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Is It Time to Stop Teaching Bystanders Ventilation as Part of Pediatric Cardiopulmonary Resuscitation?

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The International Liaison Committee on Resuscitation (ILCOR) is made up of the world's major resuscitation councils. Part of its function is to periodically perform systematic reviews of resuscitation topics that are the foundation for council-specific resuscitation guidelines for basic and advanced life support for both adults and children. ILCOR's Pediatric Task Force regularly reviews pediatric resuscitation science to generate evidence-informed treatment recommendations to guide the care of pediatric victims of out-of-hospital cardiac arrest (OHCA).[1] ILCOR's ability to do so has historically been limited by the number and size of the pediatric studies available for its systematic reviews.

For more than a decade, the All-Japan Utstein Registry of its Fire and Disaster Management Agency has prospectively collected adult and pediatric OHCA data from across Japan. The registry has an impressive history of accurate and complete data capture, with no missing, incomplete, or inconsistent data for patients included in many of its studies.[2] This registry has allowed observational study of many important clinical questions. Two such questions are addressed in the 2 articles from this registry published in this issue of *Circulation*: What is the outcome of children with OHCA resuscitated by lay rescuers using chest compression–only cardiopulmonary resuscitation (CC-CPR) compared with conventional CPR (with ventilation)[2]? And what are the associations between the duration of CPR for pediatric OHCA and patient outcomes.[3]

Bystander CPR rates in many parts of the world remain low, and the inability or unwillingness to provide ventilation as part of conventional CPR has been one of the often-cited explanations. This, coupled with the greater complexity associated with teaching lay rescuers ventilation and the interruptions to chest compressions to give breaths, has led guidelines and training organizations to encourage CC-CPR by lay rescuers for adult (primarily cardiac-based) OHCA, especially by those rescuers untrained in conventional CPR.[4] To date, outcomes after bystander CC-CPR have been comparable to those after conventional CPR in adults, as supported by data from not only observational studies but also several randomized, controlled trials.[5]

CC-CPR might be acceptable for use in adults, but what about children? As opposed to the arrhythmic arrests commonly seen in adults, pediatric OHCA is often respiratory in origin, supporting the concept that ventilation may be more critical in pediatric resuscitation.[6] ILCOR's 2015 treatment recommendations encouraged rescuers to provide ventilation and chest compressions for pediatric OHCA victims[1] and were based on pooled data from 2 studies from the All-Japan Utstein Registry, showing that the use of CC-CPR compared with conventional CPR was associated with worse 30-day intact neurological survival (risk ratio, 0.46; 95% confidence interval [CI], 0.34–0.62).[7,8] Of these 2 studies, the Kitamura study provided more detailed analysis of subgroup outcomes based on the type of cardiac arrest, includ-

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ing specifically those children between 1 and 17 years of age. There was no difference in favorable neurological outcome in children 1 to 17 years of age who suffered a cardiac arrest of a primary cardiac cause, regardless of which CPR technique was used. Conversely, children with cardiac arrest of a noncardiac cause had better outcomes when conventional CPR was provided instead of CC-CPR (adjusted odds ratio [OR], 5.54; 95% CI, 2.52–16.99). Both studies used data from 10 years ago, before the 2010 CPR guidelines and the introduction of dispatcher-assisted CPR in Japan.

Fukuda et al[2] studied all pediatric patients (n=2257) >1 year of age with an OHCA between 2011 and 2012. The primary outcome was favorable neurological status (cerebral performance category 1–2) at 1 month after arrest, and the predictor of interest was the type of bystander CPR provided: conventional CPR, CC-CPR, or no bystander CPR. A total of 1150 patients (53.3%) received bystander CPR, of whom 733 (63.7%) received CC-CPR. The investigators performed multivariable regression analyses to adjust for the imbalances found on univariate analyses. Given the limitations of regression modeling, the authors also performed propensity score matching for those patients who received bystander CPR.

Any CPR compared with no CPR was associated with higher odds of neurologically favorable survival (adjusted OR, 5.01 [95% CI, 2.98–8.57] and 3.29 [95% CI, 1.93–5.71] for conventional and CC-CPR, respectively). In unadjusted analysis, conventional CPR was superior to CC-CPR, but there was no longer a statistically significant difference in neurologically favorable survival between patients receiving either bystander conventional or CC-CPR by multivariable regression analysis (adjusted OR, 1.52; 95% CI, 0.93–2.49) and by propensity score matching (OR, 1.20; 95% CI, 0.81–1.77). There were no subgroups, including children with asphyxial cardiac arrest, in whom conventional CPR was associated with improved neurologically favorable survival compared with CC-CPR.

