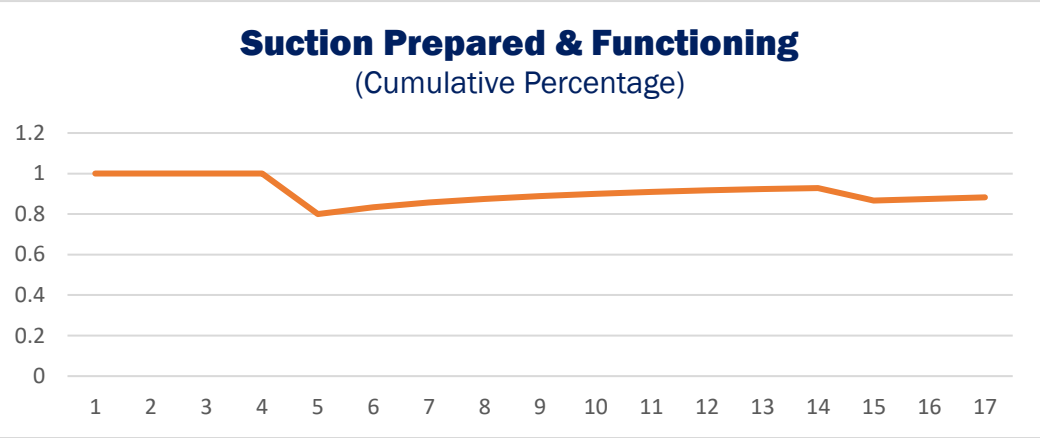

Bag Valve Mask Used
(Cumulative Percentage)
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

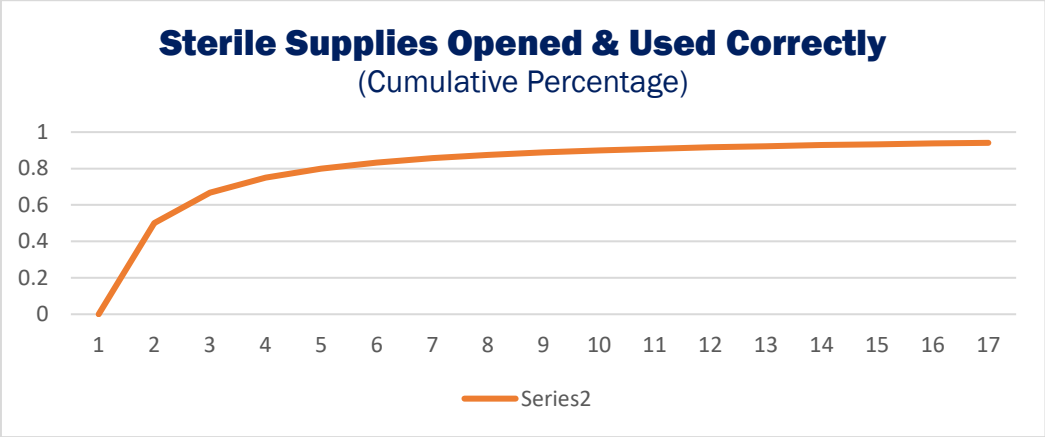

Amiodarone Given (When Indicated)
(Cumulative Percentage)
1.05
1
0.95
0.9
0.85
0.8
0.75
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Internal Cardiac Massage
(Cumulative Percentage)
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

RESULTS







Missing data (four simulations)

Variability in data, inclusive of "N/A"

Trends largely consistent, reassuring

RESULTS

- 69 of 76 eligible ICU RNs (91%) completed the “mini-mock” intervention, exceeding the original goal of 85%
- **Average time to emergent resternotomy 4:50**
- Of the 12 outcomes measured, eight (67%) were compliant with the protocol in at least 75% of simulated events

RESULTS CONTINUED: CSU-ALS Event Debriefs

"I felt prepared, thankfully I had randomly done a couple mock codes in the past couple weeks, so I didn't feel unprepared to get in the chest at all. I think for me it was more [of] the little things that I wouldn't have thought of in the moment, but I think that will come with time and experience."

"I felt comfortable in my role this weekend."

"Very nice job by the team with the cardiac arrest this morning. Quick stacked defibrillations and rapid prep for sternotomy. No doubt a result of all the repetitions with the simulations."

