Research

Out-of-hospital cardiac arrest protocol comparison

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Abstract

Background

Early identification of out-of-hospital cardiac arrest (OHCA) has been proven to increase survival rates. Toward this goal, emergency medical dispatchers commonly use one of two types of emergency medical dispatcher systems, each with a unique OHCA protocol. The criteria-based dispatch (CBD) protocol is a set of guidelines and prompts intended for dispatchers with clinical background and experience, while the medical priority dispatch (MPD) is a scripted caller interrogation protocol intended for non-healthcare dispatchers. The objective of this study was to compare CBD and MPD protocols in terms of accuracy and duration of the identification process.

Methods

To compare the two protocols we conducted an OHCA simulation of an emergency phone call by a bystander. Two groups participated in the simulation: 1) emergency medical technicians during paramedic vocational training, in the role of CBD dispatchers, and 2) non-healthcare personnel in the role of MPD dispatchers. Dispatchers were asked to identify whether a patient was having a cardiac arrest based on the information they received from the bystander.

Results

Duration of the OHCA identification process was significantly shorter for participants using MPD (CBD 50 seconds vs. MPD 33 seconds, $p=0.003$). The OHCA accuracy was 86.49% for the CBD and 82.86% for MPD, but this difference was not statistically significant ($p=0.60$).

Conclusion

The advantages of each protocol suggest that some combination of the two protocols may optimise the OHCA identification process, leading to increased accuracy and shorter duration of the identification process.

Keywords:

cardiac arrest; emergency medical dispatcher; protocol; criteria based dispatch (CBD); medical priority dispatch (MPD)

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Introduction

Out-of-hospital cardiac arrest (OHCA) is one of the leading causes of mortality around the world (1,2). Every minute of delay in the resuscitation effort reduces the survival rate by 3% to 10% (3-5). Early identification by an emergency dispatcher and initiation of immediate lifesaving procedures have proven to increase survival rates (6-8). To identify an OHCA, emergency dispatchers follow protocols aiming to evaluate whether the patient is conscious and breathing normally (9). According to information provided via a phone call by a bystander, the dispatcher determines if the patient is having a cardiac arrest and if there is a need to start guiding the bystander to perform cardiopulmonary resuscitation (CPR).

Two types of emergency protocols are commonly used. The medical priority dispatch (MPD) protocol is a scripted caller interrogation protocol featuring a symptom-based identification process (10). The MPD protocol, which guides the dispatcher through scripted and specific key questions about the patient's condition, can be used by non-healthcare personnel (11,12). In contrast, the criteria-based dispatch (CBD) protocol is normally used by certified clinical personnel such as paramedics, emergency medical technicians (EMTs) or nurses. The CBD protocol includes guidelines and prompts that allow dispatchers more freedom of action in using their professional experience to identify the patient's condition (12,13). The identification process in both protocols consists of two sequential phases: the conscious phase and the breathing phase. The conscious phase aims to evaluate if the patient is 'responsive', and the breathing phase to evaluate if the patient is breathing normally (Figure 1).

The measurement of the accuracy of identification under the two protocols is consistent in most retrospective studies, ranging 76% to 97% for CBD and 58% to 82% for MPD (12,14). Yet the measurement of the identification duration is not as

consistent. Some retrospective studies measure duration until initiation of CPR instructions (12) while other retrospective studies measure duration until initiation of the CPR itself (15). Clearly, any comparison of the two types of protocols should be made on equal terms.

Aim

The aim of this study is to compare the CBD and MPD protocols and determine which one could increase the accuracy of OHCA identification and shorten the duration of the identification process.

Methods

We conducted a simulation of an emergency phone call by a bystander to a dispatcher using either protocol. In this study, both the accuracy and duration were evaluated and compared under the assumption that the non-scripted CBD protocol performed by the clinical personnel will take more time but will result in more accurate identification.

The OHCA protocols

The CBD protocol (Figure 1) selected for this study is used in Israeli OHCA emergency medical dispatcher systems by certified paramedics and experienced EMTs. The MPD protocol (Figure 1) selected for this study was developed in 2016 in collaboration with the American Heart Association with two emergency medical services in Arizona. Implementation of this MPD protocol has been reported to increase the provision of phone CPR from 43.5% to 52.8% and to shorten the identification process from 256 to 212 seconds (15).

Study design and setting

Based on the simulation STROBE statement (16), a low fidelity simulation (17) appropriate for the evaluation and training

Figure 1. The CBD and MPD protocols

Note: the 'conscious phase' and 'breathing phase' (in red) are additions of the authors.

procedures (18) was designed. The simulation took place at two simulation facilities at Ben-Gurion University of the Negev between October and November 2017. The simulation was conducted in two separate rooms: 1) the dispatcher's room, which featured the CBD or MPD protocol and a mobile phone. On receiving a phone call from a bystander reporting an emergency event, the dispatcher in this room had to follow the protocol's procedure and to identify if the patient was having a cardiac arrest; and 2) the bystander's room, which featured a television that played a short video simulating a scenario of an emergency event (19). In addition, a Laerdal QCPR® mannequin was available for chest compressions. On encountering the simulated emergency event, the bystander was asked to use a mobile phone and call the dispatcher for instructions.

