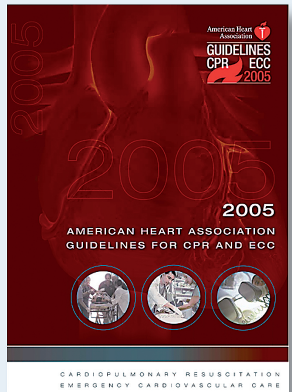
The Concept of Q-CPR

THE NEED FOR QUALITY CPR

"Push hard, push fast, allow full chest recoil after each compression, and minimise interruptions in chest compressions."[1]

Victims of cardiac arrest need immediate CPR. This provides a small but critical blood flow to the heart and brain. It also increases the likelihood that a defibrillatory shock will terminate VF and enable the heart to resume an effective rhythm and effective systemic perfusion. Chest compression is especially important if a shock cannot be delivered sooner than 4 or 5 min after collapse.[2]

Available at www.erc.edu



Available at www.c2005.org

Needs

Deeper chest compressions increase shock success.

The quality of CPR prior to defibrillation directly affects clinical outcomes.
Specifically, longer pre-shock pauses and shallow chest compressions are associated with defibrillation failure.[3]

Sudden Cardiac Arrest patients need tailored CPR.

Objective measurements of CPR quality during actual cardiac arrest have found that longer pre-shock pauses and shallow chest compressions are significantly correlated with decreased shock success. The opportunity to improve the quality of CPR in clinical practice is now practically available and may significantly improve resuscitation success. Approaches to minimise (or eliminate) pre-shock pauses and optimise compression depth should be made.[3]

Feedback improves the quality of CPR.

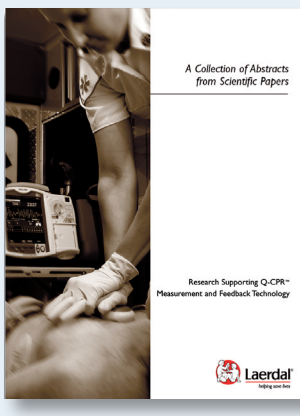
In a recent study[4], the results indicated that the percentage of compressions with adequate depth increased from 24% to 53% a 120% improvement with use of Measurement and Feedback technology. Automatic feedback improved CPR quality correlating to better better outcomes and higher probability of survival.

Response

Q-CPR offers measurement feedback and coaching within the recommended Guidelines

The Reusci Anne skills station is educationally effective by focusing on the core skills for BLS training. With the integrated Q-CPR Measurement and Feedback Technology trainees are guided with real-time CPR voice feedback according to 2005 AHA/ERC Guidelines for Resuscitation

Q-CPR offers measurement and guiding feedback on:
1 Compression depth, rate and leaning
2 Ventilation frequency, time and volume
3 CPR interruptions (hands-off time)



"A Collection of Abstracts from Scientific Papers" Containing important abstracts from recent years research supporting the Q-CPR Measurement and Feedback Technology. Available at www.laerdal.com

Reference:
1. AHA Guidelines 2005
2. ERC Guidelines 2005
3. Dana P. Edelson et. al.: Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest. Resuscitation (2006) 71, 137 – 145)
4. Jo Kramer-Johansen: Quality of out-of-hospital cardiopulmonary resuscitation with real time automated feedback Resuscitation (2006) 71, 283 – 292

QUALITY CPR RESEARCH

Research supporting Resusci Anne Skills Station with Measurement and Feedback Technology (Q-CPR)

Please, consider the following:

- Research demonstrates that the quality of cardiopulmonary resuscitation (CPR) has a direct effect on patient outcome from cardiac arrest.
- Research also indicates caregivers, on the whole, do not perform CPR within established guidelines associated with compression rate and depth, duration of no compression activity (or "hands-off" time), and ventilation rate.

These statements relate directly to the need to establish a higher level of CPR quality and to embrace appropriate tools and techniques to achieve that level. The Resusci Anne Skills Station with Q-CPR represent one such improvement option.

In this chapter we share what we believe is important science that points us all in a direction that can significantly improve survival from cardiac arrest. We believe that evidence and education are the motivation for change and hope that these abstracts serves to be of value for you, our customers and partners.

We hope that you will find this collection of abstracts helpful in better understanding the importance of CPR quality. The abstracts is not a comprehensive review of the literature, but rather represents significant clinical works that we believe show the promise of Q-CPR. It is important to note that these abstracts are "our" interpretation of the literature. We have taken every effort to fairly and accurately represent the research without commercial bias. We encourage you to read the specific papers if interested.