UVA | SCHOOL of NURSING

DISCUSSION

- The data itself is variable, and does not present a clear pre- and post-implementation measure of protocol compliance given method for data collection and intentional manipulation of simulation elements
- CSU-ALS event outcomes data will emerge over coming years
  - Three stacked shocks delivered within 20 seconds
  - Fluid conversion from pulseless, shockable rhythm to perfusing, paced rhythm
  - Team prepared for emergent resternotomy, but were ultimately able to avoid
- Anecdotal feedback for routine simulation and hands-on exposure offered through “mini-mock” intervention is strong
- Multi-modal training supports clinician adherence to protocol, but the process requires ongoing reinforcement

SPECIAL CONSIDERATIONS

UVA | SCHOOL of NURSING

COST IMPLICATIONS

Current CSU-ALS Simulation Cart

- Re-Sternotomy Quick Pack: $18.99
- Sterile gloves: $1.16
- Laparotomy Drapes: $4.83
- Sterile Gown XL: $1.96
- Sterile Gown L: $1.83

Cost per simulation event variable, but roughly the cost of one "Re-Sternotomy Quick Pack," or $18.99

Costs may be mitigated through:

- Use of donated supplies via MERCI program or supplies that would otherwise be discarded on the unit
- Training activities hosted during routinely scheduled time

Additive Cost in Isolated CABG: (Q1 2021-Q4 2023)

VCSQI, STS Adult Cardiac Surgery Database

$68K
Operative Mortality

$71K
Prolonged Ventilation

$78K
Reoperation

$106K
Renal Failure

SPECIAL CONSIDERATIONS

DIVERSITY, EQUITY, & INCLUSIVITY

Broad participation in mini-mocks observed, regardless of tenure and experience

Standardized protocol, but focus of mini-mocks tailored to meet unique needs of individual staff

ETHICAL CONSIDERATIONS

Nonmaleficence

Minimizing “noise” associated with simulations, mini-mocks

INTEGRATE & SUSTAIN PRACTICE CHANGE

- Integration of “mini-mocks” and simulations into required unit-based annual competencies and required APP check-offs (coupled with OR time)
- Expansion of CSU-ALS protocol to staff caring for post-sternotomy patients in acute/intermediate care
- Expansion of simulation to acute/intermediate care, preparing staff to respond to off-unit emergencies
- Expansion of simulation practices to other emergencies within the ICU (e.g., ECPR, ACLS)

DISSEMINATE RESULTS

October 10-11, 2024
Poster Presented

January 24-26, 2025
E-Poster Presented & Podium Presentation (Matthew Weber, MD) at Annual Meeting

For Additional Consideration:

Libra
Society of Critical Care Medicine
Doctors of Nursing Practice Conference
AACN's National Teaching Institute & Critical Care Exposition
Virginia State Simulation Alliance
Virginia Council of Nurse Practitioners
The Journal of Thoracic and Cardiovascular Surgery

Supporting fellow hospitals and health systems to implement CSU-ALS training programs

And many more…

Questions?

Brooke Smith, MSN, APRN, AGACNP-BC, CNL, CCRN

434-996-3546

bes6d@virginia.edu

UVA | SCHOOL of NURSING

REFERENCES

Akinpelu, T., Shah, N. R., Alhendy, M., Thangavelu, M., Weaver, K., Muller, N., McElroy, J., & Bhalala, U. S. (2022). Emergent bedside resternotomy: an innovative simulation model for training pediatric cardiac intensive care teams. *Journal of Pediatric Intensive Care.* https://doi.org/10.1055/s-0042-1758453

Arlotta, G., Verdicchio, L., Gaetani, C., Di Cola, R., Buralli, D., D'Antonio, D., Balducci, F., Mazza, A., Nesta, M., Cavaliere, F., Martinelli, L., Calabrese, M., Antoniucci, E., Guarneri, S., Corrado, M., De Paulis, S., Zamparelli, R., Conti, F., Corsi, F., Bevilacqua, F., Scapigliati, A. (2018). The ReSTE course: 6-hours course on resuscitation and resternotomy after cardiac surgery [Conference abstract]. *Resuscitation, 130*(e80). https://doi.org/10.1016/j.resuscitation.2018.07.163

Bowdish, M. E., D'Agostino, R. S., Thourani, V. H., Schwann, T. A., Krohn, C., Desai, N., Shahian, D. M., Fernandez, F. G., & Badhwar, V. (2021). STS adult cardiac surgery database: 2021 update on outcomes, quality, and research. *The Annals of Thoracic Surgery, 111*(6), 1770-1780. https://doi.org/10.1016/j.athoracsur.2021.03.043

Dearholt, S. L., Bissett, K. M., Melnyk, B. M., Fineout-Overholt, E., Yost, J., Cullen, L., Fowler, C., Hanrahan, K., Larabee, J. H., Hunter, S. C., Kitson, A., Schultz, A. A., Stetler, C. B., & Stevens, K. R. (2023). Models to guide implementation and sustainability of evidence-based practice. In B. M. Melnyk & E. Fineout-Overholt (Eds.), *Evidence-Based Practice in Nursing & Healthcare: A Guide to Best Practice* (5th ed., pp. 466-518). Wolters Kluwer.

