Cardiopulmonary Resuscitation through the ages

Nikhil Jagan MD, FCCP

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Faculty Disclosure

Speaker: Nikhil Jagan

Dr. Jagan has listed no financial interest/arrangement that would be considered a conflict of interest.

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Objectives

At the conclusion of this presentation, these objectives will be addressed:

- Beginnings of CPR into the current-day methods to improve resuscitation techniques
- What have we learnt through the ages
- CPR in the COVID era

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Origins

- The Lord God breathed into his nostrils the breath of life and man became a living being
- The Old Testament describes resuscitation in the books of Kings, where the Hebrew Prophet Elijah performed the assumed first documented case of mouth-to-mouth resuscitation

1530-1800s

- The Bellows Method first used by Swiss physician Paracelsus.

1800's

- Marshall Hall introduces his simple resuscitation technique: alternately repositioning the patient from face up to side. He then updates the approach by adding pressure on the thorax
- Henry Silvester, created the chest-pressure arm-lift method: raise the patient's arms up to expand the chest, then cross the arms over the chest to apply expiratory pressure

- 1878 : In Germany, Rudolph Boehm shows that external compressions of the heart provide adequate circulation in cats

- 1891: After using external compressions to restart the hearts of 2 young human patients, German surgeon Dr. Friedrich Maass becomes the first to advocate chest compressions, rather than ventilation alone, to help with circulation. But the technique doesn't take hold, and for the next half century, open-heart massage is the standard

1900's

- 1903: In Cleveland, Ohio, Dr. George Crile's research confirms that external chest compressions restore circulation in dogs

- 1904: Dr. Crile reports successful closed-chest cardiac massage in 1 human case. But once again, the noninvasive technique doesn't gain traction, and patients continue to receive open-heart massage

- 1924: Six cardiologists meet in Chicago and form the American Heart Association (AHA) as a professional society for physicians
- Nearly a century later, the AHA will be the world leader in CPR and emergency cardiovascular care training and education

- 1933: Researchers at Johns Hopkins University, rediscover external compressions when they find that pressure on a dog's sternum provides adequate circulation to the brain to keep the animal alive until defibrillation can restart its heart. Their results are confirmed in more than 100 dogs

- 1956: Dr. Elam and Dr. Peter Safar prove that mouth-to-mouth resuscitation is an effective lifesaving method. They play leading roles in promoting rescue breathing to professional healthcare providers and the public alike.
- For the first time in human medicine, an external defibrillator successfully restores a steady rhythm to a quivering heart. Harvard cardiologist Dr. Paul Zoll leads the study with funding from the AHA.
- 1957: The United States military adopts the mouth-to-mouth resuscitation method to revive unresponsive victims.


Cardiac
Pacemaker

- Kouwenhoven discovered that closed chest cardiac massage could effectively prolong the period of potential successful resuscitation for dogs with ventricular fibrillation and then demonstrated that this innovative intervention could be life-saving for patients

- 1960: Resuscitation pioneers Drs. Kouwenhoven, Safar, and Jude combine mouth-to-mouth breathing with chest compressions to create cardiopulmonary resuscitation, the lifesaving actions we now call CPR

- The AHA starts a program to acquaint physicians with closed-chest cardiac resuscitation, which becomes the forerunner of CPR training for the general public

- Cardiac arrest is the quintessential example of simultaneous profound respiratory, circulatory, and neurologic insults, and CPR has transformed this uniformly fatal event to a treatable critical care problem.

- Head tilt jaw thrust maneuver
- Initially on primates and then on humans

Laerdal
helping save lives

- Resusci Anne, also known as Rescue Anne, CPR Annie, Resuscitation Annie, Little Annie, or CPR Doll is a model of medical simulator used for teaching both emergency workers and members of the general public.
- It was developed by the Norwegian toy maker Asmund Laerdal and Peter Safar and is produced by the company Laerdal Medical

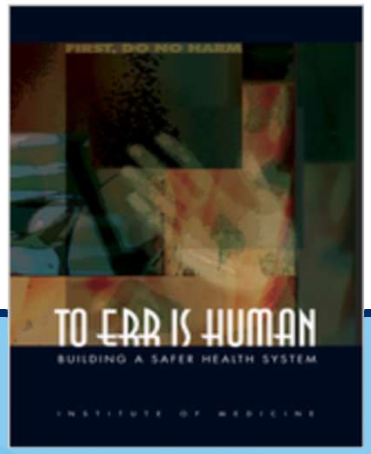
- They then combined the two techniques as the well-known ABCs (airway, breathing, circulation) of CPR
- Dr Safar also championed the concept of cardiopulmonary cerebral resuscitation which included advanced life support and post arrest care focused on optimizing neurologic outcome in addition to survival
- His Brain Resuscitation Clinical Trial Groups pioneered randomized controlled trials in the setting of cardiac arrest .
- His studies provided the foundation for modern day post arrest care, including optimizing hemodynamic support and postarrest therapeutic hypothermia

