A Collection of Abstracts from Scientific Papers

Version 3, 2014

Research supporting QCPR Measurement, Assessment and Feedback Technology

Introduction

An increasing amount of scientific research suggests that the Quality of CPR can have a direct impact on survival from cardiac arrest. Compressing at the appropriate rate and to the appropriate depth together with minimal interruptions and 'hands off time', have been shown to increase the chances of survival with favorable outcomes. 'Favorable' in this context often means more than 'just' Return of Spontaneous Circulation (ROSC), but survival to discharge with good neurological function. In human terms, this means that patients can leave hospital to resume their lives as before.

High Quality CPR involves 5 critical components:[1)]

1. Minimize Interruptions - Chest Compression Fraction >80%
2. Compression rate of 100 to 120/min
3. Compression depth of at least 50 mm in an adult (1/3 AP depth in infants).
4. No residual leaning between compressions.
5. Avoid excessive ventilation (Only minimal chest rise and a rate of <12 breaths/min)

Achieving and maintaining proficiency in any skill requires regular practice and objective assessment of the skill. The old saying that "Practice Makes Perfect" is just as important for Resuscitation Quality Improvement (RQI) as it is with other human activities. Through better objective measurement, real time feedback during training and systems improvement processes of CPR performance, we can help improve CPR quality which will, in turn, have a significant impact on survival from cardiac arrest.

The body of evidence is growing that links improved survival with real time feedback of CPR performance during training, actual quality of resuscitation performance and post event debriefing with the ability to review objective CPR performance data.

Our primary motivation for providing this abstract booklet is to share what we believe is significant science that points us in a direction that can significantly improve survival from cardiac arrest. We believe that evidence and education are the appropriate vehicles for change and hope that this booklet is of value to you, and our resuscitation partners.

We hope that you will find this third edition of the collection of abstracts helpful and it enables you to better understand the importance of High Quality CPR and the impact it can have on patient survival.

This booklet is not a comprehensive review of all the literature, but it represents significant clinical work that we believe illustrates the potential of High Quality CPR and the part that measurement assessment and feedback can play to help provide High Quality CPR. It is important to note that the abstracts included in this booklet are our best effort at interpreting the literature.
We have taken every effort to represent the research fairly and accurately, without commercial bias.
We encourage you to read the full specific Journal papers if interested.

1) Peter A. Meaney, Bentley J. Bobrow, Mary E. Mancini, Jim Christenson, Allan R. de Caen. Farhan Bhanji, Benjamin S. Abella, Monica E. Kleinman, Dana P. Edelson, Robert A. Berg, Tom P. Aufderheide, Venu Menon and Marion Leary,
CPR Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital: A Consensus Statement From the American Heart Association; Circulation June 2013.

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Why quality of CPR has an Impact on Survival

CPR is a lifesaving intervention and the cornerstone of resuscitation from cardiac arrest. A significant amount of research has shown that the quality of CPR has a significant impact on survival. Delivering oxygen and glucose to vital organs during the resuscitation event is the principle aim of CPR. To deliver the oxygen and glucose to these vital organs requires an adequate blood flow to be generated. This can only be provided by effective chest compressions during the time of the cardiac arrest.

A strong link between decreased survival and inappropriate high compression rates and inappropriate shallow chest compressions has been reported. Long pre and peri shock pauses has also had a significant negative impact on survival. In essence, Poor Quality CPR should be considered as 'Preventable Harm'.

Five main components have been identified as critical for adequate blood flow and survival:

- Minimize hands off time.
- Compression rate between 100 – 120 per min.
- Compression depth of at least 50 mm in an adult (1/3 AP in an infant)
- No leaning between compressions
- Avoid excessive ventilations.

List of abstracts in this section

i. Bobrow, B.J., Vadeboncoeur, T.F., Stolz, U. et al. (2013), Annals of Emergency Medicine; The Influence of Scenario-Based Training and Real-Time Audiovisual Feedback on Out-of-Hospital Cardiopulmonary Resuscitation Quality and Survival From Out-of-Hospital Cardiac Arrest

ii. Christenson J., Andrusiek D, Everson-Stewart, S., et al.; The Resuscitation Outcomes Consortium Investigators (2009), Circulation; Chest Compression Fraction Determines Survival in Patients with Out-of-Hospital Ventricular Fibrillation"

iii. Edelson, D.P., et al. (2006), Resuscitation; Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest.

iv. Idris, A., Guffey, D., Aufderheide, T.P., et al.; the Resuscitation Outcomes Consortium (ROC) Investigators (2012), Circulation; Relationship Between Chest Compression Rates and Outcomes From Cardiac Arrest

v. Monsieurs, K.G., De Regge, M., Vansteelandt, K., et al. (2012), Resuscitation; Excessive Chest Compression Rate is Associated with Insufficient Compression Depth in Prehospital Cardiac Arrest.

vi. Stiell, I.G.,Brown, S.P., Christenson J., et.al. (2012) Crit. Care. Med; What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation.

vii. Tomlinson, A.E., Nysaeter, J., Kramer-Johansen, J., Steen, P.A., Dorph,E., (2006), Resuscitation; Compression force-depth relationship during out-of-hospital cardiopulmonary resuscitation.

viii. Vadeboncoeur T., Stolz, U., et al. (2014) Resuscitation; Chest compression depth and survival in out-of-hospital cardiac arrest

ix. Sutton, R. M., French, B., Niles, D. E., Donoghue, A., Topjian, A. A., Nishisaki, A., Leffelman, J., Wolfe, H., Berg, R. A., Nadkarni V. M., Meaney, P. A. (2014) Resuscitation "2010 American Heart Association recommended compression depths during pediatric in-hospital resuscitations are associated with survival"

The Influence of Scenario-Based Training and Real-Time Audiovisual Feedback on Out-of-Hospital Cardiopulmonary Resuscitation Quality and Survival From Out-of-Hospital Cardiac Arrest

Bentley J. Bobrow, Tyler F. Vadeboncoeur, Uwe Stolz, et al.
Annals of Emergency Medicine 2013;62:47-56.e1.

Keyword: Cardiac Arrest, CPR Quality, Training, Real Time Feedback, Survival.

Objective: To determine whether a quality improvement program for out-of-hospital providers affected the quality of CPR and survival rates.

Method: The study was conducted by an independent EMS agency in two phases with 373 professional rescuers. During Phase 1 - pre-training phase, (October 2008 to March 2010), out-of-hospital providers were trained with real-time defibrillator feedback disabled. During Phase 2 after scenario-based training was conducted with defibrillator feedback enabled (March 2010 – September 2011). Patient survival to discharge was the primary outcome of interest; CPR quality measures were also compared in the two phases.

Results: Records from forms and defibrillators were collected from 484 consecutive cardiac arrest patients (232 in Phase 1; 252 in Phase 2). Patient outcomes and CPR quality were improved in Phase 2.

Outcome by study period	**Overall**	**Phase 1**	**Phase 2**	**Absolute difference to Post-Pre (95% CI)**
Total No.	484 (100)	232 (47.9)	252 (52.1)	NA
Return of spontaneous circulation, No. (%)	113 (23.4)	58 (25.0)	55 (21.8)	_3.2 (-10.7 to 4.4)
Survival to hospital discharge for all rhythms No./total (%)	55/483(11.4)	20/231 /8.7)	35/252 (13.9)	5.2 (-0.4 to 10.8)
Survival to hospital discharge for witnessed arrests, shockable rhythms, No/total (%)	35/93 (37.6)	15/57 (26.3)	20/36 (55.6)	29.2 (9.4 to 49.1)
Favorable functional outcome (CPC score_1 or 2) for all rhythms, No./total (%)	42/481(8.7)	15/230 (6.5)	27/251 (10.8)	4.2 (-0.8 to 9.2)
Favorable functional outcome (CPC score_1 or 2) for witnessed arrests, shockable rhythms, No./total (%)	27/91 (29.7)	11/56 (19.6)	16/35 (45.7)	26.1 (6.6 to 45.6)

Conclusion: This is the first study to demonstrate improvement of both CPR quality and associated patient survival rates and favorable functional outcomes after through training that incorporates scenario-based practice and real-time audio and visual feedback. This analysis demonstrates that a systematic and comprehensive approach to improving out-of hospital CPR quality in a large EMS system was associated with achieving the 2010 AHA guideline recommendations for CPR quality, an increase in survival to hospital discharge, and favorable functional outcomes.

It strongly support the current emphasis that the 2010 AHA Guidelines place on high-quality CPR as means to improve survival.

Chest Compression Fraction Determines Survival in Patients with Out-of-Hospital Ventricular Fibrillation

Jim Christenson, Douglas Andrusiek, Siobhan Everson-Stewart, et al.; the Resuscitation Outcomes Consortium Investigators
Circulation 2009;120:1241-47.

Keyword: Cardiac arrest, CPR, Fibrillation, Chest compression fraction, Survival,

Objective: To estimate the effect of an increasing proportion of time spent performing chest compressions during cardiac arrest on survival to discharge in patients with out-of-hospital ventricular fibrillation or pulseless ventricular tachycardia.

Method: This is a prospective observational cohort study of 506 adult cardiac arrest patients who met the following criteria: listed in the Resuscitation Outcomes Consortium Cardiac Arrest Epistry; confirmed VF or VT; no defibrillation before emergency medical services arrival; electronically recorded CPR before the first shock; and a confirmed outcome. Patients were followed up to discharge from the hospital or death.

Results: After adjustment for age, gender, location, bystander CPR, bystander witness status, and response time, the odds ratios of surviving to hospital discharge in the two highest categories of chest compression fraction compared with the reference category were 3.01 (95% CI, 1.37 to 6.58) and 2.33 (95% CI, 0.96 to 5.63). The estimated adjusted linear effect on odds ratio of survival for a 10% change in chest compression fraction was 1.11 (95% CI, 1.01 to 1.21).

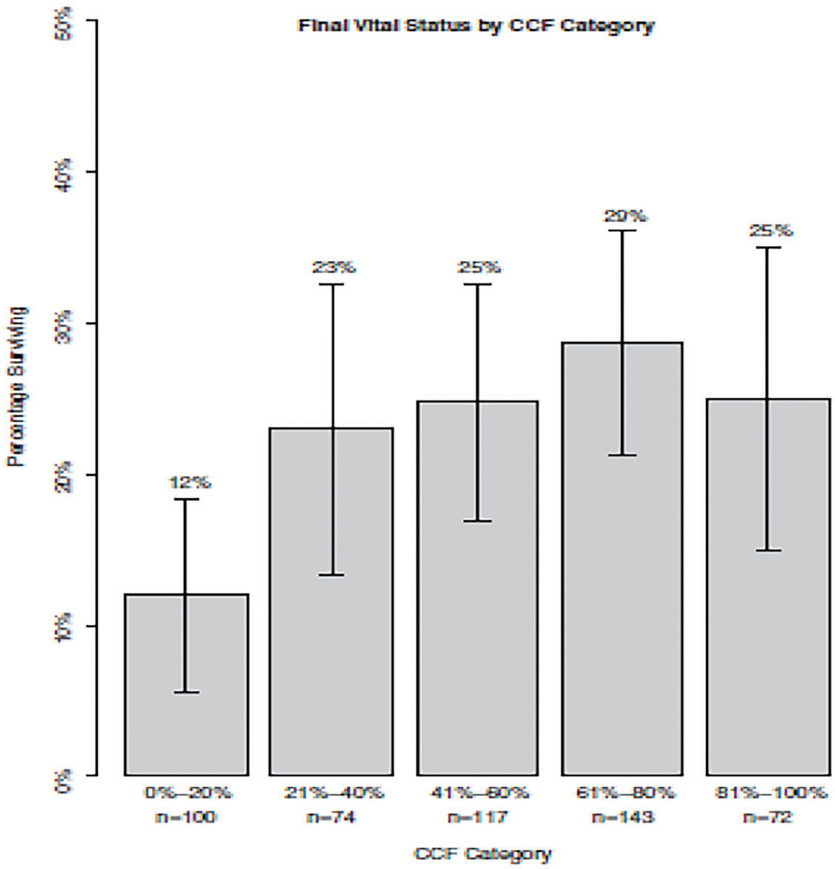


Figure 2. Survival to discharge for each category of chest compression fraction.

Conclusion: An increased chest compression fraction is independently predictive of better survival in patients who experience a pre-hospital ventricular fibrillation/tachycardia cardiac arrest.

