REVIEW

Nurses prepare epinephrine faster than physicians in simulated cardiac arrest

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ABSTRACT

Introduction: One million people die of cardiac arrest every year in the United States and Europe, almost one person every 30 sec. These patients can be managed with cardiopulmonary resuscitation.

Objective: Rapid preparation and administration of drugs may be of importance in the management of cardiac arrest. The present study evaluated the time needed by physicians and nurses to prepare a vial of epinephrine (1mg) for intravenous administration.

Methods: This prospective observational, simulation study was conducted at a large tertiary hospital in Athens. Ninety three healthcare professionals participated voluntarily. All participants were asked to assemble a 10cc syringe, draw up 1cc of 1:1.000 concentration of epinephrine and draw up 9cc of sterile water into the 10cc syringe. We arbitrarily set a period of 10sec as an acceptable time to prepare epinephrine for intravenous administration. A descriptive, quantitative design was selected.

Results: Twenty nine percent of the participants performed the task within the 10 sec period. Nurses (45.6%) performed the task in less than 10 sec in comparison to physicians (2.8%), ($p<0.001$). Doctors had approximately 30 times higher probability to overcome the cutoff point of 10 sec (Odds ratio: 29.4; 95% Confidence interval: 5.3-162.2) than nurses. No statistically significant difference was observed between healthcare professionals that had attended a CPR course and those who did not (21.37±12.6 sec vs 19.21±16.31 sec, $p=0.68$).

Conclusion: Nurses prepare and administer epinephrine faster than physicians. Hospital doctors should receive practical education in the early stages of their working life. Furthermore, demonstration of the skill during advanced life support courses should be considered.

Keywords: emergency drugs, epinephrine, cardiac arrest, physicians, nurses

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INTRODUCTION

Cardiac arrest is a daunting medical emergency, as every second counts for successful outcome of the victim (Xanthos et al 2011). One million people die of cardiac arrest every year in the United States and Europe, almost one person every 30 sec. The reported incidence of in-hospital cardiac arrest ranges from 1 to 5 per 1000 admissions (Sandroni et al 2007, Chalkias et al 2013). Recent data from the American Heart Association's National Registry of cardiopulmonary resuscitation (CPR) indicate that survival to hospital discharge for all rhythms after in-hospital cardiac arrest is 17.6% (Hunt et al 2009).

In an attempt to increase survival, advanced life support courses provide healthcare professionals with theoretical knowledge and practical skills to manage cardiac arrest (Gabbott et al 2005). As the science of resuscitation continues to evolve, guidelines are updated regularly to reflect these developments (Nolan et al 2010).

Treatment with pharmacological agents is frequently required during cardiopulmonary resuscitation efforts and almost always during the post-resuscitation period. However, the lack of scientific evidence, the potent side effects, and the association of resuscitation drugs with poor outcome act as a disincentive for their use (Xanthos et al 2011). The use of epinephrine in the management of cardiac arrest is still recommended by the 2010 European Resuscitation Guidelines (Nolan et al 2010, Xanthos et al 2011). It is well known that coronary perfusion pressure decreases when delivery of a vasopressor delays. (Andreka et al 2006, Stroumpoulis et al 2008) and time to drug administration can predict return of spontaneous circulation (Rittenberger et al 2007). However, although it is widely known that in CPR every second counts (Karlis et al 2014) time needed to draw up drugs and have them ready for administration has never been measured. Moreover, the level of preparedness in quickly assembling the epinephrine solution has never been investigated for doctors and nurses.

The aim of the present study was to evaluate the time needed by physicians and nurses to prepare epinephrine for intravenous administration in a simulated cardiac arrest setting.

METHODS

Sample and data collection

This prospective observational simulation study was undertaken from January 1st 2013 to March 31st 2013. The study group was all volunteer medical and nursing personnel. Healthcare professionals from the internal medicine, cardiology, intensive care unit, emergency room and anesthesiology department of a large tertiary hospital in Athens comprised the study group. The total number of healthcare professionals working in these departments is 145. After briefing on the purpose of the study, 93 (79%) agreed to participate voluntarily.

Exclusion criteria were age younger than 18 years and work in other departments than the aforementioned. Prior to the start of the study, the research ethics committee of our hospital decided that ethics approval was not required since no patients were included in the study and participation of healthcare professionals was voluntary.

Questionnaires and Measurement tools

Participants were asked to complete a demographic questionnaire that was specifically designed for the present study including questions regarding age, sex, working department, previous attendance of CPR courses, professional grade and years of working experience. A cardiac arrest scenario taken from the advanced cardiovascular life support (ACLS) instructor manual was then given to the participants and it was clarified that at that point epinephrine should be administered to the patient. The same scenario was used for all participants indifferent if they were doctors or nurses. Thus, all participants should assemble a 10cc syringe, draw up 1cc of 1:1.000 concentration of epinephrine and draw up 9cc of sterile water into the 10cc syringe. All attempts were carried out under the supervision of two investigators. The endpoint of the study was when the syringe was given to the first investigator who had previously set the scenario. Participants were randomly tested in isolation and in different medical departments within the hospital to avoid prior knowledge. The second investigator timed participants using the same stopwatch. The time of 10 sec was arbitrarily set as an acceptable time frame. However, the same cutoff point has been previously used (Davidson et al 2009).

