Clinical Summary

Prolonged interruptions in chest compressions, for reasons other than defibrillation, worsen clinical outcomes for out-of-hospital cardiac arrest patients with ventricular fibrillation

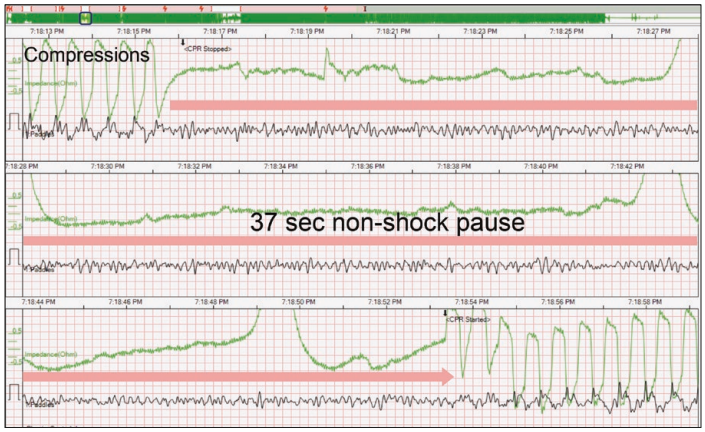
Brouwer T, Walker R, Chapman F, et al. Association Between Chest Compression Interruptions and Clinical Outcomes of Ventricular Fibrillation Out-of-Hospital Cardiac Arrest. *Circulation*. 2015;132:1030-1037.

Purpose

Minimizing pauses in chest compressions (CC) during CPR is a focus of the 2013 AHA Consensus Statements on improving survival from cardiac arrest and the 2015 AHA Guidelines for BLS and ALS.[1,2] Prior studies found that prolonged CC pauses for defibrillation (peri-shock pauses) are associated with worse survival.[3,4] And one study found that prolonged pre-shock pauses were associated with worse ventricular fibrillation (VF) termination.[3] This study used a large data set to evaluate the association between CC pauses for all reasons (peri-shock and non-shock pauses) and both VF termination and patient survival, thus offering a more complete analysis of cardiac arrest.

The following CODE-STAT Data Review Software images illustrate how peri-shock and non-shock CC pauses are defined.

Peri-shock CC pause: pause before and after defibrillation



Non-shock CC pause: pause for reasons other than defibrillation:

- Intubation
- IV/IO access
- Rescuer change
- Hand-off of care from BLS to ALS
- Pulse checks
- Rhythm identification
- "Clustering" care or interventions

Methods

This was an observational study of prospectively collected cardiac arrest data from AEDs used in the Amsterdam Resuscitation Study (ARREST). Researchers detailed interruptions in CC among 319 patients undergoing VF/VT out-of hospital cardiac arrest (OHCA).

The following key CC measurements were summarized from the data:

- Longest peri-shock pause in each case
- Longest non-shock pause in each case
- Longest overall CC pause (peri-shock or non-shock) in each case
- Pre-shock CC pause of every shock

The CC pause results were then compared to survival to discharge. And the pre-shock pause results were then compared with VT/VF termination success.

The study population was a rural and urban mix of patients from Noord-Holland, The Netherlands.

Inclusion criteria consisted of patients in initial rhythm VT/VF where resuscitation was attempted; exclusion criteria consisted of those with arrest from a non-cardiac cause, use of non-Physio-Control AED, no electronic ECG download or data not available from all defibrillators used during resuscitation.

Results

Chest compression pause and resuscitation attempts:

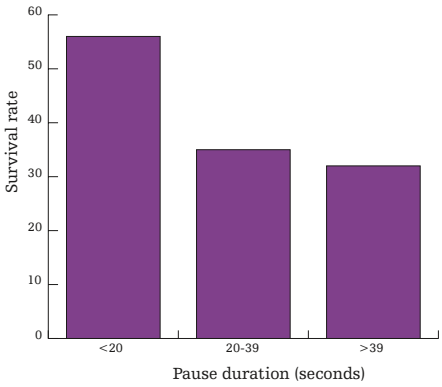
- 319 cases met inclusion criteria and were analyzed. For each category of CC pause, the longest such pause occurred on average during the first several minutes of the resuscitation attempt.

Chest compression pause duration and survival:

- 121 of 319 survived to discharge (37.9%); 113 of the 121 (93%) survivors were discharged with a good neurological outcome (CPC 1 or 2).
- Overall CC fraction was 0.79 (0.71, 0.84)
- The median CC pause durations (in some cases the peri-shock pause was the longest and in others the non-shock pause was the longest):
  - The longest peri-shock CC pause was 23 seconds
  - The longest non-shock CC pause was 24 seconds
  - The longest overall CC pause was 32 seconds

In a multivariable regression (adjusted for Utstein variables + CCF) survival decreased 11% per 5 second increase in duration of longest overall CC pause.

Longest overall pause



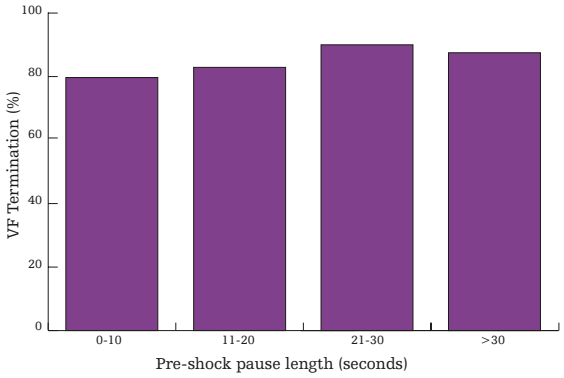
The longer the CC pause, for any reason, the lower the survival to discharge.