Effects of Compression Depth and Pre-Shock Pauses Predict Defibrillation Failure During Cardiac Arrest

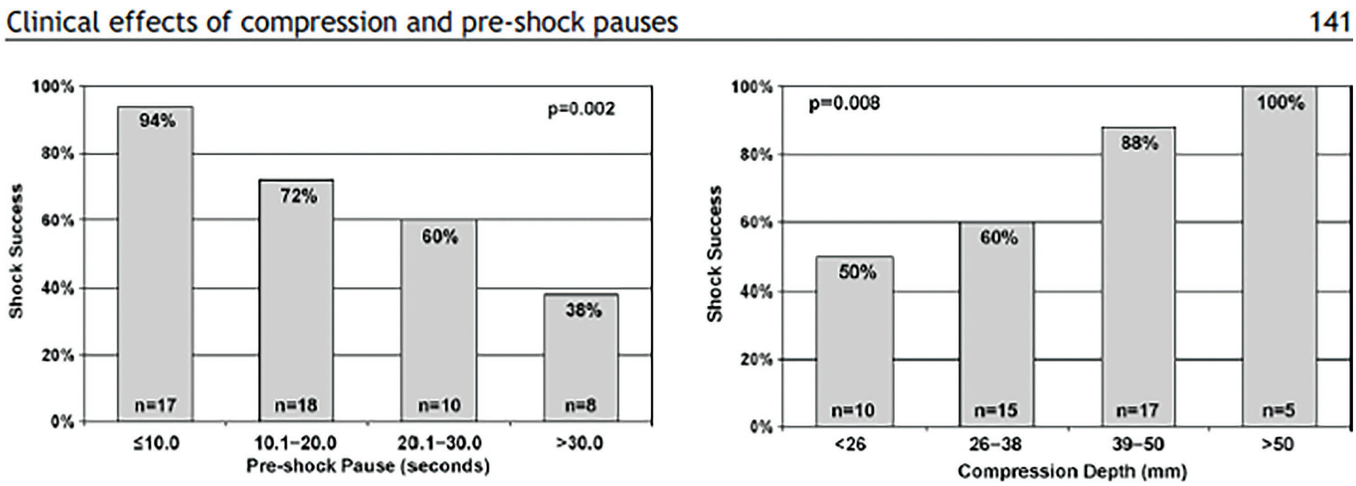
Dana P. Edelson, Benjamin S. Abella, Jo Kramer-Johansen, et al.
Resuscitation 2006; 71:137-45.

Keyword: Cardiac Arrest, CPR, Pre-shock pauses, Compression depth, Shock success.

Objective: To examine whether pre-shock pause and compression depth, two likely determinants of blood flow preceding defibrillation, affect the ability of a shock to terminate VF.

Method: A prospective, multi-center, observational study of adult in-hospital and out-of-hospital cardiac resuscitations was conducted between March 2002 and December 2005. An investigational monitor/defibrillator equipped to measure compression characteristics during CPR was used.

Results: Sixty cases were included for analysis. Patients' age, sex, arrest location, time to shock, ventilation rate, chest compression rate and no-flow (pause) time were not significantly associated with success of the first shock. However, successful shocks were associated with a shorter median pre-shock pause duration (11.9 s versus 22.7 s; P = 0.002) and higher mean chest compression depth in the 30s of CPR preceding the pre-shock pause (39 ± 11 mm versus 29 ± 10 mm, P = 0.004).



Conclusions: Longer pre-shock pauses and shallower chest compressions are correlated significantly with decreased shock success. Approaches to minimize (or eliminate) pre-shock pauses and optimize compression depth should be made and consideration should be given to the use of newer-generation AEDs with shorter (less than 10 seconds) analysis times.

Relationship Between Chest Compression Rates and Outcomes From Cardiac Arrest

Ahamed H. Idris, Danielle Guffey, Tom P. Aufderheide, et al.; the Resuscitation Outcomes Consortium (ROC) Investigators
Circulation 2012;125:3004-12.

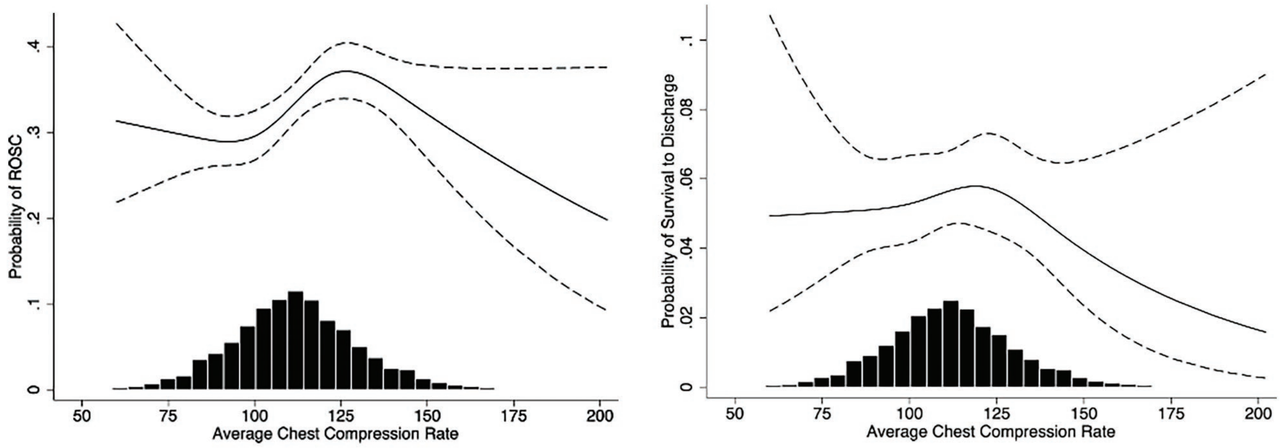
Keyword: Cardiac Arrest, CPR, Compression rate, Patient outcome

Objective: To document chest compression rates used by emergency medical services providers and to investigate the relationship between compression rate and patient outcome.

Method: Patient inclusion criteria were: age ≥ 20 years, out-of-hospital cardiac arrest treated by emergency medical services providers within the Resuscitation Outcomes Consortium. Monitor- defibrillator recordings during cardiopulmonary resuscitation provided the relevant data. Between December 2005 and May 2007, data from 3098 patients were included in the study.

Results: A curvilinear association between chest compression rate and return of spontaneous circulation was found in cubic spline models after multivariable adjustment (P = 0.012). Return of spontaneous circulation (ROSC) rates peaked ≈125 compressions/min. Chest compression rate was not significantly associated with survival to hospital discharge in multivariable categorical or cubic spline models.

Chest Compression Rates and Patient Outcomes



Adjusted cubic spline model includes sex, age, bystander- witnessed arrest, emergency medical services–witnessed arrest, first known emergency medical services rhythm, attempted bystander cardiopulmonary resuscitation, public location, and site location (y axis). Average chest compression rate vs probability of positive outcome when other covariates are equal to the population average is shown. We used a global test that tested the null hypothesis that the spline curve is a horizontal line (P = 0.63). A histogram of the compression rates and numbers of patients is included. Dashed lines show 95% confidence intervals.

Conclusions: Chest compression rate was independently associated with return of spontaneous circulation, with a rate of 125 compressions/min producing the highest likelihood of ROSC. Compression rate alone was not linked to survival to hospital discharge in out-of-hospital cardiac arrest.

Excessive Chest Compression Rate is Associated with Insufficient Compression Depth in Prehospital Cardiac Arrest

Koenraad G. Monsieurs, Melissa De Regge, Kristof Vansteelandt, et al.
Resuscitation 2012;83:1319–23.

Keyword: Cardiac arrest, CPR, Chest compressions, Compression depth, Compression rate, Pre-hospital.

Objective: To examine the relationship between chest compression rate and compression depth; more specifically, to test the hypothesis that that faster compressions are associated with decreased depth

Method: Data from 133 consecutive patients who underwent pre-hospital CPR by health care professionals were included. An accelerometer recorded chest compression rate and depth. Defibrillator feedback (metronome and voice prompt) was activated if the rate fell below 80 or if the depth failed to reach 4 cm on 3 of 5 compressions. Compression depth was compared for 3 rate categories: <80/min, 80–120/min, and >120/min. A difference in compression depth ≥0.5 cm was considered clinically significant.

Results: In 77 (58%) of the 133 patients, rates >120/min were associated with significantly lower depth compared to rates 80–120/min, and in 40 (30%) of the 133, this difference was also clinically significant. Mixed models analysis showed that the deepest compressions (4.5 cm) were performed at a rate of 86/min, with progressively lower compression depths at higher rates. Predicted average compression depth was 4.5 (SE 0.06) for rates 80–120/min and 4.1 cm (SE 0.06) for compressions >120/min (mean difference 0.4 cm, P < 0.001).

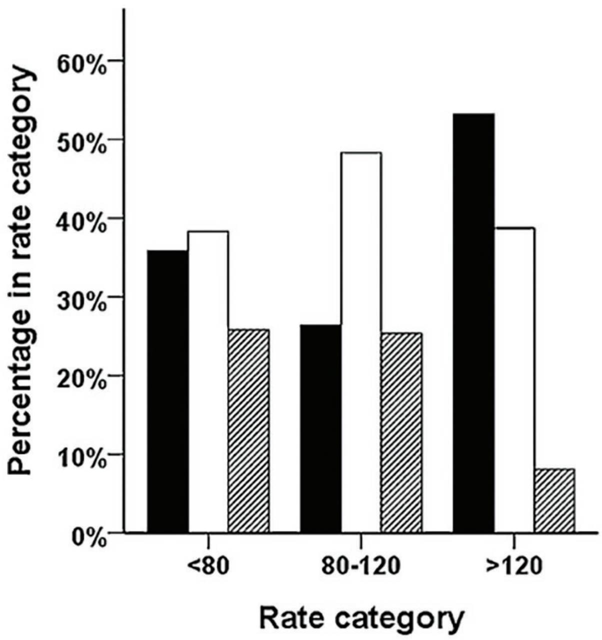


Fig. 1. Distribution of depth according to rate category. Black bars indicate <4 cm depth, white bars 4–5 cm depth, crossed bars >5 cm depth.

Conclusion: This study showed an association between higher compression rates and lower compression depths. Avoiding excessive compression rates may lead to more compressions of sufficient depth.

What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation?

Ian G. Stiell; Siobhan P. Brown; James Christenson; Sheldon Cheskes; Graham Nichol; Judy Powell; Blair Bigham; Laurie J. Morrison; Jonathan Larsen; Erik Hess; Christian Vaillancourt; Daniel P. Davis; Clifton W. Callaway; the Resuscitation Outcomes Consortium (ROC) Investigators
Critical Care Medicine 2012; 40:1192–1198

Keyword: Cardiac Arrest, CPR, Compression depth, EMS, Survival

Objective: The 2010 Guidelines for CPR recommended an increase in the minimum compression depth from 38 to 50 mm. The ROC investigators sought to study patterns of CPR compression depth and their as¬sociations with patient outcomes in out-of-hospital cardiac arrest cases treated by the 2005 guideline standards.

Method: A Prospective cohort study involving seven U.S. and Canadian urban regions. EMS treated out-of-hospital cardiac arrest patients from the ROC Epistry –Cardiac Arrest for whom electronic cardiopulmonary resuscitation compression depth data were available, from May 2006 to June 2009.: Anterior chest wall depression in millimeters and the period of active CPR (chest compression fraction) for each minute of cardio¬pulmonary resuscitation were calculated. Covariates including compression rate and adjusted odds ratios were controlled for any return of spontaneous circulation, 1-day survival, and hospital discharge.

Results: 1029 adult patients with the following characteristics: mean age 68 yrs; male 62%; bystander witnessed 40%; bystander CPR 37%; initial rhythms: VF/VT 24%, PEA 16%, asystole 48%, other non-shockable 12%; outcomes: ROSC 26%, 1-day survival 18%, discharge 5%. For all patients, median compression rate was 106 per minute, me¬dian compression fraction 0.65, and median compression depth 37.3 mm with 52.8% of cases having depth <38 mm and 91.6% having depth <50 mm. We found an inverse association between depth and compression rate (p < .001). Adjusted odds ratios for all depth measures (mean values, categories, and range) showed strong trends toward better outcomes with increased depth for all three survival measures.

Conclusions: It was found suboptimal compression depth in half of patients by 2005 guideline standards and almost all by 2010 standards as well as an inverse association between compres¬sion depth and rate. We found a strong association between sur¬vival outcomes and increased compression depth but no clear evidence to support or refute the 2010 recommendations of >50 mm. Although compression depth is an important component of CPR and should be measured rou¬tinely, the most effective depth is currently unknown.

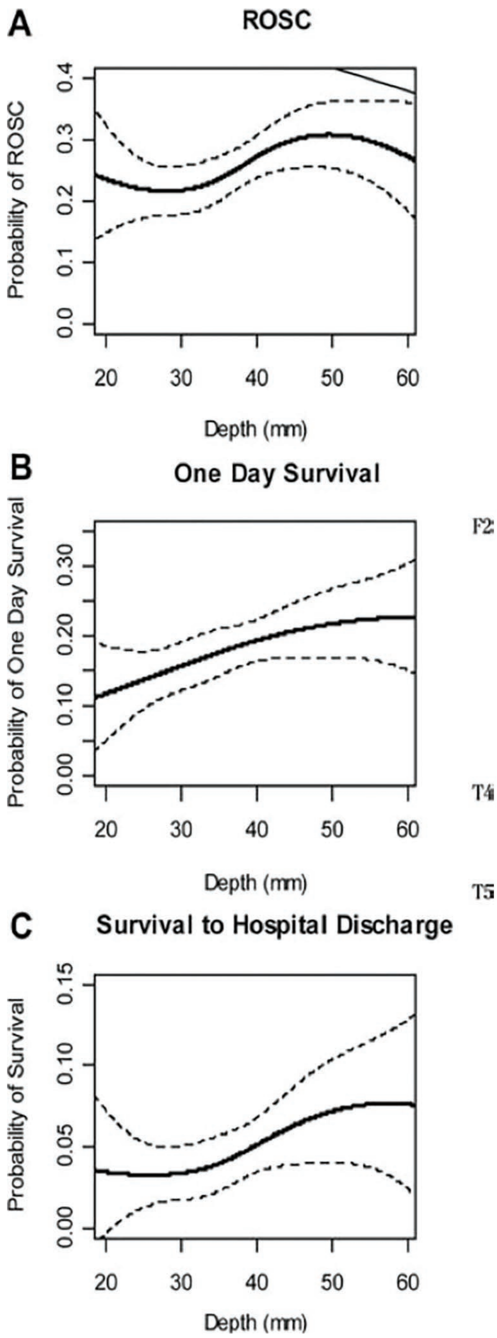


Figure 2. A–C, Plots of outcomes vs. average compression depth. ROSC, return of spontaneous circulation.

