Clinical Summary

Optimize use of a mechanical chest compression device within a high-performance CPR approach to out-of-hospital cardiac arrest resuscitation

Levy M, Yost D, Walker R, et al. A quality improvement initiative to optimize use of a mechanical chest compression device within a high-performance CPR approach to out-of-hospital cardiac arrest resuscitation. *Resuscitation*. 2015;92:32-37.

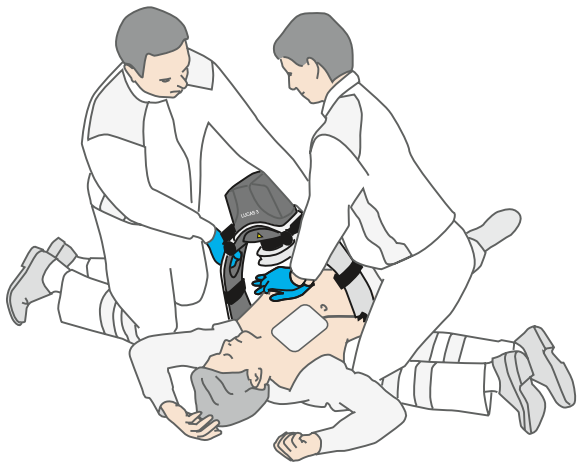
Background

This publication describes a quality initiative undertaken by Anchorage Fire Department (AFD) in Alaska, US, to reduce their LUCAS® 2 chest compression device application time intervals and optimise their overall CPR process. AFD initially deployed the LUCAS devices in 2008 in both basic and advanced life support vehicles. Ongoing review of data downloaded from their monitor/defibrillators provided evidence of inefficient device application process, i.e., long time durations between the end of manual compressions and the initiation of mechanical chest compressions (MCC). The quality improvement initiative implemented in January 2013 included four components:

1. Updated crew training on high-performance CPR, with particular emphasis on scene leadership and team choreography.
2. Protocol change requiring two full cycles of manual CPR before transition to MCC to ensure all cardiac arrests with the potential for early return of spontaneous circulation received four minutes of minimally interrupted chest compressions before any additional interruption time was needed for mechanical CPR device application.
3. Emphasis on using existing protocol-specified CPR interruptions for placement of device's back plate under the patient and feeding the device's leg through the arm of the rescuer providing manual compressions, without interfering with the continuity of their compressions.
4. Immediate resumption of manual compressions if there is any device malfunction.

Purpose

To compare CPR process data from the year prior to the year during and after initiation of the quality improvement initiative, to assess the impact on duration of chest compression interruptions for application of the mechanical compression device (LUCAS 2).



Method

Continuous ECG and impedance data recorded by LIFEPAK® 12 and 15 monitor/defibrillators were analysed independently by two investigators using CODE-STAT™ 9.0 data review software. The interval from the last manual chest compression to the first MCC was measured (MCC were distinguished from manual compressions by their distinctive morphology). Chest compression fraction over entire resuscitation and duration of single longest compression interruption were also measured.

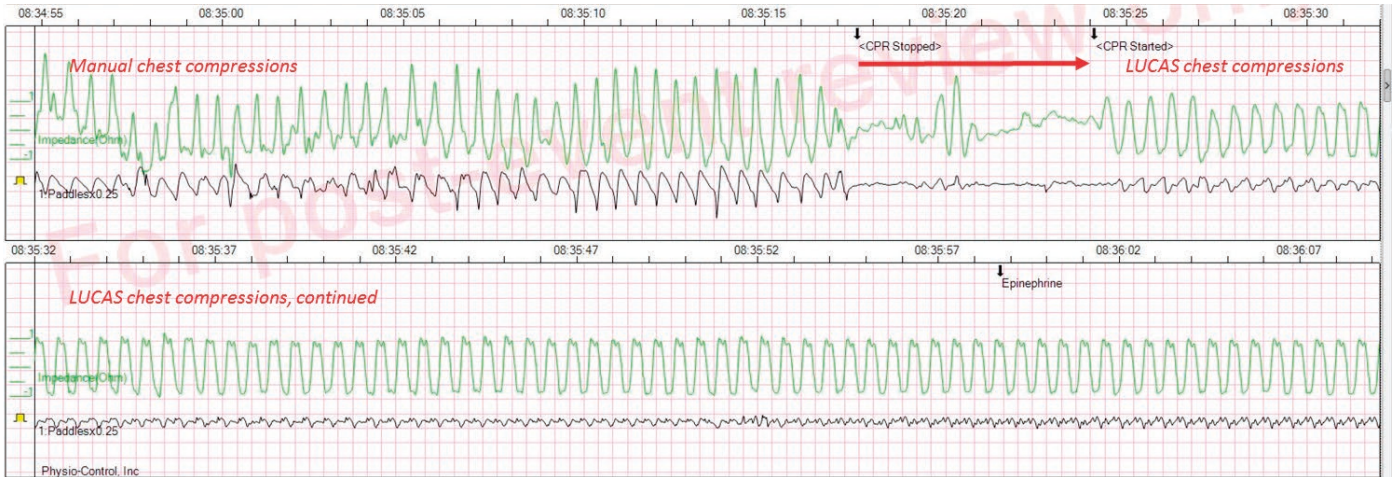


Figure 1: An example of how CODE-STAT software can measure the pause (time interval) to apply the LUCAS device. Red arrow indicates no flow time (approximately 7 seconds).

Inclusion

All out-of-hospital cardiac arrest patients during 2012 (before quality improvement initiative) and during 2013 (after quality improvement initiative) in which the LUCAS device was used and there were CODE-STAT software data available for analysis.