SP7024 rev A
Chapter 6

An Automated Voice Advisory Manikin System for Training in Basic Life Support Without an Instructor. A Novel Approach to CPR Training

Wik, L.; Thowsen, J.; Steen, P.A.
Resuscitation, 2001, 50, pp. 167-172

Objective: To test if an automatic Voice Advisory Manikin (VAM) with a CPR feedback system can be used to improve the basic CPR quality of paramedic students.

Methods: 24 paramedic students were tested. The students were divided into two groups, 12 in each group. Group 1 performed CPR on a manikin for 3 minutes, without any feedback, followed by 3 minutes of CPR with feedback (after a 2 minute pause). Group 2 performed the two 3-minute periods in the reverse order. For both groups all ventilation and chest compressions were continuously recorded and were evaluated according to the European Resuscitation Council and the American Heart Association guidelines for CPR.

Results: For group 1 (Figure 1), with feedback in 2nd 3-minute round of CPR, correct inflations increased from 2% to 64% and the percentage of inflations too fast decreased from 94% to 25%. Correct depth of chest compressions increased from 32% to 92%.

Fig1: Improved CPR w/ Feedback

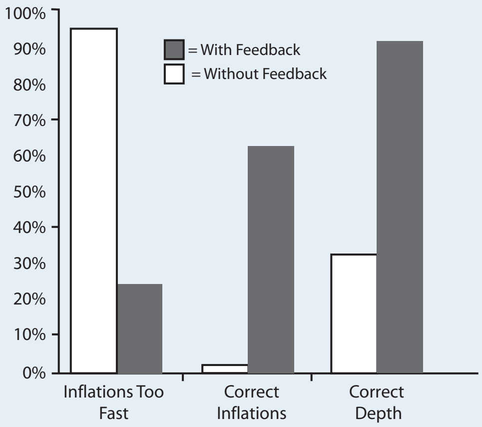
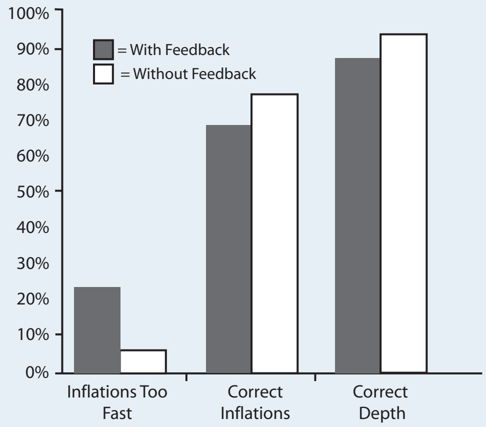


Fig2: Improved Retention w/Feedback



For group 2 (Figure 2), with feedback in the 1st 3-minute round of CPR, the percentage of correct inflations and percentage of correct chest compression depth all improved during the first 3 minute CPR with feedback. In the second period, without feedback, there was no significant change in correct inflations. However, there was a deterioration tendency between the first and second period, and the percentage of correct compressions did not change during this period.

Conclusion: Feedback can (almost immediately) improve the basic CPR skills performance of paramedic students. In addition, when students begin with feedback, they attain a high level of performance and maintain that high level even when feedback is taken away.

The voice advisory manikin (VAM): An innovative approach to pediatric lay provider basic life support skill education

Sutton RM, et al., Resuscitation, 2007

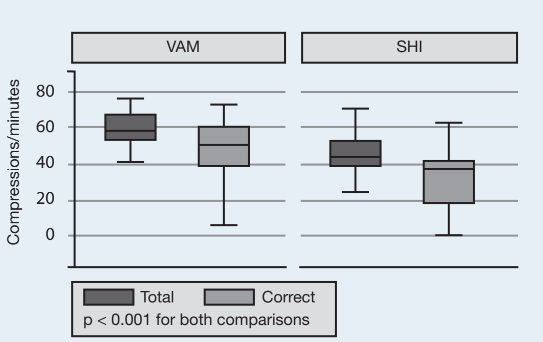
Objective: To determine the efficacy of real-time, corrective and standardized audio feedback training supplied by the voice advisory manikin (VAM) versus high quality standardized instructor feedback training for the initial acquisition of 1-rescuer lay provider pediatric BLS skills.

Method: Fifty lay care BLS providers of hospitalized children 8-18 years of age at the Children's Hospital of Philadelphia were divided into two groups of training one rescuer pediatric BLS skills: VAM (23 persons) and standardized human instructions (27 persons).