Compression force – depth relationship during out-of-hospital cardiopulmonary resuscitation

A.E. Tomlinson, J. Nysaether, J. Kramer-Johansen, P.A. Steen, E. Dorph
Resuscitation, (2006), 72: pp. 364-370

Keywords: Cardiac Arrest, Chest compression, Compression depth, Compression force.

Objective: Recent studies have reported a high incidence of inadequate chest compression depth. The objective of this study was to measure compression force and depth during CPR to assess the difficulty of attaining recommended compression depth in certain patients.

Method: A specially designed monitor/defibrillator equipped with a sternal pad fitted with an accelerometer and a pressure sensor was used to measure force and depth of compressions during CPR in 91 adult out-of-hospital cardiac arrest patients.

Results: There was a strong non-linear relationship between the force of compression and depth achieved. Mean applied force applied for all patients was 30.3±8.2kg and mean absolute compression depth was 42±8mm. Figure 1 shows the relationship between compression force and depth for all the individual episodes. Chest wall elasticity varied greatly between individuals with a range of force from 10 to 54kg in patients where 38mm compression depth was achieved. Force needed to reach the guidelines recommended depth was higher for males than females. Stiffer chests were compressed more forcefully than softer chests (p<0.001), but softer chests were compressed more deeply than stiffer chests (p=0.001)

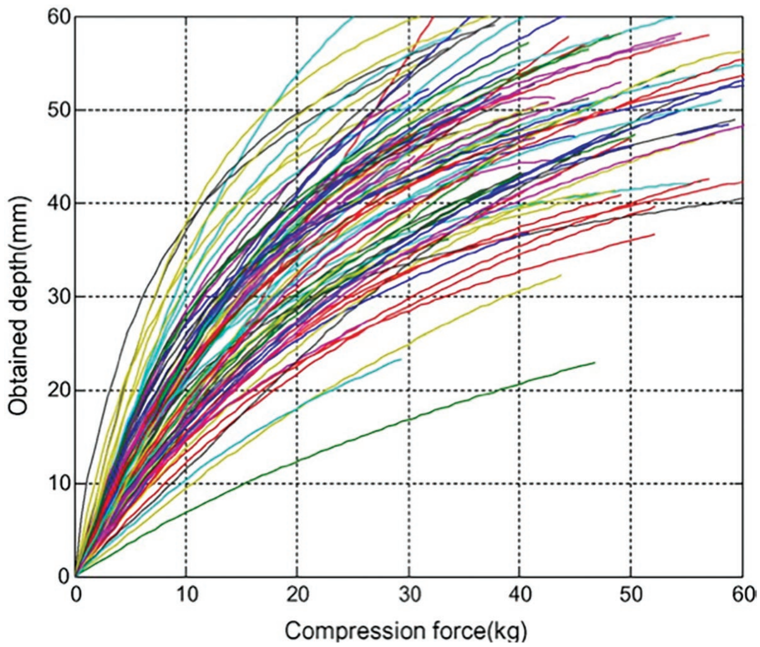


Figure 1; Compression force (kg) vs. absolute compression depth (mm) for all episodes.

Conclusion: Force pressure required to reach guidelines recommended compression depth varies between individuals. Chest wall elasticity of individuals in the study ranged from 10 to 54kg to achieve 38mm. On average, adequate chest compression depth can be achieved by a force of <50kg.

Chest compression depth and survival in out-of-hospital cardiac arrest

Tyler Vadeboncoeur; Uwe Stolz; Ashish Panchal; Annemarie Silver; Mark Venuti; John Tobin; Gary Smith; Martha Nunez; Madalyn Karamooz; Daniel Spaite; Bentley Bobrow.
Resuscitation 85; 2014; 182 – 188

Keyword: Cardiac arrest, CPR, Compression depth, EMS, Survival

Objective: Outcomes from out-of-hospital cardiac arrest (OHCA) may improve if rescuers perform chest com-pressions (CCs) deeper than the previous recommendation of 38–51 mm and consistent with the 2010 AHA Guideline recommendation of at least 51 mm. The aim of this study was to assess the relationship between CC depth and OHCA survival.

Methods: Prospective analysis of CC depth and outcomes in consecutive adult OHCA of presumed cardiac etiology from two EMS agencies participating in comprehensive CPR quality improvement initiatives. Multivariable logistic regression was used to calculate adjusted odds ratios (aORs) for survival to hospital discharge and favorable functional outcome.

Results: Among 593 OHCAs, 136 patients (22.9%) achieved return of spontaneous circulation, 63 patients (10.6%) survived and 50 had favorable functional outcome (8.4%). Mean CC depth was 49.8 ± 11.0 mm and mean CC rate was 113.9 ± 18.1 CC min−1. Mean depth was significantly deeper in survivors (53.6 mm, 95% CI: 50.5–56.7) than non-survivors (48.8 mm, 95% CI: 47.6–50.0). Each 5 mm increase in mean CC depth significantly increased the odds of survival and survival with favorable functional outcome: aORs were 1.29 (95% CI 1.00–1.65) and 1.30 (95% CI 1.00–1.70) respectively.

Table 4
Logistic regression analyses for compression depth and survival to hospital discharge and favorable functional outcome upon hospital discharge.

	Survival to hospital discharge		Favorable functional outcome (CPC 1 or 2)	
	Adjusted OR**	95% CI	Adjusted OR***	95% CI
Mean compression depth (per 5 mm increase)*	1.29	(1.00 to 1.65)	1.30	(1.00 to 1.70)
Mean compression depth (categories)*				
<38.0 mm	1 (REF.)		1 (REF.)	
38.0–50.9 mm	5.92	(0.69 to 51.13)	5.00	(0.44 to 57.12)
≥51.0 mm	7.99	(0.87 to 73.17)	7.74	(0.63 to 94.69)
Mean compression 38 mm or greater*	6.66	(0.8 to 55.44)	5.97	(0.57 to 62.47)
Percent of compressions ≥51 mm (per 10% increase)*	1.21	(1.02 to 1.45)	1.21	(1.00 to 1.46)
Compression fraction (per 10% increase)	0.62	(0.39 to 1.00)	0.48	(0.28 to 0.82)
Mean compression rate (per 10 compressions/minute)	0.97	(0.71 to 1.32)	0.88	(0.62 to 1.26)
Post vs. pre intervention	3.93	(1.15 to 13.42)	5.09	(1.31 to 19.76)
Witnessed arrest	3.82	(1.64 to 8.91)	3.51	(1.35 to 9.14)
Shockable rhythm (V-fib/V-tach) on EMS arrival	7.68	(3.17 to 18.63)	8.04	(2.93 to 22.06)
Age (per year)	0.98	(0.95 to 1.00)	0.97	(0.94 to 0.99)
Male sex	0.38	(0.17 to 0.85)	0.53	(0.21 to 1.33)
Provision of TH (prehospital or hospital)	16.45	(6.81 to 39.71)	15.97	(5.8 to 43.97)
Provision of Bystander CPR	1.34	(0.62 to 2.92)	1.10	(0.46 to 2.63)
Dispatch to EMS arrival interval (per minute)	0.99	(0.97 to 1.01)	0.99	(0.97 to 1.02)
Location of arrest				
Residential	1 (REF.)		1 (REF.)	
Medical facility	1.32	(0.39 to 4.51)	1.29	(0.30 to 5.55)
Public area	1.31	(0.52 to 3.26)	1.83	(0.68 to 4.91)
Adequate MICR	1.63	(0.56 to 4.71)	1.07	(0.35 to 3.26)

CPC, cerebral performance category; CPR, cardiopulmonary resuscitation; CI, confidence interval; EMS, emergency medical services; MICR, minimally interrupted cardiac resuscitation; mm, millimeters; PEA, pulseless electrical activity; ROSC, return of spontaneous circulation; TH, therapeutic hypothermia; V-fib, ventricular fibrillation; V-tach, ventral tachycardia.
* Adjusted for all other variables without "*".
** Hosmer–Lemeshow goodness-of-fit *p*-value = 0.76.
*** Hosmer–Lemeshow goodness-of-fit *p*-value = 0.74.

Conclusion: Deeper chest compressions were associated with improved survival and functional outcome following OHCA. Our results suggest that adhering to the 2010 Guideline-recommended depth of at least 51 mm could improve outcomes for victims of OHCA.

2010 American Heart Association recommended compression depths during pediatric in-hospital resuscitations are associated with survival

Robert M. Sutton, Benjamin French, Dana E. Niles, et al
Resuscitation 2014;85: 1179 - 1184

Keyword: Cardiac Arrest, Cardiopulmonary Resuscitation, Quality

Aim: Gaps exist in pediatric resuscitation knowledge due to limited data collected during cardiac arrest in real children. The objective of this study was to evaluate the relationship between the 2010 American Heart Association (AHA) recommended chest compression (CC) depth (≥51 mm) and survival following pediatric resuscitation attempts.

Methods: Single-center prospectively collected and retrospectively analyzed observational study of children (>1 year) who received CC between October 2006 and September 2013 in the intensive care unit (ICU) or emergency department (ED) at a tertiary care children's hospital. Multivariate logistic regression models controlling for calendar year and known potential confounders were used to estimate the association between 2010 AHA depth compliance and survival outcomes. The primary outcome was 24-h survival. The primary predictor variable was event AHA depth compliance, prospectively defined as an event with ≥60% of 30-s epochs achieving an average CC depth ≥51 mm during the first 5 min of the resuscitation.

Results: There were 89 CC events, 87 with quantitative CPR data collected (23 AHA depth compliant). AHA depth compliant events were associated with improved 24-h survival on both univariate analysis (70% vs. 16%, $p < 0.001$) and after controlling for potential confounders (calendar year of arrest, gender, first documented rhythm; aOR 10.3; CI95: 2.75–38.8; $p < 0.001$).

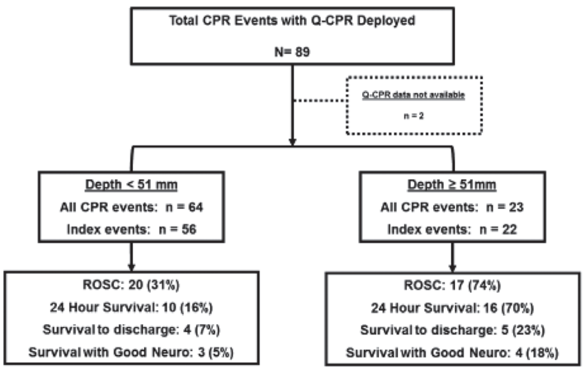


Fig. 1. Utstein style diagram.

Conclusion: In this study of children >1 year of age, performance of CPR compliant with the 2010 American Heart Association chest compression depth recommendations (≥51 mm) was associated with higher rates of ROSC and 24-h survival after in-hospital cardiac arrest. In contrast to previous investigations, we did not observe an association between CC depth and other quality variables – specifically, CC depth did not decline as rates increased.

How feedback improves CPR Quality

Cardiac resuscitation in clinical practice requires a complex set of actions to be carried out by multiple rescuers, often under considerably stress. Research suggests that caregivers at this stressful time are often unable to perform CPR within the established guidelines associated with High Quality CPR. We believe that for High Quality CPR to be performed routinely, and then real time objective measurement needs to be provided to the trainee/rescuer. For example, research has shown a link that commonly occurs between compression rate and depth, increasing the compression rate results in loss of compression depth. Real time objective feedback helps avoid this.

Real-time feedback in resuscitation can help rescuers deliver guideline High Quality CPR. Both audio and visual real-time feedback together with post event debriefing have been shown to help improve the quality of CPR.

List of abstracts in this section

i. Buléon, J. Parienti, J-J, Halbout, L., et. al.(2013) AJEM; Improvement in chest compression quality using feedback device (CPRmeter):a simulation randomized crossover study

ii. Cason, C.L., Trowbridge, C., Baxley, S.M., & Ricard, M.D. (2011), BMC Nursing; A Counterbalanced Cross-Over Study of the Effects of Visual, Auditory and No Feedback on Performance Measures in a Simulated Cardiopulmonary Resuscitation.

iii. Dine, C.J., Gersh, R.E., Leary, M., et al. (2008), Crit Care Med; Improving Cardiopulmonary Resuscitation Quality and Resuscitation Training by Combining Audiovisual Feedback and Debriefing.

iv. Edelson, D.P., Litzinger, B., Arora, V. (2008), Archives of Internal Medicine; Improving In-Hospital Cardiac Arrest Process and Outcomes with Performance Debriefing.

v. Hostler, D., Everson-Steward, S., Rea, T.D., et al.; the Resuscitation Outcomes Consortium Investigators, (2011), BMJ; Effect of Real-Time Feedback During Cardiopulmonary Resuscitation Outside Hospital: Prospective, Cluster-Randomised Trial.

vi. Kirkbright, S.: Finn J. et.al. (2014) Resuscitation; Audiovisual feedback device use by health care professionals during CPR: A systematic review and meta-analysis of randomized and non-randomized trials.

vii. Kramer-Johansen, J., Myklebust H., Wik, L., et al. (2006), Resuscitation; Quality of Out-of-Hospital Cardiopulmonary Resuscitation with Real Time Automated Feedback: A Prospective Interventional Study.

viii. Lyon, R.M., Clarke, S., Milligan, D., & Clegg, G.R. (2012), Resuscitation; Resuscitation Feedback and Targeted Education Improves Quality of Pre-Hospital Resuscitation in Scotland.

ix. Martin, P., Theobald, P., Kemp, A., et al. (2013) Resuscitation; Real-Time Feedback Can Improve Infant Manikin Cardiopulmonary Resuscitation by up to 79%—A Randomized Controlled Trial.

x. Skorning, M., Beckers, S.K., Brokmann, J.C., et al. (2010), Resuscitation; New Visual Feedback Device Improves Performance of Chest Compressions by Professionals in Simulated Cardiac Arrest"

xi. Sutton,R.M., Niles, D., French, B., et. al.(2013) Resuscitation; First quantitative analysis of cardiopulmonary ewsuscitation quality during in-hospital cardiac arrest of young children.

xii. Yeung, J., Meeks, R., Edelson, D. (2009), Resuscitation; The Use of CPR Feedback/Prompt Devices During Training and CPR Performance: A Systematic Review.

xiii. Zapletala B., Greifb R., Stumpfc D., (2013) Resuscitation; Comparing three CPR feedback devices and standard BLS in a single rescuer scenario: A randomized simulation study.

