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LIST DO REDAKCJI / *LETTER TO THE EDITOR*

A new strategy for cardiopulmonary resuscitation training. Commentary to the article: "The effect of strength training on quality of prolonged basic cardiopulmonary resuscitation"

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I read the article by Abelairas-Gómez et al. [1] "The effect of strenght training on quality of prolonged basic cardiopulmonary resuscitation" with great interest. To my knowledge, this was the first report to evaluate the effect of physical training on the quality of cardiopulmonary resuscitation (CPR). I would like to discuss three important issues about this interesting article.

First, many rescuer factors could influence the quality of chest compression, such as the rescuer's sex, body weight (including body mass index), exercise time, and muscle strength [2–8]. Among these, the major determinant of high-quality chest compression is the rescuers' body weight because the force transferred to the cardiac arrest patient's chest is proportional to the mass of the rescuer's upper body [9]. Lightweight rescuers, especially women, cannot achieve adequate chest compression depth [4, 5]. Lightweight rescuers need more muscle strength to overcome light upper body mass, because a force of 50 kg (approximately 500 N) is needed to achieve 5 cm of chest compression depth [10]. Therefore, strength training effects will be maximised in female rescuers with light body weight.

I also agree with the authors' proposal for introduction of a specific physical training programme to improve the quality of CPR. This programme will be an important part of a new strategy for CPR training. However, considering that cardiac arrest events can occur in two different settings (in-hospital or out-of-hospital), a new strategy should consider two settings. For example, most rescuers in an in-hospital setting are healthcare providers. In contrast, most rescuers in an out-of-hospital setting are laypersons. In the former case, we can organise CPR teams with male rescuers who have normal body weight and greater muscular strength, to enhance the quality of chest compression during in-hospital CPR. In addition, a specialised and easily administered strength-training programme could be introduced for CPR team members at little cost. However, in the latter case (out-of-hospital setting), introducing and managing a specialised strength-training programme for a large number of laypersons would be difficult. In this case, we could add a simplified strength-training programme to the basic life support course (including the recertification programme). However, the effect of a simplified strength-training programme should be verified by further study.

In addition, a specialised CPR training programme to overcome light body weight could be considered. Krikscionaitiene et al. [11] developed Andrew's manoeuvre. Using this manoeuvre during CPR training could increase the CPR quality provided by low body-weight female rescuers and elderly female rescuers [11, 12]. The specialised CPR training programme and the strength-training programme could be combined if trainee CPR quality does not improve by using either programme alone.

Second, although the strength-training programme could result in over-ventilation, this adverse effect could be avoided with the new strategy for CPR training. Mouth-to-mouth ventilation could be avoided by using an advanced airway in the in-hospital setting. It also could be avoided in the out-of-hospital setting because the 2015 CPR guidelines recommend that dispatchers provide chest compression-only CPR instructions for adults with suspected out-of-hospital cardiac arrest [13, 14]. Chest compression-only CPR is recommended as a reasonable alternative to conventional CPR in adult cardiac arrest patients [14]. Therefore, the adverse effect of a strength-training programme could be avoided in both settings.

However, we should keep in mind that rescuer fatigue could increase more rapidly during chest compression-only CPR compared with conventional CPR [15, 16]. This is why the strength-training programme will be an important part of a new strategy for CPR training.

Third, the authors' strength-training programme included four exercises using specific devices [1]. If the same effects could be achieved by a strength-training programme without specific devices (e.g. plyometric exercise), the programme could be widely and easily disseminated. I believe that this study will be the first to introduce a new strategy for CPR training. More studies should be conducted to develop a more precise and efficient strength-training programme for high-quality CPR.

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Response to the letter concerning the article "The effect of strength training on quality of prolonged basic cardiopulmonary resuscitation"

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We would like to thank Professor Oh for his interest in our article about the effect of a strength training programme on the quality of cardiopulmonary resuscitation (CPR) [1, 2]. Body mass index was studied to check its effect on the quality of chest compressions [3–6], and the force needed to achieve the minimum chest compression depth was assessed [6, 7],

as well as the decrease in CPR quality due to fatigue [8]. Therefore, it is advisable to relieve the rescuer every 2 min [9] in order for him/her to provide feedback [9–11], with a view to increasing CPR quality. However, these measures are not effective for a person not physically able to keep a compression rate of 100–120 com/min at a depth of 50–60 mm. Therefore, strength training will be especially beneficial to female or lightweight people.

Our study has demonstrated that personalised strength training monitored by using fitness devices contributes to an increase in chest compression quality and its longer duration. Our data can be considered as a good starting point to design training programmes according to the type of rescuer. Just as Professor Oh claims [1], it is our opinion that physical training strategies must be different according to the target population. CPR itself is a physical activity which, if done repeatedly, may contribute to muscle mass building. Andrew's manoeuvre consists of somebody pushing the shoulders of the rescuer ten times with gloved hands while performing chest compressions [12]. This technique would contribute to improving the capacity of the muscles involved in CPR, such as pectoralis major, rectus abdominis, erector spinae, or triceps brachii [2, 13], and could be included in a more complete programme to improve muscle strength. One of the problems that the training programme set out in this study entails is the use of fitness devices. This may create little training adherence since it involves going to a gym to train. Therefore, the development of calisthenics programmes may be considered as an alternative. Once the effect of a strength programme on CPR quality has been tested, it becomes necessary to continue research on what type of training contributes to this objective, and to what degree.

Like Professor Oh [1], we consider that increasing the research on strength training for CPR quality will be useful in avoiding the over-ventilation mentioned in our study. Regarding in-hospital cardiac arrests, it should not be a problem if staff were properly trained in advanced airway management and ventilation. However, for out-of-hospital coronary events where mortality increases with respect to the in-hospital ones, it is of vital importance to perform quality CPR from the very beginning. It could be argued that over-ventilation is not a major problem for a layperson because the 2015 guidelines promote a hands-only CPR protocol (HO-CPR) for such people. However, we think that, instead of regarding it as a minor problem, we should try to find a training programme that improves chest compression quality without affecting the quality of ventilation. Despite the fact that the use of HO-CPR is recommended for lay people, we find it necessary to investigate the improvement of the quality of ventilation as an important part of the CPR protocol. Furthermore, it is important to study the possible differences between standard CPR and HO-CPR in the effect of strength training. The latter makes the effects of fatigue appear earlier with a consequent decrease in quality [5]. As was observed in our study, strength training improved CPR quality which was also maintained for longer. The protocol used in our study was standard CPR, but similar results may be obtained with HO-CPR.

In conclusion, we think that investigation of the benefits of strength training in CPR quality should continue by: 1) comparing training programmes with specific training material and without any material at all; 2) assessing the differences of the effects between standard CPR and HO-CPR; 3) avoiding over-ventilation caused by training; and 4) including CPR performance in the training.

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