The results of the multivariable regression model aligned well with those of the propensity score–matched model. Location of arrest (public or private) was not included in the analyses. This is particularly important for propensity score because matching assumes that both groups have the same prognosis at the time of treatment allocation, which would not necessarily be the case if the groups were imbalanced on this variable. In addition, the authors could not specify how bystander CPR was determined, if the type of bystander CPR changed at any point, how long it was provided, or if the quality of the CPR was adequate.

The Goto et al[3] study describes the relationship between the duration of emergency medical services (EMS)–delivered CPR for pediatric OHCA (<18 years of age) and patient outcomes using registry data between 2005 and 2012. After the exclusion of patients with unknown initial rhythm or missing time variables, 12877 patients were included in the analysis. The authors used multivariable regression modeling with duration of CPR as a continuous variable and constructed cumulative proportion curves to determine the duration at which <1% of patients had a neurologically favorable survival.

The authors found that with each additional minute of prehospital CPR by EMS, the OR for 30-day survival with cerebral performance category 1 to 2 was 0.90 (95% CI, 0.88–0.92). They found <1% survival with cerebral performance category 1 to 2 to be at a duration of >42 minutes, and >46 minutes if bystander CPR was provided. The stratified analyses based on initial rhythm found the duration to be >39, 42, and 46 minutes for ventricular fibrillation/pulseless ventricular tachycardia, pulseless electric activity, and asystole, respectively. No patient with prehospital CPR by EMS for >57 minutes survived with cerebral performance category 1 to 2.

The main strength of the Goto et al study is the number of patients enrolled, resulting in a very strong power to detect a difference. In Japan, EMS cannot declare death (except in obvious cases, eg, rigor mortis or decapitation); therefore, one must use caution when comparing these results with other studies or practice settings. A number of limitations are common to both studies. As with all observational studies, the authors were unable to control for unknown confounders and other known confounders such as in-hospital resuscitation practices and postresuscitation care, which are associated with outcomes. Furthermore, resuscitation practices may differ by jurisdiction. One striking example is that EMS use of epinephrine in Japan was <5% as a result of local regulations,[2] whereas in North America, epinephrine was used by EMS in 68% of pediatric OHCAs.[9] Last, both groups studied CPR, but neither included data on quality of CPR.

What messages are we to take away from these articles? The Goto et al study helps inform management for those few patients with prolonged out-of-hospital CPR for whom it can be difficult to decide when to stop CPR in the absence of a return of spontaneous circulation. This study will no doubt be cited often in the literature and in clinical practice because it deals with an issue with which many of us struggle. It is useful to have some guidance, but in reality, the decision is more complex than this study could do justice. One must consider premorbid conditions, in-hospital resuscitation practices, various out-of-hospital resuscitation factors (which may differ in Japan), and patient/family preferences when making such an important decision.

Is CC-CPR equivalent to conventional CPR for pediatric OHCA (at least for children >1 year of age), and is "doing something" (ie, CC-CPR) better than "doing nothing" (no bystander CPR)? The answer to the first question appears to be "maybe yes" and to the second question "yes or at a minimum probably yes," at least within the Japanese

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prehospital healthcare system. One might find it intuitive that providing CC-CPR (doing something) is better than not providing any CPR (doing nothing). It is interesting to note that this was not found to be the case when analysis of the pooled data from the 2 older registry studies was performed by an ILCOR systematic review.[1] The documented increase in bystander CPR rates and CC-CPR in Japan in the last 10 years may be due to the more accepted use of CC-CPR. In any case, this increased bystander CPR rate has been associated with an improved neurologically favorable survival, suggesting that even for children in cardiac arrest, pushing by itself is better than doing nothing at all. We echo the authors' call for a well-powered, prospective, randomized, controlled trial comparing CC-CPR with conventional CPR for pediatric OHCA, although this might be a challenging study to implement. We hope that the resuscitation science community views this study as providing equipoise to support the proposal for a randomized, controlled trial.

DISCLOSURES

None.

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FOOTNOTES

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