DEATH BEFORE DISCO: THE EFFECTIVENESS OF A MUSICAL METRONOME IN LAYPERSON CARDIOPULMONARY RESUSCITATION TRAINING

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Abstract—Background: A novel musical memory aid has been proposed for aiding laypersons in complying with the American Heart Association (AHA) cardiopulmonary resuscitation (CPR) guidelines of 100 compressions per minute (cpm). Objective: This study tested usefulness of such a memory aid to improve layperson long-term compliance with CPR compression rate guidelines. Methods: A prospective randomized controlled trial was conducted using CPR-untrained laypersons. Subjects received either a standard CPR educational experience (AHA Heartsaver® CPR class) or an experimental CPR educational experience (AHA Heartsaver® CPR class augmented with a musical metronome). Experimental group subjects were taught to perform compressions to the cadence of a pop music song (The Bee Gees “Stayin’ Alive”; Saturday Night Fever, The Original Movie Soundtrack; Polygram International Music, 1977) with a tempo of 100 beats/min. Compression rates, depth of compressions, and correct compressions were measured initially and upon retesting 6 weeks post-training. Results: Control subjects had a higher mean compression rate both immediately (121 [standard deviation (SD) = 21] vs. 109 [SD = 15] cpm; 95% confidence interval [CI] of mean difference 4–19; \( p = 0.002 \)) and at follow-up (120 [SD = 20] vs. 111 [SD = 13] cpm; 95% CI of mean difference 2–16; \( p = 0.014 \)). Compression rates stratified to 100–120 cpm demonstrated no difference between groups initially (39% vs. 48%; \( p = 0.382 \)), but more experimental subjects maintained these rates at follow-up (43% vs. 74%; \( p = 0.003 \)). Conclusions: Subjects trained to use a musical metronome more often maintained a compression rate of 100–120 cpm at 6-week follow-up, suggesting the memory aid may improve long-term guideline adherence. © 2015 Elsevier Inc.

Keywords—cardiopulmonary resuscitation; CPR; chest compressions; music; feedback; education; training; metronome

INTRODUCTION

An estimated 166,200—320,000 out-of-hospital sudden cardiac arrests occur in the United States annually, with reported median rates of survival to hospital discharge of 7.9% (1–3). Bystander cardiopulmonary resuscitation (CPR) is associated with a four-fold increase in survival of cardiac arrest victims (4). During the past decade, bystander CPR rates have remained...
low, between 20% and 30%, despite numerous public health initiatives (5). Bystanders have cited the reluctance to perform mouth-to-mouth breathing or the overall complex nature of this task as reasons to avoid bystander CPR (6).

The most important feature of CPR has been shown to be the quality and rate of chest compressions, which doubles or even triples a patient’s chance of survival when properly performed (7–10). However, it has also been shown that most often manual chest compressions are often performed ineffectively (11,12). Observational studies of medical professionals and bystanders performing CPR have shown that target compression and ventilation rates are not uniformly maintained (8,9). In addition, retention of CPR knowledge and skills is often poor, with a significant decrease seen as early as 6 weeks and some trainees reverting to baseline skill levels as early as 6 months post training (13–15).

What is needed is a means to keep CPR skills fresh and achievable, especially for layperson providers. One such mechanism is the use of “real-time” feedback provided concurrently while CPR is being performed. CPR sensing monitors/defibrillators that measure chest compression rate and depth via both accelerometer and force-detection sensors have been shown to improve quality; however, the specific technology must be present at the time CPR is initiated, limiting its application to mostly medical professionals in healthcare settings (16,17). The use of a musical metronome that is low cost, ubiquitous, and easily utilized represents an ideal standard for laypersons performing bystander CPR.