Max Harry Weil

- The first president of SCCM in 1970
- He was a cardiologist, biomedical engineer, airplane pilot, and intensivist, whose early investigations focused on monitoring, initial classification, and pathophysiology-based treatment of shock
- To improve resuscitation from shock he invented the mobile crash cart, precursor of the modern day code cart

- 1975: The AHA publishes the first Advanced Cardiovascular Life Support (ACLS) Textbook.
- 1981: A program to provide telephone instructions for performing CPR begins in Washington. The program trains emergency dispatchers to give callers CPR instructions while EMT personnel are in route to the scene.
- 1990: Public access defibrillation programs provide training and resources, including AEDs, to the public so that they can help resuscitate victims of cardiac arrest.

- **To Err Is Human** breaks the silence that has surrounded medical errors and their consequence but not by pointing fingers at caring health care professionals who make honest mistakes.
- Instead, this book sets forth a national agenda-with state and local implications for reducing medical errors and improving patient safety through the design of a safer health system.



- Estimate that as many as 98,000 people or more die in any given year from medical errors that occur in hospitals.
- That's more than die from motor vehicle accidents, breast cancer, or AIDS.
- More people die annually from medication errors than from workplace injuries.

- Reveals statistics of medical error and the disparity between the incidence of error and public perception of it, given many patients' expectations that the medical profession always performs perfectly.
- A careful examination is made of how surrounding forces of legislation, regulation, and market activity influence the quality of care provided by health care organizations using a detailed case study, the book reviews the current understanding of why these mistakes happen.
- **A key theme is “How can we learn from our mistakes?"**

- Physicians extended this approach to improve in-hospital CPR through the development of in-hospital registries
- The American Heart Association's **Get With The Guidelines-Resuscitation**
- SCCM's "**Project IMPACT"** to evaluate the effectiveness of in-hospital CPR and potential opportunities for quality improvement

What did we learn

- In-hospital Cardiac arrests were heralded by hours of potentially actionable early warning signs sparking the development of rapid response teams

SPECIAL ARTICLE

Findings of the First Consensus Conference on Medical Emergency Teams*

DeVita, Michael A. MD; Bellomo, Rinaldo MD; Hillman, Kenneth MD; Kellum, John MD; Rotondi, Armando PhD; Teres, Dan MD; Auerbach, Andrew MD; Chen, Wen-Jon MD, PhD; Duncan, Kathy RN; Kenward, Gary MSc, BSc(Hons), RN, QARANC; Bell, Max MD; Buist, Michael MBChB, FRACP, FJFICM; Chen, Jack MBBS, PhD; Bion, Julian FRCP, FRCA, MD; Kirby, Ann MD; Lighthall, Geoff MD, PhD; Ovreveit, John PhD, C Psychol, MIHM; Braithwaite, R Scott MD; Gosbee, John MD; Milbrandt, Eric MD; Peberdy, Mimi MD; Savitz, Lucy PhD, MBA; Young, Lis MA, CCM, FFAFPHM; Galhotra, Sanjay MD

Author Information

Proceedings of the 12th International Conference on Rapid Response Systems and Medical Emergency Teams