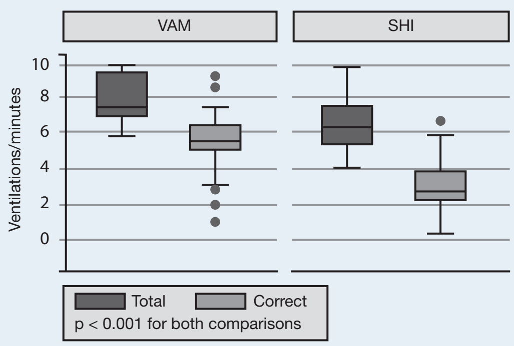
The two groups received 10 minutes of identical CPR introduction and 20 minutes of manikin practice time. The standardized human instructor group received individualized BLS instructor feedback on the delivery of their psychomotor skills – without voice advisory computer feedback. The VAM group had 20 minutes of training with voice advisory feedback.

After the introduction and training, the two groups' quantitative psychomotor skill data was recorded during 3 minutes of CPR testing epochs – without voice advisory computer feedback. The primary outcome measure was CPR psychomotor skill success attainment, defined as 70% correct compressions and ventilations delivery. The persons who did not pass the primary outcome measure received 5 minutes retraining and were then retested. The testing was handled by a modified Resusci Junior manikin (Laerdal Medical, Stavanger, Norway).

Results: Shown in the two graphs below, the VAM trainees delivered more total compressions per minute (58,7 ± 7,9 versus 47,6 ± 10,5), more correct compressions per minute (47,9 ± 15,7 versus 31,2 ± 16,0), more correct total ventilations per minute (7,8 ± 1,2 versus 6,4 ± 1,4), and correct ventilations per minute (5,4 ± 1,9 versus 3,1 ± 1,6).



Total and correct chest compressions delivered per minute (median with interquartile ranges)



Total and correct ventilations delivered per minute (median with interquartile ranges)

The Concept of Q-CPR

More VAM trainees (12/23, 52%) than standardized human instructor training (1/26, 4%) met the primary outcome measure (70% correct compressions and ventilations delivery) after the first 3 minute test. After retraining and retesting, VAM group had 65% (15/23) passing the primary outcome and the human training group 27% (7/26) correct.

Conclusion: The authors conclude: "The study demonstrated that voice advisory manikin system can improve the initial skill acquisition of one-rescuer pediatric basic life support skills in lay providers through immediate, corrective audio feedback when compared to high quality individualized human instruction. The mechanism of improved CPR skill competence appears to be related to faster acquisition of skills proficiency."

The Three-Phase Model of Cardiac Arrest as Applied to Ventricular Fibrillation in a Large, Urban Emergency Medical Services System

Vilke, G.M.; Chan, T.C.; Dunford, J.V.; Metz, M.; Ochs, G.; Smith, A.; Fisher, R.; Poste, J.C.; McCallum-Brown, L.; Davis, D.P.
Resuscitation, 2005, No. 64, pp. 341-346

Objective: To study the relationship between time since cardiac arrest collapse, and performance of bystander CPR and survival.

Methods: Data records for 1,141 non-traumatic cardiac arrest victims were studied.

Results: The table presents the percentage survival of cardiac arrest victims with and without performance of bystander CPR prior to EMS arrival.

Percentage Survival With and Without Bystander CPR

		Survival (%)	
Time since collapse	*Number of Patients*	*CPR*	*No CPR*
Less than 4 minutes	18	40.0	38.5
4 minutes or greater	254	17.3	0
4-10 minutes	46	26.7	0
Greater than 10 minutes	37	0	0
Unknown	171	18.9	0

With no bystander CPR delivered, no patients survived when time since collapse exceeded 4 minutes. The survival rate was 26.7% for patients receiving bystander CPR within 4-10 minutes. Patients in the "unknown" category all had response times greater than 4 minutes. Hence, these data were included in the "4 minutes or greater" category. No patients with time since collapse greater than 10 minutes survived.

Conclusion: For patients with time since cardiac arrest of more than 4 minutes, the performance of bystander CPR, prior to EMS arrival, increased the chance of successful resuscitation and long-term survival. For patients with time since cardiac arrest less than 4 minutes there was no survival advantage to bystander CPR versus no CPR.

Efficacy of Bystander CPR: Intervention by Lay People and by Healthcare Professionals

Herlitz, J.; Svensson, L.; Holmberg, S.; Ängquist, K, Young, M.
Resuscitation, 2005, pp. 291-295

Objective: To evaluate the impact on survival of no bystander CPR, lay bystander CPR and professional bystander CPR. The study is a follow up to the year 2000 study with a detailed description of the patient outcome considering whether the bystander was a lay person or a professional.

