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ORIGINAL RESEARCH

Is mouth-to-mouth ventilation effective in first responders? Comparing the effects between 30 : 2 algorithm versus hands-only. An exploratory pilot simulation study

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Abstract

Aim: Compare which resuscitation (for cardiac arrest scenario) has a higher quality when first responders with a duty of care are deprived of material: a standard resuscitation algorithm or a hands-only one when performed by first responders with training on mouth-to-mouth ventilation. Besides, a more specifics objectives were: to analyze the characteristics of these mouth-to-mouth ventilations and study the association between Body Mass Index and the different variables related to compressions. **Methods**: We conducted a prospective quasi-experimental crossover study of consecutive standardized simulated cases with 41 volunteers attached to the Plan of Surveillance and Rescue in Beaches. Each participant performed 2 minutes of basic life support (CPRb). Afterward, each participant performed 2 minutes of CPR with hands-only (CPRho). The data collection was carried out with a CPR calibrated Mannequin. **Results**: The mean depth was 48.1 ± 9.0 mm for CPRb, and 44.8 ± 9.7 mm for CPRho (t = 5.8, $P < 0.001$, 95% CI, 2.2 - 4.4), the rate was 123 ± 16.1 compressions/min for CPRb and 120 ± 17.9 for CPRho. The CPRho achieved a mean of 106 ± 42.5 complete compressions with full chest recoil, versus 57 ± 55.3 for CPRb (z = -2.6, $P = 0.009$). 20.7% of ventilation were hypoventilation and 42.7% were hyperventilation. **Conclusions**: Mouth-to-mouth ventilations performed by first responders during simulated scenario not met European Resuscitation Council guideline based targets to ventilation, despite being performed by well-trained providers. When ventilations were not performed, the number of high-quality compressions increased in absolute values.

Keywords

Cardiopulmonary resuscitation; Simulation; Chest compression; Basic life support; Hands-only

1. Introduction

In the past few years, some studies have suggested that the CPR algorithm has been modified, with a tendency to prioritize compressions over ventilation in adults, resulting in that numerous studies suggest that there is an equivalence between CPR with only chest compressions and chest compressions combined with rescue breathing for cardiac arrest in adults [1–5]. This is because although the impact of high-quality chest compressions has been studied extensively, the role of ventilation and oxygenation is not yet clear [6].

This equivalence has been suggested based on the survival of the patients after 30 days. It is understood that hands-only CPR (CPRho) could provide advantages concerning the basic 30 : 2 algorithm (CPRb) for non-healthcare rescuers or first responders who provide CPR alone and without protective equipment. These advantages could be due to the simplification of the algorithm, the reduction of the time needed before starting the compressions, and the increase in their quality as well [7–10]. Another argument in favor could be the better acceptance by the population when the need for mouth-to-mouth ventilation is eliminated (due to the misgivings concerning this procedure and the moral dilemma created in the responder who does not wish to perform this maneuver or due to the feeling of "not having done everything possible" if the resuscitation fails). Furthermore, mouth-to-mouth resuscitation can be an obstacle to provide basic life support (BLS) [11].

Additionally, coronavirus disease 2019 (COVID-19) could have an important impact on cardiopulmonary resuscitation performed by bystander-witnessed. At the present, the efforts of the scientific community are focused on finding the balance between the risk to the rescuer when undertaking cardiopulmonary resuscitation on a person with possible COVID-19 and the risk to that person if CPR is delayed. Among the

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recommendations, we find "no check for breathing and no mouth to mouth/nose ventilation should be taught during the pandemic as these interventions increase the risk of infection" [12].

Having this in mind, the present work seeks to compare which resuscitation method (for a cardiac arrest scenario) has a higher quality when first responders with a duty of care are deprived of material: a standard resuscitation algorithm or a hands-only one, when performed by volunteers, who have had extensive training on mouth-to-mouth ventilation and cardiopulmonary resuscitation. Besides, a more specifics objectives were: to analyze the characteristics of these mouth-to-mouth ventilations and study the association between Body Mass Index (BMI) and the different variables related to compressions.