Ethics

The study was approved by the Human-Subjects Research Committee of Ben-Gurion University (BGU) of the Negev, Israel.

Participants

Since MPD dispatchers are usually non-healthcare personnel (12,20,21) with 5–7 weeks of training (21,22), participants in the MPD group were non-healthcare students. To qualify participants as MPD dispatchers, we conducted a short training program based on the MPD OHCA training (20,21) and the 2015 American Heart Association guidelines (9) which included cardiac arrest symptoms, OHCA identification, and the OHCA MPD protocol. To rule out that both MPD and bystander participants didn't have any clinical experience they were interviewed before the simulation session. Participants in the CBD group were experienced EMTs during their paramedic vocational training. Participants who used the CBD protocol went through the same training as MPDs except for the change to the CBD protocol. Both groups were trained separately and both training programs were approved by the department of emergency medicine at Ben-Gurion University.

The sample size estimation was calculated for the duration of the OHCA identification based on the previous reports (12). Under the condition of an alpha error of 5%, the power of 0.99 and Cohen's *d* of 1, 38 OHCA scenarios were needed for each protocol group (28).

Simulation scenarios

The accuracy measurement was done with two type of cases: true cardiac arrest cases (ie. true positive) and other clinical cases with similar clinical symptoms (ie. false positive) (23,24). To include both cases, five video scenarios were chosen for the simulation and randomly assigned to each participant. Based on cardiac-arrest characteristics (25), all the scenarios included middle-aged men as the patient. Out of the three true positive scenarios, two scenarios included a patient who is unconscious and not breathing normally; the third scenario featured agonal

breathing, a challenging symptom to identify via a phone call (15,26). Based on symptoms known as similar to a cardiac arrest (27), the two remaining scenarios were of events other than cardiac arrest events, and served as a false positive.

Outcome measures

To compare the CBD and MPD protocols, the independent variable protocol type was the predictor. Results for protocol type are considered statistically significant at the 5% level ($p < 0.05$). Using video and audio recordings, the collected results included three items: 1) the decision accuracy (12,14), whether correct or incorrect according to the specific scenario played; 2) the duration of the identification process (12,15), measured in seconds from the beginning of the consciousness phase until the dispatcher's decision either to rule out OHCA or to start instructing the bystander to initiate CPR; and 3) the number of questions that the dispatcher asked the bystander before the decision.

Statistical analysis

For the first categorical data item – decision accuracy, the χ^2 test was used for comparisons and the results are reported as percentages. For the second continuous data item – duration of the identification process, the non-parametric Mann-Whitney U-test was used for comparisons and the results are reported as medians along with first interquartile Q_1 and third interquartile Q_3 results. Results for both data items are considered statistically significant at the 5% level ($p < 0.05$). For the third numeric data item – number of questions, the Bayesian Information Criterion (BIC) goodness-of-fit test was used to select the Poisson regression over the negative-binomial regression (29). Then, after the assumption of a Poisson distribution was tested by using the Kolmogorov-Smirnov test at the 5% significance level ($p < 0.05$), the estimated means of the Poisson regression model were used for comparison. For each one of the Poisson regression models, results are reported as the predictor value with a log link function along with the odds ratio (OR) and the 95% confidence intervals (95% CI). Additionally, the Pearson correlation co-efficient was used at the 5% significance level ($p < 0.05$) to assess the relationship between the number of questions to the duration of the identification process and the accuracy to identify the OHCA. SPSS V17® and Microsoft Excel® 2016 were used for statistical analysis.

Results

The study experiment included 142 simulated events. In 37 events, the CBD protocol was used, and in 105 events the MPD protocol was used. Of the events, 82 were true positive scenarios and 60 were false positive scenarios.

The duration to of the OHCA identification process

The median duration of the identification process was 33 seconds ($Q_1 = 19$, $Q_3 = 52$) for participants that used MPD. In comparison testing, this result was significantly different

($p=0.003$) from the median of 50 seconds ($Q_1 = 29$, $Q_3 = 100$) for the CBD users (Figure 2). The duration of the conscious phase was significantly different as well ($p<0.001$): 14 seconds for MPD users ($Q_1 = 8$, $Q_3 = 23$) versus 21 seconds for CBD users ($Q_1 = 15$, $Q_3 = 35$). No significant difference was observed in the duration of the breathing phase ($p=0.32$): 12 seconds ($Q_1 = 6$, $Q_3 = 22$) for MPD users versus 16 seconds (0, 31) for CBD users.