In 36% of cases, the longest chest compression pause was a non-shock CC pause; this subgroup had lower survival than the group in whom the longest pause was a peri-shock CC pause (27% versus 44%, respectively; P<0.01) despite a higher chest compression fraction.

Chest compression pre-shock pause duration and VF termination:

- 1,048 shocks were available for analysis of the relationship between the duration of the pre-shock pause in CC and the probability of VF termination.
- The VF termination rate was 82% overall, 85% for the 902 biphasic shocks, and 64% for the 146 monophasic shocks.
- The median pre-shock pause was 8 seconds for shocks that terminated VT/VF vs. 7 seconds for shocks that failed to terminate VT/VF (P=0.18).

Pre-shock pause and VF termination



The VT/VF termination rate did not deteriorate with increasing pre-shock pause duration.

Conclusions

1. The duration of the single longest interruption in chest compressions, regardless of the reason, has a strong negative association with survival.
   - The negative association between the longest CC pause and survival is not explained by chest compression fraction.
   - Individual long pauses may be more harmful than multiple short pauses, even if overall chest compression fraction is similar.
2. Prolonged interruptions for reasons other than shock delivery (non-shock CC pause) have a strong association with survival as found earlier for prolonged peri-shock interruptions (peri-shock CC pause).
   - In 36% of the patients, the longest pause was a non-shock pause.
   - Survival was significantly lower in this group than in the 64% of patients where the longest peri-shock pause was the longest pause (27% vs. 44%, P=0.004).
   - The data imply that the focus now placed on minimizing perishock pauses should be broadened and that similar emphasis should be placed on eliminating or minimizing pauses for other interventions.
3. This data indicates that there is no association between the duration of the pre-shock pause and termination of VF. Over 1,000 shocks were included in the analysis.

Physio-Control discussion points

New insight into all chest compression pauses and survival

- No other study has looked at long CC pauses for reasons other than shock delivery. The results from this study will set a new standard for evaluation CC pauses during cardiac arrest care.
- Long pauses in CC may worsen clinical outcomes whether or not they are for a shock.
- Clinicians should now think more broadly about CC pauses. Avoiding long pauses for interventions other than defibrillation may be even more important than minimizing peri-shock CC pauses or further increasing chest compression fraction.

Strategies for minimizing all chest compression pauses

- Clinicians use a couple of techniques to minimize peri-shock CC pauses.
  - Pre-charging the defibrillator at 1:45 sec into the CC cycle prior to stopping CPR to shock will minimize pre-shock CC pause.
  - Use the "hover technique" which requires the rescuer to keep their hands just above the sternum during defibrillation in order to quickly resume CC immediately after the shock.
- Clinicians should place equal attention to minimizing long non-shock CC pauses. Start by identifying the potential causes.
  - Intubation
  - IV/IO access
  - Rescuer change
  - Hand-off of care from BLS to ALS
  - Pulse checks
  - Rhythm identification
  - Deployment of mechanical chest compression devices
  - "Clustering" care or interventions resulting in long pauses

What about chest compression fraction?

- Focusing on CC fraction alone does not tell the clinician if there were multiple short pauses or one long pause in CC. The observations in this study suggest that individual long pauses are more harmful than multiple short pauses, even if overall chest compression fraction is similar.

What tools can help clinicians minimize pauses?

- CODE-STAT™ Data Review Software not only gives clinicians CC fraction, but shows the longest CC pause. This allows clinicians to broaden their analysis of CPR performance and focus on the causes of long peri-shock pauses and non-shock pauses.
- The LUCAS® Mechanical Chest Compression System not only provides consistent, high-quality CPR, but may eliminate peri-shock CC pauses by providing CC through defibrillation and eliminate some non-shock pauses by providing CC through other non-defibrillation related patient care during cardiac arrest.
- The LUCAS device can be applied quickly using the two-step process that results in two short CC pauses, avoiding singular long CC pauses. Recent data now shows that when the LUCAS device is properly integrated into a high-performance CPR system with focused training, application times (and interruptions in CC) can be as short as seven seconds.[5]

Do pre-shock pauses impact defibrillation success?

- The results from this study parallel three other large studies, totaling over 2,200 OHCA patients. All show that pre-shock CC pauses are not associated with termination of VT/VF for OHCA patients.[6-8]
- This finding contradicts the widely taught concept that longer pre-shock pauses reduce probability of termination of VT/VF. This was based on one small study.[3]
- Employing a shock protocol with escalating energy is a more clinically proven way to improve defibrillation success. Clinical data show a statistically significant benefit in shock success when using defibrillation protocols (BTE waveform) that escalate to 360 joules vs. those that do not.[9-11]

What about hands-on defibrillation?

- Some suggest that hands-on defibrillation is a way to eliminate pre-shock CC pauses.
- The majority of the clinical data now show that pre-shock CC pauses have no effect on defibrillation success.
- Given the risks of current flow through the rescuer during hands-on defibrillation, the less proven benefits of eliminating pre-shock pause do not outweigh the risks.
- Instead of choreographing efforts to eliminate pre-shock pauses with hands-on defibrillation, shorten pauses as much as you can without touching the patient during defibrillation.

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