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# Impact of verbal pressure on CPR and AED performance: a randomized simulation study

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**Abstract:** **Objective:** The aim of this randomized-controlled simulation study was to evaluate the impact of external verbal pressure on the effectiveness and safety of automatic external defibrillator (AED) use and hands-on cardiopulmonary resuscitation (CPR) performed by students.

**Methods:** Sixty-two first-year nursing students were recruited. Participants were split into pairs (n=31), randomly assigned to the study (n=16 pairs) and control groups (n=15 pairs). Subsequently, each pair took part in a brief simulation scenario concerning out-of-hospital cardiac arrest. One student was responsible for performing chest compressions, whilst the second was responsible for using an AED. The researcher verbally pressed the participants responsible for AED use in the study group. Students performing chest compressions were not the addressee of any comments. Participants in the control group acted without the researcher's pressure.

**Results:** Only 2 participants in the control group used AED incorrectly, compared with 8 participants in the study group who incorrectly performed defibrillation. The rate of hands-on CPR was significantly faster in the study group compared to the control group (124±29.7 versus 104±20.8; P=0.028).

**Conclusion:** Verbal pressure in simulation settings significantly diminishes the quality of performance during AED use. The pressure affected not only the participants to whom it was directly addressed but also their teammates, who performed worse compared to those without additional stressors.

**Keywords:** Automatic External Defibrillator; Cardiopulmonary Resuscitation; Verbal Pressure

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## 1. Introduction

Cardiovascular diseases are still one of the most common causes of death all around the world. Some cardiological conditions (e.g., acute coronary syndrome or myocarditis) lead to ventricular arrhythmias and, as a result, to cardiac arrest (1). The annual incidence of out-of-hospital cardiac arrest (OHCA) in Europe ranges between 67 and 170 per 100 000 inhabitants (2).

Witnessing OHCA is typically associated with increased stress levels and emotional distress, especially in non-medically educated individuals. Medical professionals are not free from adverse feelings, but they should keep calm in the face of a life-threatening condition. However, some of them show a tendency to use verbal pressure in stressful situations (3).

In spite of the high level of stress for witnesses, there is a need for quick first aid to maximize the chances of survival for OHCA patients. Key tasks to be completed are good-quality chest compressions and an immediate defibrillation (made with automated external defibrillator (AED)), if the device is available (4). AEDs are getting widely available in public spaces, such as shops and churches. Defibrillation using an AED device is user-friendly and intuitive. The device provides all necessary audio instructions and legible graphics. It is considered safe to perform defibrillation, unless anyone touches the patient during the shock.

Moreover, resuscitation providers need to stay calm and focused in order to manage emotional stress during critical moments. The direct effect of verbal pressure made during cardiopulmonary resuscitation (CPR) has not yet been investigated. Despite this fact, it is known that external distractors and high levels of stress are unfavourable in emergency medicine (5-9). Recently, non-technical aspects of resuscitation have been getting more understood. However, there are still some research gaps to fulfil (10).

This randomized-controlled simulation study aimed to evaluate the impact of external verbal pressure on the effectiveness and safety of AED use and hands-only CPR performed by students. The objective was to determine whether the pressure directed at one team member affects the performance of the whole team.

## 2. Methods

Sixty-two first-year nursing students, who did not participate in any previous CPR training during their studies, were recruited. All participants signed written consent before the simulation. Participation was fully voluntary; no personal data was collected. Participants were paired (n=31) and randomized using a simple random number generator into a study group (n=16 pairs) and a control one (n=15 pairs). Initially, all participants received a short CPR instruction (verbal and presentation) on how to perform proper chest compression and the use of an AED. Subsequently, each pair took part in a brief simulation scenario concerning an OHCA. One student was performing chest compressions, while the other was responsible for using an AED. Each time, shock was advised by the device, and the scenario ended once it was delivered. At the start of the simulation, participants were informed that the prehospital medical care system had been informed, the environment was safe, and they could start their tasks immediately.

The team leader measured the time from the beginning of the scenario to AED shock delivery. The correctness of AED use was evaluated by pad placement and whether the shock was delivered without anyone touching the patient. The quality of chest compressions was assessed using the manikin Prestan 2000 (combined with a mobile app that stores performance data). It enables the collection of data: depth and rate of chest compressions, recoil accuracy (%), and hands-off time.