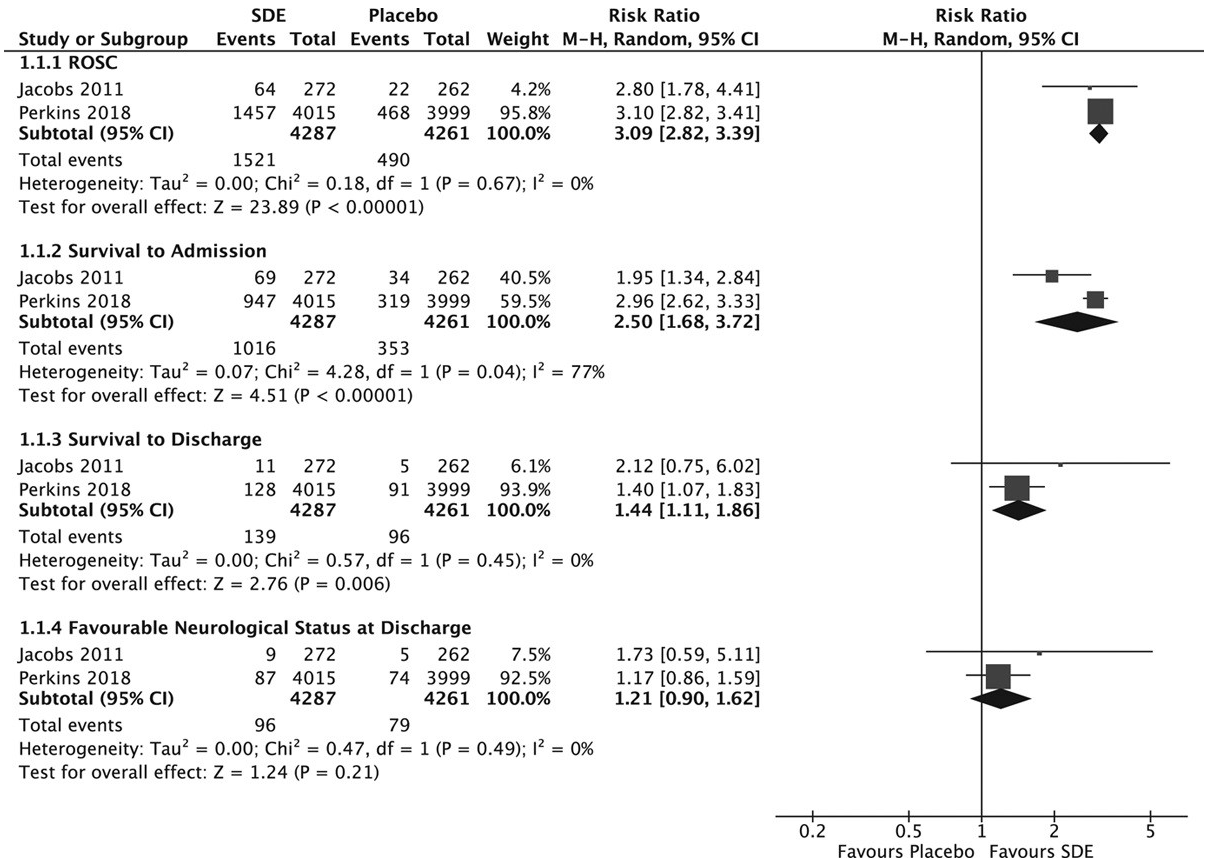
Jones, D. BSc(Hons) MBBS FRACP FCICM MD PhD; Holmes, J. RNBN; Currey, J. RNBN(Hons) GCertHigherEd GCertSc(App Stats) PhD; Fugaccia, E. MBBS FRACP FCICM; Psirides, A. J. MBBS BSc FCICM; Singh, M. Y. MD IDCC FNB EDIC FCICM; Fennessy, G. J. BHB MBChB FCICM FRNZCUC PG DipComEmergMed; Hillman, K. MBBS FCICM; Pilcher, D. V. MBBS MRCP FRACP FCICM; Bellomo, R. MD FCICM FRACP; DeVita, M. MD FCCM Author Information

- Time to defibrillation was a major determinant of survival from in-hospital VF
- Defibrillation was delayed for greater than 3 minutes in 30% of arrests
- Survival outcomes were worse for nighttime and weekend cardiac arests compared with daytime and weekday arrests
- Cardiac arrest outcomes varied greatly among hospitals
- Avoiding interruptions in chest compressions is associated with improved outcomes
- Extracorporeal membrane oxygenation–assisted CPR (ECPR) can be life-saving for highly selected populations

- An axiom that has emerged is that the empiric use of **“more therapy”** is often not optimal.

- Epinephrine during CPR increases rates of ROSC and survival with favorable neurologic outcomes, epinephrine also can increase the rates of survival with unfavorable neurologic outcomes, especially when provided in high doses or late in the resuscitation effort. Optimal dosage and frequency of epinephrine during CPR are important knowledge gaps.