2. Methods

2.1 Study population

We conducted a prospective quasi-experimental crossover exploratory pilot study of consecutive standardized simulated cases. Providers were blinded to the specific characteristics we were evaluating (depth, volume, chest recoil, etc). Each particpant acted as their own control. The target population was composed of active Red Cross volunteers belonging to the Plan of Surveillance and Rescue in Beaches and Rescue at Sea of the Region of Murcia (Spanish acronym "COPLA Plan" 2018), from the municipality of Mazarrón (Murcia-Spain). The sample was composed of 54 volunteers (N = 54). The following inclusion criteria were established: being an active Red Cross volunteer of the Plan of Surveillance and Rescue in Beaches 2018, not having any illness or disability that could interfere in the study, and having a Body Mass Index (BMI) of 18.5-24.9 Kg/m^2 (normo-weight), to avoid the dispersion of data. Workers who were health professionals and those who refused to participate in the study were excluded. The final size of the sample was composed of 41 participants (n = 41, Fig. 1). The minimum training possessed by the participants included: a course in lifesaving and BLS that lasted 40 hours (12 hours allocated to BLS: to know the survival chain, learn how to perform chest compressions, evaluate the absence of consciousness and breathing, mouth-to-mouth ventilation maneuver). Another course on water rescue (lifeguard course) that lasted 60 hours (12 hours allocated to BLS), a 12-hour course on semi-automated external defibrillation and a 12-hour refresher (12 hours allocated to BLS) course for those whose water rescue diploma had expired more than 2 years previously. All previous BLS courses were intended for lay people. For the Red Cross volunteers attached to Plan COPLA, a refresher course is mandatory every year.

2.2 Data collection

The data collection was carried out during the summer season. The time of the session, the start and end of the simulation and the data measurement was performed automatically with the Resusci Anne QCPR® simulator (SimPad Plus with SkillReporter ™) from the Laerdal Medical® brand, which was calibrated and checked before experimenting and periodically during the experimental phase. The participants were not informed about the results of their intervention until the end of the study.

Simulation scenario used in the study is available in supplementary file 1.

2.3 Outcome measures of resuscitation quality

The variables studied to assess the high quality of resuscitation were: depth (50-60 mm), rate (100-120 compressions/min), number of compressions with full recoil, percentage of compressions with correct recoil and the pauses between compressions to ventilation. To analyze the quality of the ventilations, the following were recorded: the volume ventilated (mL), the number of hyperventilation ($>$ 600 mL), the number of hypoventilation ($<$ 500 mL) and number of effective ventilation (500-600 mL).

2.4 Statistics

For the analysis of the data, descriptive statistics were calculated (mean, median, standard error, standard deviation, interquartile range, frequencies, and percentages). Continuous data were assessed for normality. We compared the differences for each algorithm using Student's *t*-test for related samples. Spearman's rho coefficient was calculated to analyze the association between BMI and the rest of the variables, since it did not present a Normal distribution. The results were considered statistically significant at $P < 0.05$. For the processing and analysis of data, we used the statistical package IBM SPSS® v. 22.0 for Windows® (New Castle, New York, USA).

3. Results

The final sample was composed of 41 participants, of which 29% (12/41) were female, and 71% (29/41) were male, with an average age of 23 $\pm$ 2.9. The median BMI Kg/m^2 was 22.8, interquartile range (IQR) = 3.2 and 39% of the participants had received a 12-hour refresher course training less than 6 months before the study; the other 61% had received it less than one year prior.

The chest compressions results showed that their mean depth was 48.1 $\pm$ 9.0 mm for CPRb, and 44.8 $\pm$ 9.7 mm for CPRho (t = 5.8, $P < 0.001$, 95% CI, 2.2-4.4) (Fig. 2). Table 1 shows the parameters related to compressions and ventilations.

Of either CPR algorithm, 31.7% of the participants (CPRb & CPRho) reached the recommended depth. An optimal rate was performed by 36.6% of the participants with CPRb, while for the CPRho algorithm this was reached by 48.8% of volunteers. The percentage of compressions with full recoil increased when only compressions were performed, from 33.5% (57/170) in CPRb to 44.2% (106/240) for CPRho. The complete compressions decreased from 48.8% (83/170) for CPRb to 38.8% (93/240) for CPRho (Fig. 2).

The Spearman's rho coefficient of association between the BMI and depth variables was Rho (CPRb) = 0.6/Rho (CPRho) = 0.6, $P < 0.001$; between BMI and chest recoil Rho (CPRb) = -0.1/Rho (CPRho) = -0.2, $P < 0.001$; and between BMI and rate Rho (CPRb) = -0.1/Rho (CPRho) = -0.2, $P < 0.001$.

