Strengthening the Chain of Survival: Cardiopulmonary Resuscitation Workshop for Caregivers of Children at Risk

Cristina Tomatis Souverbielle, MD*; Felipe González-Martínez, MD, PhD†; Maria I. González-Sánchez, MD‡; Marta Carrón, MD; Luis Guerra Miguez, MD; Laura Butragueño, MD; Henar Gonzalo, MD; Tomas Villalba, RN; Jimena Perez Moreno, MD; Blanca Toledo, MD; Rosa Rodríguez-Fernández, MD, PhD

Abstract
Background: Parents and caregivers should receive training regarding pediatric cardiopulmonary resuscitation (CPR) because this knowledge improves survival. We conducted a study as part of a Patient Safety Project to improve caregivers’ CPR knowledge and skills. We also aimed to improve the quality of patient care. Methods: We performed a prospective, longitudinal study in 2013–2014 in a pediatric hospital. We enrolled the caregivers of all patients admitted with a diagnosis of an acute life-threatening event, apnea, or choking. We provided a 45-minute CPR workshop for parents at discharge and evaluated the results using a test before, immediately after, and at 1 and 3 months after the workshop. Participants also completed an evaluation survey about the CPR workshop. Results: We admitted 62 patients [median age, 1 mo (0.5–2 mo)]. We provided 62 pediatric CPR workshops to 106 enrolled relatives. The median score was 5 (CI, 3–6) out of 10 at baseline, which increased to 8 (CI, 7–10) immediately after the workshop (P < 0.01). After 1 and 3 months, the median score was 8 (CI, 6–9; P < 0.01). The severity of the acute life-threatening event episode correlated with a better score (P = 0.02). The utility of the workshop scored 9.9 out of 10. Conclusions: This CPR workshop significantly increased CPR knowledge and confidence, and this was maintained up to 3 months post-training. Caregiver satisfaction was high. (Pediatr Qual Saf 2019;4:e141; doi: 10.1097/pq9.0000000000000141; Published online February 7, 2019.)

INTRODUCTION
Pediatric hospital medicine is a field that seeks to provide diagnosis and cure for their patients, but also education and prevention of common pediatric problems. The Hospital Infantil Gregorio Marañón (Children’s Hospital Gregorio Marañon) is a public, tertiary care hospital in Madrid, Spain. It has 185 beds and 8,000 admissions per year. It is a referral hospital in the area and cares for a population of 135,000 children 16 years old and younger. The Hospital Pediatrics Service at The Hospital Infantil Gregorio Marañon plays an important role in the care of admitted patients with 1,800 patients admitted to the service per year, 1,000 outpatient visits, and numerous consults from other specialties. At our center, the Hospital Pediatrics Service is responsible for developing quality improvement programs, implementing a culture of patient safety, and being a leader in health education for our patients. Since 2012, our service has participated in a hospital-wide multidisciplinary project to improve patient safety. One of the goals of the project is to transition to a “family-centered” patient care model. Family participation in the care process

From the *Division of Infectious Diseases, Nationwide Children’s Hospital, Columbus, Ohio; †Department of Pediatrics, Hospital General Universitario Gregorio Marañon, Madrid, Spain; and ‡Department of Pediatric Nurses, Hospital General Universitario Gregorio Marañon, Madrid, Spain.

Copyright © 2019 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

To cite: Tomatis Souverbielle C, González-Martínez F, González-Sánchez MI, Camon M, Guerra Miguez L, Butragueño L, Gonzalo H, Villalba T, Perez Moreno J, Toledo B, Rodríguez-Fernández R. Strengthening the Chain of Survival: Cardiopulmonary Resuscitation Workshop for Caregivers of Children at Risk. Pediatr Qual Saf 2019;4:e141.

Received for publication March 15, 2018; Accepted December 28, 2018.

Published online February 7, 2019.

DOI: 10.1097/pq9.0000000000000141

Preprint data were presented at 2 national meetings of the Spanish Pediatric Association (Asociacion Española de Pediatría), first as an oral presentation, June 2013, Sevilla, Spain, and then as a poster presentation, June 2015, Bilbao, Spain. The poster was selected as one of the best abstracts presented.