A novel and largely untested memory aid has been anecdotally proposed for aiding practitioners in complying with American Heart Association (AHA) CPR compression rate guidelines (18,19). It has been noted that several pop music renditions have a cadence that is timed to approximately 100 beats/min (bpm), the same rate as 2005 AHA CPR guidelines (19). CPR providers can use the cadence of the music to help them time external compression rates to 100 bpm. Recent pilot experiences with medical professionals using a pop music memory aid to time CPR compression rates during simulated cardiac arrest scenarios has been favorable (19,20). However, its usefulness as a training tool and a mechanism for long-term adherence to compression rate guidelines among layperson CPR providers has not been explored. We hypothesize that use of a pop music song as a CPR metronome during layperson CPR training will improve long-term chest compression rate adherence to the AHA 2010 CPR guidelines, as compared to standard CPR training.

METHODS

Study Design and Setting

A randomized educational intervention study utilizing a control group was conducted. The primary outcome measure was a chest compression rate between 100 and 120 compressions per minute (cpm) between groups at 6-week follow-up. Secondary outcomes included a chest compression rate between 100 and 120 cpm immediately during training, adequate compression depth, the proportion of adequate compressions, and subject’s attitudes performing CPR.

Standard and experimental educational experiences were offered to the students and employees of the University of Illinois at Urbana-Champaign (UIUC). UIUC is a public University located in Urbana-Champaign, east-central Illinois straddling the twin cities of Urbana and Champaign and offers undergraduate and graduate education for > 40,000 students annually. There are also > 10,000 faculty and staff employed by the University. The student body is composed of 54% men and 46% women.

Selection of Participants

Adult UIUC students without CPR certification were recruited from the Urbana-Champaign community for participation in the trial. Subjects were recruited using written flyers and direct invitations to UIUC undergraduate student groups, as many students are required to have AHA CPR certification to participate in certain school activities or work-study programs. Subject exclusion criteria included age older than 80 years (due to concerns about the ability to perform and maintain adequate CPR external compressions for five cycles), the inability to speak or comprehend the English language, a significant primary or secondary hearing impairment (as reported by the subject; defined as requiring a hearing assist device for daily activities), a self-reported physical inability to perform CPR compressions for at least five full cycles, a reported occupation as a health care professional, and prior formal CPR training < 5 years before enrollment in the study.

AHA CPR instructors were recruited via e-mail invitations to local AHA CPR instructor list servers. The invitation described the study in general terms, and interested instructors attended a general study training session detailing general study details and protocols. Instructors were required to have experience in teaching the AHA Heartsaver® CPR class in the past. The instructors were randomly assigned to either the experimental or the control group via computer randomization and utilized the usual instructor materials and coursework that
are provided with the AHA Heartsaver® CPR class. Classes are designed to be a group educational environment using a combination of didactic instruction and hands on CPR practice using mannequins, and conclude with instructors performing skills testing. As is the usual practice with the AHA Heartsaver® CPR class, if a student successfully completed the requirements of the practical testing at the end of the course, instructors awarded the student an AHA Heartsaver® CPR Course Completion Card.

**Interventions**

All students enrolling in the study were randomized into either standard or experimental CPR experiences. Stratified block randomization occurred at the time of enrollment with subjects placed into either the interventional or the control group in groups of four. The AHA Heartsaver® Adult CPR Course teaches one-rescuer adult CPR and the management of airway obstruction. It is designed to be a 2- to 3-hour course, and each participant receives an AHA training booklet and supplemental CPR Instructional CD-ROM to take home. Final skills testing for both groups was performed by instructors using the standard criteria for passing the AHA Heartsaver® Adult CPR class, and certification cards distributed if subjects passed the class. The control group, representing a standard CPR experience, adhered tightly to the educational guidelines for the AHA Heartsaver® CPR course. In the experimental group, CPR instruction also adhered to the education guidelines for the AHA Heartsaver® CPR course, but students were also taught to perform CPR using the 100 bpm cadence of The Bee Gees “Stayin’ Alive” (Saturday Night Fever, The Original Movie Soundtrack; Polygram International Music, 1977) to help time compression rates during practice sessions. Before study initiation, the tempo of the song was verified at 103 bpm using MixMeister BPM Analyzer (MixMeister Technology, LLC, Ft. Lauderdale, FL). To reinforce this concept, this song was audibly played during all practice sessions for the intervention group.