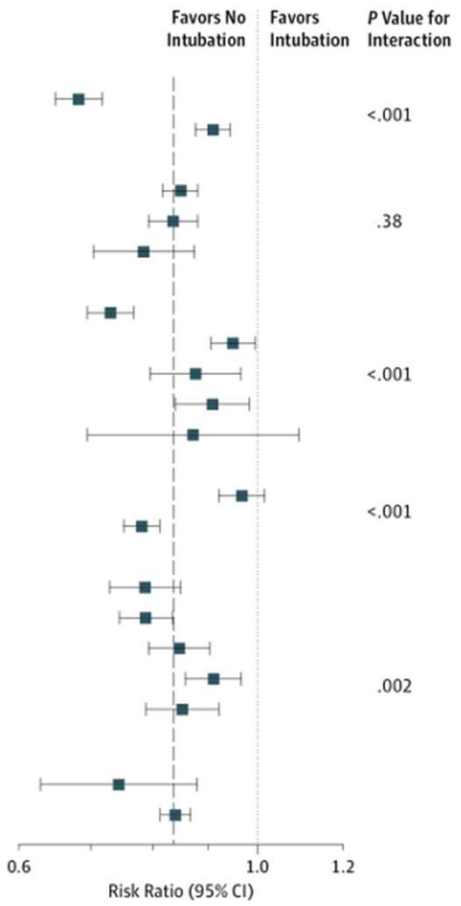
J Emerg Med 2020; 59:856–864
Crit Care Med 2020; 48:225–229


SDE
Placebo
Risk Ratio
Risk Ratio
Study or Subgroup Events Total Events Total Weight M-H, Random, 95% CI
M-H, Random, 95% CI
1.1.1 ROSC
Jacobs 2011 64 272 22 262 4.2% 2.80 [1.78, 4.41]
Perkins 2018 1457 4015 468 3999 95.8% 3.10 [2.82, 3.41]
Subtotal (95% CI) 4287 4261 100.0% 3.09 [2.82, 3.39]
Total events 1521 490
Heterogeneity: Tau² = 0.00; Chi² = 0.18, df = 1 (P = 0.67); I² = 0%
Test for overall effect: Z = 23.89 (P < 0.00001)
1.1.2 Survival to Admission
Jacobs 2011 69 272 34 262 40.5% 1.95 [1.34, 2.84]
Perkins 2018 947 4015 319 3999 59.5% 2.96 [2.62, 3.33]
Subtotal (95% CI) 4287 4261 100.0% 2.50 [1.68, 3.72]
Total events 1016 353
Heterogeneity: Tau² = 0.07; Chi² = 4.28, df = 1 (P = 0.04); I² = 77%
Test for overall effect: Z = 4.51 (P < 0.00001)
1.1.3 Survival to Discharge
Jacobs 2011 11 272 5 262 6.1% 2.12 [0.75, 6.02]
Perkins 2018 128 4015 91 3999 93.9% 1.40 [1.07, 1.83]
Subtotal (95% CI) 4287 4261 100.0% 1.44 [1.11, 1.86]
Total events 139 96
Heterogeneity: Tau² = 0.00; Chi² = 0.57, df = 1 (P = 0.45); I² = 0%
Test for overall effect: Z = 2.76 (P = 0.006)
1.1.4 Favourable Neurological Status at Discharge
Jacobs 2011 9 272 5 262 7.5% 1.73 [0.59, 5.11]
Perkins 2018 87 4015 74 3999 92.5% 1.17 [0.86, 1.59]
Subtotal (95% CI) 4287 4261 100.0% 1.21 [0.90, 1.62]
Total events 96 79
Heterogeneity: Tau² = 0.00; Chi² = 0.47, df = 1 (P = 0.49); I² = 0%
Test for overall effect: Z = 1.24 (P = 0.21)
0.2
0.5
1
2
5
Favours Placebo
Favours SDE

