

Mechanical chest compression systems:

Better compressions, but above all, more compressions

The purpose of this retrospective study is to demonstrate the superiority of mechanical chest compression systems with regard to the duration of compressions during a resuscitation event by comparing the ratios of compressions duration and the total Cardiopulmonary Resuscitation (CPR) time.

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Method used

Physio-Control has designed a new version of its data review software; CODE-STAT™ V7.0, which is used to archive the data collected by their LIFEPAK® defibrillators. New functionalities have been implemented in this software, one of which attracted my attention: the possibility of generating reports on the performance of CPR. In addition to a simple data storage system, the software provided an analysis of the data collected.

Thanks to a detailed analysis of records collected, based on transthoracic impedance measured by the defibrillator throughout CPR, the software allows the precise identification of chest compressions. This allows us to obtain a ratio of the duration of compressions over the total duration of the CPR. The time period analyzed is limited to the period between the power on and off of the defibrillator, but it may be selected manually.

From this perspective, it was interesting to compare compression ratios when using the LUCAS® to that of manual compressions.

Initially, a dozen recent files were analyzed, and there appeared to be a difference in the ratios in favor of using the mechanical chest compression system. However, because multiple biases could be involved, we randomly created two cohorts of 200 patients and reran the software analysis. This software is capable of using the data recorded even before this version. The software uses the database of the LIFEPAK without the need to record specific additional data. This allows the re-use of old recordings for inclusion in the study.

In order to avoid any problems with the duration of the recordings, each file was reviewed to be sure that the end of the data collection corresponded well to the end of CPR, and, for example, that one didn't leave the defibrillator on for an additional 10 minutes after the end of CPR. In about 7% of the recordings it was found that the software was not able to determine the compression time due to a lack of recording of the transthoracic impedance. For these files, manual identification was necessary.

For all cases, this was CPR performed pre-hospital. The defibrillator was powered on when the medical team was at the victim's side, and was powered off at the end of CPR. In cases of ROSC (return of spontaneous circulation), the moment that ROSC occurs is considered to be the end of CPR. In day-to-day practice, this represents a cardiac rhythm recording that is compatible with cardiac output, and of stopping compressions for more than 3 minutes. The subsequent episodes of compressions in the same record are excluded from the evaluation for ease of calculation, but these could have been retained as a new episode of CPR.

Validation of CODE-STAT software

One of the first steps was to see whether this functionality of the software had been scientifically validated. This had been done as described in the following article: Stecher FS, Olsen JA, Stickney RE, Wik L. Transthoracic impedance used to evaluate performance of cardiopulmonary resuscitation during out of hospital cardiac arrest. Resuscitation 2008; 79:432-7.

There was therefore nothing opposing the realization of the study.

Example of the utilization of the CODE-STAT software:

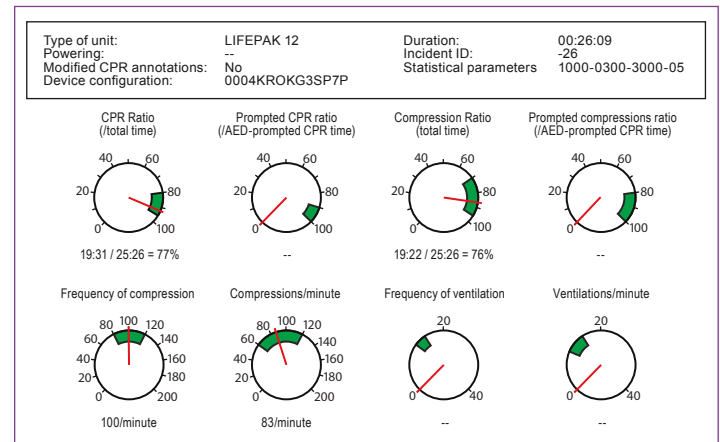


Image 1: Representation of a CPR analysis with mechanical chest compressions.