Statistical Analysis

Continuous variables are presented as means ± 1 standard deviation. The Kolmogorov-Smirnov test and graphical methods were used for normality analysis of the distributions. Comparisons of continuous variables were performed using Student's unpaired t-test and Mann-Whitney non-parametric test, as appropriate. Linear relationships between quantitative normally distributed parameters were assessed with Pearson's correlation coefficient; Spearman's rho was used otherwise. Comparisons between multiple groups were performed using Analysis of Variance (ANOVA). Analysis of covariance (ANCOVA) was used in order to control for covariates. In cases of multiple hypothesis testing, false discovery rate (FDR) was utilized to assess statistically significant differences and maintain a

family-wise error <0.05. All tests were two-sided, and p <0.05 was considered to be significant. All analyses were conducted by using IBM SPSS 19.0 for Windows.

RESULTS

Ninety-three healthcare professionals participated in this study. Demographic characteristics of the population studied are shown in table 1. There was no statistically significant difference in demographic characteristics between nurses and doctors. The mean time needed by nurses to prepare the solution of epinephrine for intravenous use was significantly lower than that of doctors as shown in figure 1.

Table 1. Demographic characteristics of the sample

	N (%)
Sex	
Men	30 (32.3%)
Medical personnel	**36 (38.7%)**
Resident doctors	20 (21.5%)
Cardiologists	8 (8.6%)
Internal medicine doctors	4 (4.3%)
Anesthesiologists	4 (4.3%)
Nursing personnel	**57 (61.3%)**
Nurses	46 (49.5%)
Assistant nurses	11 (11.9%)
Higher education	
Doctor of Philosophy	3 (3.2%)
Master of Science	4 (4.3%)
University	37 (39.8%)
Technical institute	38 (40.9%)
Secondary education	11 (11.8%)
CPR course attendance	11 (11.8%)

CPR: cardiopulmonary resuscitation

Table 2. Time to prepare an epinephrine vial for intravenous administration; grouped by specialty

Specialty	Time (sec)	P<0.05
Assistant nurses	10.8 ± 3.2	R, A, C
Nurses	12.8 ± 6.3	R, A, C
Internal medicine doctors	18.3 ± 2.2	A, C
Resident doctors	23.1 ± 15.1	AN, N, A, C
Anesthesiologists	36.8 ± 15.0	AN, N, IM, R, C
Cardiologists	52.3 ± 21.8	AN, N, IM, R, A

AN: Assistant nurses; N: Nurses; IM: Internal medicine doctors; R: Resident doctors; A: Anesthesiologists; C: Cardiologists

Furthermore, when we arbitrarily set the 10 sec cutoff point as an acceptable time to prepare epinephrine for intravenous administration, only 29% of the participants performed the task within the 10 sec period. Almost half of the nurses (45.6%) performed the task in less than 10 sec in comparison to 2.8% of doctors (p<0.001). Doctors had approximately 30 times higher probability to overcome the cutoff point of 10 sec (Odds ratio: 29.4; 95% Confidence interval: 5.3 – 162.2) than nurses. No statistically significant difference was observed between healthcare professionals that had attended a CPR course and those who did not (21.37±12.6 sec vs 19.21±16.31 sec, p=0.68).

At a subgroup analysis it was demonstrated that assistant nurses who achieved the lowest mean time, prepared epinephrine for intravenous use, 5 times faster than cardiologists who had the highest mean time. Relevant means and standard deviations as well as statistically significant differences are shown in table 2.

Analysis of linear correlations between quantitative parameters revealed a significant positive correlation between age and time needed for preparation of epinephrine for intravenous administration (r=0.34, p=0.001). We then performed an analysis of covariance to check if the aforementioned differences of subgroups could be attributed to differences in age. Even after normalization of subgroups regarding age, the difference between nurses and doctors remained statistically significant (p<0.001) as well as most of the differences observed between the various specialties (p<0.05). The only differences that were not statistically significant were those of anesthesiologists versus cardiologists and resident doctors.

DISCUSSION

To our knowledge this is the first study to evaluate the time needed by healthcare professionals to prepare epinephrine for intravenous administration in cardiac arrest simulation.