Improvement in chest compression quality using a feedback device (CPRmeter): a simulation randomized crossover study

Clément Buléon, Jean-Jacques Parienti, Laurent Halbout, et.al.
American Journal of Emergency Medicine 2013;1457 - 1461

Keyword: Simulated Cardiac Arrest, CPR feedback, Chest compression depth and rate

Objective: The goal of the present study was to evaluate the improvement of chest compression quality performed by untrained students without any skill in CPR using a feedback device (CPRmeter) in a simulated cardiac arrest situation with minimal instructions.

Methods: 144 students inexperienced in cardiopulmonary resuscitation representing untrained rescuers were included. Participants performed 2 minutes of chest compression without interruption with feedback (group G), or without feedback (group B). Four months passed between the two crossover phases to avoid resilience effect. Data collected by the CPRmeter device were: Chest Compression rate, depth and release.

Results: Efficient chest compression rate (primary outcome) (absolute difference [95% CI]) was significantly improved in group G (feedback) (71%) compared to group B (blinded) (26%; [45 {36-55}]; P b .0001). Adequate depth rate (N38 mm) was significantly improved in group G (feedback) (85%) compared to group B (blinded) (43%; [42 {33-52}]; P b .0001). Adequate CC rate (90-120/min) was significantly improved in group G (feedback) (81%) compared to group B (blinded) (56%; [25 {15-35}]; P b .0001). The average CC rate and depth in group G (feedback) were significantly less dispersed around the mean compared to group B (blinded) (test of variance P b .007; P b .015 respectively).

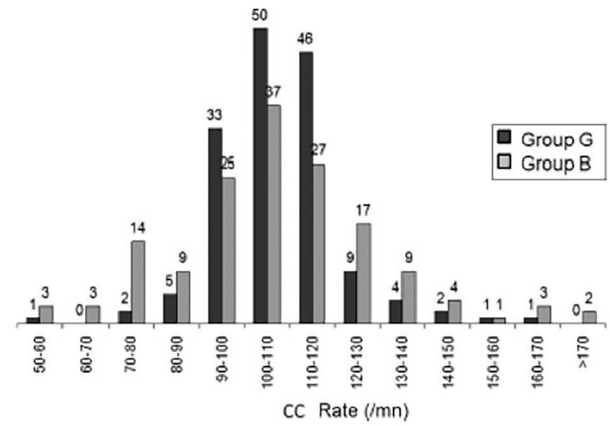


Fig. 3. CC rate distribution according to feedback group (group G with feedback and group B without). Data expressed in number of participant. CC: Chest Compression

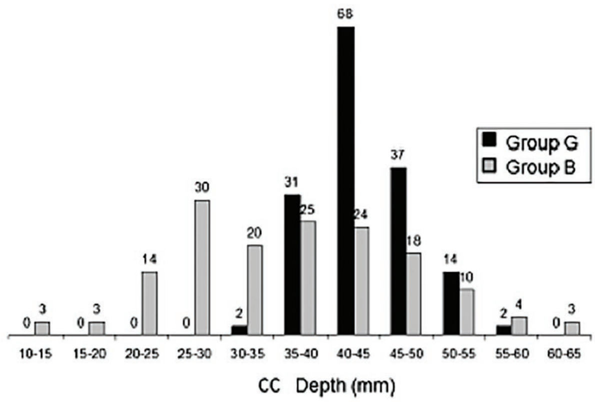


Fig. 4. CC depth distribution according to feedback group (group G with feedback and group B without). Data expressed in number of participant. CC: Chest Compression

Conclusions: The use of the CPRmeter significantly improved chest compression quality performed by students inexperienced in cardiopulmonary resuscitation.

A Counterbalanced Cross-Over Study of the Effects of Visual, Auditory and No Feedback on Performance Measures in a Simulated Cardiopulmonary Resuscitation

Carolyn L. Cason, Cynthia Trowbridge, Susan M. Baxley, and Mark D. Ricard
BMC Nursing 2011, 10:15.

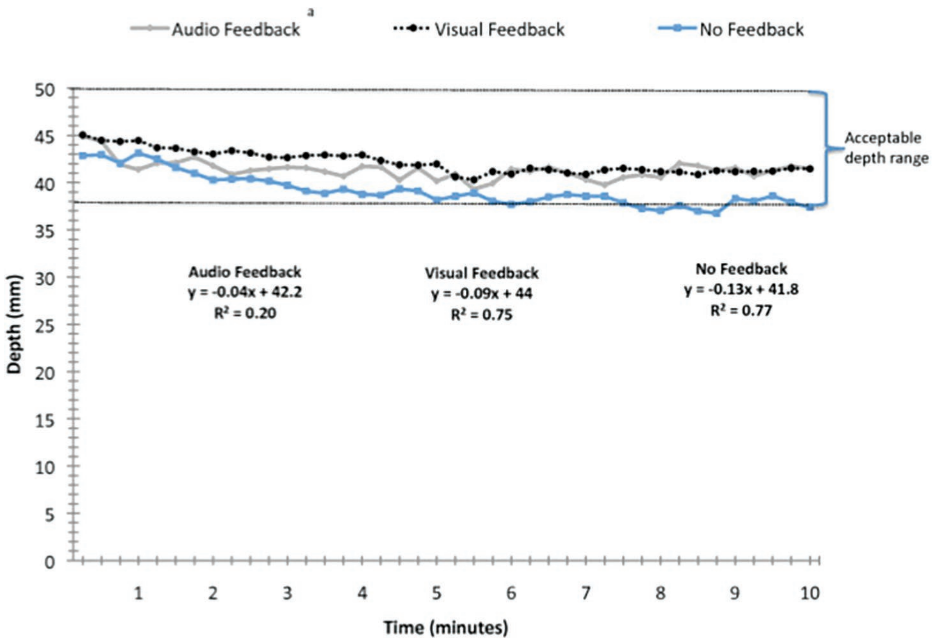
Keyword: CPR, Audio and visual feedback, CPR Quality

Objective: To assess the effects of auditory and visual feedback on the quality of CPR, with particular attention to mitigation of performance decline under conditions of rescuer fatigue.

Method: Fifteen female volunteers performed 10 minutes of 30:2 CPR. Three feedback conditions were used for each participant: no feedback, auditory feedback in the form of error correction by a voice-assisted manikin, and visual feedback via continuous graphic display. Fatigue was measured with blood lactate levels (mmol/dl) and perceived exertion. The manikin recorded measures of CPR quality.

Results: Although feedback did not improve compression rates, visual feedback yielded a greater percentage of overall correct compressions (78.1 ± 8.2%) than did auditory (65.4 ± 7.6%) or no feedback (44.5 ± 8.1%). Absence of feedback was associated with shallower compressions and a lower percentage of compressions within the accepted 38-50 mm range than with auditory or visual feedback ($p < 0.05$).

Mean Compression Depth as a Function of Time and Feedback



Conclusions: Both auditory and visual feedback can improve CPR performance, and the negative effects of fatigue on performance may be mitigated particularly well by visual feedback.

Improving Cardiopulmonary Resuscitation Quality and Resuscitation Training by Combining Audiovisual Feedback and Debriefing

C. Jessica Dine, Ronna E. Gersh, Marion Leary, et al.
Crit Care Med 2008;36:2817-22.

Keyword: Simulated cardiac arrest, CPR feedback, Debriefing, CPRQuality

Objective: Delivery of high-quality cardiopulmonary resuscitation increases survival from cardiac arrest, yet studies have shown that cardiopulmonary resuscitation quality is often poor during actual in-hospital resuscitation. Furthermore, re- cent work has shown that audiovisual feedback alone during cardiopulmonary resuscitation modestly improves performance. We hypothesized that a multimodal training method comprising audiovisual feedback and immediate debriefing would improve cardiopulmonary resuscitation performance among care providers.

Method: Eighty nurses each underwent three trials of simulated cardiac arrest. In the second and third trials, each participant was randomized to receive either real-time audiovisual feedback on compression rate and depth ("feedback group") or no feedback ("debriefing-only group"). Both groups received individual debriefing after the second trial. Quality of compressions was recorded by a resuscitation-sensing defibrillator and converted to a composite CPR adequacy score.

Results: The percentage of participants providing compressions of adequate depth improved in both groups but was greater for the feedback group. Compression rate was unaffected by either intervention alone, but rate compliance in the feedback group improved from 45% to 84% (P = 0.001) and the number of participants who performed compressions with adequate rate and depth more than doubled, from 29% to 64% (P = 0.005).

	Trial 1	Trial 2	P value (Trial 1 Trial 2)	Trial 3	P value (Trial 2 Trial 3)
Debriefing only (n=34)					
Percentage adequate depth	47	38	0.471	68	0.015
Percentage adequate rate	29	42	0.310	50	0.465
Percentage adequate CPR	21	24	0.770	35	0.287
Feedback (n=31)					
Percentage adequate depth	19	58	0.002	74	0.180
Percentage adequate rate	45	45	1.000	84	0.001
Percentage adequate CPR	16	29	0.220	65	0.005

Performance by Group

Conclusions: Healthcare providers exhibit deficits in the quality of their CPR. Debriefing and feedback together can result in significant performance improvements, which may translate to better care for cardiac arrest patients.

Improving In-Hospital Cardiac Arrest Process and Outcomes with Performance Debriefing

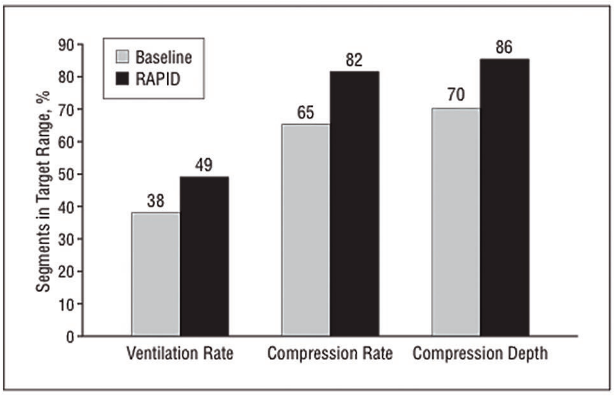
Dana P. Edelson, Barbara Litzinger, Vineet Arora, et al.
Arch. Intern. Med. 2008;168:1063-9.

Keyword: Cardiac Arrest, CPR Quality, Feedback, Debriefing, Survival.

Objective: To test the hypothesis that a debriefing intervention that incorporates CPR quality data from actual in-hospital cardiac arrests would improve CPR performance and initial patient survival.

Method: Over a one-year period, internal medicine residents participated in weekly sessions that debriefed the prior week's resuscitations [program name: RAPID]. Sessions focused on reviewing data from a CPR-sensing and feedback-enabled defibrillator used during resuscitation attempts. Objective metrics of CPR quality and initial return of spontaneous circulation (ROSC) for the period (n of patients = 123) were compared with those of a historical cohort (n of patients = 101) that had defibrillator feedback but no debriefing program.

Results: Significant improvements in the RAPID group included a decrease in mean (SD) ventilation rate (18 [8]/min vs 13 [7]/min vs; P < .001), and an increase in compression depth (44 [10] mm vs 50 [10] mm; P = .001). These changes correlated with an increase in the rate of ROSC in the RAPID group (44.6% vs 59.4%; P=.03) but no change in survival to discharge (8.9% vs 7.4%; P=.69).



Cardiopulmonary resuscitation (CPR) quality as a percentage of time within target range. Data are given as percentage of 30-second segments during the first 5 minutes of CPR that are 15/min or less for ventilations, 38 mm or greater for compression depth, and 90/min to 120/min for compression rate. P = .001 for each parameter. RAPID indicates resuscitation with actual performance integrated debriefing.

Conclusions: The combination of debriefing and real- time audiovisual feedback improved CPR quality, whereas feedback alone did not. Resuscitation-sensing and recording devices, because of their ability to enhance debriefing, have potential to fundamentally improve resuscitation training.

Authors postulate: One of the ways RAPID worked was trough sensitizing rescuers to the real time audiovisual prompts they received trough subsequent resuscitations. Another potential mechanism that may have accounted for the improved resuscitation performance by the house staff was the knowledge that their performance was going to be reviewed in an open forum with faculty and colleagues.

Effect of Real-Time Feedback During Cardiopulmonary Resuscitation Outside Hospital: Prospective, Cluster-Randomised Trial

David Hostler, Siobhan Everson-Stewart, Thomas D Rea, et al.; the Resuscitation Outcomes Consortium Investigators
BMJ 2011;342:d512.