Dunning, J., Nandi, J., Ariffin, S., Jerstice, J., Danitsch, D., & Levine, A. (2006). The cardiac surgery advanced life support course (CALS): delivering significant improvements in emergency cardiothoracic care. *The Annals of Thoracic Surgery, 81*(5), 1767-1772. https://doi.org/10.1016/j.athoracsur.2005.12.012

Dunning, J., Fabbri, A., Kolh, P. H., Levine, A., Lockowandt, U., Mackay, J., Pavie, A. J., Strang, T., Verteegh, M. M., & Nashef, S. (2009). Guideline for resuscitation in cardiac arrest after cardiac surgery. *European Journal of Cardiothoracic Surgery, 36*(2009), 3-28. doi:10.1016/j.ejcts.2009.01.033

REFERENCES

Dunning, J., Levine, A., Ley, J., Strang, T., Lizotte Jr., D. E., Lamarche, Y., Bartley, T., Zellinger, M., Katz, N., Arora, R. C., Dembitsky, W., Cheng, A. M., Lonchyna, V. A., Jaft, J., Deakin, C. D., Mitchell, J. D., Firestone, S., & Bakaeen, F. G. (2017). The Society of Thoracic Surgeons expert consensus for the resuscitation of patients who arrest after cardiac surgery. *The Annals of Thoracic Surgery, 103*(3), 1005-1020. http://dx.doi.org/10.1016/j.athoracsur.2016.10.033

Gali, B., Arteaga, G. M., Au, G., & Herasevich, V. (2021). Impact of in situ education on management of cardiac arrest after cardiac surgery. *Southwest Journal of Pulmonary & Critical Care, 23*(2), 54-61. https://doi.org/10.13175/swjpcc028-21

Guenther, T. M., Chen, S. A., Gustafson, J. D., Wozniak, C. J., & Kali, B. (2020). Development of a porcine model of emergency resternotomy at a low-volume cardiac surgery centre. *Interactive CardioVascular and Thoracic Surgery, 31*(6), 803-805. doi:10.1093/icvts/ivaa191

Hermann, C. (2014). Cardiac advanced life support-surgical guideline: overview and implementation. *AACN Advanced Critical Care, 25*(2), 123-129. doi:10.1097/NCI.0000000000000016

Kohn, M., & Valente, S. (2012). Development of an audit tool for evaluating team competency for the simulation procedure “emergency resternotomy” in the ICU post cardiac surgery [Conference abstract]. *Clinical Simulation in Nursing, 8*(8). https://doi-org.proxy1.library.virginia.edu/10.1016/j.ecns.2012.07.074

Lane, M., Allen, M., Ghez, O., Desai, A., Kakat, S., Pool, N., Cotterill, J., deCosta, K., Combes, J. (2012). Impact of an in situ multi-professional simulation team training program in pediatric cardiac arrest postcardiac surgery: a pilot project [Conference abstract]. *Pediatric Anesthesia, 22*(2012), 916-922. https://doi-org.proxy1.library.virginia.edu/10.1111/j.1460-9592.2012.03913.x

Langley, G. L., Moen, R., Nolan, K. M., Nolan, T. W., Norman, C.L., & Provost, L. P. (2009). *The improvement guide: A practical approach to enhancing organizational performance* (2nd ed.). Jossey-Bass Publishers.