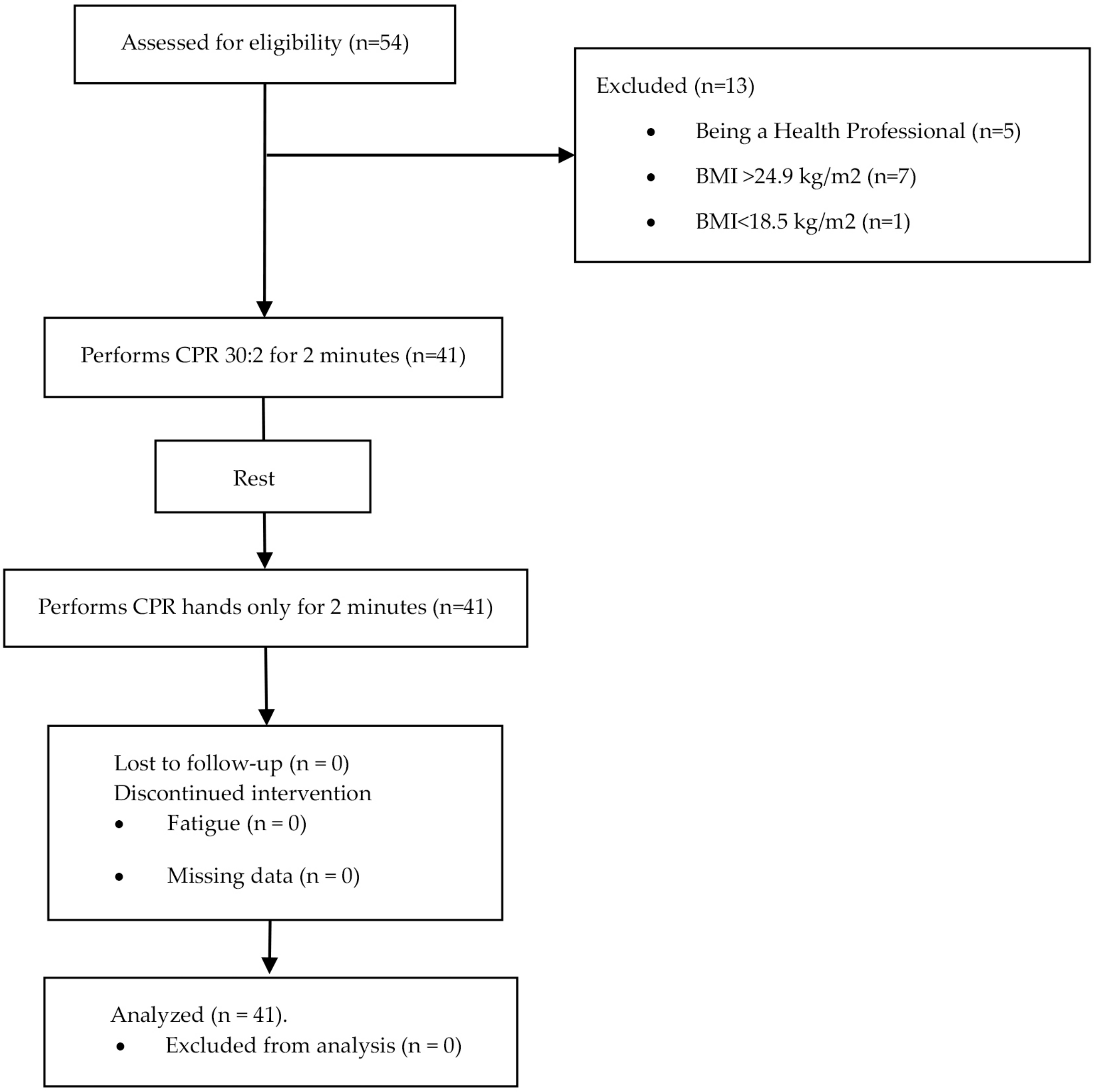

FIGURE 1. Flow diagram.

TABLE 1. Performance of the compressions and ventilations.

Variables	Cardiopulmonary resuscitation	Cardiopulmonary resuscitation Hands-Only	*t*-test	*P* value
	Mean ± SD	Mean ± SD		
TC	170 ± 17.6	240 ± 35.9	-15.9	< 0.001
Rate (comp/min)	123 ± 16.1	120 ± 17.9	1.61	0.116
NCC	83 ± 78.1	93 ± 44.8		0.26
NCR	57 ± 55.3	106 ± 42.5		0.009
PCR	33.5 ± 35.2	44.2 ± 42.6		0.002

Note: SD = Standard deviation; NCC = Number of complete compressions (depth 50-60 mm); NCR = Number of compressions with complete recoil; PCR = Percentage of compressions with correct recoil; TC = Total compressions in 2 minutes.

The results did not show statistically significant differences between males and females.

We found no statistically significant differences in the parameters related to compressions and ventilations between the volunteers who received the refresher course 6 months ago and those who received it less than a year ago.