Method: The study is based on the Swedish Cardiac Arrest Registry and covers the period 1990-2002. A total of 29711 patients with out-of-hospital cardiac arrest who were given CPR and were not witnessed by the ambulance crew were included and studied.

Results: 36 % of the patients received bystander CPR. Of these, 72% was initiated by lay persons and 28% by professionals. As shown in the table below patients who received CPR from lay persons were hospitalized alive more frequently than patients that did not receive bystander CPR. Moreover, patients who received bystander CPR from professionals were hospitalized alive more frequently than the patients who received lay person bystander CPR.

Characteristics and Result in Relation to Type of Bystander Among All Patients

Bystander CPR Performance	No B-CPR	Lay Person CPR	Professional CPR
Bystander Witnessed	58	73	78
Place: At Home	72	60	32
Initial Rhythm	27	38	44
Interval Between: Call for and Arrival of EMS (Median; min.)	6	8	6
Hospitalized Alive	12.8	16.1	22.9
Alive at 1 Month	2.2	4.9	9.2

A multivariate analysis (adjusting for dissimilarities in age, sex, place of arrest, witnessed status and emergency medical service response time) was performed and showed that lay bystander CPR was associated with improved survival compared to no bystander CPR with an odds ratio (OR) of 2.04. In the same multivariate analysis, professional bystander CPR was associated with improved survival compared to lay bystander CPR with an OR of 1.37.

For the bystander witnessed cardiac arrest patients (n=17050) the survival rate at 1 month after arrest was 3.1% for the no-bystander CPR group, 6.2% for the lay bystander CPR group and 10.8% for the professional CPR group. When performing the same multivariate analysis (as in the above paragraph), more patients were alive month after cardiac arrest (OR=2.16) when they received bystander CPR from lay persons versus no bystander. Furthermore, the multivariate analysis showed that patients who received bystander CPR from professionals versus lay persons had a increased survival with an OR of 1.31.

Conclusion: Bystander CPR performed by lay persons is associated with an two-fold increase in the chance of survival from out-of-hospital cardiac arrest (in a multivariate analysis). Furthermore, when bystander CPR is performed by healthcare professional the survival rate is even higher. However, the authors note in their conclusion that these differences may not be explained by differences in the quality of CPR.

The Effect of a Voice Advisory Manikin (VAM) System on CPR Quality Among Prehospital Providers

Hostler, D., PhD, NREMT-P; Wang, W., MD, MPH; Parrish K., RN, EMT-P; Platt, T.E.; M.ED., NREMT-P, Guimond, G., BS, NREMT-P
Prehospital Emergency Care, 2005, Vol. 9, No. 1, pp. 53-60

Objective: To investigate if a Voice Advisory Manikin (VAM) system would improve the CPR performance by prehospital providers.

Methods: The study included 114 prehospital providers who performed two 3-minute one-rescuer periods of CPR on the VAM system; one period with the feedback turned off, and one period with the feature turned on.

Results: As can be seen from the table, VAM prompting did not directly result in correct compressions. Nevertheless, with VAM turned off, there was decrease in the percentage of correct compressions. This decrease was not an issue with audio prompts turned on. There was a small increase in the compression depth over the period, especially when the VAM feedback was on. Correct inflations decreased with the VAM prompting, but much more so with the prompting turned off. With respect to the tidal volume, there was a continuous increase over the 3-minute period, both with and without VAM feedback.

Compression and Ventilation Variables Measured Over Three Minutes of CPR With and Without Voice Advisory Manikin (VAM) Feedback

Parameter	VAM Feedback	30 Seconds	45 Seconds	60 Seconds	75 Seconds	90 Seconds
Correct Compressions	On	56.5 ± 34.1	58.4 ± 32.3	60.0 ± 32.5	62.9 ± 33.0	64.7 ± 33.4
	Off	56.0 ± 34.0	54.5 ± 32.4	53.1 ± 32.6	52.3 ± 33.1	50.9 ± 33.4
Compressions Depth (mm)	On	40.6 ± 8.8	41.4 ± 6.3	41.2 ± 6.0	41.5 ± 5.6	41.7 ± 5.2
	Off	40.4 ± 9.1	41.1 ± 7.1	41.2 ± 7.1	41.2 ± 7.3	40.9 ± 7.8
Correct Inflations (%)	On	61.3 ± 31.2	54.9 ± 30.7	57.3 ± 28.0	56.5 ± 28.5	57.0 ± 28.5
	Off	70.6 ± 31.2	63.9 ± 30.2	57.6 ± 27.4	54.6 ± 28.2	52.4 ± 28.3
Tidal Volume (ml)	On	626 ± 385	674 ± 351	689 ± 334	702 ± 339	703 ± 330
	Off	596 ± 376	630 ± 350	630 ± 334	667 ± 342	686 ± 337