Supplemental digital content is available for this article. Clickable URL citations appear in the text.

Previous address: Department of Pediatrics, Hospital General Universitario Gregorio Marañon, Calle O’Donnell 50, 28007, Madrid, Spain.

This project also received the VI award for “Best Quality Improvement Practices in Healthcare Service of Madrid” (Mejores Prácticas en Gestión de Calidad en el Servicio Madrideño de Salud) on November 22, 2017.

*Corresponding author. Address: Rosa Rodriguez-Fernández, MD, PhD, Department of Pediatrics, Section of General Pediatrics, Hospital Infantil Gregorio Marañon, Calle O’Donnell 50, 28007, Madrid, Spain.

Phone: +34 619312632.

Email: rodriguez.hu@salud.madrid.org
is a key component to improve patient safety during and after hospitalization. For this reason, the Hospital Pediatrics Service plays an important role as an educator in health-related topics such as secondhand smoke exposure, the vaccine schedule, and pediatric cardiopulmonary resuscitation (CPR).

In the first year of life, acute life-threatening events (ALTEs), which can precede cardiopulmonary arrest, represent an important cause of critical out-of-hospital episodes. The incidence of ALTE is about 0.05%–6% among healthy newborns.1

Independent of the cause of ALTE, or now brief resolved unexplained event, parents and caregivers of infants should receive information about pediatric CPR.2 Research indicates that immediate and effective bystander CPR for victims of cardiac arrest improves survival, and knowledge of CPR guidelines increases the rate of bystander CPR.3,5

The “Pediatric Advanced Life Support” course provided by The American Academy of Pediatrics teaches the concept of the “chain of survival.”5 The chain of survival emphasizes the role that adult knowledge of infant CPR (outside of healthcare personnel) plays in the prevention and treatment of the causes of ALTE/brief resolved unexplained events, especially in those adults who take care of pediatric patients.

Our service has previously been teaching CPR to the caregivers of our patients admitted due to a life-threatening event (about 70 patients per year), with the aim of improving survival in these children if a second event occurred. However, this training was not standardized. For this reason, in 2013, we conducted a prospective study to improve caregiver CPR knowledge and skills, thus strengthening the “chain of survival” between patients and the healthcare system.

METHODS
We designed a prospective, longitudinal study with an educational intervention, and conducted it from 2013 to 2014 in a tertiary care pediatric hospital in Madrid, Spain. The Ethical Committee of our institution (Comité Ético de Investigación Clínica Hospital General Universitario Gregorio Maranon; address: C/Dr. Esquero, 46, 28007, Madrid, Spain) approved our project (CEIC 332/13) on December 18, 2013. At the time of development of this project, the term ALTE was standard. We enrolled all admitted patients with a diagnosis of ALTE, apnea episodes, and choking. We used the following inclusion and exclusion criteria:

**Inclusion Criteria**
- Caregivers responsible for the hospitalized patients (admitted with the above diagnoses) who agreed to participate in the workshop and voluntarily completed the pre- and post-training test and survey. Participants gave verbal informed consent.

**Exclusion Criteria**
- Workshop participants who did not want to complete the study tests.
- Caregivers who did not speak the language of the workshop (Spanish).
- Caregivers who had previous healthcare-related pediatric CPR training. (These parents received training, but we excluded them from the analysis.)

We collected clinical and epidemiologic data by chart review. We provided the pediatric CPR workshop to all parents or caregivers of patients with the above diagnoses (per protocol), regardless if they were willing to participate in the study.

Before the workshop, participants completed a 30-minute (maximum) test of 10 multiple choice questions about basic pediatric CPR (see Appendix 1, Supplemental Digital Content, available at [http://links.lww.com/PQ9/A71](http://links.lww.com/PQ9/A71)). The authors of the study jointly developed and approved the test. The day before discharge, we gave participants a written information booklet about basic pediatric CPR and foreign body airway obstruction basic life support maneuvers (with the European Resuscitation Council 2010 recommendations6) and encouraged them to review it. After this, we gave the pediatric CPR workshop, using an infant manikin. The workshop instructors were pediatric physicians with training in advanced pediatric life support. After the workshop, participants again completed the same 10 questions test. The caregivers completed the same test again 1 and 3 months after discharge. We scheduled subsequent follow-up visits until 12 months postdischarge. Patients were called and received a letter at their home address with the scheduled appointment.