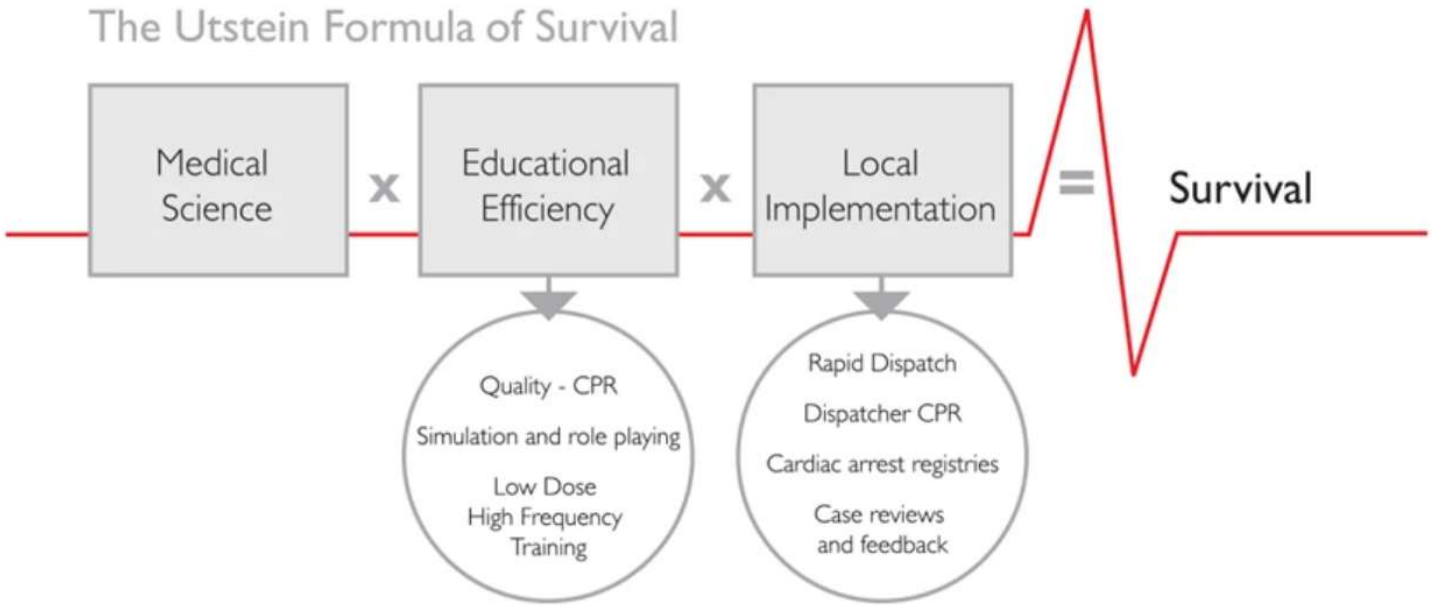
- Airway and breathing interventions are controversial.
- Hands-only CPR (i.e., without rescue breathing) is an effective approach for initial bystander CPR in adults.
- Tracheal intubation for assisted ventilation during CPR is associated with worse outcomes in children and adults, presumably because of interruptions in potentially life-saving chest compressions .

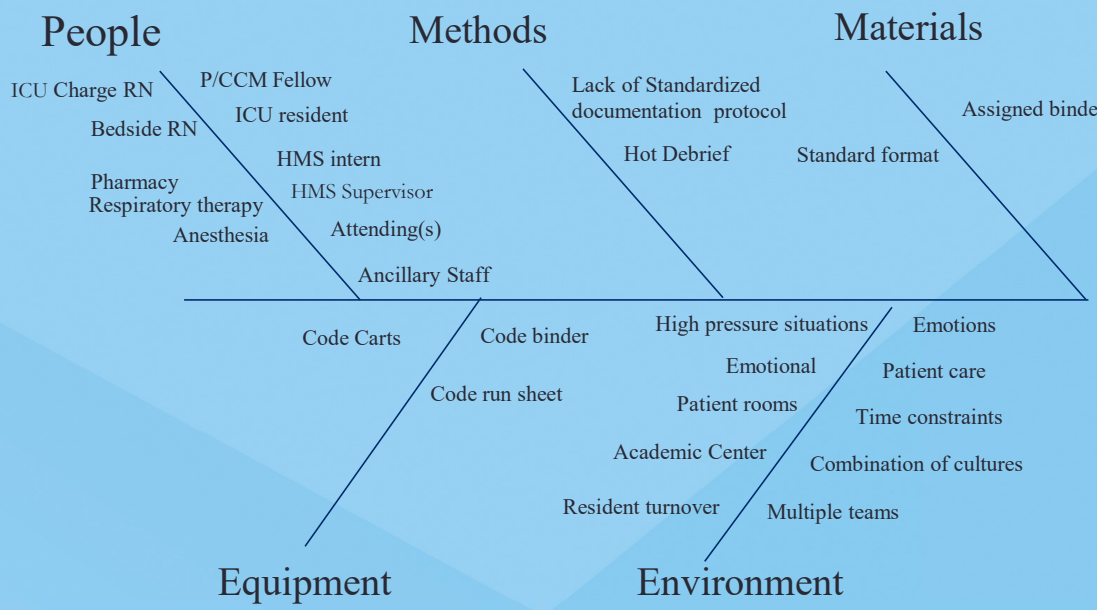
Resuscitation 2020; 156:A35–A79
JAMA 2017; 317:494–506