Post education, both groups performed 2 min (five cycles) of CPR on a Resusci®/Anne SkillReporter™ recording manikin without audio stimulus. During the final 2-min evaluation, participants did not receive feedback unless their performance would have resulted in failure of the course. All participants were asked to return at least 6 weeks after their educational experience and again demonstrated 2 min of CPR unassisted on the SkillReporter™ recording manikin. Six weeks was chosen as the follow-up period as previous studies have demonstrated that by this time a significant decrease in the retention of CPR knowledge can occur (21,22). Subjects remained in their previously assigned randomization categories and those in the experimental group were not allowed to utilize music. After completion of 2 min of CPR (5 cycles), instructor feedback was given to subjects regarding their performance. Upon completion of follow-up, all participants completed a brief survey investigating their comfort levels in performing bystander CPR and their likelihood to perform bystander CPR using a 5-point Likert scale.

This study was approved by our Institutional Review Board before initiating the research and all subjects signed a written informed consent. This trial was not registered with clinicaltrials.gov, as it represented an educational initiative not involving a drug, biologic, or device subject to U.S. Food and Drug Administration regulation.

**Outcome Measures**

Compression rate (cpm), compression depth (>50 mm considered adequate), and percent of correct compressions (adequate rate, depth, and compression release) were all recorded by the Resusci®/Anne SkillReporter™ software for the initial and follow-up sessions. The compression rate in each group was defined as cpm during initial testing and at 6 weeks. Mean rates of compressions were recorded individually and grouped for analysis into two groups: 100–120 cpm and other cpm. The preferred compression rate range for this study was defined as 100–120 cpm.

**Analysis**

Earlier published research has demonstrated that laypersons newly trained in CPR have compression rate adherence during follow-up testing of 24%–50% (23,24). We chose 40% as a control subject baseline percentage for adequate maintenance of compression rates at follow-up. We hypothesized that 70% of subjects utilizing the novel musical metronome would maintain CPR compression rates between 100 and 120 cpm upon retesting at 6 weeks. Using these assumptions, 42 subjects from each group would allow us to test such difference with 80% power at a two-sided significant level of 0.05.

All Resusci®/Anne SkillReporter™ data were entered into an Excel spreadsheet (Microsoft Corporation, Redmond, WA) and analyzed using SAS 9.2 software (SAS Institute Inc., Cary, NC) with subject identifiers removed. Pearson’s χ² or Fisher’s exact tests were used for categorical variable comparisons. For continuous variables, two-sample t-test or Wilcoxon two-sample test were conducted based on the normality assumptions check. As both tests had the same results, 95% confidence intervals (CIs) and p values were reported using the t-test results.
Wilcoxon two-sample tests were used for ordinal survey data. Analysis of covariance modeling was used for controlling the baseline score when the outcome variable was continuous. Log-binomial regression was used to estimate the relative risk.

Data were analyzed using an intention to treat model and using all subjects and excluding extreme outliers. Excluding the extreme outliers did not affect the results, therefore, all results were reported using all subjects. Two-tailed $p$ values were calculated for all tests, and $p < 0.05$ was considered for statistical significance.

RESULTS

Characteristics of Study Subjects

A total of 96 subjects were initially enrolled in the trial, with 88 participants completing follow-up (see Figure 1). Fifty participants were randomized into the experimental group and 46 into the control group. Four participants from each group failed to complete follow-up. As shown in Table 1, the two groups did not show statistical difference by sex (52% vs. 40% male) or educational level (74% vs. 86% having completed some college, college graduate, some graduate or professional school training). The experimental group was significantly older, with a mean age of 20 ± 1.5 years vs. 19 ± 1.5 years ($p = 0.008$).

Main Results

When the mean individual compression rates were grouped for analysis into two groups: 100–120 cpm and other cpm (Table 2), it was noted that a higher but nonsignificant proportion of subjects were able to maintain 100–120 cpm in the experimental group (48% vs. 39%; relative risk = 1.23; 95% CI 0.77–1.95; $p = 0.382$). When the follow-up cpm rate was again stratified as 100–120 cpm and other rates (Table 2), significantly more of the experimental group were in the 100–120 cpm range (74% vs. 43%; relative risk = 1.72; 95% CI 1.17–2.55; $p = 0.003$). After adjusting for the baseline data, the experimental follow-up group still had more subjects in the 100–120 cpm range (relative risk = 1.76; 95% CI 1.20–2.58; $p = 0.0036$).