As for mouth-to-mouth ventilation (Fig. 3), the mean number of ventilations performed during the 2 min cycle was 7.9 ± 3.8, the mean number of hyperventilation was 3.4 ± 3.9, hypoventilation 1.6 ± 2.2 and optimal volume 2.9 ± 3.0. From the total participants, 7.3% had pauses longer than 10 seconds between compression and ventilation. Lastly, 61%

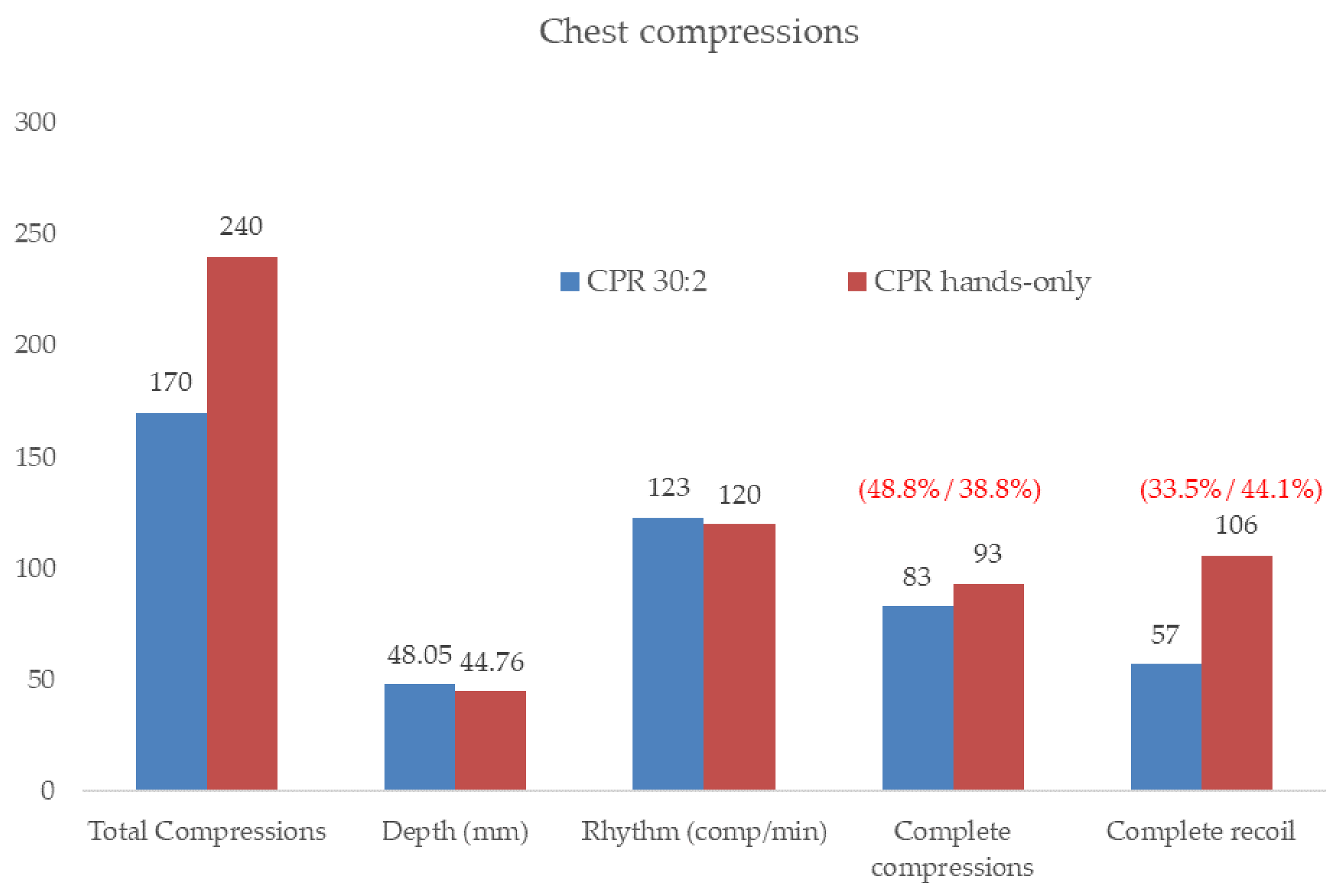

FIGURE 2. Distribution of the variables depth for each CPR algorithm. Complete compressions = Number of compressions with depth 50-60 mm; Complete recoil = Number of compressions with full chest recoil.

of the rescuers performed-as a minimum-1 hyperventilation during the entire 2 min cycle, and 73.2% performed-as a maximum-1 effective ventilation of the 2 specified after the 30 compressions.

