Air Medical Journal 35 (2016) 288–291

Contents lists available at ScienceDirect

Air Medical Journal

journal homepage: http://www.airmedicaljournal.com/

Original Research

Cardiopulmonary Resuscitation Quality by Helicopter Rescue Swimmers While Flying

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A B S T R A C T

Objective: Our objective was to assess the cardiopulmonary resuscitation (CPR) quality by helicopter rescue swimmers (HRSs) while flying.
Methods: Twenty HRSs from the Spanish Maritime Safety took part in this study. The research protocol included 2 phases: a baseline test (5 minutes of CPR on land) and a challenge test (5 minutes of CPR on a Sikorsky S-61N helicopter in-flight). A Laerdal Resusci Anne mannequin with Laerdal PC Skill Reporting (Stavanger, Norway) was used to register CPR variables.
Results: CPR quality on land versus in-flight was not significantly different. The mean chest compression (CC) depth (52.6 mm on land vs. 51.9 mm in-flight) was inside the recommended range, but mean CC rate (133 vs. 132 per minute), tidal volume (752 vs. 888 mL), and hands-off time (9 per cycle in both tests) were above the 2015 recommended goal. Incomplete chest re-expansion was observed in 19% of on land and 26% in-flight CCs. CPR quality was maintained throughout the 5-minute challenges.
Conclusion: HRSs are able to perform CPR in a flying helicopter with similar quality to CPR on land. They need additional training to avoid excessive CC rates, tidal volumes, and hands-off times and to permit chest re-expansion.

The debate about the right decision regarding “stay and play” versus “load and go” remains in prehospital emergency care.[1] A relevant point in this discussion is if cardiopulmonary resuscitation (CPR) is feasible in moving medical vehicles (ambulances and helicopters) and can be performed with adequate quality. In drowning cases, immediate and continued good quality CPR with emphasis not only on chest compression (CC) but also on rescue ventilations is essential to achieve the best possible neurologic outcome.[2,3]

Considering the potential advantages of air transport, most countries have implemented helicopter emergency services.[4] Helicopter transport contributes to reducing the time to reach the hospital and expediting the application of critical interventions like CPR.[5] However, the limited space, movements, and vibrations could interfere with CPR quality and might be dangerous for the rescuer.[1,6,7]

Some studies have assessed the CPR quality delivered by helicopter health staff and the impact of feedback devices, observing a relatively good in-flight CPR quality.[1,8] In countries like Spain or Sweden, offshore rescue helicopter crews do not include medical/nurse staff, but they do include professional lifeguards or rescue divers; unfortunately, we lack data about the CPR performance of these nonhealth emergency staff. Therefore, our objective was to

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1067-991X/$36.00

http://dx.doi.org/10.1016/j.amj.2016.04.014

evaluate the quality of CC and ventilations delivered by rescue lifeguards on a mannequin while on a flying helicopter.

Methods

Procedures

This observational simulation study of CPR compared CPR performance performed on land and in-flight and included 20 helicopter rescue swimmers (HRSs) from the Spanish Maritime Safety Agency. All of them were voluntary and signed an informed consent form.

In Spain, accreditation as a lifeguard is a prerequisite to become an HRS. Candidates are specifically trained on basic life support, immediate life support, and main prehospital emergencies including trauma; therefore, they should be able to perform good quality CPR on victims in adverse circumstances.

The study protocol included 2 phases. First, the subjects made a baseline test consisting of 5 minutes of continued CPR. Second, they repeated the test (challenge phase) on the helicopter in-flight with calm weather conditions. For security reasons, the test was not permitted during takeoff and landing.

CPR Test and Mannequin

We used the Laerdal Resusci Anne Manikin with Laerdal PC Skill Reporting configured according to the following 2010 European Resuscitation Council Guidelines for Resuscitation[9]: CC depth from 50 to 60 mm, CC ratio from 100 to 120 beats/min, and tidal volume from 500 to 600 mL. Rescuers were asked to imagine a drowning victim and to perform 5 rescue ventilations and then start with 30:2 compression:ventilation cycles.[10] Ventilations were performed using a pocket mask, a barrier device used by HRSs in real interventions.

CPR quality analyzed variables included CC depth, rate, incomplete release, hands position, hands-off time, airway opening, and tidal volume. Only CC without error in any CC quality component was deemed as fully correct. No feedback (visual or acoustic) was permitted during the tests. The participants were not permitted to do pretest or warm-up training on the mannequin.

Helicopter and Equipment

Tests were performed on a 5-crew (pilot, copilot, and 3 HRSs) Sikorsky S-61N helicopter. One of the HRSs is a hoist operator, the second one performs the rescue in the sea, and the third one supports the procedure on an as-needed basis. In order to reproduce the real working conditions as accurately as possible, we inserted the challenge in a regular training session, and the third rescuer in each session was the tested subject. HRS equipment included Gore-Tex, a dry suit (Ursuit 5030 model Oosterhout, Nederland), and an LSC life jacket (Apollo Beach, Florida). During flight, they wore hearing protection devices.