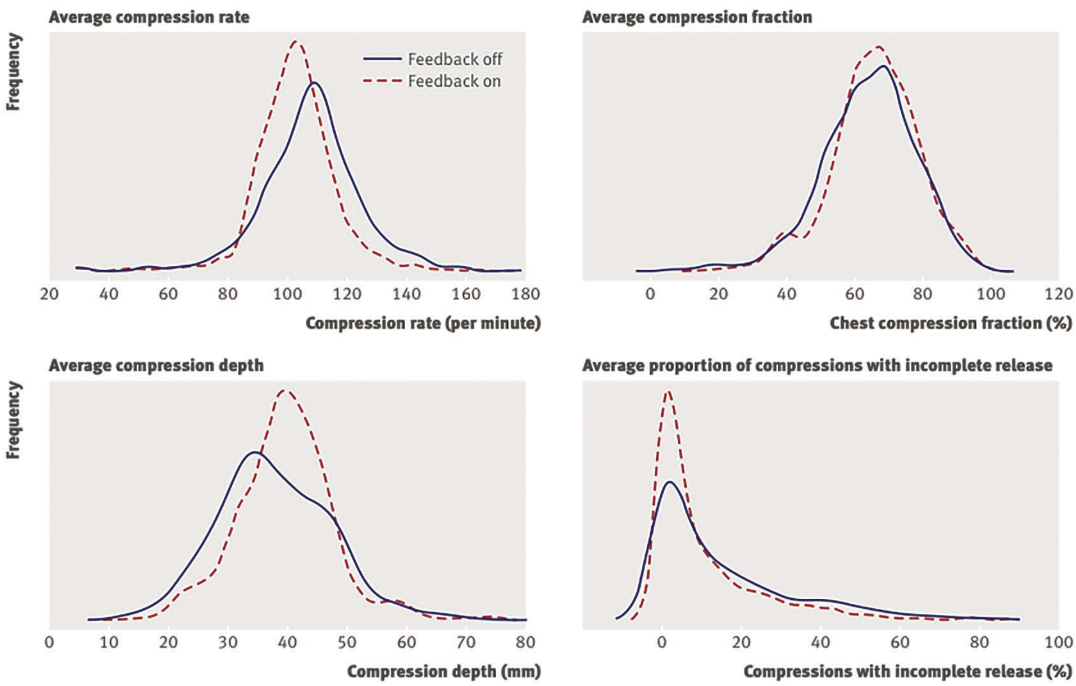
Keyword: Cardiac Arrest, EMS, Real-time audiovisual feedback, CPR performance, ROSC

Objective: To investigate whether real-time audio and visual feedback during CPR outside hospital increases the proportion of subjects who achieved pre-hospital return of spontaneous circulation.

Method: Data from 1586 people who suffered cardiac arrest outside hospital and received a resuscitation attempt from emergency medical services were analyzed. Rescuers in these cases either did (n = 815 cases) or did not (n = 771 cases) have real-time audiovisual feedback from the defibrillator. CPR quality and return of spontaneous circulation (ROSC) were measured.

Results: Feedback was associated with increased chest compression fraction (64% vs 66%, cluster-adjusted difference 1.9 [95% CI 0.4 to 3.4]), deeper compressions (38 vs 40 mm, adjusted difference 1.6 [CI 0.5 to 2.7]), and lower proportion of compressions with incomplete release (15% vs 10%, adjusted difference −3.4 [CI −5.2 to −1.5]). Frequency of ROSC did not differ (45% vs 44%, adjusted difference 0.1% [CI −4.4% to 4.6%]). Retrospective analysis showed poorer outcomes with feedback during early trials vs later ones.

Frequency Distributions of Rate, Fraction, and Depth of Compressions, and Proportion of Compressions with Incomplete Release



Conclusions: Real-time visual and audible feedback during CPR improved performance but did not affect ROSC. Results suggest that resuscitation performance become closer to established guidelines and more proficient at using feedback interfaces as experience accumulates.

Audiovisual feedback device use by health care professionals during CPR: A systematic review and meta-analysis of randomised and non-randomised trials

Shelley Kirkbright, Judith Finn, Hideo Tohirab,
Resuscitation 2014: 460 – 471

Keyword: Meta-analysis, Cardiac arrest, CPR, Feedback devices

Objectives: A systematic appraisal of the literature to determine if audiovisual feedback devices can improve CPR quality delivered by health care practitioners (HCPs) and/or survival outcomes following cardiac arrest.

Methods: The authors searched the Cochrane Central Register of Controlled Studies (CENTRAL) on The Cochrane Library, MEDLINE, EMBASE, CIHAHL and AUSTHEALTH in May 2013 for experimental and observational (human or manikin) studies examining the effect of the use of audiovisual feedback devices by HCPs in simulated and actual cardiac arrest. The primary outcome for human studies was survival to hospital discharge with good neurologic outcome. Secondary outcomes were other survival data and quality of CPR performance; the latter was also reported for manikin studies.

Results: Three human interventional studies (n = 2100) and 17 manikin studies met the inclusion criteria. Overall quality of included studies was poor, with significant clinical heterogeneity. All three human studies reported no significant change to any survival outcomes despite improvement in chest compression (CC) depth by 2.5 mm (95% CI 0.9–4.3), CC rate 6 min−1 closer to 100 (95% CI 2.4–10.7) and a reduction in no-flow fraction by 1.9% on meta-analysis. Manikin studies showed similar improvements in chest compression parameters.

Conclusion: In both manikin and human studies, feedback during resuscitation can result in rescuers pro-viding CC parameters closer to recommendations. There is no evidence that this translates into improved patient outcomes. The reason for this is not yet evident and further patient centered research is warranted.

Quality of Out-of-Hospital Cardiopulmonary Resuscitation with Real Time Automated Feedback: A Prospective Interventional Study

Jo Kramer-Johansen, Helge Myklebust, Lars Wik, et al.
Resuscitation 2006;71:283-92.

Keyword: Cardiac arrest, EMS, Real-time audio visual feedback, CPR quality, Survival

Objective: To compare quality of CPR during out-of-hospital cardiac arrest with and without automated feedback. The study was carried out by 3 European Ambulance Services at 3 European sites between March 2002 and October 2003 (baseline - without feedback) and between October 2003 to September 2004 (with feedback).

Method: Two hundred eighty-four consecutive resuscitation attempts for out-of-hospital cardiac arrest from all causes were included in the study. In 108 cases, defibrillators provided real time audio and visual feedback on the skills being performed; in the remaining 176 cases no feedback was provided. The primary outcome of interest was quality of CPR. Patient outcome, defined as survival to hospital admission, was also documented.

Results: Feedback was associated with increased compression depth (mean ± S.D.): 34 ± 9 vs 38±6mm (mean difference (95% CI) 4 (2, 6), P<0.001), and with a higher median percentage of compressions with adequate depth (24% to 53% (P < 0.001). Mean compression rates were also closer to guidelines in the feedback group: 121±18 vs 109±12 min−1; difference −12 (−16, −9), P=0.001. Average compression depth (per mm increase) was the only skill that independently predicted survival to admission.

Table 3 Performance of CPR in baseline and feedback groups

	Baseline (n = 176)	Feedback (n = 108)	Mean difference (95% CI)	P-value
No flow				
NFR	0.48 ± 0.18	0.44 ± 0.17	0.04 (−0.01, 0.08)	0.08
NFR_{adj}	0.39 ± 0.17	0.37 ± 0.16	0.02 (−0.02, 0.06)	0.3
Compressions				
Compressions (min^{-1})	64 ± 23	63 ± 21	1 (−4, 7)	0.5
Compression rate (min^{-1})	121 ± 18	109 ± 12	12 (9, 16)	<.001
Depth (mm)	34 ± 9	38 ± 6	−4 (−6, −2)	<.001
Depth 38–51 mm (%)	24 (19, 31)	53 (45, 57)		<.001
Too deep (>51 mm) (%)	0 (0, 1)	1 (0, 3)		0.01
Too shallow (<38 mm) (%)	71 (66, 78)	41 (30, 50)		<.001
Incomplete release (%)	0 (0, 1)	0 (0, 1)		0.08
Compression as part of duty cycle (%)	42 ± 4	41 ± 4	0 (−1, 1)	0.4
Ventilations (n = 163 and 98, respectively)				
Ventilations (min^{-1})	11 ± 4.8	11 ± 4.0	0 (−1, 1)	0.8

Values given as mean ± S.D. and differences as mean difference with 95% confidence interval (CI) and P-values for difference not equal to 0 from two-sided independent samples t-test, except for percentages of compressions with depth 38–51 mm, too deep, too shallow and with incomplete release which are given as median values with 95% CI and P-values of difference not equal to 0 with Mann–Whitney U-test.

Conclusion: Automated feedback improved measures of CPR quality, including compression depth. The data suggest that increased compression depth is associated with increased short-term survival.

Resuscitation Feedback and Targeted Education Improves Quality of Pre-Hospital Resuscitation in Scotland

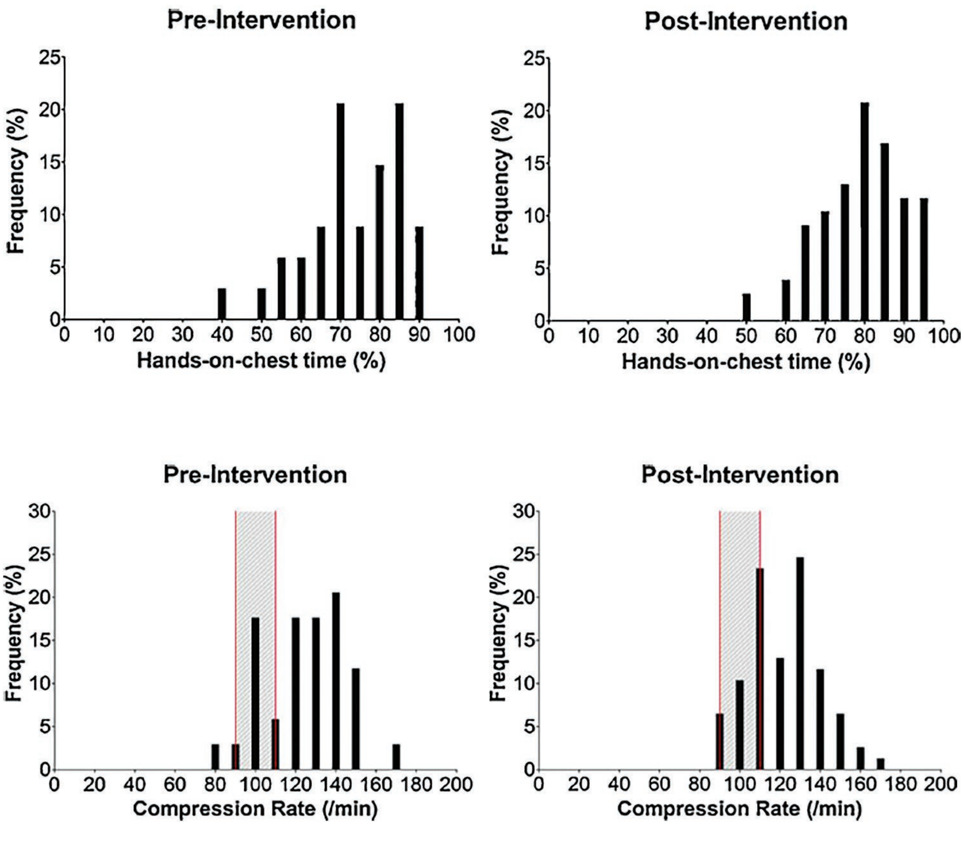
R.M. Lyon, S. Clarke, D. Milligan, and G.R. Clegg
Resuscitation 2012;83:70–5.

Keyword: Cardiac arrest, EMS, Post event feedback, CPR Quality

Objective: To analyze the effects of targeted CPR feedback and training on quality of pre-hospital resuscitation.

Method: Prospective, single-center, 13-month cohort study. Three months of baseline pre-hospital resuscitation data was collected. Following each resuscitation attempt, the event was sent via telemetry and the transthoracic impedance trace was analyzed. Outcome measures were time spent performing chest compressions, compression rate, the interval to shock, and use of automatic or manual cardiac rhythm analysis. Targeted resuscitation classes were held and feedback after a resuscitation attempt was provided. The quality of resuscitation pre- and post-intervention was compared.

Results: One hundred eleven resuscitation events were analyzed. Mean hands-on-chest time improved significantly after the intervention (73.0% vs 79.3%, P = 0.007). Compression rate did not change significantly. There was a reliable reduction in median time- to-shock interval from 20.25s (IQR 15.50–25.50s) to 13.45s (IQR 2.25–22.00s) (P = 0.006). Automatic rhythm recognition fell from 50% to 28.6% (P = 0.03) in the pre-post period.



Conclusion: Targeted resuscitation training and ambulance feedback improve the quality of pre-hospital resuscitation.

Real-Time Feedback Can Improve Infant Manikin Cardiopulmonary Resuscitation by up to 79% - A Randomized Controlled Trial

Philip Martin, Peter Theobald, Alison Kemp, et al.
Resuscitation 2013;84:1125-30.

Keyword: Simulated infant CPR, Real-time feedback, Chest compression quality.

Objective: To test the hypothesis that instantaneous feedback can improve the quality of chest compressions performed in simulated infant CPR.

Method: Sixty-nine certified CPR providers were randomly assigned to either a 'no-feedback' or 'feedback' group. The feedback group received automated real time feedback on three parameters of chest compression: depth (CD), rate (CR), and release force (RF). Participants performed two-thumb and two-finger chest compressions on an instrumented resuscitation manikin. Baseline skills were recorded for both groups, then CPR was performed again ("experimental phase"), this time with the feedback group receiving the intervention. Measures of chest compression quality were depth, release force, rate, and duty cycle.