4. Discussion

One of the objectives of this study was to obtain evidence of the improvement in the variables that defined high-quality CPR if only compressions were performed (CPRho) by non-healthcare personnel. Keeping in mind that ventilation is the weakness of CPR, we wanted to compare CPRb vs. CPRho in the initial minutes of the CPR procedure, performed by individuals with ventilation training, as well as the effectiveness of mouth-to-mouth ventilation (in a simulation, without barrier devices such as a bag-mask).

The reasons for studying these differences were, in the first place, the existing difficulties and reluctance from the non-healthcare personnel for performing mouth-to-mouth ventilation in the absence of methods with barriers or ventilation devices. And in second place, the practical implementation that this simplification would imply in the teaching of CPRho [13, 14], as its dissemination is associated with an increased survival rate, the favorable neurological results are not been altered [15–17], and it would also result in the improvement of the five key points of high-quality CPR [18].

The overall results from the study showed that there was an increase in the magnitude of the variables studied for the CPRho algorithm, as well as low effectiveness of the mouth-to-mouth ventilation, without reaching European Resuscitation Council guideline based targets to ventilation, in agreement with the results from Neth *et al*. [19].

The compression results showed an increase in the number of high-quality compressions for CPRho, with the rate improving slightly to 100-120 compressions per minute. The results did not show significant differences between men and women, unlike other studies [20], however, we found an association between depth and BMI. In our opinion, the ability to perform high-quality CPR is more influenced by the physical characteristics of the rescuer than by gender. This correlation is in agreement with other studies such as those of [21, 22], in which participants with greater weight, height and BMI provided a greater depth of compressions. On the other hand, as opposed to the study by Contri *et al*. [23], in which people with a higher BMI were less likely to achieve a complete chest recoil, our study found a low association between BMI, rate

