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Usefulness of a metronome to improve quality of chest compressions during cardiopulmonary resuscitation

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ABSTRACT

The objective of this study was to improve the quality of chest compressions after the introduction of a metronome during cardiopulmonary resuscitation (CPR). A retrospective analysis of Zoll® compression data of 219 in-hospital adult participants who received CPR from January 2017 to December 2018 was done. A metronome was introduced during chest compressions in January 2018, and the 2017 data served as the control. The main outcome measure compared the overall quality of chest compressions measured by the rate (100 to 120 compressions per minute), depth (2.0 to 2.4 inches), and mean release velocity (≥400 mm/sec) on chest recoil. Compared to control, the metronome group had a statistically significant improvement of the mean percent compression rate within 100 to 120 beats per minute: 28.16% vs. 71.14% ($P < 0.001$) and a statistically significant improvement of the mean percent compression depth within 2.0 to 2.4 inches: 29.35% vs. 34.84% ($P = 0.03$). However, there was no statistically significant improvement of mean percent release velocity ≥400 mm/second: 47.41% vs. 51.09% ($P = 0.38$). Our data suggest that an inexpensive and widely available intervention may improve the quality of CPR. We suggest that further research be conducted to measure patient clinical outcomes.

KEYWORDS Cardiopulmonary resuscitation; CPR; metronome

A metronome is a tool that is widely used to help musicians maintain a precise tempo. It provides a regular beat that can be preprogrammed at any desired rate per minute. We hypothesized that the utilization of a metronome during cardiopulmonary resuscitation (CPR) would improve the quality (rate, depth, and mean release velocity) of compressions. Multiple mannequin studies and a small number of human trials have demonstrated some improvement in the quality of compressions with the introduction of metronomes; however, these human studies have been limited to measuring the rate of compressions.[1–4] We looked at a more comprehensive evaluation of the quality of compression by also including depth and mean release velocity.[5]

METHODS

This study was approved by the State University of New York Upstate Medical University's institutional review board. We studied the rate, depth, and mean release velocity of compressions performed before and after utilization of a metronome during resuscitation by the rapid response/code team. A MeIdeal® M50 Mini digital metronome was used. Included were a total of 219 adult patients who received CPR in response to cardiopulmonary arrest. The control group included 91 patients who underwent CPR in 2017 prior to utilization of a metronome. The intervention group included 128 patients who received CPR in 2018 after the introduction of a metronome. Excluded from this study were cardiopulmonary arrests that occurred in the emergency department, cardiac catheterization laboratory, pediatric floors, and operating room. The rapid response/code team did not intervene for code blue events in these areas, and a metronome was not utilized.

The rate, depth, and mean release velocity of compressions were collected from Zoll R Series® defibrillators, which

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relay minute-by-minute data to the in-house Zoll database. Analysis of each CPR event provided mean compression rate, mean compression depth, percent compressions with appropriate depth (2.0 to 2.4 in), and percent compressions within appropriate rate (100 to 120 compressions per minute). For each minute of CPR, a value of mean release velocity was calculated. The value of 400 mm/second was set to be the lowest acceptable mean release velocity.[6] The percentage of compression minutes that had adequate mean release velocity was then calculated. If a minute had >10 s without compressions, that data point was excluded in all calculations.

A two-sample *t* test was performed, assuming unequal variances, to compare the pre- and postintervention data for percent of compressions within the appropriate rate, percent of compressions within the appropriate depth, and percent of minute compressions with adequate mean release velocity. The type I error rate was set at <0.05.

RESULTS

Compared to control, the metronome group had a statistically significant improvement of the mean percent compression rate within 100 to 120 beats per minute: 28.16% vs. 71.14% ($P < 0.001$) and improvement of the mean percent compression depth within 2.0 to 2.4 inches: 29.35% vs. 34.84% ($P = 0.03$). There was no statistically significant improvement of mean percent release velocity ≥400 mm/second: 47.41% vs. 51.09% ($P = 0.38$).

DISCUSSION

This is the first study to investigate the change in overall quality (rate, depth, and mean release velocity) of compressions after the introduction of a metronome. We found a significant improvement in both the rate and depth of compressions after introducing a metronome during CPR, without a change in mean release velocity.

Mandatory supplemental Advanced Cardiovascular Life Support and Basic Life Support training have been shown to improve rates of return to spontaneous circulation and survival to hospital discharge.[7,8] Despite current mandated annual/biannual training, the quality of compressions during resuscitation is still suboptimal, with the natural decay of CPR skills within the first year after training.[9] Previous studies have tried to address maintenance of the fidelity of skills, including low-dose, high-frequency CPR training rather than longer, less frequent training approaches.[10] However, it is difficult to increase training frequency with the already busy schedules of health care providers and the high financial costs of additional training. Therefore, we propose a low-cost approach to improving the quality of CPR by using a metronome.

However, we noted that with the introduction of a metronome there was no improvement of mean release velocity. We hypothesized that body mechanics likely played a significant role in allowing for full recoil of the chest, including variables like the height of the bed vs height of compressor, level of fitness, or technique. Characteristics of patients have also been shown to play a role in mean release velocity; young obese men often maintain a higher mean release velocity than thin elderly women.[11]

Since our study was a retrospective analysis, some limitations applied. First, the data points in 2017 were not adequately associated with patients' charts. Only the time, date, and location of the events were documented. Therefore, clinical outcomes like mortality after return to spontaneous circulation or length of stay could not be analyzed and compared. Within the intervention group, there was a lack of clear documentation of the time of initiation of the metronome; however, it was understood by the code team and ancillary staff that metronomes were to be used during all code events. Also, as this was a before-and-after study without randomization, we cannot say for certain that the intervention caused the improvement in resuscitation (there could be correlation rather than causation). However, we believe that the improvement was likely due to the intervention and not confounding factors, as that is the most plausible reason for the change. A randomized trial could be conducted to confirm these findings.

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