Subgroup	Survival to Hospital Discharge, No. of Patients With Outcome/Total Patients (%)		Risk Ratio (95% CI)
	Intubation	No Intubation	
Initial rhythm			
Shockable	1786/6675 (26.8)	2608/6646 (39.2)	0.68 (0.65-0.72)
Nonshockable	5266/36639 (14.4)	5799/36668 (15.8)	0.91 (0.88-0.94)
Time of matching, min[a]			
0-4	4321/25219 (17.1)	5098/25219 (20.2)	0.85 (0.82-0.88)
5-9	2248/14937 (15.0)	2693/14937 (18.0)	0.84 (0.79-0.88)
10-15	483/3158 (15.3)	616/3158 (19.5)	0.78 (0.70-0.87)
Illness category			
Medical cardiac	2697/15716 (17.2)	3710/15779 (23.5)	0.73 (0.70-0.77)
Medical noncardiac	2695/20017 (13.5)	2834/19979 (14.2)	0.95 (0.91-1.00)
Surgical cardiac	632/2197 (28.8)	747/2274 (32.8)	0.88 (0.80-0.96)
Surgical noncardiac	910/4708 (19.3)	984/4623 (21.3)	0.91 (0.84-0.98)
Trauma	118/676 (17.5)	132/659 (20.0)	0.87 (0.79-1.09)
Respiratory insufficiency[b]			
Yes	2546/14845 (17.2)	2630/14822 (17.7)	0.97 (0.92-1.02)
No	4506/28469 (15.8)	5777/28492 (20.3)	0.78 (0.75-0.81)
Location			
Emergency department	914/4546 (20.1)	1131/4422 (25.6)	0.79 (0.73-0.85)
Floor with telemetry	1570/9373 (16.8)	1987/9342 (21.3)	0.79 (0.74-0.83)
Floor without telemetry	1432/12331 (11.6)	1684/12263 (13.7)	0.85 (0.79-0.90)
Intensive care unit	2161/13384 (16.1)	2406/13556 (17.7)	0.91 (0.86-0.97)
Operating room, postanesthesia care unit, or interventional unit	758/2550 (29.7)	903/2585 (34.9)	0.85 (0.79-0.92)
Other	217/1130 (19.2)	296/1146 (25.8)	0.74 (0.63-0.88)
Overall	7052/43314 (16.3)	8407/43314 (19.4)	0.84 (0.81-0.87)



How do we continue to learn





Lack of consistent and focused Code Blue training and signifies the need for a multidisciplinary approach

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Code Blue Training : A Multidisciplinary approach