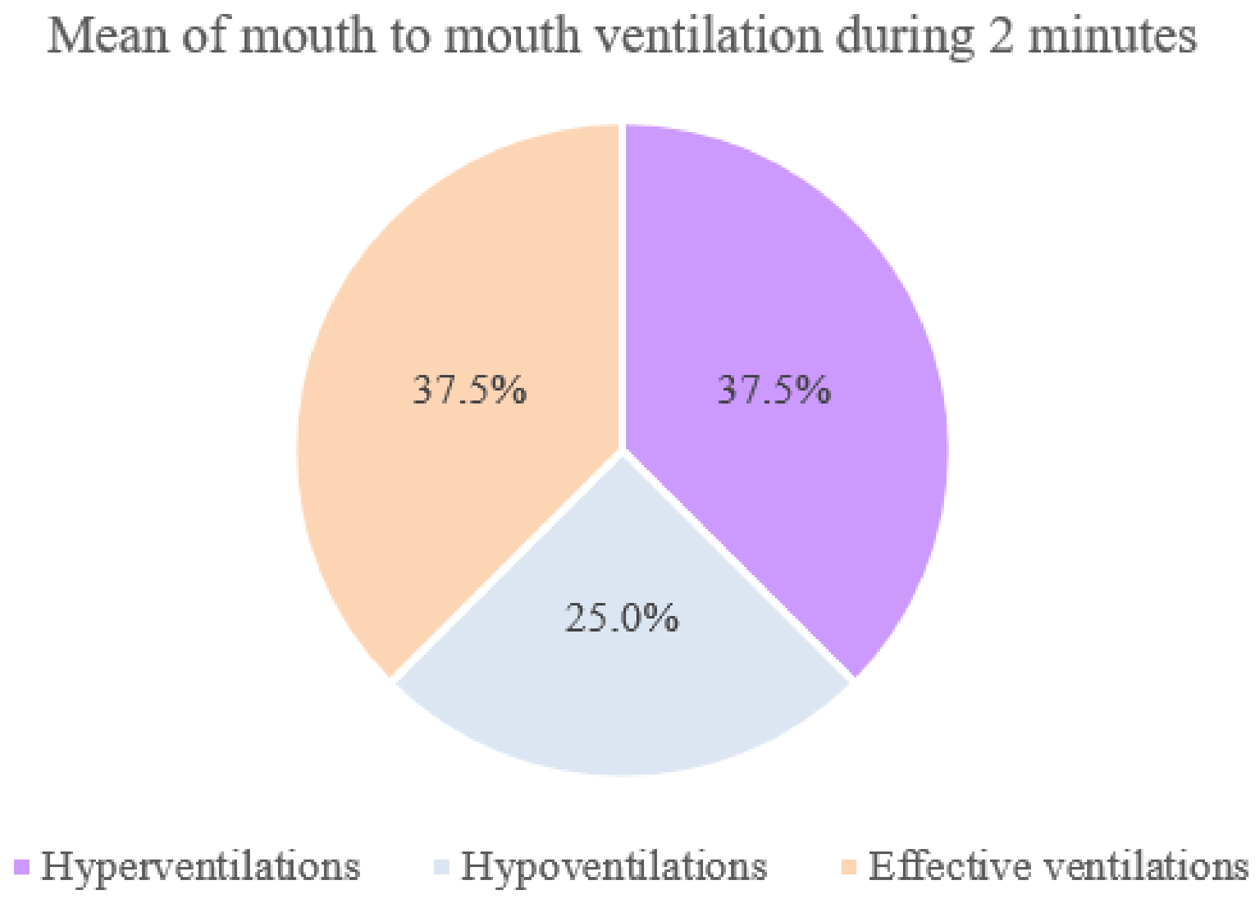

FIGURE 3. Characteristics of mouth-to-mouth ventilations. Source: Author created. Hyperventilations = eate of ventilations > 600 mL; Hypoventilations = eate of ventilations < 500 mL; Effective ventilations: rate of ventilations 500-600 mL.

and chest recoil. We believe this may be due to the absence of participants with extreme BMI.

Our results are in agreement with those of Shin J *et al*. (2014) [24] since, in both studies, the depth rate of chest compressions for CPRb was more adequate compared to CPRho. However, the number of adequate chest compressions was higher with compression only than with standard CPR during the first 2 minutes, with statistically significant differences for both studies. This lower index of depth in CPRho can be explained by an increase in fatigue, produced by the absence of interruptions to ventilate, which causes fatigue in the provider. It is essential to take into account the role of accumulated fatigue, which affects the depth of chest compressions, for this it is important to assess the role of reliefs and telephone or bystanders instructions [25].

However, we believe that "every compression counts" and if the ventilations performed by first responders are not effective: chest compressions alone (without interruptions in ventilations) until the arrival of emergency services (for a cardiac arrest scenario) reduces the time off the chest. This could improve coronary and cerebral perfusion in the first minutes of OHCA, increasing the probability of return of spontaneous circulation [26].

We found no statistically significant differences in the parameters related to compressions and ventilations between the volunteers who received the refresher course 6 months ago and those who received it less than a year ago. This leads us to think that skills lost over time may require refresher courses before 6 months.

When the 30 : 2 sequence was performed, the low effectiveness of the mouth-to-mouth ventilation maneuver was detected, as the ventilation volume exceeded the guidelines. This finding is in line with other studies [27, 28], and it could be associated with hyperventilation and reduction cardiac output (as the increased intrathoracic pressure produced by positive pressure ventilation reduces inflow of blood to the right side of the heart [29]) or the probability of regurgitation or bronchoaspiration [30]. When ventilations were not carried out, the number of high-quality compressions increased in absolute values. We believe that these findings could be due to the simplified CPR sequence, which avoids the initial and final compressions "of adjustment" to the rhythm and depth every time a new cycle starts and increases the number of compressions per minute.

As for the ventilation variables, the mean volume ventilated by the participants was found within optimum values. However, it should be taken into account that these results were due to the calculation of the arithmetic mean of all the ventilation. It is necessary to point out that in most cases, hyperventilation was produced, which, -according to numerous studies [31, 32]

-was the most expected outcome (followed by regurgitation) when it is performed by non-trained personnel, and even when performed by professionals [33]. Nevertheless, it should be known that when this maneuver was not performed, the volume insufflated was found to be below the optimum levels and when it was performed, the most repeated result was hyperventilation, as mentioned above. Also, more than 73% of the rescuers performed only one effective ventilation from the two specified after the 30 compressions; even taking into account that in the present study, the personnel had BLS training, which included mouth-to-mouth resuscitation training.

We believe that, in the current COVID-19 pandemic, it is important to invest in training efforts in the use of ventilation devices by first responders (bag-mask devices). The skill of mouth-to-mouth ventilation is complex in out-of-hospital basic life support context. In our opinion, the current pandemic could contribute to low effectiveness of this maneuver, and it is important to invest in training efforts in the use of ventilation devices by first responders, since there are situations such as drowning, or cardiorespiratory arrest in pediatric patients, in which ventilations, and decreased hypoxia can provide additional benefit.

The main advantages found for CPRho was: the simplification of the CPR algorithm, the pauses between compressions to ventilation were eliminated, increasing in the rate of chest compressions per minute, the possibility of hyperventilation was eliminated and the time used before starting the compressions was reduced.

5. Conclusions

Mouth-to-mouth ventilations performed by first responders during simulated scenario not met European Resuscitation Council guideline based targets to ventilation, despite being performed by well-trained providers. When ventilations were not performed, the number of high-quality compressions increased in absolute values.