At the 1-month follow-up, we also asked participants to evaluate the workshop. The survey (see Appendix 2, Supplemental Digital Content, available at [http://links.lww.com/PQ9/A71](http://links.lww.com/PQ9/A71)) asked about the caregivers’ level of satisfaction with the workshop, the global utility of the workshop, and if they thought necessary to repeat this workshop, and how often.

We compared the data among baseline knowledge, immediate postworkshop knowledge, and at 1 and 3 months follow-up. We expressed numeric variable results by median and interquartile ranges (IQRs) or means and SD where appropriate and the categorical variables in percentages. We performed a statistical analysis of before–after paired data with $\chi^2$, Mann–Whitney, Kruskal–Wallis, and Friedman tests. We performed multivariable linear regression with the dependent variable the number of correct answers immediately after participating in the workshop, and independent variables were the severity of episode (defined as that which required admission to the pediatric intensive care unit), underlying condition, and the caregiver’s level of education attained. A $P$ value of < 0.05 was considered statistically significant.
RESULTS
We prospectively enrolled the eligible caregivers of 62 patients admitted to our service with any of the previously described diagnoses. Table 1 shows the patient characteristics.

Their median age was 1 month (IQR, 0.5–2). We conducted 62 pediatric CPR workshops to 106 relatives (mothers, fathers, grandparents, and other). The median age of mothers was 33 years (IQR, 29–36), the median age of fathers was 33 years (IQR, 28–36), and the median age of grandparents was 50 years (IQR, 46–54). Fifty-eight percent of caregivers were mothers, 36.8% were fathers, and 5.7% were other caregivers.

The median duration of the workshop was 45 minutes (IQR, 40–50). One hundred one caregivers completed the test at baseline, 93 immediately after the workshop, 36 at 1-month follow-up, and 22 at the 3 months follow-up. Patients and caregivers were enrolled regardless of socioeconomic status. We compared the level of education between caregivers who did follow-up and the ones who were lost to follow-up, and there was no significant difference (high school studies: 33.3% versus 32.6%, respectively, \( P = 0.99 \); college studies: 5.5% versus 8.5%, respectively, \( P = 0.70 \)).

Concerning baseline knowledge about CPR, the median score was 5 points (CI, 3–6) out of 10, which increased to 8 points (CI, 7–10) immediately after participating in the workshop. This difference was statistically significant (\( P < 0.01 \)). After 1 and 3 months, acquired knowledge remained with a median score of 8 (CI, 6–9) and the difference between these results and baseline was again statistically significant (\( P < 0.01 \)). The difference between the results obtained immediately after the workshop, and the 1- and 3-month follow-up tests were not statistically significant (\( P = 0.07 \)).

In our cohort, a repeat ALTE that required any CPR occurred in 7% of patients, and all caregivers were able to apply their acquired knowledge and skills. Caregivers felt confident in their skills and were very satisfied. All patients recovered well after these episodes.

None of the participants’ characteristics (gender, maternal or paternal age, or level of education) correlated with the preworkshop examination scores. However, the multivariate analysis indicated a statistically significant association between the severity of the episode and the presence of an underlying condition with a better result in the immediate postworkshop test \( R^2, 45\% \) [underlying condition \( t = 2.33 \) and \( P = 0.03 \), severity \( t = 2.49 \) and \( P = 0.02 \)].

We also assessed the participants’ evaluation of the course by a survey. The score given to the theoretical and practical part of the course was 9.69 (±0.62) and 9.65 (±0.71) out of 10, respectively. Global utility scored 9.87 (±0.47) out of 10. All participants noted that they were able to practice with the manikin and clarify their questions. Eighty-six percent of the participants wanted to repeat the training frequently, at a mean of 10.4 months (±6.25 months) after the original training.

DISCUSSION
In our study, we found a significant increase in CPR knowledge of caregivers of pediatric patients admitted because of an ALTE, apnea episode, or choking episode after a 45-minute training workshop. This knowledge remained up to 3 months after discharge. The majority of participants thought the workshop was useful, as demonstrated in the postworkshop survey.

