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SHORT COMMUNICATION

The quality of defibrillation performance among students of the University of Medical Sciences

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Abstract The major objective was to assess the time period from a witnessed ventricular fibrillation (VF) to the first defibrillation (DEF) in a simulated manikin scenario, while the minor objective was to analyze the most common errors that occurred during DEF and the maintenance of 2-min intervals during resuscitation. We examined 210 students (medical faculty students, MF; and paramedic faculty students, PF) who had to treat a patient with VF. In the study we used the Laerdal® Training Manikin and the Zoll M Series® defibrillator. The mean time period from the witnessed VF to the first DEF was 50.1 s (SD 32.5 s) in the MF group and 62.9 s (SD 36.9 s) in the PF group (no statistically significant difference). The delay resulted from the lack of constant ECG monitoring and charging in the option "Monitor" instead of the option "Defibrillation." The PF group shortened the 2-min cycles between defibrillations. The problems observed during the study were technical and educational. We concluded that the option "Monitor" should be removed from the equipment because it seems to be redundant. The teaching problems were a lack of constant ECG monitoring, incorrect handling of the defibrillator, and not keeping to 2-min loops of CPR.

Keywords Defibrillation · Ventricular fibrillation · Education · Advanced Life Support Guidelines

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Defibrillation (DEF) is the most effective initial treatment of ventricular fibrillation (VF) and pulseless ventricular tachycardia [1]. The time to defibrillation is still the most important factor affecting survival in cardiac arrest [2]. While teaching trainees, we need to emphasize the role of immediate rhythm recognition and quick defibrillation in cases of VF. The major objective of the present study was to assess the time period from a witnessed VF to the first defibrillation in a simulated manikin scenario. The minor objective was to analyze the most common errors occurring during the defibrillation and the maintenance of 2 min intervals during resuscitation (CPR), according to the ALS.

We investigated 210 students recruited from our University of Medical Sciences, who agreed to participate in the survey. One group (168 students) consisted of third-year Medical Faculty students (MF). The other group (42 students) included third-year students of the Paramedic Faculty (PF). During the study, we had to exclude 32 MF and 10 PF students because of their dangerous performances of the defibrillation procedure. Thus, the final test included 136 MF and 32 PF students. We used a simulation technique with proven efficacy in education [3]. The students' task was to treat a 55-year-old patient at the Emergency Department who was suffering from chest pain. At the beginning, the patient was conscious, with sinus rhythm (100/min) and preserved blood pressure (110/60 mmHg). Four students formed a rescue team with a leader responsible for the whole procedure, particularly the ECG analysis and DEF. The leader put self-adhesive electrodes on the manikin's chest and connected them to the monitoring system of the manual Zoll M Series® defibrillator (the II lead was obligatory). Students were instructed to observe the ECG signal continuously. The next two were in charge of pulse checks, chest compressions, breathing assessment, and artificial ventilation. The fourth member inserted an

intravenous catheter and administered drugs. The patient was supposed to develop VF, and the group had to perform resuscitation according to the ERC Guidelines 2005. The procedure was finished just after the third defibrillation had been completed. During the study, we assessed the following issues: (1) how quickly students responded to the sudden occurrence of VF, and how long it took to perform the first defibrillation; (2) the most common errors made during the defibrillation procedure; (3) keeping to 2-min intervals during resuscitation. In order to check the time period from a witnessed VF to the first DEF we used the Sensored ALS Skill Master Interactive Training Manikin from Laerdal®, which was connected to a computer with Laerdal® HeartSim 4000 software that continuously recorded all the data. For the purpose of our study, we used a Zoll M Series® biphasic defibrillator with a Zoll Linear Flash 4 MB memory card (100 MHz)®. We measured the following time intervals: (1) from the onset of the VF to the moment when the defibrillator was switched to the "Defibrillation" (D) option; (2) from setting the defibrillator to the D option to the first defibrillation (DEF1); (3) from readiness after charging the defibrillator to the DEF1; (4) the total interval of time from the onset of the VF to the DEF1; (5) the total interval of time between the DEF1 and the second defibrillation (DEF2); and (6) the total interval of time between the DEF2 and the third defibrillation (DEF3). The statistical analysis was performed with Statistica, version 7.1 (StatSoft, Inc. 2005). Qualitative variables were expressed as means with standard deviations (±SD). In order to compare intervals between defibrillations, we used the *t*-test, because the data had a normal distribution. The Mann–Whitney *U* test was applied to identify any differences between the groups. *P* values of <0.05 were considered statistically significant.

The results are presented according to the aims of the study. (1) The time interval from the onset of VF to the first defibrillation was extended in both groups. The MF students reacted to the onset of VF faster than the PF students, particularly at the beginning of the procedure (Table 1). Statistical analysis of the particular elements of the first defibrillation performed by the groups was not significant (Mann–Whitney *U* test; $P > 0.05$). (2) The most common error was not switching the defibrillator from the "Monitor" to "Defibrillation" mode. This type of mistake led to 75% of the errors performed by MF students and 80% of those done by PF students. This was reflected in the extended time interval from the onset of the VF to the moment at which the defibrillator was switched to the D mode. The other error was connected with attempts to perform defibrillation during charging. (3) MF students kept to 2-min CPR cycles between defibrillations more strictly.