A recent study performed in the UK evaluated the time needed for different groups of healthcare personnel working on medical wards to correctly assemble pre-filled emergency drug syringes (Davidson et al 2009). Authors concluded that resident doctors performed worse than nurses and senior doctors who had the best mean times. In the present study nurses performed better than doctors. Even though we did not evaluate the same skill, nurses prepared the dilution in half the time needed compared to medical personnel. The reasons are not clearly understood but the fact that nurses repeatedly convert doses and draw up medications may have probably helped them perform better. Interestingly, assistant nurses prepared the dilution faster than nurses. However, this trend was not statistically

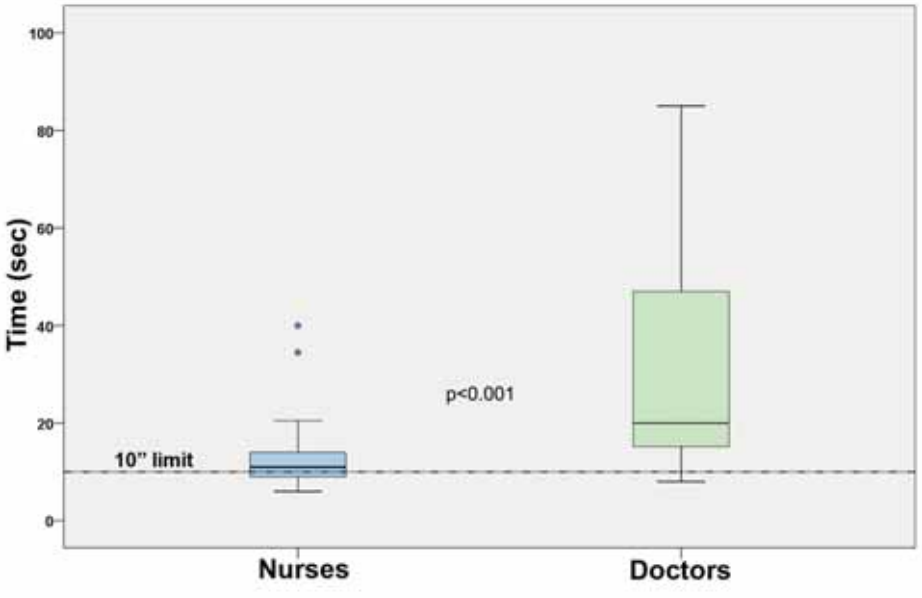

Figure 1. Time needed by nurses and doctors to draw up an epinephrine vial for intravenous administration.

significant, meaning it could have been due to chance.

The subgroup analysis demonstrated that cardiology residents together with anesthesiologists performed worse than all the other medical doctors with internal medicine doctors having paradoxically the best mean times among medical personnel. This was an unexpected result, since cardiologists and anesthesiologists involve more often than any other physician to real time CPR situations and thus they are expected to have a higher level of preparedness. Various studies in Greece have previously demonstrated that medical doctors and specifically cardiologists have theoretical knowledge gaps in resuscitation guidelines (Kyriakou et al 2010, Pantazopoulos et al 2011, Passali 2011). The present study demonstrated that skills considered necessary for doctors often involved in resuscitating patients, such as the rapid preparation of an epinephrine solution are also inadequate.

Cardiac arrest is an emergency situation and when it occurs there is little time to respond and perform advanced life support. The 2010 resuscitation guidelines recommend that drugs administered in patients in cardiac arrest should be prepared as soon as possible (Nolan et al 2010). One animal study (Wenzel et al 1999) reported lower coronary perfusion pressure when delivery of a vasopressor was delayed. Time to drug administration was also a predictor of return of spontaneous circulation in a retrospective analysis of swine cardiac arrest (Rittenberger et al 2007). The same applies for antiarrhythmic drugs too (Xanthos et al 2009). Two clinical studies (Kudenchuk et al 1999; Dorian et al 2002) reported data suggesting worse survival for every minute that antiarrhythmic drug delivery was delayed (measured from time of dispatch). However, this finding was potentially biased by a concomitant delay in onset of other ACLS interventions. In one study (Dorian et al 2002) the interval from first shock to administration of an antiarrhythmic drug was a significant predictor of survival. Thus, time to drug treatment appears to have importance.

In addition, in our study, no correlation was observed between preparation of an epinephrine solution and attendance of CPR courses. To our knowledge, this is the first study highlighting the deficit of all CPR courses as this skill is never taught.

This study has several potential limitations. The number of participants was small and all of them came from the same hospital. Also, we did not evaluate the time needed by participants to assemble pre-filled epinephrine syringes as in Greek hospitals epinephrine can only be found in vials of 1:1000 concentration. Furthermore these mean times may not reflect their actual time as measurements were made in simulation conditions.

CONCLUSIONS

This study highlights that nurses prepare epinephrine solution for intravenous administration faster than physicians. Medical personnel have never been taught and rarely practice this skill which should be introduced early in every doctor's training. Moreover, demonstration of the skill during advanced life support courses should be considered. Further international studies should be performed to validate our results.

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