Parameter	VAM Feedback	105 Seconds	120 Seconds	135 Seconds	150 Seconds	165 Seconds	180 Seconds
Correct Compressions	On	66.8 ± 32.8	68.1 ± 32.4	68.5 ± 32.0	69.4 ± 31.9	68.3 ± 33.2	68.0 ± 35.0
	Off	52.0 ± 32.8	52.1 ± 32.4	52.1 ± 32.1	52.0 ± 32.0	50.1 ± 33.2	48.8 ± 35.0
Compressions Depth (mm)	On	41.9 ± 5.0	41.9 ± 4.8	41.8 ± 4.6	41.8 ± 4.3	42.0 ± 4.2	41.9 ± 4.0
	Off	40.6 ± 8.5	40.5 ± 9.5	40.4 ± 10.6	40.3 ± 11.7	40.0 ± 12.9	39.7 ± 14.2
Correct Inflations (%)	On	58.4 ± 29.2	59.8 ± 29.2	59.3 ± 29.4	63.6 ± 25.7	59.8 ± 26.7	58.8 ± 27.7
	Off	52.3 ± 29.4	51.8 ± 29.3	52.1 ± 30.0	52.0 ± 27.0	49.1 ± 28.3	47.9 ± 29.6
Tidal Volume (ml)	On	715 ± 311	721 ± 301	723 ± 285	721 ± 285	724 ± 289	733 ± 286
	Off	696 ± 319	710 ± 310	712 ± 294	709 ± 295	721 ± 298	725 ± 296

Conclusion: Over a period of 3-minute one-rescuer CPR, verbal feedback prevents decrease of chest compression and ventilation performance.

Twelve-Month Retention of CPR Skills with Automatic Correcting Verbal Feedback

Wik, L.; Myklebust, H.; Auestad, B.H.,
Resuscitation, 2005, Vol. 66, Issue 1, pp. 27-30

Objective: To evaluate the twelve-month retention of CPR skills after initial CPR training. (A follow-up study to the
six-month retention study published in Resuscitation, 2002, vol. 52.)

Methods: 35 volunteers performed 20 minutes of individual training, without an instructor, on a computer-based voice advisory feedback system (VAM).* The feedback given depended on CPR performance versus set limits for compressions and ventilations. Twelve of the participants received an additional ten 3-minute self-training sessions one month after the initial individual training. All the participants were now tested 12 months after the initial training with feedback.

Results: There were no significant changes in CPR skills when the volunteers were tested with active feedback 12 months after initial training session with activated feedback versus immediate feedback or 6 month training. However, there was a slightly lower number of compressions per minute at 12 months versus immediate post-training in the subgroup with 20 minutes of initial training (47 compressions per minute versus 52). There were no differences between the 20 minute and 50 minute training subgroups at 12 months.

The Concept of Q-CPR

Time after Training	Baseline	Immediate Thereafter	Six Months		Twelve Months	
Audio feedback (VAM*)	No	Yes	Yes	Yes	Yes	Yes
Group:	All	All	20 Minutes	50 Minutes	20 Minutes	50 Minutes
Study period	1	2	3	3	4	4
Number of subjects	35	35	18	12	16	12
Correct inflations	9±20	71±27	56±27	67±28	62±25	75±23
Inflations too fast	81±32	16±22	33±24	19±24	20±14	17±21
Inflations / minute	6±2	7±1	7±1	7±1	7±1	7±1
Correct compression depth	32±33	91±8	81±19	87±11	87±9	88±12
Compression rate (minute)	91±26	108±7	101±11	105±6	101±8	102±8
Compression (minute)	45±15	52±4	49±5	51±5	47±4	49±4
Compression part duty cycle	38±9	45±4	44±5	49±7	43±6	46±4
Incomplete release	2±9	3±9	6±16	17±26	11¬±27	16±26
Hand position too low	8±20	0±0	7±24	7±17	5±16	11±27

Conclusion: A computer-based voice advisory feedback system can improve the basic life support CPR skills on a manikin with no worsening in feedback supported performance after 12 months.