We chose two groups of students, as they were taught by different teachers. During the classes in the MF group, special attention was placed on the role of early defibrillation in the final outcome of the victim. The discussion with the PF group revealed that such information was not highlighted during their course. This was probably the reason for the delay in defibrillation in the PF group. The students had no problems interpreting the ECG. Most of the questions arose regarding the decision of whether or not to defibrillate, and about which procedure—CPR or defibrillation—should be used first. The VF and VT are simple rhythms to recognize. Thus the correct interpretation of more sophisticated electrocardiograms was not satisfactory, as also reported by Lever et al. [4]. In spite of previous exercises, students still seemed to be unfamiliar with the defibrillator. The manual Zoll M Series® defibrillator

Table 1 Statistical analysis of how quickly students (136 from the Medical Faculty, MF; 32 from the Paramedic Faculty, PF) responded to the sudden occurrence of ventricular fibrillation (VF), and how long it took to perform the first and next defibrillations (DEF)

Mean times (±SD) of particular parts of the defibrillation procedure	
1. Time interval (in s) from the onset of the VF to the moment at which the defibrillator was switched to the "Defibrillation" option	
MF 31.1 (±25.3)	PF 44.1 (±37.9)
2. Time interval (in s) from setting the defibrillator to the "Defibrillation" option to the first defibrillation (DEF1)	
MF 18.8 (±11.2)	PF 18.8 (±6.3)
3. Time interval (in s) from readiness after charging the defibrillator to the DEF1	
MF 2.5 (±1.7)	PF 2.8 (±1.5)
4. The total interval of time (in s) from the onset of the VF to the DEF1	
MF 50.1 (±32.5)	PF 62.9 (±36.9)
5. The total interval of time (in s) between the DEF1 and the second defibrillation (DEF2)	
MF 122.2 (±25.7)	PF 97.9 (±34.9)
t test: $t = -2.2$; $df = 39$; $P = 0.031$	
6. The total interval of time (in s) between the DEF2 and the third defibrillation (DEF3)	
MF 122.9 (±23.1)	PF 88.1 (±27.4)
t test: $t = -3.5$; $df = 38$; $P = 0.001$	

has the following options: "Pacing," "Off," "Monitor," and "Defibrillation". The defibrillation is possible only in "Defibrillation" mode. The most pronounced mistake was a failure to switch the defibrillator from the "Monitor" mode to "Defibrillation." Thus, the students tried to perform DEF although it was technically unfeasible. The option "Monitor" confused the students and delayed DEF. ECG monitoring was also possible in the "Defibrillation" mode. The other cause of delay was connected with attempts to perform defibrillation during charging. We could have avoided this error by increasing the number of defibrillation exercises. Having analyzed the time period from readiness after charging the defibrillator to DEF, we discovered a steady period with no statistical significance in both groups. This could not have been shortened and ultimately had no influence on the DEF. We found no statistical correlation between the two groups of students in the time intervals from the onset of VF to DEF. This result does not mean that the students' reaction times were fast enough. The extended reaction time to the onset of the witnessed VF in both groups could be considered extremely dangerous: any delay in DEF decreases its effectiveness [2].

The MF students maintained the appropriate time intervals between defibrillations. We noticed a general trend towards extending CPR cycles. Extending the duration of chest compressions is not harmful; this is consistent with Ewy et al. [5], who suggested minimally interrupting chest compressions. On the other hand, the PF students' mean values for the DEF1–DEF2 and DEF2–DEF3 periods were shortened and were connected to very quick rates of chest compression during CPR. Keeping to 2-min cycles was recommended by the guidelines, and the teachers should have paid more attention to the quality of CPR during advanced life support (ALS) training. The teachers of the MF group expressed particular concern about the quality of CPR loops. Their thorough explanation of why strict adherence to the guidelines is so important helped these students to keep to the recommended 2-min loops. This was not the main priority of the teaching in the PF group, who shortened the CPR loops significantly. After the test, the students emphasized the influence of stress in the decision about DEF. Perhaps more attention should be placed on coping with stress. All of the participants accentuated the usefulness of the simulation techniques, but there is always more to do if we want to improve teachers' efficacy in education.

The problems observed during the study stemmed from technical and educational issues. The main technical problem causing an extension in the time to the first defibrillation resulted from a technical issue. The option "Monitor" did not allow for defibrillation, but the option "Defibrillation" enabled monitoring. We concluded that the option "Monitor" should be removed from the equipment. The educational issue was connected with the teaching of a quick reaction to the shockable rhythm. We can also suggest some technical improvements for defibrillators, such as an acoustic signal followed by a voice command to defibrillate when VF occurs on the monitor (similar to AED). We can also propose some improvements to the teaching: more attention should be paid to continuous ECG observation, the time allotted to students to familiarize themselves with the various equipment should be increased, and different kinds of defibrillators should be used during training. Not all teachers accentuate the importance of 2-min loops of resuscitation during teaching. The trend observed in our country for limiting practical postgraduate training among young doctors supports the opinion that the quality of teaching during university courses should be of the highest standard.

Conflict of interest There are no conflicts of interest.

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