Similar to other studies about emergency transportation, the mannequin was placed longitudinally with the head opposite the direction of travel.[11] As it happens in a real drowning rescue, neither the victim (manikin) nor the rescuers were secured by belts or other systems.

Statistical Analysis

The independent variables that were analyzed were weight, height, sex, age, and body mass index. Dependent variables are related to the quality of CCs and rescue breaths. Data are presented as means, standard deviations, and relative frequencies. Repeated measures analysis of variance was used to analyze the effect of 2 intragroup factors: the place where CPR was performed (land vs. flying) and minutes of CPR (5 minutes). The chi-square test was used to investigate the relationship between the place and the quality of CCs and rescue breaths, and the Pearson correlation coefficient was used for the association among quantitative variables. A significance level of $P < .05$ was considered in all analyses.

Table 1
Cardiopulmonary Resuscitation (CPR) Results on Land and in Helicopter

CPR Variable	On Land	In Helicopter	ANOVA	Chi-square
	Mean (SD) Frequency	Mean (SD) Frequency		
Quality of chest compressions				
Mean depth (mm)	52.6 (8.0)	51.9 (7.1)	0.568	
<50 mm (% of participants)	4/20	7/20		0.288
Mean rate (beats/min)	133 (16)	132 (13)	0.890	
<100/min (% of participants)	1/20	0/20		0.429
>120/min (% of participants)	16/20	15/20		
% of incorrect re-expansion	19 (29)	26 (35)	0.091	
% correct hand position	90 (23)	89 (17)	0.897	
Workload (rate · depth)	6,980 (1,403)	6,843 (1,091)	0.562	
<5,000 (% of participants)	2/20	1/20		0.525
>7,200 (% of participants)	9/20	9/20		
Hands-off in seconds	9 (2)	9 (2)	0.507	
Quality of ventilations				
Mean of ventilations per minute	6 (0.6)	6 (0.4)	0.845	
Tidal volume (mL)	752 (184.2)	888 (273)	0.070	
<500 mL (% of participants)	0/20	1/20		0.017
>600 mL (% of participants)	15/20	19/20		

ANOVA = analysis of variance; SD = standard deviation.

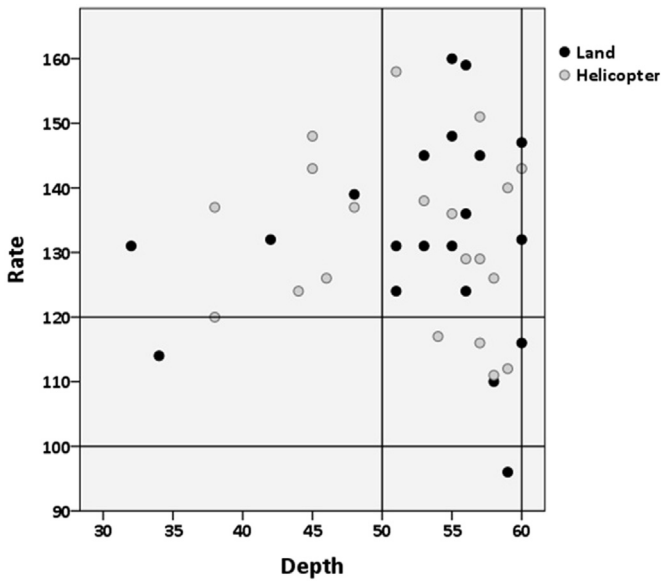

Figure 1. HRSs who were able to perform CPR according to guidelines.

Results

Twenty HRSs aged (mean ± standard deviation) 33.1 ± 5.1 years old, with a weight of 73.5 ± 8.3 kg, a height of 1.74 ± 0.1 m, and a body mass index of 23.9 ± 1.9 kg/m^2, participated in the study. All of them were men. Quality CPR results on land and in-flight are shown in Table 1 and Figure 1.

The mean CC depth was quite good and achieved the recommended goal both on land and in-flight. However, 4 subjects did not reach the goal on land and 7 did not in the helicopter. A mean of 19% and 26% of CCs did not permit chest re-expansion on land and in-flight, respectively (nonsignificant difference). Hand position was correct in 90% of CCs on land and 89% in-flight. The mean CC rate was similar in both conditions (133 on land vs. 132 in-flight), but it was above the recommended rate. Only 3 subjects delivered the recommended CC rate on land and 5 in-flight. The mean hands-off time per cycle was 9 in both conditions.

The number of rescue breaths was also similar in both conditions. The tidal volume was slightly higher in-flight (nonsignificant), and