In the study group, the person responsible for the use of AED was experiencing verbal pressure from the researcher using words: 'hurry up with the defibrillator', 'faster!', 'Come on, he is dying!' The pressure was delivered by the same person for each participant; standardized phrases (as above) were used. The pressure was only directed towards the participant who was preparing to perform defibrillation; the students performing chest compressions did not receive any comments. This is crucial, since the intervention did not intend to accelerate the chest compression rate. All participants were asked to perform the best CPR they possibly could - according to the instructions received previously. The participants of the control group performed the task without the researcher's verbal pressure.

No footage has been recorded; therefore the evaluation was conducted live. As a result, no blinding of the evaluator could be implemented. Statistical analysis was conducted using Jamovi software, the significance threshold at $P<0.05$ was set. The U Mann-Whitney test and chi-squared analysis were performed. Lavene's test revealed that the assumption of equal variances was not met so Student's t-test was not applied.

## 3. Results

Verbal pressure applied towards a student responsible for defibrillation decreased the quality of the performance of the whole team. Defibrillation under verbal pressure was performed significantly faster but with more errors than in the control group. The pressure affects the student responsible for chest compressions as well.

General characteristics and results are presented in the table 1. In the control group, only 2 participants used AED incorrectly. Both participants performed shock whilst their partner was touching the patient and one of them placed pads incorrectly (both pads in front of the chest). In the study group, 8 participants used AED incorrectly: two participants defibrillated while the patient was being touched, in 4 cases pads were placed in front of the chest, one participant placed the right pad on the abdomen and another one placed both pads at the right side of the chest. Overall, participants exposed to verbal pressure performed more quickly, but with higher rate errors. Participants in the study group who were responsible for hands-on CPR performed chest compression at a significantly higher rate than the control group ones. Most of them were performing the compressions with the rate greater than 120/minute, which exceeds the recommended rate. Moreover, significant negative correlation was observed between chest compression rate and relaxation (rho = -0.489; P-value = 0.005). Having said that, those who perform chest compressions too fast tend not to perform proper chest recoil.

## 4. Discussion

It is well established that high levels of stress are associated with worse performance in emergency medicine (5,6). External distractors worsen the quality performance during critical care simulation as well (7-9). However, no direct evidence was provided linking verbal pressure made by a leader (rushing up) with performance during CPR. A pilot study suggesting some advantages of verbal pressure in emergency medicine has been published, but sample size is a significant limitation of this study (11).

In our study, rushing up reduced the time from the start of the scenario to AED shock but significantly increased the frequency of errors. Even if time to defibrillation is crucial for survival, this must be done correctly. Although participants in the study group delivered AED shocks earlier, more errors were committed, and fewer focused on graphics that informed about pad placement.

Significant differences between the study and the control group were observed despite the brief duration of the scenario. These differences include chest compression rate and chest recoil quality. None of the participants performing CPR were directly pressured, yet findings indicate that verbal pressure directed at the other group members affected the quality of their performance. While it remains unclear whether the pressure was acting as a distractor or a stressor, it nonetheless negatively impacted the performance of the whole group.

Recently, awareness of the impact of distractors in emergency medicine has increased significantly, however, notable gaps still require further investigation. Noise, for example, is known to be a factor which reduces the quality performance of medical professionals (12-14). The combination of noise with increased stress (as a result of verbal pressure), could explain poorer performance among participants in the study group responsible for AED use. Additionally, verbal pressure directed to the colleagues reduced the quality of chest compressions within the study group (even though CPR providers were not the direct recipients of verbal pressure). This phe-

**Table 1** Study results

| Feature | | Study group (n=16 pairs) | Control group (n=15 pairs) | P-value |
|---|---|---|---|---|
| Age (years) | | 31.6±7.7 | 32.5±8.6 | 0.548 |
| Females: males | | 31: 1 | 28: 2 | 0.516 |
| AED | Correct use | 8 (50%) | 13 (87%) | 0.029 * |
| | Misuse | 8 (50%) | 2 (13%) | |
| | Times (s) | 55.0±18.1 | 72.4 ±22.0 | 0.009 * |
| Chest compressions | Depth (cm) | 6.32±0.03 | 6.20 ±0.24 | 0.999 |
| | Relaxation (%) | 82.4±24.1 | 92.0±13.9 | 0.074 |
| | Rate (n/minute) | 124±29.7 | 104±20.8 | 0.028 * |
| | Rate < 100 /min | 2 (12%) | 6 (40%) | 0.080 |
| | Rate ≥ 100 /min | 14 (88%) | 9 (60%) | |
| | Rate > 120 /min | 10 (62%) | 4 (27%) | 0.045 * |
| | Rate ≤ 120 /min | 6 (38%) | 11 (73%) | |

AED: Automatic external defibrillator

nomenon can be also explained as an effect of cognitive overload which reduces effectiveness, especially among less experienced participants (15). All these factors mentioned above can be overcome with the experience, that is why simulation practice can play a major role preparing healthcare workers for stressful situations (13-15).