Secondary Results

During the initial assessment, the recorded mean compression rate for the control group (121 ± 21 cpm) was significantly higher when compared with the experimental group (109 ± 15 cpm; differences in means = 12 cpm; 95% CI 4–19 cpm; $p = 0.002$) (Figure 2A).

When the groups were assessed at 6-week follow-up, the recorded mean cpm rate was also higher among the controls compared to interventional subjects (120 ± 20 cpm vs. 111 ± 13 cpm; differences in means = 9 cpm; 95% CI 2–16 cpm; $p = 0.014$) (Figure 2B). In order to increase the precision in determining the effect of intervention on the 6-week follow-up results, we used analysis of covariance model, adjusted for the initial compression rate. The results showed no difference between intervention and control groups in the follow-up compression rate (95% CI of mean difference −3.1 to 10.3 cpm; $p = 0.4916$).

Mean compression depth did not vary in either group initially (control group 44.4 ± 10.1 mm vs. experimental group 40.6 ± 10.5 mm; difference in means = 3.8 mm; 95% CI −0.6 to 8.1 mm; $p = 0.09$) or at 6-week follow-up (control group 45.4 ± 9.5 mm vs. experimental group 41.6 ± 9.3 mm; difference in means = 3.8 mm; 95% CI −0.2 to 7.8 mm; $p = 0.06$). After adjusting for the baseline compression depth, there was no differences between the follow-up groups (95% CI mean difference −1.5 to 4.8; $p = 0.6706$).

Likewise, the percent of correct compressions also did not vary in either group initially (control group 28.4% ± 38% vs. experimental group 32.8% ± 37.4%; difference in means 4.4%; 95% CI −11% to 19.8%; $p = 0.57$) or at 6-week follow-up (control group 26.3% ± 34.3% vs. experimental group 24.5% ± 32.5%; difference in means = 1.8%; 95% CI −12% to 16%; $p = 0.798$). After adjustment for the baseline data, there were no differences between the follow-up groups (95% CI −12.7 to 15.2; $p = 0.9842$).

Survey results were analyzed for both control and experimental groups. As shown in Table 3, there was no significant difference between their comfort performing CPR or their perception of maintaining a rate of 100 cpm.

DISCUSSION

Our randomized, prospective study used a novel music metronome during the training of layperson CPR and demonstrated that both control and experimental subjects were able to maintain an effective compression rate range during initial testing. Groups did not differ in the effective delivery of compressions (depth or effective compression rates). However, on retesting 6 weeks after the initial training, experimental subjects more often maintained an effective compression rate as compared to control subjects, despite not having the music metronome available. Regardless of the intervention performed, providers had similar compression depth and proportion of correct compressions, both initially and at long term follow-up. The use of the musical metronome also did not impact the
subject’s confidence in performing CPR or their perception of being able to maintain the compression rates, if needed.

This study targets several concepts that are important. Initiation of layperson CPR improves survival in out-of-hospital cardiac arrest, but earlier studies have indicated that it occurs in only half of true arrests and most often does not achieve guideline parameters \cite{11,23,25}. Studies of medical providers during hospital resuscitations have demonstrated that most maintain compression rates < 80 cpm \cite{26}. The use of real-time audio-video feedback, and specifically metronomes, has been explored as a means to improve CPR compression rate guideline adherence. Kern et al. noted in a prospective randomized trial of medical providers, that metronome-assisted CPR significantly improved CPR

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{subject_enrollment_schema.png}
\caption{Subject enrollment schema. CPR = cardiopulmonary resuscitation.}
\end{figure}
performance (17). Other commercial systems have demonstrated similar results with other devices (15,16). Two prior studies have been performed using a musical metronome, each demonstrating an increased proportion of compressions being delivered at 100 cpm. Our study enrolled first-time nonmedical provider learners of CPR. This population is congruent with the AHA’s goal of broadening CPR training for bystander-initiated CPR, and more closely mimics a general population model likely to perform out-of-hospital CPR (27).