Results: Baseline data aligned well with that of other studies: <1% of chest compressions met the target for the four quality measures. Participants' performance improved in response to feedback (all measures: P < 0.001). Feedback enabled providers to simultaneously achieve the four targets in 75% (two-finger) and 80% (two-thumb) of chest compressions.

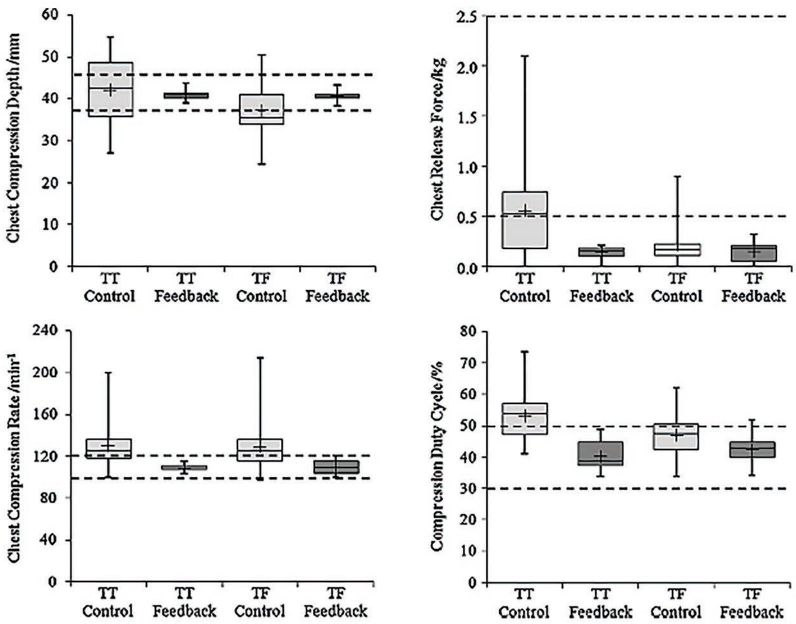


Fig. 4. Simulated chest compression quality measures, illustrated against evidence based quality targets, for both two-thumb (TT) and two-finger (TF) chest compressions, as performed by the feedback and control groups at the experimental stage. Chest compression quality targets are illustrated by dashed lines. Compression depth targets were 36.7-46mm, release force targets were <2.5 kg and <0.5 kg, compression rate targets were 100-120 min $^{-1}$ and duty cycle targets were 30-50%

Conclusions: Real-time feedback produced a dramatic increase in the quality of chest compressions. Feedback could support providers in consistently performing high-quality chest compressions during infant CPR, and thus potentially improve clinical outcomes.

New Visual Feedback Device Improves Performance of Chest Compressions by Professionals in Simulated Cardiac Arrest

Max Skorning, Stefan K. Beckers, Jörg Ch. Brokmann, et al.
Resuscitation 2010;81:53–8.

Keyword: Simulated cardiac arrest, Real-time feedback, Chest compression quality.

Objective: To evaluate a new visual feedback system designed to improve chest compressions among healthcare professionals.

Method: Ninety-three healthcare professionals volunteered (14 emergency medical technicians, 45 paramedics, 34 physicians; age 32 ± 7.2 (range 21–61); 72% male) in this randomized cross-over study. All subjects were tested on a CPR training manikin with a CPR visual |feedback device (CPRmeter, Laerdal Medical) in identical mock cardiac arrest scenario and asked to perform 2 min of continuous ECC (secured airway): Group A (n = 46): ECC with feedback device first, followed by ECC without feedback device a minimum of 45 min later; group B (n = 47): vice versa. Primary endpoints: mean compression rate 90–120 min−1 ; mean compression depth 38–51 mm. Data were analyzed using repeated measure logistic regression model for binary categorized endpoints and repeated measure ANOVA test for continuous endpoints.

Results: Correct compression depth was achieved by only 45.2% of subjects (95% CI: 30.5 to 64.9 mm) who did not use the feedback device vs 73.1% (95% CI: 40.3 to 57.4 mm) for those who did use the feed back device (P < 0.001). Similarly, correct compression rate was demonstrated by 62.4% (95% CI: 78 to 147.8 min−1) without feedback device vs 94.6% (95% CI: 87.3 to 126.6 min−1) with device (P < 0.001).

Table 2
Overall performance results with and without the feedback device.

	With feedback (n = 20025)		Without feedback (n = 21190)		p-Value
	n	%	n	%	
Correct compression depth	14086	70.3	9616	45.4	$p < 0.0001$
Too deep compressions	5541	27.7	8339	39.4	$p = 0.0452$
Too shallow compressions	398	2.0	3235	15.3	$p < 0.0001$
Compressions with inappropriate decompression	33	0.16	929	4.4	$p = 0.0075$
Correct compression depth > 80%	53	57.0	26	28.0	$p < 0.0001$
Too deep compressions > 20%	36	39.8	49	52.7	$p = 0.0349$
Too shallow compressions > 20%	2	2.0	17	18.3	(–)[a]
Inappropriate decompression >5%	0	0.0	12	12.9	(–)[a]
Correct compression rate	88	94.6	58	62.4	$p < 0.0001$
Faultless compressions[b] > 80%	50	53.8	22	23.7	$p < 0.0001$
Sufficient compressions[c] > 80%	48	51.6	17	18.3	$p < 0.0001$

Data are listed as n and as the percentage of each group.
[a] No statistical evaluation possible, at least one of the parameters was "0".
[b] Adequate compression depth and chest wall decompression.
[c] Adequate compression depth, decompression and rate.

Conclusion: The visual feedback device significantly improved compression rate and depth when used by healthcare professionals during simulated cardiac arrest.

First quantitative analysis of cardiopulmonary resuscitation quality during in-hospital cardiac arrests of young children

Robert M. Sutton, Dana Niles, Benjamin French, et. al.
Resuscitation 2014; 70 – 74

Keyword: Pediatric, CPR Quality, Audiovisual feedback, Survival

Objective: To evaluate the first time quantitatively the quality of CPR during the resuscitation of children under 8 years of age. The authors hypothesized that the CPR performed would often not achieve 2010 Pediatric Basic Life Support (BLS) Guidelines, but would improve with the addition of audiovisual feedback.

Methods: Prospective observational cohort evaluating CPR quality during chest compression (CC) events in children between 1 and 8 years of age. Defibrillators with quality CPR recording collected CPR data (rate (CC/min), depth (mm), CC fraction (CCF), leaning (% >2.5kg.)). The Audiovisual feedback was according to 2010 Guidelines in a subset of patients. The primary outcome, "excellent CPR" was defined as chest compression rate between 100 and 120 per min. Compression depth ≥50 mm, Chest Compression Fraction (CCF) >0.80, and <20% of chest compressions with leaning.

Results: 8 CC events resulted in 285 thirty second epochs of CPR (15,960 CCs). Percentage of epochs (periods) achieving targets was 54% (153/285) for rate, 19% (54/285) for depth, 88% (250/285) for CCF, 79% (226/285) for leaning, and 8% (24/285) for excellent CPR. The median percentage of periods per event achieving targets increased with audio visual feedback for rate [88(IQR:79,94) vs. 39 (IQR 18,62)%; p = 0.043] and excellent CPR [28 (IQR:7.2,52)vs. 0(IQR:0,1)%; p = 0.018].

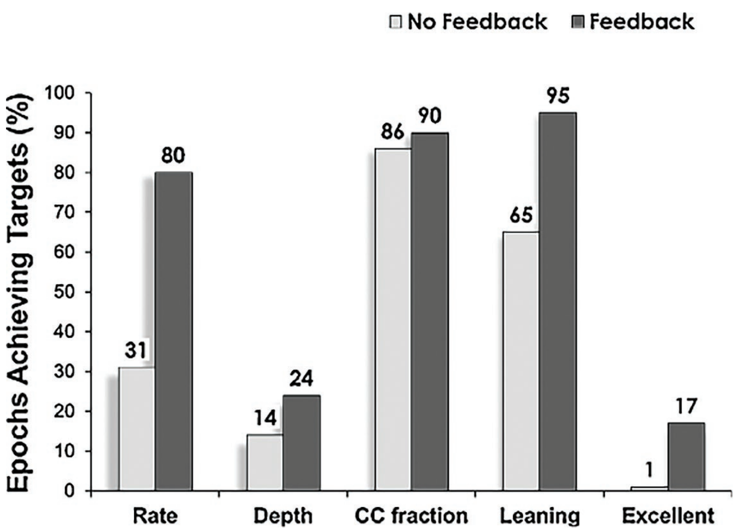


Fig. 3. Percentage of CPR epochs achieving targets for depth ≥50mm, rate ≥100 and ≤120 CC/min, CC fraction >0.80, and leaning <20% of compressions. Excellent indicates CPR having all 4 CPR elements achieving targets.

Conclusions: In-hospital pediatric CPR often does not meet 2010 Pediatric BLS Guidelines, but compliance is better when audiovisual feedback is provided to rescuers.

The use of CPR feedback/prompt devices during training and CPR performance: A systematic review

Joyce Yeung, Reylon Meeks, Dana Edelson, et al.
Resuscitation 2009;80:743-51.

Keyword: Meta-analysis, CPR feedback, CPR skill acquisition, retention

Objective: To perform a systematic review to determine whether the use of CPR feedback/prompt devices improves CPR skill acquisition, retention and real life performance with lay people and health care professionals when compared to using no devices.

Method: Four databases (Cochrane, MedLine, EmBASE, and PsycINFO) were searched systematically for papers that addressed the use of audio or visual feedback or prompts for improving CPR skill acquisition, training, or performance.

Results: Of the 509 papers identified, 33 were relevant and were classified according to their Level of Evidence (LOE; see Table 1). No LOE 1 or LOE 4 studies were found. All LOE 2 and LOE 3 studies and 20 of the 26 LOE 5 studies favored the use of feedback prompts. Eight studies showed improved compression depth and six showed improved compression rate. Six studies showed improved percentages of correct compressions. Only 11 studies investigated effects on ventilation but of these, 10 showed improved performance with feedback/prompt devices.

Conclusions: There is good evidence supporting the use of CPR feedback/prompt devices during CPR training to improve CPR skill acquisition and retention. Their use in clinical practice as part of an overall strategy to improve the quality of CPR may be beneficial.

Table 1
ILCOR levels of evidence for therapeutic interventions.

LOE 1: Randomised controlled trials (or meta-analyses of RCTs)
LOE 2: Studies using concurrent controls without true randomisation (e.g. "pseudo"-randomised) (or meta-analyses of such studies)
LOE 3: Studies using retrospective controls
LOE 4: Studies without a control group (e.g. case series)
LOE 5: Studies not directly related to the specific patient/population (e.g. different patient/population, animal models, mechanical models etc.)

Comparing three CPR feedback devices and standard BLS in a single rescuer scenario: A randomised simulation study

Bernhard Zapletal, Robert Greif, Dominik Stumpf, Franz Josef Nierscher, Sophie Frantal, Moritz Haugk, Kurt Ruetzler, Christoph Schlimp, Henrik Fischer.
Resuscitation 85 (2014) 560–566

Keywords: Cardiopulmonary resuscitation (CPR), Basic life support (BLS), Feedback device.

Background: Efficiently performed basic life support (BLS) after cardiac arrest is proven to be effective. However, cardiopulmonary resuscitation (CPR) is strenuous and rescuers' performance declines rapidly over time. Audio-visual feedback devices reporting CPR quality may prevent this decline. We aimed to investigate the effect of various CPR feedback devices on CPR quality.

Methods: In this open, prospective, randomized, controlled trial we compared three CPR feedback devices (PocketCPR®, CPRmeter®, iPhone app PocketCPR®) with standard BLS without feedback in a simulated scenario. 240 trained medical students performed single rescuer BLS on a manikin for 8 min. Effective compression (compressions with correct depth, pressure point and sufficient decompression) as well as compression rate, flow time fraction and ventilation parameters were compared between the four groups.

Results: Study participants using the PocketCPR® performed 17 ± 19% effective compressions compared to 32 ± 28% with CPRmeter®, 25 ± 27% with the iPhone app PocketCPR®, and 35 ± 30% applying standard BLS (PocketCPR® vs. CPRmeter® p = 0.007, PocketCPR® vs. standard BLS p = 0.001, others: ns). PocketCPR® and CPRmeter® prevented a decline in effective compression over time, but overall performance in the PocketCPR® group was considerably inferior to standard BLS. Compression depth and rate were within the range recommended in the guidelines in all groups.

Conclusion: While we found differences between the investigated CPR feedback devices, overall BLS quality was suboptimal in all groups. Surprisingly, effective compression was not improved by any CPR feedback device compared to standard BLS. All feedback devices caused substantial delay in starting CPR, which may worsen outcome. While we found differences between the investigated CPR feedback devices, overall BLS quality was suboptimal in all groups.

How feedback helps improve human performance

Although it is clear that High Quality CPR is a major factor for improving survival from cardiac arrest, there are considerable variations as to how this High Quality CPR is implemented in reality. As such, CPR quality varies considerably between personnel, systems and locations. Unfortunately, cardiac arrest patients frequently do not receive High Quality CPR because of a low training priority and/or other conflicting training issues. This variability in training and subsequent CPR performance can impede the development of improved systems of care which could help increase survival from cardiac arrest.