Cognitive overload is defined as 'the situation in which the demands placed on a person by mental work are greater than the person's mental abilities can cope with'. It is a result of limited capacity of memory to process a particular amount of information. Overload reduces the effectiveness of learning. Three different types of cognitive load have been distinguished: intrinsic one (related to the difficulty of a task), extraneous one (mental resources expended on elements that are not directly contributed to the activity), and germane one (proportion of working memory contributed to organizing information into long-term memory) (16). Verbal pressure applied in this study is a source of extraneous load, which reduces memory resources, which should be directed into the proper performance.

The level of overload is associated with student performance in medical simulation settings. The outcome is worse, even if students are trained in the field (16-18). Emotions are not neutral in this field. Increased invigoration and reduced tranquillity correlate positively with cognitive load experienced by students during simulation training (17). Theoretically, some level of cognitive load is necessary in the process of learning. Stress stimulates and consolidates memory; hence it is beneficial at controlled levels (18). Cognitive load and stress cannot be fully eliminated both in medical simulation and real-life emergencies, but they need to be managed properly. Students and trainees need to learn how to cope with their emotions and redirect them favourably.

Participants' stress during medical simulations is a complex problem. Its level depends on scenario fidelity, general academic performance of students, habituation, as well as anticipatory anxiety. Stress severity can be measured with proper scales, as well as physiological reactions (e.g., heart rate, blood pressure, respiratory rate, skin conductance, or cortisol concentration). What is important is that simulation settings cannot fully replicate the stress experienced during acute cases that trained medical professionals face at work. This tool is fruitful, especially in the evaluation of students' performance. The proper level of stress is beneficial because it stimulates the learning process, which is particularly important for students (19).

Stress, especially chronic stress, has indirect but significant effects. They cover professional burnout, depression, sleep disorders and addictions (20). Acute stress in a critical condition is integral, but it needs to be worked through. The role of debriefing should be mentioned here as an extremely beneficial tool for critical care teams. It can help overcome the adverse effects of stress and improve the future performance of team members (21).

It is worth mentioning that negative correlations between relaxation and chest compression rate have been observed in previous studies as well. An increased rate of chest compressions reduces the time for proper chest recoil. As a result, insufficient blood return occurs, which decreases the CPR effectiveness and potentially reduces the chance of OHCA survival (22,23).

The results seem promising, yet the study is not without significant limitations. Sample size is quite small (31 pairs), hence, a confirmation study with a greater group of participants is needed in order to increase the power of the obtained statistics. Moreover, the research has engaged only nursing students at an early stage of their education. Investigating the effects of verbal pressure on experienced medical professionals would be valuable. Additionally, verbal pressure characteristics vary between individuals. Variety of intensity, volume, and words used in communication could affect CPR providers in a different way, which should be also addressed in future studies. Blinding of the evaluator could strengthen the power of conclusions of future research on this topic. Nevertheless, it would be extremely difficult to perform complete blinding in the context of such a study.

The study brings us new insights with potential implications for simulation training. Currently, training programs rarely implement elements of external pressure. Students and trainees usually practice in calm and quiet environments. Consequently, they are not prepared to work under external pressure from their team leaders or patients' relatives. It is therefore recommended to address this issue at both the academic and non-professional levels while educating for resuscitation.

## 5. Conclusion

Verbal pressure plays a significant role in the performance of CPR and AED use. When applied to individuals without a healthcare background, such as during out-of-hospital cardiac arrest, it may significantly reduce the quality of CPR and negatively impact the safety and effectiveness of AED use. This effect is observed even when the individual is not the target of the pressure.

## 6. Declarations

### *6.1. Acknowledgement*

None.

### *6.2. Authors' contribution*

All authors contributed to the manuscript equally.

### *6.3. Conflict of interest*

None.

### *6.4. Funding*

None.

### *6.5. Ethical considerations*

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study does not require bioethics committee approval because conducted simulator studies are not subject to such evaluation. All participants gave written voluntary consent to participate in the study. The students were not gratified in any form.

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