Nikhil Jagan

Jeffrey Macaraeg

Jacqueline Chung

Sarah Aurit

Heidi Dennis

Emily Oppel

Deb Richey

Lee Morrow

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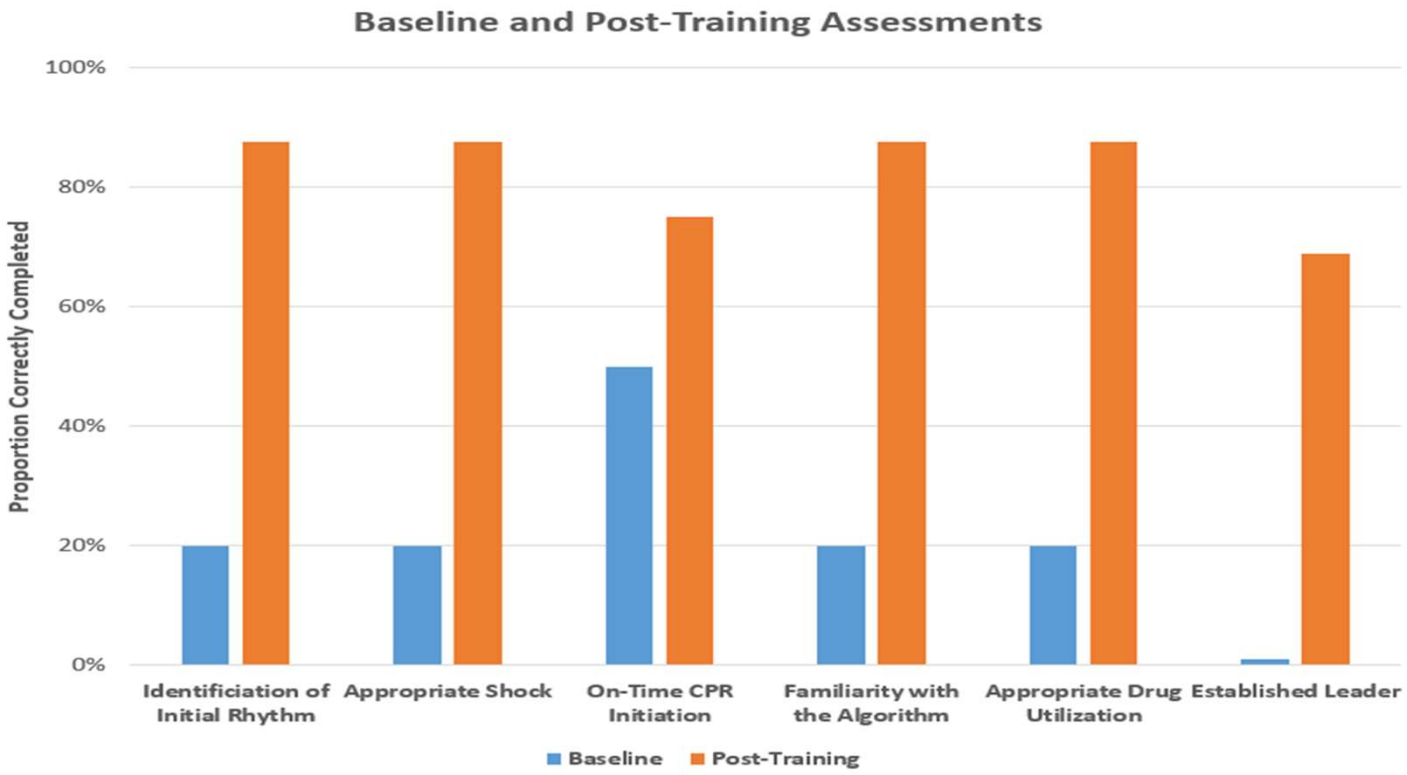

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Post Cardiac arrest care

- Post arrest care focuses on identifying and treating the underlying cause, addressing special resuscitation circumstances, achieving hemodynamic and respiratory support targets, and effectively deploying neuroprotective strategies, including targeted temperature management

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School of Medicine

Catholic Health Initiatives

Background

According to the AHRQ Patient Safety network debriefing is an integral aspect to learning & performance improvement. It is recommended by the AHRQ and AHA guidelines after a Real-life emergency response. Debriefing is a dialogue that occurs between two or more People. Debriefing allows for the open discussion of the actions & thought processes that occur during a patient care situation. It offers & encourages reflection & an opportunity For performance improvement. A 2013 Current Opinion-Critical Care was useful in the Improvement in resuscitative performance. Post code debriefing identified areas for Improvement, system errors such as treatment delay, equipment issues, leadership & communication issues. The American Heart Association Get with The Guidelines recommends debriefing after an event to provide an opportunity to review actions and interventions taken during an event, promoting continuous quality improvements in patient care.

Current Condition

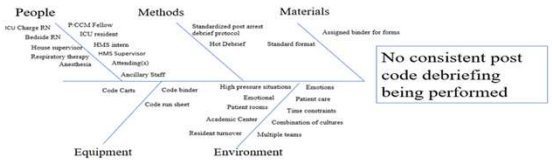
In hospital cardiac arrest is an unpredictable occurrence at Creighton University Medical Center- Bergan Mercy. There is no standardized protocol in place currently, that is reliable or consistent for the facilitation & sustainability of post code debriefing.

Goal

To improve post code debriefing by 25% and identify areas in need of improvement

Root Cause Analysis

Fishbone diagram

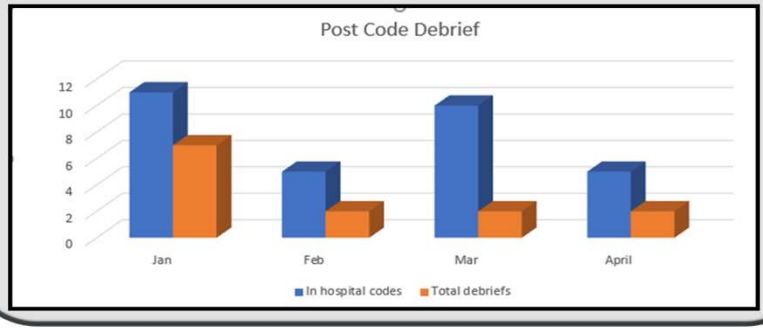


Pareto Chart

Countermeasures

Suspected cause	Action Item	Responsible	Due	Findings
1. Didn't know there is a debrief form	Education	JCM	12/31/2019	
2. There is no formal process	Standardized protocol	JCM	1/1/2019	
3. Location of debrief forms	Moved to code cart	JCM	4/1/2019	