6. Limitations

There are several limitations to our study. First, it is a simulation study and the first responder performance during the experiment may be different from a real out-of-hospital cardiac arrest. Second, more studies are needed with a broader sample more representative of the general population (not only normoweight people) and with a size calculation.

Also, in our opinion, two minutes is too short, it would be interesting to assess the general trend of the variables studied in each rescuer for CPR algorithm that lasts more than 2 minutes.

This exploratory pilot study lays the foundations for subsequent experimental research, with randomization of the experimental conditions to the participants, which would give greater validity to the results.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during this research study. This research fulfilled the requirements of the Declaration of Helsinki and was approved by the Ethics Committee of the Catholic University of Murcia (UCAM) (code: CE031901). All of the participants were informed about their participation and signed a form indicating their informed consent.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon request.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.signavitae.com/mre-signavitae/article/1309012519002488832/attachment/Supplementary%20material.docx.

REFERENCES

[1] Bohm K, Rosenqvist M, Herlitz J, Hollenberg J, Svensson L. Survival is similar after standard treatment and chest compression only in out-of-hospital bystander cardiopulmonary resuscitation. Circulation. 2007; 116: 2908-2912.

[2] Bobrow BJ, Spaite DW, Berg RA, Stolz U, Sanders AB, Kern KB, *et al*. Chest compression-only CPR by lay rescuers and survival from out-of-hospital cardiac arrest. Journal of the American Medical Association. 2010; 304: 1447-1454.

[3] Kitamura T, Kiyohara K, Nishiyama C, Kiguchi T, Kobayashi D, Kawamura T, *et al*. Chest compression-only versus conventional cardiopulmonary resuscitation for bystander-witnessed out-of-hospital cardiac arrest of medical origin: a propensity score-matched cohort from 143,500 patients. Resuscitation. 2018; 126: 29-35.

[4] SOS-KANTO study group. Cardiopulmonary resuscitation by bystanders with chest compression only (SOS-KANTO): an observational study. The Lancet. 2007; 369: 920-926.

[5] Hüpfl M, Selig HF, Nagele P. Chest-compression-only versus standard cardiopulmonary resuscitation: a meta-analysis. The Lancet. 2010; 376: 1552-1557.

[6] Olasveengen TM, de Caen AR, Mancini ME, Maconochie IK, Aickin R, Atkins DL, *et al*. 2017 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations summary. Circulation. 2017; 136: e424-e440.

[7] Spelten O, Warnecke T, Wetsch WA, Schier R, Böttiger BW, Hinkelbein J. Dispatcher-assisted compression-only cardiopulmonary resuscitation provides best quality cardiopulmonary resuscitation by laypersons: a