Systems with low dose, high frequency CPR training regimens (< 5min. per training session but performed > 2 times a month) have been shown to provide optimal chest compressions compared with those systems that train less frequently. In addition, the rescuers within those systems who have had the low dose, high frequency CPR training who have also had the addition of objective real time feedback, have been shown to develop more self-confidence when providing CPR during a 'real' cardiac arrest in a clinical setting.

List of abstracts in this section:

i. Diez, N, Rodriguez-Diez, M-C, Nagore, D, et al. (2013), Sim Healthcare; A Randomized Trial of Cardiopulmonary Resuscitation Training for Medical Students: Voice Advisory Mannequin Compared to Guidance Provided by an Instructor.

ii. Kardong-Edgren, S.E., Oermann, M.H., Odom-Maryon, T., Ha, Y. (2010), Resuscitation; Comparison of Two Instructional Modalities for Nursing Student CPR Skill Acquisition.

iii. Meaney, P.A. et. Al. (2013) Circulation; CPR Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital: A Consensus Statement From the American Heart Association.

iv. Mpotosa N, Weverb B.D, Cleymansc N, et.al. (2013) Resuscitation; Efficiency of short individualised CPR self-learning sessions with automated assessment and feedback.

v. Niles D., Sutton R.M., Donoghue A., Kalsi M.S., et.al. (2009) Resuscitation; "Rolling Refreshers": A novel approach to maintain CPR psychomotor skill competence.

vi. Perkins, G. D., Yeung J., Considined J. (2013) Editorial, Resuscitation; Improving Resuscitation Quality

vii. Sutton, R.M., Niles, D, Meaney, P.A., et al. (2011), Pediatr Crit Care Me; "Booster Training": Evaluation of Instructor-Led Bedside Cardiopulmonary Resuscitation Skill Training and Automated Corrective Feedback to Improve Cardiopulmonary Resuscitation Compliance of Pediatric Basic Life Support Providers During Simulated Cardiac Arrest.

Randomized Trial of Cardiopulmonary Resuscitation Training for Medical Students: Voice Advisory Mannequin Compared to Guidance Provided by an Instructor

Nieves Diez, Maria-Cristina Rodriguez-Diez, David Nagore, et al.
Simulation in Healthcare 2013; 234 - 241

Keyword: CPR Quality, Training, Audio feedback

Objective: To compare the quality of CPR training among second-year medical students trained with a voice advisory mannequin (VAM) versus instructor guidance.

Method: Forty-three students received a theoretical reminder about CPR followed by a 2-minute pretest on CPR (compressions/ventilations cycle) with Resusci Anne SkillReporter (Laerdal Medical). They were then randomized into a control group (n = 22), trained by an instructor for 4 minutes per student, and an intervention group (n = 21) trained individually with VAM CPR mannequin for 4 minutes. After training, the students performed a 2-minute posttest, with the same method as the pretest.

Results: Participants in the intervention group (VAM) performed more correct hand positions (73% vs. 37%; P = 0.014) and tended to display better compression rates (124/min vs 135/min; P = 0.089). Women trained with VAM improved significantly in compression depth (36 mm vs 46 mm, P = 0.018) and in percentage of insufficient compressions (56% vs 15%; P = 0.021).

TABLE 2. Resusci Anne SkillReporter Intragroup Differences Pretraining and Posttraining

	Control Group (Instructor)			Intervention Group (VAM)		
n	22			20		
Female, n (%)	15 (68)			12 (60)		
	Pretraining	Posttraining	P*	Pretraining	Posttraining	P*
Total compressions, mean (SD)	187 (44)	170 (22)	0.042	177 (28)	150 (23)	0.001
Compression rate per minute, mean (SD)	140 (27)	135 (15)	0.270	132 (22)	124 (18)	0.023
Compression depth, mean (SD), mm	40 (12)	42 (8)	0.464	39 (10)	47 (7)	0.003
Average number of compression depth						
Correct, mean number (SD) [%]	82 (72) [44]	89 (55) [52]	0.538	74 (61) [42]	94 (53) [61]	0.225
Excessive, mean number (SD) [%]	44 (71) [22]	32 (47) [18]	0.196	28 (48) [16]	39 (53) [28]	0.139
Insufficient, mean number (SD) [%]	61 (80) [33]	49 (62) [30]	0.198	75 (79) [42]	17 (24) [10]	0.002
Average number of correct hand position, mean number (SD)[%]	104 (78) [58]	62 (70) [37]	0.038	77 (83) [41]	109 (58) [73]	0.126
Incomplete release, number [%]	4 [18]	3 [14]	0.317	1 [5]	2 [10]	0.564

*χ^2 test for categorical variables (Fisher exact test when values <5) and Mann-Whitney U test for continuous variables.

Conclusions: In comparison to the traditional instructor-led training method, training medical students with VAM improves the quality of chest compressions by improving hand position and compression rate applied to mannequins. Among women, VAM was also superior for compression depth training. This technology reduces costs by 14% in the present setup and may have the potential to release instructors' time for other activities.

Comparison of two instructional modalities for nursing student CPR skill acquisition

Suzan E. Kardong-Edgren, Marilyn H. Oermann, Tamara Odom-Maryon, and Yeongmi Ha
Resuscitation 2010;81:1019–24.

Keyword: CPR Quality, Training, Audio feedback

Objective: To compare performance of compressions, ventilations with bag-valve-mask (BVM), and single rescuer CPR associated with a computer-based course (HeartCode™ BLS) with voice advisory manikin (VAM) feedback versus an instructor-led (IL) course without manikin feedback.

Method: Nursing students (n = 604) were randomized to receive either the computer-based course or the IL course. After the course, students' performance of 3 min each of compressions; ventilations with BVM; and single rescuer CPR was recorded. Measures of primary interest were: (1) compression rate, (2) percentage of compressions with adequate depth, (3) percentage of compressions with correct hand placement, (4) ventilation rate, and (5) percentage of ventilations with adequate volume.

Results: The groups did not differ in compression rates. Students who practiced with VAM feedback had higher percentages of compressions of adequate depth and correct hand placement and higher percentages of ventilations with adequate volume. During the single rescuer CPR, students who had the VAM feedback had more compressions with adequate depth and more ventilations with adequate volume than students with IL training.

Table 2
Three group compression data: HeartCode vs. instructor-led with manikins A and B.

Measure	Mean	SD	p	HC vs. Manikin A, p	HC vs. Manikin B, p	Manikins A vs. B, p
Compressions rate (min)						
HC	104	9	0.44	0.96	0.69	0.91
IL Manikin A	108	19				
Il Manikin B	111	18				
Compressions depth (mm)						
HC	37.7	6.7	0.05	0.95	0.002	0.04
IL Manikin A	37.4	9.3				
IL Manikin B	31.8	10.9				
Percentage of compressions with adequate depth						
HC	52.8	35.1	p.0002	0.13	<0.0001	0.04
IL Manikin A	40.3	36.0				
Il Manikin B	25.2	32.2				
Percentage of compressions with correct hand placement						
HC	92.0	21.3	0.002	0.04	0.001	0.96
IL Manikin A	85.3	31.0				
Il Manikin B	83.1	31.6				

HC, HeartCode; IL, instructor-led; Manikin A, Resusci® Anne; Manikin B, hard molded. HC, $n = 258$; IL with Manikin A, $n = 108$; IL with Manikin B, $n = 229$. Unadjusted p values reported. Participants performed 3 min each of compressions, ventilations with BVM, and single rescuer CPR.

Conclusion: The evidence supports the use of HeartCode BLS with VAM for training nursing students in CPR. They performed more compressions with adequate depth, used proper hand placement, and provided more ventilations with adequate volume than students who had instructor lead training.

CPR Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital - A Consensus Statement From the American Heart Association

Peter A. Meaney, Chair; Bentley J. Bobrow, Co-Chair, Mary E. Mancini, Jim Christenson, Allan R. de Caen, Farhan Bhanji, Benjamin S. Abella, Monica E. Kleinman, Dana P. Edelson, Robert A. Berg, Tom P. Aufderheide, Venu Menon, Marion Leary, on behalf of the CPR Quality Summit Investigators, the American Heart Association Emergency Cardiovascular Care Committee, and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation.
Circulation. 2013;128:00-00.

Keywords: AHA Scientific Statements, Cardiac arrest, CPR, CPR quality, Outcomes, Resuscitation

Abstract: The "2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" increased the focus on methods to ensure that high-quality cardiopulmonary resuscitation (CPR) is performed in all resuscitation attempts. There are 5 critical components of high-quality CPR: (1) minimize interruptions in chest compressions, provide compressions of adequate (2) rate and (3) depth, (4) avoid leaning between compressions, and (5) avoid excessive ventilation.

Although it is clear that high-quality CPR is the primary component in influencing survival from cardiac arrest, there is considerable variation in monitoring, implementation, and quality improvement. As such, CPR quality varies widely between systems and locations. Victims often do not receive high-quality CPR because of provider ambiguity in prioritization of resuscitative efforts during an arrest. This ambiguity also impedes the development of optimal systems of care to increase survival from cardiac arrest. This consensus statement addresses the following key areas of CPR quality for the trained rescuer: metrics of CPR performance; monitoring, feedback, and integration of the patient's response to CPR; team-level logistics to ensure performance of high-quality CPR; and continuous quality improvement on provider, team, and systems levels. Clear definitions of metrics and methods to consistently deliver and improve the quality of CPR will narrow the gap between resuscitation science and the victims, both in and out of the hospital, and lay the foundation for further improvements in the future.

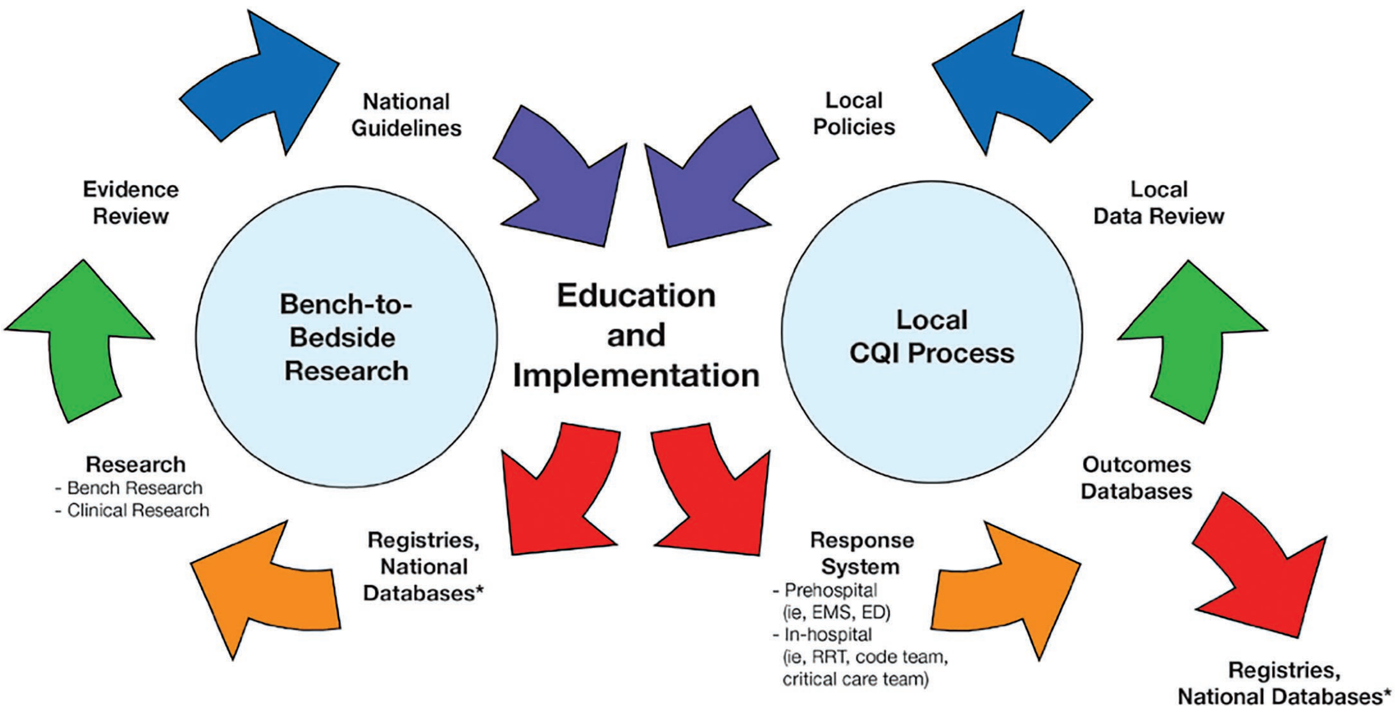


Figure 2. A continuous process evaluates and improves clinical care and generates new guidelines and therapy. Outcome data from cardiac arrest and periarrest periods are reviewed in a continuous quality-improvement (CQI) process. Research and clinical initiatives are reviewed periodically in an evidence-based process. Experts then evaluate new therapy and make clinical and educational recommendations for patient care. The process is repeated, and continual progress and care improvements are generated. ED indicates emergency department; EMS, emergency medical services; and RRT, rapid response team. *This is an overlap point in the cycle. That is, data come from outcomes databases (shown on the right) and go into registries and national databases (shown on the left).

Efficiency of short individualised CPR self-learning sessions with automated assessment and feedback

Nicolas Mpotosa, Bram De Weverb, Nick Cleymansc, et.al.
Resuscitation 2013; 84; 1267– 1273

Keywords: Assessment, Basic life support, CPR, Feedback, Retention Self-learning

Introduction: Regular assessments are recommended to identify individuals requiring additional resuscitation training. We developed a strategy of short CPR self-learning sessions followed by automated assessment with feedback and investigated its efficiency to achieve a pre-defined level of compression skills.