Exclusion

Any case where MCC was already underway at the beginning of the recording.

Results

The quality improvement initiative resulted in a significant reduction of interruption at application of the LUCAS device, from 21 seconds to 7 seconds (median). The chest compression fraction increased significantly from 90% to 95%. The longest pause decreased significantly from 25 sec to 13 sec, and the application of the LUCAS device was causing the longest pause in only 31% of the cases in 2013.

There were also improvements in other CPR quality metrics as a result of the choreographed team approach. The number of shocks during LUCAS device compressions increased from 36 in 2012 to 69 in 2013. The mean perishock compression interruption decreased from 9 (7, 12) seconds to 8 (4, 10) seconds and the number of shocks without a compression pause during LUCAS device compressions increased from 11% to 26% over the same time period.

CPR metrics measured	2012 (n=61)	2013 (n=71)	p Value
Chest compression interruption prior to first MCC (seconds)	21 (25, 31)	7 (4, 12)	<0.001
Longest chest compression interruption during resuscitation (seconds)	25 (20, 35)	13 (10, 20)	<0.001
Compression Fraction (proportion of time with chest compression during CPR)	0.90 (0.88, 0.93)	0.95 (0.93, 0.96)	<0.001
Proportion of cases in which longest interruption was for MCC device	74%	31%	<0.001
Interruption for MCC device application time as proportion of total “hands off” time	18% (12, 32)	10% (6, 18)	<0.001

Conclusion

A targeted quality improvement initiative was able to achieve a significant reduction in the duration of the primary CPR interruption associated with application of a mechanical CPR device.

Discussion/limitations

- "A key take-away from our experience is the notion that use of a mechanical CPR device in the setting of out-of-hospital cardiac arrest is a team skill, not just an individual skill."
- Continuous CPR data downloaded from monitor/defibrillator was critical in identifying and monitoring LUCAS device application times.
- This study measured the interruption time between the last manual compression and the first mechanical compression as this can conclusively be identified on the CODE-STAT software reading. The two step application process of the MCC give rise to an initial interruption to manual CPR to position the device back plate, an interruption which is not possible to attribute or identify with certainty on the CODE-STAT software readings. However, the fact that overall hands-on time increased and the longest single pause decreased indicates that the overall application time of the LUCAS device was significantly improved.
- Some data was not available from cases during the study period. Main reasons for missing data included: not downloaded from device, failure to capture impedance data (not in PADDLES lead), and LUCAS device application prior to attaching ALS monitor/defibrillator.

Stryker discussion points

- Training focused on teamwork and team communication around device application is key to optimising integration of mechanical CPR into the existing resuscitation process. The key take-away is that with a well-defined approach, it is possible to apply the LUCAS device with minimal interruptions to CPR. It is possible to apply the LUCAS device with interruption of less than 10 seconds, even as short as median 7 seconds as demonstrated in this study.
- After the quality improvement initiative, the majority (69%) of the longest interruptions were due to other causes, not LUCAS device application.
- It is necessary to measure and review your team's performance on an ongoing basis to identify CPR performance in general, and specifically, manual-to-mechanical compression transition time. The program used in this study was CODE-STAT data review software. This program allows team members to view and actually measure the pauses occurring during the resuscitation and to make efforts to decrease or eliminate.
- A growing number of protocols describe well-defined timing and steps to minimise compression interruptions and avoid delays in defibrillation and include the following steps:
  - One or more full cycles of manual CPR before deployment of the LUCAS device.
  - AED analysis/defibrillation or manual rhythm check/ defibrillation, if indicated, before the LUCAS device is applied (avoid delaying defibrillation in patients with presenting rhythm of VF).
  - Using 2-step application (to allow for manual compressions in between back plate placement and LUCAS device attachment to back plate).
  - Not allowing any pause greater than 10 seconds.
- Yost, et al., found the median interruption time for applying the LUCAS device was 32.5 seconds even though prehospital providers estimated that it took less than 20 seconds in 71% of the cases.[1] Reviewing your agency's data would be the best way to know your application time for certain and adopt changes as needed. Anchorage is a prime example. Although this paper focuses on rapid application, it is highly important that speed does not compromise correct suction cup positioning. Correct suction cup placement is necessary for optimum perfusion and minimising injury.
- Looking at LUCAS application in 72 cardiac arrest patients in a hospital setting, Couper and colleagues found that the mean interruptions due to the application of the LUCAS back plate and upper part were less than 10 seconds each.[2]
- Interruptions to CPR and application time of different mechanical CPR devices may differ in manikin tests as well as in real clinical use. In an earlier manikin study by Caruana, et al., the LUCAS device has been proven to be significantly quicker to apply than the AutoPulse® mechanical chest compression system (ZOLL®).[3] This study by Levy and team shows the LUCAS device can be applied with as little interruption as seven seconds, in real clinical use by a team consisting of both BLS and ALS rescuers. Lyon, et al., looked at the interruption when applying the AutoPulse by a second tier, advanced cardiac arrest response team, and found a median of 39 seconds (IQR 29-47) interruption to CPR to apply AutoPulse.[4] The prior removal of the patient's clothes took an additional 33 seconds. Additional unexpected interruptions to AutoPulse operation caused a median of 20 second interruption for reapplication of the LifeBand®.

References

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4. Lyon R, Crawford A, Crookston C, et al. The combined use of mechanical CPR and a carry sheet to maintain quality resuscitation in out-of-hospital cardiac arrest patients during extrication and transport. *Resuscitation.* 2015 Aug;93:102-6.

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