In the United States, the incidence of out-of-hospital cardiac arrest in the pediatric population is reported to vary from 2.6 to 19.7/100,000. Of these, only 27.4% received bystander CPR, and the reported average survival to discharge among this population is only 6.7%.3

In Spain, the “Spanish Study group of cardiopulmonary arrest in children” aims to improve CPR training in healthcare personnel and in laypersons to improve survival. A multicenter prospective study from this group evaluated the characteristics and outcomes of out-of-hospital cardiac arrest in Spanish children. A subanalysis from this study published in 2005 found that initial survival was 47% and 1-year survival was 26.4% and that patients who were initially resuscitated by laypersons or paramedics had higher survival (53% versus 15.2%; \( P = 0.001 \)).4,7–9

Research indicates that CPR courses are effective and they give the families the feeling of situation control and decrease anxiety.3,10 Seventy to 80% of cardiac arrests occur at home. These arrests have a lower survival rate

Table 1. Patient Characteristics

| Variable                           | Patients % (Total N = 62) |
|------------------------------------|---------------------------|
| Median age                         |                           |
| 1 mo (IQR, 0.5–2 mo)               |                           |
| Median gestational age at birth    |                           |
| 39 wk (IQR, 37.5–40 wk)            |                           |
| Sex                                |                           |
| Female                             | 56.5% (35/62)             |
| Male                               | 43.5% (27/62)             |
| Medical history*                   | 32%                       |
| Care provided by EMS before arrival to hospital | 3%            |
| PICU admission                     | 8%                        |
| Discharge diagnosis                |                           |
| Obstructive apnea                  | 66% (41/62)               |
| Choking                            | 37% (26/62)               |
| GERD                               | 27% (17/62)               |
| Central apnea                      | 13% (8/62)                |
| ALTE                               | 11% (7/62)                |
| Other†                             | 19% (12/62)               |
| Caffeine prescribed at discharge   | 11% (7/62)                |
| Cardiac an pulse oximetry monitor device at discharge | 14.5% (9/62)          |
| Mortality                          | 0% (0/62)                 |

*Prematurity (4), cardiopathy (patient foramen ovale, ventricular septum defect, pulmonary stenosis, ascending aortic dilatation, aberrant right subclavian artery) (5), transient tachypnea of newborn (5), pyelocalcic dilatation (1), previous apneas (4), laryngomalacia (1).
†Bronchiolitis (9), choking (17), upper airway abnormality (1).
EMS, emergency medical system; in Madrid called SAMUR; “servicio de atención médica de urgencias”; GERD, gastroesophageal reflux disease; PICU, pediatric intensive care unit.
Parents and caregivers are generally willing to perform CPR, especially on family members. However, their knowledge of current guidelines is poor, and thus, reduces their confidence. A study from Saudi Arabia found that public awareness and knowledge on infant CPR were inadequate, even among the younger population and among parents of disabled children. Level of education was unrelated. Fortunately, they were all willing to improve. In our study, we found workshop evaluations with more complex knowledge and feedback devices can help teach the psychomotor skill of CPR; and 2-year retraining cycles are not optimal, and more frequent training may be beneficial. Studies have shown increased confidence and willingness to perform CPR after repeat training sessions.

In our study, we used manikins, and the instructors gave feedback as needed. Even though our manikins were not the high-fidelity devices referred to above, we think our situation may be comparable to other settings in which such technologies are not yet available, and for us, these proved to be useful. We have recently started providing audiovisual materials for caregivers to further reach out to other potential learners who are not able to attend the courses and to give them a chance to review the steps at home whenever they want to. Furthermore, we have implemented in our hospital's intranet system an online pediatric CPR course in the “education for parents” section. This course is available to all parents/caregivers of patients admitted to our service, regardless of the reason for admission.

Our study has some limitations. Our study population was small, and it is a single-center study, so our results may not be generalizable to all populations. We did not test actual CPR skills (only knowledge) at the 1- and 3-month marks due to time and staff limitations. We did corroborate the successful resuscitation skills of those caregivers whose infants had a repeat event. The test content was identical in all 4 time-points to make the score results comparable, but caregivers did not receive feedback for the incorrect answers to questions during any of the 3 testing periods. Families did ask questions and received feedback during and at the end of the workshop (after the first preworkshop test), reviewing all concepts imparted.