In this study, the primary outcome measure was compression rate adherence at long-term follow-up, in order to study how the intervention improved subject CPR recall and performance after training. An earlier non-randomized observation trial using medical providers and the same music metronome demonstrated improved compliance with compression rate guidelines at 6 weeks. However, that trial utilized medical personnel, lacked a control group, and enrolled a small number of participants (19). This prospective randomized design demonstrated that laypersons trained using the musical metronome were significantly more likely to maintain compression rate guidelines at 6 weeks, compared to those who were not trained using the musical metronome, while having similar compression depth and percent correct compressions.

A recent prospective randomized crossover trial performed in the United Kingdom (UK) was performed using Nellie the Elephant (by Little Bear, Little Acorns, Summerisle, 2001) or That’s the Way (I like it) (by KC and the Sunshine Band, The Best of KC and the Sunshine Band, EMI Records, 1990) during layperson CPR training, and demonstrated an increased proportion of subjects providing appropriate compression rates during skill testing (20). However, the use of the UK musical metronome also resulted in an increased proportion of compressions performed at an inadequate depth, and no difference in the proportion of correct compressions between groups. Based on their findings, Rawlins et al. recommended discontinuing the use of musical metronomes as a CPR learning aid; whereas, due to the improved compression rate adherence at long-term follow-up, we recommend employing musical metronomes.

We acknowledge that our mean compression depth was < 5 cm and the overall correct compression percentage was < 30%, but this did not vary between the experimental or control groups, either initially or at follow-up, suggesting different mechanisms are responsible for these measures. While some have demonstrated that metronome-guided CPR reduces the mean compression depth, Oh et al. felt this may be due to the multi-tasking required by the simultaneous use of auditory perception and CPR technique (20,28,29). However, Chung et al. noted that the mean compression depth were higher in > 100 cpm metronome-guided controls (30).

Furthermore, they demonstrated this effect was due to

Table 1. Subject Demographics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Controls</th>
<th>Experimental</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>24 (52.2)</td>
<td>20 (40)</td>
<td>0.232</td>
</tr>
<tr>
<td>Female</td>
<td>22 (47.8)</td>
<td>30 (60)</td>
<td></td>
</tr>
<tr>
<td>Education, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school graduate/GED</td>
<td>12 (26)</td>
<td>6 (14)</td>
<td>0.154</td>
</tr>
<tr>
<td>Some college, college graduate, or some graduate or professional school training (%)</td>
<td>34 (74)</td>
<td>37 (86)</td>
<td></td>
</tr>
<tr>
<td>Age (years), mean (SD)</td>
<td>19 (1.5)</td>
<td>20 (1.5)</td>
<td>0.008</td>
</tr>
</tbody>
</table>

GED = General Educational Development; SD = standard deviation.

Table 2. Compressions Per Minute between Experimental and Control Groups During the Initial and Follow-Up Assessments

<table>
<thead>
<tr>
<th>Initial assessment</th>
<th>Control Group (n = 46)</th>
<th>Experimental Group (n = 50)</th>
<th>Mean Difference or Relative Risk (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cpm</td>
<td>None</td>
<td>121 (21)*</td>
<td>109 (15)*</td>
<td>12 (4 to 19)</td>
</tr>
<tr>
<td>100–120 cpm</td>
<td>None</td>
<td>18 (39)*</td>
<td>24 (48)*</td>
<td>1.23 (0.77 to 1.95)</td>
</tr>
<tr>
<td>Other cpm</td>
<td>None</td>
<td>28 (61)*</td>
<td>26 (52)*</td>
<td></td>
</tr>
<tr>
<td>Follow-up assessment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean cpm</td>
<td>None</td>
<td>120 (20)*</td>
<td>111 (13)*</td>
<td>9 (2 to 16)</td>
</tr>
<tr>
<td>Adjusted</td>
<td>117.6 (22.7)*</td>
<td>114.1 (22.1)*</td>
<td>3.5 (−3.1 to 10.3)</td>
<td>0.492</td>
</tr>
<tr>
<td>100–120 cpm</td>
<td>None</td>
<td>18 (43)*</td>
<td>34 (74)*</td>
<td>1.72 (1.17 to 2.55)</td>
</tr>
<tr>
<td>Other cpm</td>
<td>None</td>
<td>24 (57)*</td>
<td>12 (26)*</td>
<td></td>
</tr>
<tr>
<td>Adjusted</td>
<td></td>
<td></td>
<td></td>
<td>1.76 (1.20 to 2.58)</td>
</tr>
</tbody>
</table>