Figure 2. Duration of OHCA identification and consciousness/breathing evaluation

The accuracy of OHCA identification

No significant difference was observed in the OHCA identification accuracy ($p=0.60$): 86.49% for the CBD versus 82.86% for MPD (Figure 3). A significant difference was observed, however, between the accuracy to incorrectly identify normal breathing and consciousness ($p<0.001$): 82.14% failures to identify breathing versus 17.85% failures to identify consciousness.

Figure 3. The accuracy of OHCA identification

The number of questions participants asked

For all three Poisson regression models, the predictive variable protocol type was considered significant: in the conscious phase ($p<0.001$), in the breathing phase ($p=0.01$) and throughout the identification process ($p<0.001$). The MPD protocol was associated with a decreased number of questions throughout the identification process (OR 0.68; 95% CI 3.29–4.18), with an estimated mean of 3.73 questions versus an estimated mean of 5.46 questions (95% CI 4.45–6.47) for the CBD protocol (Figure 4). Similar results can be seen for both conscious and breathing phase. In the conscious phase, the estimated mean for the MPD protocol was 2.14 questions (OR 0.66; 95% CI 1.86–2.42) versus 3.24 questions (95% CI 2.31–4.17) for the CBD protocol. In the breathing phase, the estimated mean was 1.59 questions for the MPD protocol (OR 0.71; 95% CI 1.32–1.86) versus an estimated mean of 2.22 questions (95% CI 1.77–2.66) for CBD protocol.

Figure 4. Estimated means of questions asked by participants

The correlation between the number of questions and the duration of the identification process ($r=0.84$, $p<0.001$) was positive and significant. No significant correlation was observed between the number of questions to the accuracy of OHCA identification ($r=-0.13$, $p=0.12$).

Discussion

Previous study results (12) revealed significant insights about the differences between the MPD and CBD systems. However, no differences between the OHCA protocols were identified. By comparison between the protocols in a simulation study, we uncovered new findings of the factors that affect the OHCA identification. When considering that OHCA rates in Europe and the US are approximately 275,000 and 420,000 respectively (30–32), and the negative effect of delaying the resuscitation are known (3–5), factors that affect the OHCA accuracy and duration should still continue to be studied.

Besides the differences between the two systems (10–12), the structure of the protocol creates a unique and different

identification process. The MPD protocol contains alternatives for every answer of the bystander (15) and a specific clinical check if uncertainty about the clinical symptoms still exists. Thus, MPD dispatchers do not have to rely on their personal knowledge and past experiences, but rather to follow the protocol.

We found that MPD dispatchers asked fewer questions throughout the identification process, and we assume that these differences depend on the protocol structure. While MPD dispatchers should follow the full procedure of the protocol, CBD dispatchers are not limited to the number of questions, and can rely on their clinical experience. In addition, CBD dispatchers tend to use the information they get from the bystander to ask more specific questions until they get the information they need to have the differential diagnosis that allows them to make a decision.

In terms of accuracy, these results are in line with some studies which found no significant difference between the CBD and MPD systems (12). Yet, previous studies suggested that accuracy is higher for clinicians using the CBD protocol (14). The clinical background and experience of CBD dispatchers possibly lead to key questions, their answers to which contain sufficient information to identify the OHCA correctly. For MPD dispatchers, on the other hand, the protocol structure forces them to complete all phases of the identification process, and thus the accuracy is independent of the number of questions.

As mentioned in previous studies (12,33,34), the present study found that the failure to identify if the patient is breathing normally to be the lead cause of incorrect identification. While CBD users can rely on their background and experience in the identification process because they are clinicians, MPD users need scripted instructions and alternatives throughout all of the identification process. These are available for the consciousness phase in the MPD protocol, but not in the breathing phase. It is safe to assume that additional questions and alternatives in the breathing phase could decrease the number of wrong identifications.

This study highlights the trade-offs between the accuracy and the duration of the identification process. The number of protocol questions should be carefully optimised. On the one hand, more questions may increase the accuracy on the other hand, more questions imply a longer identification process which reduces the access to CPR and potentially survival rates. Future studies should include professional dispatchers as participants, and evaluate the use of the MPD protocol by CBD dispatchers

Limitations

This study had two limitations that need to be addressed in future research: first, the use of television to present the patient's symptoms lack features that are important for such

simulation. Future studies should conduct the simulation with actors to create more realistic clinical symptoms and bring the scenarios closer to reality. Second, participants in the CBD group didn't receive the same training as professional dispatchers.

Conclusion

In this study, the use of the MPD protocol led to a shorter identification process, and the CBD protocol presented marginally higher accuracy. Combination of the two protocols may optimise the identification process, leading to shorter duration and increase accuracy by emergency dispatchers.

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Author contributions

All authors contributed to the conception and design of the study, analysis, drafting the manuscript and approved the final version of the manuscript.

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Conflict of interest

The authors report no competing interests. Each author of this paper have completed the ICMJE conflict of interest statement.

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