Additionally, many of our course participants were lost to follow-up after discharge. However, patients/caregivers were selected regardless of their socioeconomic status, and there was no difference in the level of education between caregivers who followed-up and the ones who did not. Despite this, the patients/caregivers who did follow-up may have been more motivated for unknown reasons.

With the lessons learned, we would suggest future more robust studies with larger number of participants, if able multicenter, and with dedicated staff as instructors and for follow-up visits. We would like to enhance postworkshop evaluations with more complex knowledge and CPR skills tests. It would be ideal as well, if follow-up visits could be done at home or by phone so as to minimize patient loss.

Currently, this quality improvement project is part of our routine family-centered patient care protocols. In
another survey done by patients’ families to measure the perceived quality of care, our service scored a median of 8.5 (CI, 8–9.1) out of 10 (unpublished data) after this intervention. This project was the only change in a long time before such survey took place. As reported here, the workshop evaluation survey revealed a high global utility score. There could have been other causes of an increase in perceived quality of care, but we believe this contributed the most.

CONCLUSIONS
Our CPR workshop significantly increased knowledge about CPR in the caregivers of infants admitted for ALTEs, choking episodes, and apneic episodes, and knowledge was maintained up to 3 months after the course. Caregivers’ satisfaction and evaluation of the workshop were high, thus improving the perception of the quality of care provided by our unit. Caregivers considered this initiative very helpful, and they felt more confident to perform CPR after training. Families that were required to use their CPR skills after discharge demonstrated that they were capable of doing so. For these reasons, we believe that this work contributes to strengthening the “chain of survival” and could be generalizable to other units and centers.

It is fundamental to combine theory and practice when teaching CPR, allowing participants to use manikins and ask questions. Including families in our patient care model allows us to reach a high level of satisfaction and improve quality of care.

ACKNOWLEDGMENTS
The authors thank the following members for assistance with the study: all residents and attending physicians who helped as instructors and with recruiting patients; caregivers who participated in this project; entire pediatric service nurse team that helped in this project; and Shaina Hecht and Erica Martz for reviewing this article.

DISCLOSURE
The authors have no financial interest to declare in relation to the content of this article.

REFERENCES
1. Palmieri A, Riccardi S, Bergamino L, et al. Apparent life threatening event (ALTE): the role of the training in the follow-up. Minerva Pediatr. 2011;63:139–148.
2. Tieder JS, Bonkowski JL, Etzel RA, et al. Brief Resolved Unexplained Events ( Formerly Apparent Life-Threatening Events) and Evaluation of Lower-Risk Infants: Executive Summary. Pediatrics. 2016;137(5):e20160591.
3. Cu J, Phan P, O’Leary FM. Knowledge and attitude towards pediatric cardiopulmonary resuscitation among the carers of patients attending the Emergency Department of the Children’s Hospital at Westmead. Emerg Med Australas. 2009;21:401–406.
4. Fonte M, Ouileo-erozo I, Rodriguez-Núñez A, et al. Out-of-hospital pediatric cardiopulmonary resuscitation in Galicia: impact of the 2003 resuscitation guidelines. Pediatr Emerg Care. 2011;27:697–700.
5. Callahan JM, Fuchs SM. AAP COMMITTEE ON PEDIATRIC EMERGENCY MEDICINE. Advocating for Life Support Training of Children, Parents, Caregivers, School Personnel, and the Public. Pediatrics. 2018;141(6):e20180704.
6. Nolan JP, Soar J, Zideman DA, et al; ERC Guidelines Writing Group. European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary. Resuscitation. 2010;81:1219–1276.
7. López-Herce Cid J, García Sanz C, Domínguez Sampedro P, et al. Grupo Español de Estudio de la Parada Cardiorrespiratoria en Niños. Characteristics and evolution of cardiopulmonary arrest in children in Spain: comparison between autonomous communities. Med Intensiva. 2006;30:204–211.
8. López-Herce J, García C, