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Simulation and education

Use of an electronic decision support tool improves management of simulated in-hospital cardiac arrest☆

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ABSTRACT

Introduction: Adherence to advanced cardiac life support (ACLS) guidelines during in-hospital cardiac arrest (IHCA) is associated with improved outcomes, but current evidence shows that sub-optimal care is common. Successful execution of such protocols during IHCA requires rapid patient assessment and the performance of a number of ordered, time-sensitive interventions. Accordingly, we sought to determine whether the use of an electronic decision support tool (DST) improves performance during high-fidelity simulations of IHCA.
Methods: After IRB approval and written informed consent was obtained, 47 senior medical students were enrolled. All participants were ACLS certified and within one month of graduation. Each participant was issued an iPod Touch device with a DST installed that contained all ACLS management algorithms. Participants managed two scenarios of IHCA and were allowed to use the DST in one scenario and prohibited from using it in the other. All participants managed the same scenarios. Simulation sessions were video recorded and graded by trained raters according to previously validated checklists.
Results: Performance of correct protocol steps was significantly greater with the DST than without (84.7% v 73.8%, $p < 0.001$) and participants committed significantly fewer additional errors when using the DST (2.5 errors vs. 3.8 errors, $p < 0.012$).
Conclusion: Use of an electronic DST provided a significant improvement in the management of simulated IHCA by senior medical students as measured by adherence to published guidelines.

1. Introduction

The practice of hospital-based and perioperative medicine requires the knowledge and application of many diverse acute care skills, including the management of in-hospital cardiac arrest (IHCA). The presence of advanced cardiac life support (ACLS) trained providers and adherence to published guidelines for the management of cardiac arrest are associated with improved outcomes.[1–6] However, management skills and appropriate application of ACLS guidelines have been shown to quickly fade after training.[7–9] Furthermore, current evidence shows that sub-optimal resuscitation is common in both medical and surgical patients.[3,4,10–13]

During rapidly evolving or deteriorating patient conditions, there is often insufficient time for physicians to re-familiarize themselves with current guidelines. Although both paper and electronic aids may facilitate guideline adherence during the management of acute patient instabilities or cardiac arrest,[14–16] there is also evidence that cognitive aids can negatively affect the way in which providers deliver care during cardiac arrest.[17,18] Therefore, we sought to determine whether the use of an electronic decision support tool (DST) that dynamically guides a provider through American Heart Association (AHA) ACLS protocols would improve performance during high-fidelity simulations that require the management of acute dysrhythmias and IHCA.

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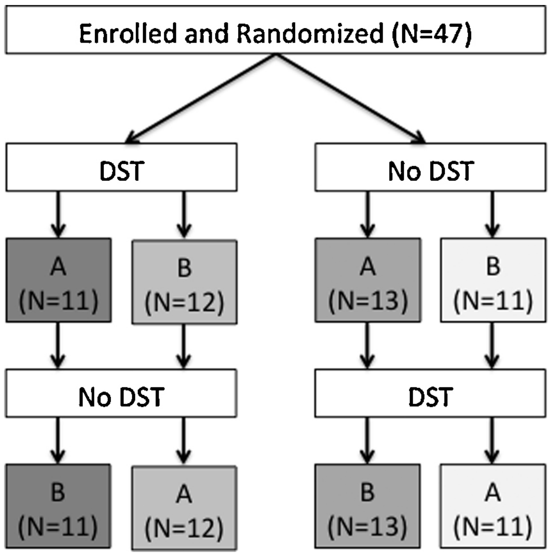

Fig. 1. This figure illustrates participant randomization and allocation. Participants were randomized to one of four pathways, representing an equivalent to randomizing both the order of DST use and the order of Megacode scenario testing. After they managed the first Megacode scenario, they then managed the remaining scenario with or without the DST, opposite from how they managed the first scenario. [DST = decision support tool; A = Megacode scenario A; B = Megacode scenario B].