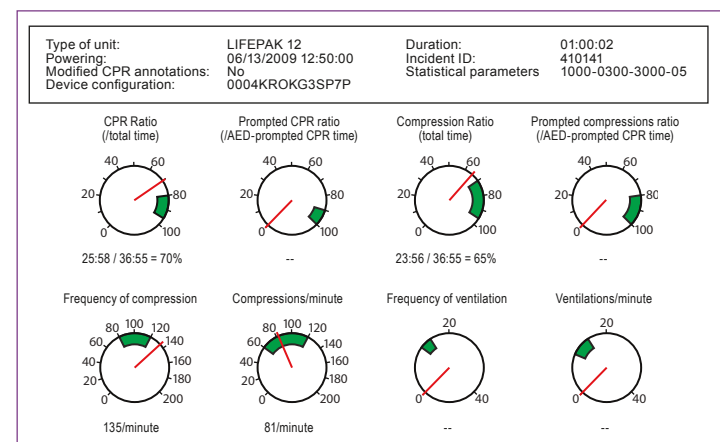


Image 2: Representation of a CPR analysis without mechanical chest compressions.

Creation of cohorts

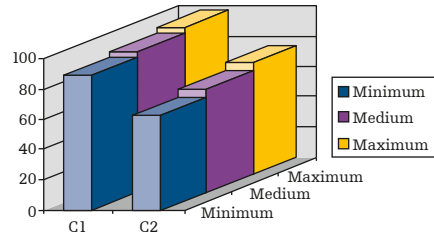
Two cohorts, each including 200 recordings of non-traumatic CPR were randomly selected. They are comparable in terms of total duration of CPR: 41 minutes 20 seconds +/- 5 minutes 15 sec.

C1 includes the recordings of CPR using a mechanical chest compression system, in this case the LUCAS. C2 includes the recordings of CPR with manual compressions.

Results:

For C1, we found an average of 93% +/- 4% of time ratio of compressions to total CPR time.

For C2, we found an average of 69% +/- 6% of time ratio of compressions to total CPR time.



Conclusions

Some studies have already demonstrated the contribution of mechanical chest compression systems to CPR. The results of these studies are at times contradictory, probably due to the actual implementation of the chest compression device. In fact, the protocols for use differ from one center to another, and the time before starting the mechanical chest compressions varies from one study to another, such that it is very difficult to get an overall effect of performance.

What we know comes from the 2005 Guidelines of the ERC (European Resuscitation Council), which emphasize the compressions portion of CPR. This study demonstrates that the use of mechanical chest compression devices is an advantage in CPR.

If we elaborate on our results and look at a typical resuscitation event of 40 minutes, as in our study, and use manual chest compressions, the patient would receive compressions for 27 minutes and 36 seconds, while in the case where mechanical chest compression device is used, the patient would receive compressions for 37 minutes and 12 seconds.

Why such a difference?

Changes in rescuers, stopping and restarting for defibrillations and intubations, ... represent lost time in terms of manual compressions, thus explaining the differences observed.

It is therefore already evident that based on these ratios we can conclude that the mechanical chest compression device (regardless of the type of machine used) allows for optimization of compression time in CPR. The software shows the compression ratio and if the compression has been provided at the frequency recommended by the ERC, i.e. 100 compressions per minute. By including frequency in the comparison, it appears in this case that the gap between the two cohorts is even greater.

Finally, in November 2010, the ERC published its 2010 Guidelines with an increased focus on chest compression and its duration. This study clearly points to the use of mechanical chest compression systems to obtain the desired objective.

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The Editor:

What we know: The 2010 international guidelines for cardiopulmonary resuscitation (CPR) emphasize the importance of chest compressions. The victim's survival depends on the quality of these compressions, as much in terms of their frequency and of their depth.

What the article tells us: New software allows for the optimization of the performance of CPR. This study also emphasizes the interest in mechanical chest compression devices.

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