Methods: 404 students in pharmacy and educational sciences participated. Initial training (max. 40 min) consisted of a 15 min learning-while-watching video followed by manikin exercises with computer voice feedback. At baseline and after training, performance was measured using an automated test. To be judged competent participants had to achieve ≥70% compressions with depth ≥50 mm and ≥70% compressions with complete release (<5 mm) and a compression rate between 100 and 120 min−1 within a two month period. Automated feedback was provided and failed participants had to retrain within two weeks. Retraining (max. 20 min and max. three times) was done with voice feedback exercises. Before retraining, the previous test result was displayed together with feed forward. After five months all participants were invited for a retention test.

Results: After one to four sessions, 99% (401/404) of all participants achieved competency. After five months 48% (137/288) of the students participating in the retention test was still competent. The percentage competent participants was 80% (230/288) for compression depth, 97% (279/288) for complete release and 60% (172/288) for mean rate.

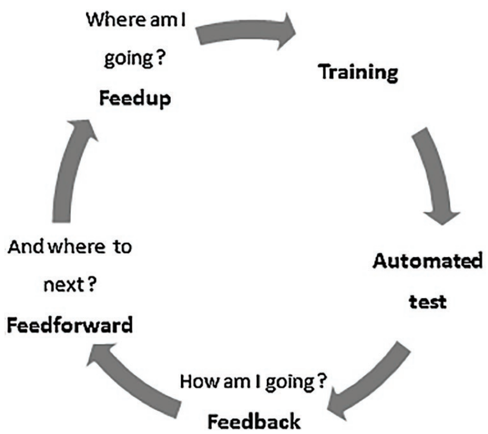


Fig. 1. Individual learning cycle incorporating feedup, training, automated testing and feedback / feedforward.

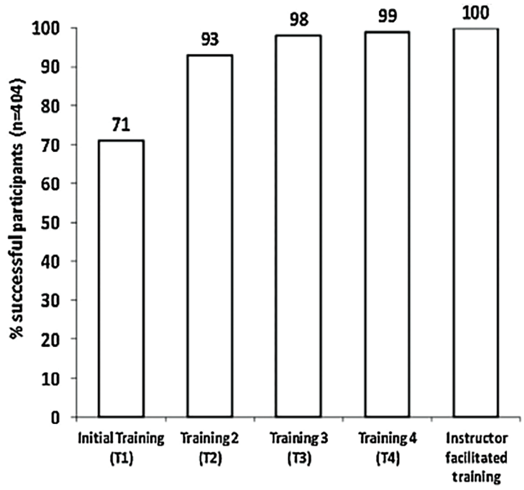


Fig. 3. Success rates after initial training (T1), retraining (T2, T3, T4) and instructor facilitated training.

Conclusions: One or multiple short self-learning sessions were highly efficient to successfully train 99% of participants. After five months, retention of compression depth and complete release was very high. However, only 48% still achieved a 70% combined score for compression skills, highlighting the importance of regular assessment and retraining.

Rolling Refreshers":A novel approach to maintain CPR psychomotor skill competence

Dana Niles, Robert M. Sutton, Aaron Donoghue, Mandip S. Kalsi, et.al.
Resuscitation 2009; 80; 909 – 912

Keywords: Cardiopulmonary resuscitation (CPR), Cardiac arrest, Children, Pediatric, BLS training, Psychomotor skills

Objectives: High quality CPR skill retention is poor. The authors hypothesized that "just-in-time" and "just-in-place" training programs would be effective and well accepted to maintain CPR skills among Pediatric Intensive Care Unit (PICU) staff.

Methods: The "Rolling Refreshers", a portable manikin / defibrillator system with chest compression sensor providing automated corrective feedback to optimize CPR skills, were conducted daily in the PICU with multidisciplinary healthcare providers. Providers practiced CPR until skill success was attained, prospectively defined as <3 corrective prompts within 30 s targeting chest compression (CC) rate 90–120/min, CC depth >38mm during continuous CPR. Providers completing ≥2 refreshers / month (Frequent Refreshers [FR]) were compared to providers completing <2 refreshers / month (Infrequent Refreshers [IR]) for time to achieve CPR skill success. Univariate analysis performed using non-parametric methods. Following actual cardiac arrests, CPR providers were surveyed for subjective feedback on training approach efficacy (5-point Likert scale; 1 = poor to 5 = excellent).

Results: Over 15 weeks, 420 PICU staff were "refreshed": 340 nurses, 34 physicians, 46 respiratory therapists. A consecutive sample of 20 PICU staff was assessed before subsequent refresher sessions (FREQ n = 10, INFREQ n = 10). Time to achieve CPR skill success was significantly less in FREQ (median 21 s, IQR: 15.75–30 s) than in INFREQ (median 67 s, IQR: 41.5–84 s; $p < 0.001$). Following actual resuscitations, CPR providers (n = 9) rated "Rolling Refresher" training as effective (mean = 4.2; Likert scale 1–5; standard deviation 0.67).

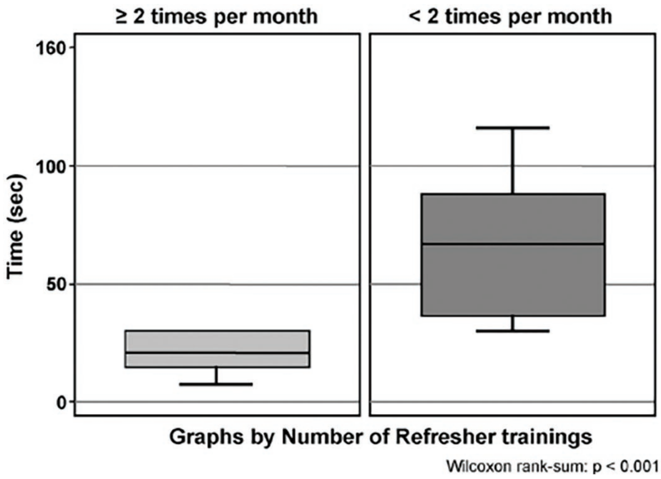


Figure 1. "Rolling Refresher" cart outside patient room.

Conclusions: A novel "Rolling Refresher" CPR skill training approach using "just-in-time" and "just-in-place" simulation is effective and well received by PICU staff. More frequent refreshers resulted in significantly shorter times to achieve proficient CPR skills.

Improving Resuscitation Quality

Perkins G. D., Yeung J., Considine J.
Resuscitation 2013;84;1295–1296 Editorial

Keyword: The European Restart a Heart Day, High quality CPR, Evidence based, Culture of quality improvement

Five decades on from the first descriptions of cardiopulmonary resuscitation (CPR) many hundreds of thousands of lives have undoubtedly been saved through widespread adoption of CPR. However for every individual life saved between six and fifty other cardiac arrest victims do not survive. The Declaration of the European Parliament of 14 June 2012 to establish a European cardiac arrest awareness week set forth the challenge to improve the awareness and education of the general public, physicians and health-care professionals about CPR.

The pathway for improving resuscitation quality revolves around enhancing resuscitation science, effective implementation and engendering a culture of quality improvement that strives for excellence.

The key elements of high quality CPR are chest compression with depths of 5–6 cm, rate of 100–120 min. and full release between compressions. Hyperventilation should be avoided and interruptions in chest compressions should be kept to a minimum. The delivery of high quality CPR provides patients with the best chance of a survival.

CPR feedback and prompt technologies are important tools for implementing the best science into clinical practice. There is good evidence that the use of these technologies are invaluable in optimizing performance during CPR training. Post cardiac arrest event debriefing can be a powerful tool for optimizing individual and team performance.

Embedding a culture of quality improvement based on measuring outcome at the system level provides the best route to deliver sustained improvements in outcomes.

“Booster” Training: Evaluation of Instructor-Led Bedside Cardiopulmonary Resuscitation Skill Training and Automated Corrective Feedback to Improve Cardiopulmonary Resuscitation Compliance of Pediatric Basic Life Support Providers During Simulated Cardiac Arrest

Robert M. Sutton, Dana Niles, Peter A. Meaney, MD, et al.
Pediatr Crit Care Med 2011;12:e116-21.

Keywords: Pediatric, CPR, Quality appraisal

Objective: To investigate the effectiveness of brief bedside “booster” training to improve quality of CPR among hospital-based pediatric providers.

Method: CPR recording/feedback defibrillators were used to evaluate CPR quality demonstrated by 69 hospital-based BLS-certified providers during simulated pediatric arrest. Participants received a 60-sec pre-training CPR evaluation, then were randomly assigned to one of three instructional/feedback methods for the 2-min CPR booster training sessions: 1) instructor- only training; 2) automated defibrillator feedback only; and 3) instructor training combined with automated feedback. Measures of primary interest were percentage of providers who performed CPR skills within guidelines.

Results: At baseline, 57% of participants performed compressions within guideline rate recommendations (rate >90 min and <120 min); 71% met minimum depth targets (depth, >38 mm); and 36% met overall CPR compliance (rate and depth within targets). After booster training, guideline compliance improved (instructor-only training: rate 52% to 87% [P = .01], and overall CPR compliance, 43% to 78% [P < .02]; automated feedback only: rate, 70% to 96% [P = .02], depth, 61% to 100% [p < .01], and overall CPR compliance, 35% to 96% [p < .01]; and instructor training combined with automated feedback: rate 48% to 100% [p < .01], depth, 78% to 100% [p < .02], and overall CPR compliance, 30% to 100% [p < .01]).

Table 3. Compliance with cardiopulmonary resuscitation guideline recommendations

	Guideline Rate ($\geq$90 mins^{-1} and $\leq$120 mins^{-1})			Guideline Depth ($\geq$38 mm)			Guideline CPR (Both)		
	Proportion			Proportion			Proportion		
	Before	After	*p*	Before	After	*p*	Before	After	*p*
Instructor-only training	52	87	.01	74	87	.26	43	78	<.02
Automated feedback only	70	96	.02	61	100	<.01	35	96	<.01
Instructor training combined with automated feedback	48	100	<.01	78	100	<.02	30	100	<.01

CPR, cardiopulmonary resuscitation.

Conclusions: Before booster CPR instruction, most certified Pediatric Basic Life Support providers did not perform guideline-compliant CPR. After a brief bedside training, CPR quality improved with both instructor and automated feedback; however, learners who received automated feedback delivered higher-quality CPR.

Sutton, R. M., French, B., Niles, D. E., Donoghue, A., Topjian, A. A., Nishisaki, A., Leffelman, J., Wolfe, H., Berg, R. A., Nadkarni V. M., Meaney, P. A. (2014) Resuscitation “2010 American Heart Association recommended compression depths during pediatric in-hospital resuscitations are associated with survival”

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The complete list of abstracts included in this collection

Why Quality CPR has an Impact on Survival

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xviii. Sutton, R. M., French, B., Niles, D. E., Donoghue, A., Topjian, A. A., Nishisaki, A., Leffelman, J., Wolfe, H., Berg, R. A., Nadkarni V. M., Meaney, P. A. (2014) Resuscitation "2010 American Heart Association recommended compression depths during pediatric in-hospital resuscitations are associated with survival"

How Feedback improves CPR Quality

xiv. Buléon, J. Parienti, J-J, Halbout, L., et. al.(2013) AJEM; Improvement in chest compression quality using feedback device (CPRmeter):a simulation randomized crossover study

xv. Cason, C.L., Trowbridge, C., Baxley, S.M., & Ricard, M.D. (2011), BMC Nursing; A Counterbalanced Cross-Over Study of the Effects of Visual, Auditory and No Feedback on Performance Measures in a Simulated Cardiopulmonary Resuscitation.

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xvii. Edelson, D.P., Litzinger, B., Arora, V. (2008), Archives of Internal Medicine; Improving In-Hospital Cardiac Arrest Process and Outcomes With Performance Debriefing.

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xxvi. Zapletala B., Greifb R., Stumpfc D., (2013) Resuscitation; Comparing three CPR feedback devices and standard BLS in a single rescuer scenario: A randomized simulation study.

How feedback helps improve human performance

viii. Diez, N, Rodriguez-Diez, M-C, Nagore, D, et al. (2013), Sim Healthcare; A Randomized Trial of Cardiopulmonary Resuscitation Training for Medical Students: Voice Advisory Mannequin Compared to Guidance Provided by an Instructor.

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What is QCPR™ Technology?

Over the past 10 years, a substantial body of research has highlighted the value of High Quality CPR as illustrated by the scientific evidence in this publication.

QCPR™ is a technology platform developed by Laerdal Medical to assist rescuers with providing guidelines-quality CPR during training and real-life emergencies. The technology was developed in co-operation with Key Opinion Leaders from leading research centers who share our commitment to help improve survival from sudden cardiac arrest.

QCPR™ technology encompasses the 5 critical components in High Quality CPR:

1. Minimize Interruptions
2. Compress fast (100 – 120 per min.)
3. Compress deep (at least 50 mm.)
4. Avoid leaning
5. Avoid excessive ventilation

QCPR™ technology allows objective measurement, assessment and guiding feedback in training and therapy. On site audible prompts and / or visual cues for the rescuer dependent on the QCPR™ application. In addition objective performance data for debriefing post training or therapy

QCPR™ technology was involved in field research from early 2000s and in 2005 introduced with HeartStart MRx from Philips Healthcare. Later have other applications using the QCPR™ technology been developed and introduced for training and therapy use.

QCPR™ technology feedback is based on recognized international guidelines for CPR.

For more information on QCPR, visit www.laerdal.com

Notes:

Laerdal
helping save lives