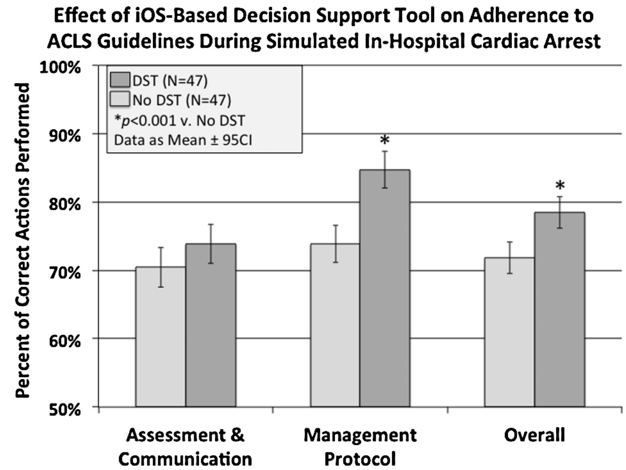

Fig. 2. This figure illustrates the difference in performance based upon use of the DST as measured by the percentage of correct actions completed during a simulated IHCA. Of note, the DST did not make a significant difference in assessment of the patient, but did significantly improve adherence to the management protocol. [DST = decision support tool].

2. Methods

2.1. Study design

After IRB approval was granted, written informed consent was obtained from 47 ACLS-certified senior medical students one month prior to graduation (26 females, 20 males). Each participant was issued an iPod Touch™ device (Apple Inc., Cupertino, CA) on which the DST was installed. They were given a brief orientation (∼30 min) to the use of the DST user interface and to the simulation environment, the simulator mannequin (SimMan 2G®, Laerdal, Inc., Stavanger, Norway), and all equipment to be used during the study (defibrillator, monitors, etc.).

Each participant managed two high-fidelity simulation scenarios involving IHCA in a cross-over design (see Fig. 1). In order to remove bias in performance due to any potential difference in scenario difficulty or due to DST order, participants were assigned to one of four combinations as shown in Fig. 1 through a random number generator. The scenarios were constructed according to AHA testing standards for Megacode scenarios where a participant manages an acute dysrhythmia in a pulsatile state, then a shockable pulseless state, and then a non-shockable pulseless state. Scenario A consisted of the patient presenting with unstable bradycardia proceeding to ventricular fibrillation and finally to asystole. Scenario B consisted of the patient presenting with a narrow complex stable tachycardia proceeding to pulseless monomorphic ventricular tachycardia and finally to PEA.

We performed all simulation sessions in a setting that replicated a patient room on a general care ward at our institution. The code cart and defibrillator used during these events replicated those in clinical use at our institution, as did the available medications, intravenous (IV) fluids, IV lines, medical gases, and airway devices. Each participant was told to assume the role of the physician team leader responding to a code in the university hospital. All other roles (chest compressions, airway manager, drug administration, and defibrillator manager) were played by a standardized code team that was comprised of simulation center staff trained to respond with consistent scripted responses.

The DST was programmed for the Apple iOS and deployed on iPod™ devices, as noted above. The Appendix shows screen shots from the DST through which the user would navigate during a brief patient assessment and then management. The management steps programmed into the DST were based upon the 2005 AHA ACLS update.

2.2. Analysis and grading

Each session was video recorded via a multi-camera system and B-line Medical® software (B-line Medical, Washington, DC) and then graded by two experienced raters according to previously validated scoring checklists derived from AHA training manuals.[19] A score for the percentage of correct actions performed was recorded. Since only errors of omission (i.e. not doing a prescribed action) are captured in the percentage of correct steps, errors of commission were recorded in a separate error count (e.g. shocking a patient in asystole).

Global performance on each scenario was compared so that any bias due to scenario difficulty could be taken into account. With no demonstrable difference in global performance between scenario A and scenario B, further adjustment of the analysis model to account for scenario difficulty was not needed. The averaged correct actions and error count scores for each participant were used in the analysis, one from the scenario managed with the DST and one from the scenario managed without the DST. Another sensitivity analysis was also performed that took into account whether the DST was used first or second, but no difference was found. Therefore, the percent correct actions and the error counts were analyzed through an ANOVA to compare performance with and without the DST. Data are presented as mean ± 95% CI for continuous variables and $p < 0.05$ was considered significant.

3. Results

Overall, as seen in Fig. 2, the total number of correct checklist items during high-fidelity simulation of IHCA was significantly improved with the iOS-based DST compared to management from memory alone (78.4% vs. 71.8%, $p < 0.001$). Further analysis by checklist item type revealed that the number of correct management steps was significantly improved with the use of the DST (84.7 vs. 73.8%, $p < 0.001$), while the number of patient assessment steps did not appear significantly improved (73.8 v 70.4%,