Effect Confirmation



Follow-up Actions

Investigation items	Responsibility	Due	Status
1. Why are there still discrepancies	JCM	5/1/2019	P
2. What are common findings	JCM,NJ,JC,KK	5/1/2019	P
3			
4			

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- Over the last 2 decades, novel critical care implementation science tools are increasingly deployed to achieve high quality cardiopulmonary cerebral resuscitation, including “just-in- time” in situ rolling refresher CPR training , post-cardiac arrest care teams and interdisciplinary debriefing programs
- Although survival has increased, many survivors suffer from post intensive care syndrome and other long-term neurologic and functional morbidities

Rehab

- Rehab of global cerebral ischemic insults post cardiac arrest had limited support.

- This area, thus lags when compared with the rehabilitation of other CNS insults such as traumatic brain injury, but represents an emerging area of interest.

Ordering pizza during a pandemic.

New Siracha Hand Sanitizer

not only will it kill germs but it will stop you touching your eyes, face and other places a second time

People walking around with DIY masks like

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The COVID era and CPR

- A single-center study of 136 patients in Wuhan reported poor outcomes . This study found only 13% achieved return of spontaneous circulation, only 1 achieved a favorable neurological outcome by 30 days

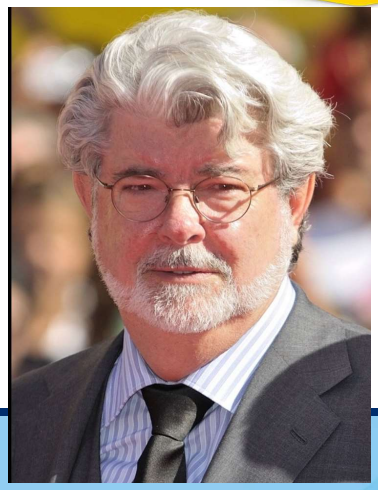
- In a case series of 54 patients, 96% had a non shockable initial rhythm, 54% achieved return of spontaneous circulation, and 0 survived to hospital discharge

- The OHCAs occurred were 694 in 2020 and 520 in 2019. Bystander cardiopulmonary resuscitation (CPR) rate was lower in 2020 (20% vs 31%, $p<0.001$), whilst the rate of bystander automated external defibrillator (AED) use was similar (2% vs 4%, $p = 0.11$)

- Excluding patients in specific settings such as cardiac catheterization labs, where arrhythmic arrests are rapidly reversible, only about 25% of patients who have an in-hospital cardiac arrest survive to hospital discharge

- Involvement of less experienced code-team members during times of staffing shortages
- Delays associated with donning PPE
- Initiating CPR in the COVID 19 **patients maybe futile as the best-case outcome is returning the patient to active clinical deterioration**

- The low hospital survival is likely driven in most patients at the time of arrest are with nonshockable initial rhythms
- Presumed respiratory etiology of arrest for most patients
- Lack of therapies to effectively treat the underlying disease



- LUCAS is a portable chest compression device designed to eliminate the problems of manual chest compression.
- LUCAS saves manpower.
- LUCAS provides basic CPR, enabling rescuers to concentrate on advanced life
- LUCAS guarantees effectiveness.
- LUCAS keep the stabilization by setting parameters,
- LUCAS removes fatigue factors and ensures the effectiveness of CPR.
- LUCAS can avoid these problems and guarantee continuous life support.

Safety of mechanical chest compression devices AutoPulse and LUCAS in cardiac arrest: a randomized clinical trial for non-inferiority

Rudolph W Koster, Ludo F Beenen, Esther B van der Boom, Anje M Spijkerboer, Robert Tepaske, Allart C van der Wal, Stefanie G Beesems, Jan G Tijssen Author Notes

European Heart Journal, Volume 38, Issue 40, 21 October 2017, Pages 3006–3013, https://doi.org/10.1093/eurheartj/ehx318

LUCAS does not cause significantly more serious or life-threatening visceral damage than manual CPR

Conclusion

- These controversies and failed therapeutic attempts have been uncovered by the ongoing quest for rigorous clinical research to provide evidence-based guidelines for CPR and advanced life support

- Better integration of preclinical and clinical investigations and education these approaches might help facilitate translation of optimal standard care and development of novel therapies