CI = confidence interval; cpm = compressions per minute.
* Values are mean (standard deviation).
† Values are n (%).
the compression rate rather than the use of the metronome itself. In addition, the mean compression depth was improved without an increasing error rate when a metronome-guided rate of 120 cpm was utilized. Although these results were obtained using a manikin model and trained senior medical students, not CPR-naïve laypersons, Chung et al. recommended metronome guidance as a useful CPR guide, and concluded that it had no additional effect on rescuer fatigue (30).

Our study demonstrated a higher mean compression rate in the control group both initially and at 6-week follow-up. We feel these findings reflect a wider range of individual mean compression rates in the control group, as demonstrated by a larger control group standard deviation. However, when the compression rates were stratified according to 100–120 cpm or other (<100 or >120 cpm), experimental subjects initially (nonsignificant but trending) and at long-term follow-up more often maintained adequate compressions. The maximal chest compression rate that best optimizes outcomes has not been precisely established. For this study, 120 cpm was chosen as the upper limit because approximately 120 cpm has been noted to achieve maximum calculated cardiac output, have maximal measured coronary perfusion pressure, and is cited as the lower boundary for ventricular tachycardia, a tachydysrhythmia that reduces cardiac output coronary perfusion pressure (31–33). In addition, a recent analysis of 133 patients receiving prehospital CPR noted that rates > 120 cpm were associated with a statistically significant decreased compression depth (34). One hundred beats per minute was chosen as the lower limit because this represents the AHA CPR guidelines at the time of the study (9).

The musical metronome we employed was easily implemented into established CPR training curriculums and required very little additional training. The song we utilized (Bee Gees Stayin' Alive) is a popular song in the United States that is well recognized and memorable. However, any song using a cadence of 100 bpm could be theoretically substituted. Several other songs that have a similar cadence have been proposed but not studied and include Another One Bites the Dust (Queen, EMI Music Publishing), Under Pressure (Queen and David Bowie, EMI Music Publishing), and Achy Breaky Heart (Billy Ray Cyrus, Mercury Records) (20,29). The use of a musical metronome is attractive because it requires little additional technology, is inexpensive, and can be easily utilized by nonmedical bystanders. The use of the song Stayin' Alive also places a positive focus on public participation in out-of-hospital cardiac arrest and has been featured on several public service campaigns promoting bystander CPR. The effect of a publically accepted and easily remembered musical metronome with compression-only CPR, may further improve bystander CPR rates.

Table 3. Survey Results

<table>
<thead>
<tr>
<th>Question (1–5 Likert Scale: 1 strongly disagree, 5 strongly agree)</th>
<th>Survey</th>
<th>Control, Mean (SD)</th>
<th>Experimental, Mean (SD)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>“If needed, I would be comfortable performing CPR.”</td>
<td>Initial</td>
<td>4.00 (0.67)</td>
<td>4.02 (0.74)</td>
<td>0.598</td>
</tr>
<tr>
<td>“I can easily keep a tempo of 100 cpm.”</td>
<td>Initial</td>
<td>3.83 (0.68)</td>
<td>3.90 (0.86)</td>
<td>0.434</td>
</tr>
<tr>
<td>“If needed, I would be comfortable performing CPR.”</td>
<td>Follow-up</td>
<td>3.88 (0.86)</td>
<td>3.87 (0.58)</td>
<td>0.588</td>
</tr>
<tr>
<td>“I can easily keep a tempo of 100 cpm.”</td>
<td>Follow-up</td>
<td>3.69 (0.68)</td>
<td>3.61 (0.77)</td>
<td>0.531</td>
</tr>
<tr>
<td>“I am able to perform lifesaving care for a person.”</td>
<td>Follow-up</td>
<td>3.88 (0.71)</td>
<td>3.87 (0.54)</td>
<td>0.976</td>
</tr>
</tbody>
</table>