randomised controlled single-blinded manikin trial. European Journal of Anaesthesiology. 2016; 33: 575-580.
[8] Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Berg RA, *et al*. Time-dependent effectiveness of chest compression-only and conventional cardiopulmonary resuscitation for out-of-hospital cardiac arrest of cardiac origin. Resuscitation. 2011; 82: 3-9.
[9] Svensson L, Bohm K, Castrèn M, Pettersson H, Engerström L, Herlitz J, *et al*. Compression-only CPR or standard CPR in out-of-hospital cardiac arrest. New England Journal of Medicine. 2010; 363: 434-442.
[10] Panchal AR, Bobrow BJ, Spaite DW, Berg RA, Stolz U, Vadeboncoeur TF, *et al*. Chest compression-only cardiopulmonary resuscitation performed by lay rescuers for adult out-of-hospital cardiac arrest due to non-cardiac aetiologies. Resuscitation. 2013; 84: 435-439.
[11] Baldi E, Bertaia D, Savastano S. Mouth-to-mouth: an obstacle to cardiopulmonary resuscitation for lay-rescuers. Resuscitation. 2014; 85: e195-e196.
[12] Nolan JP, Monsieurs KG, Bossaert L, Böttiger BW, Greif R, Lott C, *et al*. European resuscitation council COVID-19 guidelines executive summary. Resuscitation. 2020; 153: 45-55.
[13] Perkins GD, Olasveengen TM, Maconochie I, Soar J, Wyllie J, Greif R, *et al*. European resuscitation council guidelines for resuscitation: 2017 update. Resuscitation. 2018; 123: 43-50.
[14] Benoit JL, Vogele J, Hart KW, Lindsell CJ, McMullan JT. Passive ultra-brief video training improves performance of compression-only cardiopulmonary resuscitation. Resuscitation. 2017; 115: 116-119.
[15] Iwami T, Kitamura T, Kiyohara K, Kawamura T. Dissemination of chest compression-only cardiopulmonary resuscitation and survival after out-of-hospital cardiac arrest. Circulation. 2015; 132: 415-422.
[16] Wissenberg M, Lippert FK, Folke F, Weeke P, Hansen CM, Christensen EF, *et al*. Association of national initiatives to improve cardiac arrest management with rates of bystander intervention and patient survival after out-of-hospital cardiac arrest. Journal of the American Medical Association. 2013; 310: 1377-1384.
[17] Dumas F, Rea TD, Fahrenbruch C, Rosenqvist M, Faxén J, Svensson L, *et al*. Chest compression alone CPR is associated with better long-term survival compared to standard CPR. Resuscitation. 2012; 83: e41-e42.
[18] Soar J, Nolan JP, Böttiger BW, Perkins GD, Lott C, Carli P, *et al*. European resuscitation council guidelines for resuscitation 2015. Resuscitation. 2015; 95: 100-147.
[19] Neth MR, Benoit JL, Stolz U, McMullan J. Ventilation in simulated out-of-hospital cardiac arrest resuscitation rarely meets guidelines. Prehospital Emergency Care. 2020. (In press)
[20] Jaafar A, Abdulwahab M, Al-Hashemi E. Influence of rescuers' gender and body mass index on cardiopulmonary resuscitation according to the American Heart Association 2010 resuscitation guidelines. International Scholarly Research Notices. 2015; 2015: 246398.
[21] Sayee N, McCluskey D. Factors influencing performance of cardiopulmonary resuscitation (CPR) by foundation year 1 hospital doctors. Ulster Medical Journal. 2012; 81: 14-18.
[22] López-González A, Sánchez-López M, Garcia-Hermoso A, López-Tendero J, Rabanales-Sotos J, Martínez-Vizcaíno V. Muscular fitness as a mediator of quality cardiopulmonary resuscitation. The American Journal of Emergency Medicine. 2016; 34: 1845-1849.
[23] Contri E, Cornara S, Somaschini A, Dossena C, Tonani M, Epis F, *et al*. Complete chest recoil during laypersons' CPR: is it a matter of weight? American Journal of Emergency Medicine. 2017; 35: 1266-1268.
[24] Shin J, Hwang SY, Lee HJ, Park CJ, Kim YJ, Son YJ, *et al*. Comparison of CPR quality and rescuer fatigue between standard 30:2 CPR and chest compression-only CPR: a randomized crossover manikin trial. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2014; 22: 59.
[25] Pujalte-Jesús MJ, Leal-Costa C, Ruzafa-Martínez M, Ramos-Morcillo AJ, Díaz Agea JL. Relief Alternatives during resuscitation: instructions to teach bystanders. A randomized control trial. International Journal of Environmental Research and Public Health. 2020; 17: 5495.
[26] Cheskes S, Schmicker RH, Verbeek PR, Salcido DD, Brown SP, Brooks S, *et al*. The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial. Resuscitation. 2014; 85: 336-342.
[27] Ashoor HM, Lillie E, Zarin W, Pham B, Khan PA, Nincic V, *et al*. Effectiveness of different compression-to-ventilation methods for cardiopulmonary resuscitation: a systematic review. Resuscitation. 2017; 118: 112-125.
[28] Iserbyt P, Schouppe G, Charlier N. A multiple linear regression analysis of factors affecting the simulated Basic Life Support (BLS) performance with Automated External Defibrillator (AED) in Flemish lifeguards. Resuscitation. 2015; 89: 70-74.
[29] Pitts S, Kellermann AL. Hyperventilation during cardiac arrest. The Lancet. 2004; 364: 313-315.
[30] Meaney PA, Bobrow BJ, Mancini ME, Christenson J, de Caen AR, Bhanji F, *et al*. Cardiopulmonary resuscitation quality: [corrected] improving cardiac resuscitation outcomes both inside and outside the hospital: a consensus statement from the American Heart Association. Circulation. 2013; 128: 417-435.
[31] Aufderheide TP, Sigurdsson G, Pirrallo RG, Yannopoulos D, McKnite S, von Briesen C, *et al*. Hyperventilation-induced hypotension during cardiopulmonary resuscitation. Circulation. 2004; 109: 1960-1965.
[32] Park SO, Shin DH, Baek KJ, Hong DY, Kim EJ, Kim SC, *et al*. A clinical observational study analysing the factors associated with hyperventilation during actual cardiopulmonary resuscitation in the emergency department. Resuscitation. 2013; 84: 298-303.
[33] Chen KY, Ko YC, Hsieh MJ, Chiang WC, Ma MH. Interventions to improve the quality of bystander cardiopulmonary resuscitation: a systematic review. PLoS ONE. 2019; 14: e0211792.

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