LaPar, D. J., Ghanta, R. K., Kern, J. A., Crosby, I. K., Rich, J. B., Speir, A. M., Kron, I. L., & Ailawadi, G. (2014). Hospital variation in mortality from cardiac arrest after cardiac surgery: an opportunity for improvement. *The Annals of Thoracic Surgery, 98*(2), 534-540. https://doi.org/10.1016/j.athoracsur.2014.03.030

REFERENCES

Marler, G. S., Molloy, M. A., Engel, J. R., Walters, G., Smitherman, M. B., & Sabol, V. K. (2020). Implementing Cardiac Surgical Unit-Advanced Life Support through simulation-based learning: a quality improvement project. *Dimensions of Critical Care Nursing, 39*(4), 180-193. doi:0.1097/01.DCC.0000668028.87061.14

McCormack, D., El-Gamel, A., Haran, C., Conaglen, P., Kerjriwal, N., Lin, Z., Odom, N., Parkinson, G., Levine, A., & O'Rourke, T. (2018). Mortality from cardiac arrest after cardiac surgery: what can be done? [Conference abstract]. *Heart Lung & Circulation, 27*(3), S525. https://doi.org/10.1016/j.hlc.2018.04.066

Melia, D. J., Ruberti, R. P., Smith, K., Owen, S. E. (2018). Resuscitation after cardiac surgery in Australia: a survey of practice and the implementation of a training course. *Critical Care & Shock, 21*(2), 88-98. https://criticalcareshock.org/files/2018/05/Resuscitation-after-cardiac-surgery-in-Australia-a-survey-of-practice-and-the-implementation-of-a-training-course.pdf

Michaelis, P., & Leone, R. J. (2019). Cardiac arrest after cardiac surgery: an evidence-based resuscitation protocol. *Critical Care Nurse, 39*(1), 15-25. https://doi.org/10.4037/ccn2019309

Mitchell, O., Anderson, C., Sureau, K., Horowitz, J., Piper, G., Nunnally, M., & Smith, D. (2019). It takes a team to crash successfully: interprofessional team training in CALS [Conference abstract]. *Critical Care Medicine, 47*(1). http://dx.doi.org/10.1097/01.ccm.0000550930.64665.e4

Nunnick, L., Welsh, A. M., Abbey, M., & Buschel, C. (2009). In situ simulation-based team training for post-cardiac surgical emergency chest reopen in the intensive care unit. *Anaesthesia & Intensive Care, 37*(1), 74-78. doi:10.1177/0310057x0903700109

Peek, J. J., Max, S. A., Bakhuis, W., Huig, I. C., Rosalia, R. A., Sadeghi, A. H., & Mahtab, E. A. (2023). Virtual reality simulator versus conventional advanced life support training for cardiopulmonary resuscitation post-cardiac surgery: a randomized controlled trial. *Journal of Cardiovascular Development and Disease, 10*(2), 67. https://doi.org/10.3390/jcdd10020067

REFERENCES

Sadeghi, A. H., Peek, J. J., Max, S. A., Smit, L. L., Martina, B. G., Rosalia, R. A., Bakhuis, W., Bogers, J., & Mahtab, E. (2022). Virtual reality simulation training for cardiopulmonary resuscitation after cardiac surgery: face and content validity study. *JMIR Serious Games, 10*(1). doi:10.2196/30456

Shah, J., Sefton, A., Tilford, B., & Cashen, K. (2019). Cardiac resternotomy after CHD surgery in kids: crack the chest [Conference abstract]. *Critical Care Medicine, 47*(1), 664. https://dx.doi.org/10.1097/01.ccm.0000552120.01326.00

Stueben, F. (2017). Implementation of a simulation-based cardiac surgery advanced life support course. *Clinical Simulation in Nursing, 13*(9), 432-435. https://doi.org/10.1016/j.ecns.2017.04.010

Team, L., Bloomer, M. J., & Redley, B. (2023). Nurses' roles and responsibilities in cardiac advanced life support: a single-site eDelphi study. *Nursing in Critical Care*. doi:10.1111/nicc.12897

Truhlár, A., Deakin, C. D., Soar, J., Abbas Khalifa, G. E., Alfonzo, A., Bierens, J., Brattebø, G., Brugger, H., Dunning, J., Hunyadi-Anticevic, S., Koster, R. W., Lockey, D. J., Lott, C., Paal, P., Perkins, G. D., Sandroni, C., Thies, K. C., Zideman, D. A., & Nolan, J. P. (2015). European Resuscitation Council guidelines for resuscitation 2015 section 4: cardiac arrest in special circumstances. *Resuscitation, 95*(2015), 148-201. http://dx.doi.org/10.1016/j.resuscitation.2015.07.017

Whitlock, J. P. (2023). Cardiac surgery unit advanced life support training: a 10-year retrospective study examining patient mortality outcomes after implementation. *Dimensions of Critical Care Nursing, 42*(1), 22-32. doi:10.1097/DCC.0000000000000557