cpm = compressions per minute; CPR = cardiopulmonary resuscitation; SD = standard deviation.
Limitations

Several factors may limit the results noted in this study. Our layperson population was comprised mostly of young undergraduate students from a single site, possibly lending to selection bias. Although they had limited understanding and experience with CPR, their physical endurance may be different than other more diverse layperson populations, especially those more likely to perform CPR. Subjects were statistically different in age between the intervention and control groups (19 vs. 20 years), but we felt this was not clinically different. Subjects and instructors could not be blinded to the use of the musical metronome during the instructional phase of the study. However, no specific or special emphasis was placed on the musical metronome over other standard CPR measures being taught to the interventional group. In addition, the control and intervention groups were separated physically and temporally, limiting feedback among the groups. Although study participants were asked not to share details of the interventions they received during their arm of the study with other subjects, contamination may have occurred. It is possible that control subjects may have been aware of the use of a musical metronome before enrollment. However, our study occurred before any national AHA awareness campaigns that highlighted the musical metronome, and participants could not be enrolled if they had received CPR training within 5 years of the study. Subjects were not queried as to any additional CPR training experiences they may have incurred during the 6-week follow-up period, either formal or informal. Due to scheduling issues, there was some irregularity in using the four-subject block randomization strategy, which resulted in a slightly greater than anticipated enrollment in the control group vs. the intervention group (50 vs. 46 subjects). Our sample size was small, with eight subjects lost to follow-up. Although we achieved the target enrollment for our primary outcome, differences between secondary outcomes may have varied with a larger population. Current 2010 AHA CPR guidelines support a target compression rate of at least 100 cpm, but we stratified our ideal cpm range as between 100 and 120 cpm, as earlier studies have shown cardiac output and coronary perfusion pressures are decreased with higher compression rates. However, how this ideal stratification would transfer to the cardiac arrest victim, especially with potential interruptions in CPR, is unknown.

CONCLUSIONS

In summary, utilization of a novel musical metronome during standard CPR training of laypersons improved the proportion of subjects performing appropriately paced chest compressions during long-term follow-up, even without the music aid being played. Introduction of the music metronome had no effect on chest compression depth or the percentage of correct compressions at initial or follow-up testing, although these measures were low in both populations. The music metronome also had no effect on participant’s willingness to perform CPR or their perception of maintaining an adequate compression rate. The use of a music metronome represents an easily taught, cost-effective modality to assist laypersons in performing properly paced chest compressions. Additional research on a larger, heterogeneous population, as well as health care workers, is warranted.

REFERENCES

ARTICLE SUMMARY

1. Why is this topic important?
   Bystander cardiopulmonary resuscitation (CPR) improves survival for victims of cardiac arrest. Effective CPR requires 100 compression per minute (cpm), but CPR is rarely performed correctly. A novel musical aid has been proposed as a metronome, allowing improved compression rate adherence.

2. What does this study attempt to show?
   This study seeks to test the usefulness of a musical metronome (100 beats/min cadence of The Bee Gees song “Stayin’ Alive” [Saturday Night Fever, The Original Movie Soundtrack; Polygram International Music, 1977]) to improve layperson long-term compliance with CPR compression rate guidelines.

3. What are the key findings?
   Subjects trained to use a musical metronome more often maintained an adequate compression rate (100–120 cpm) at ≥ 6-week follow-up compared to control subjects. No compression rate differences were noted between groups initially.

4. How is patient care impacted?
   The use of a musical metronome during layperson CPR training is a low-cost measure that improves long-term compression rate compliance.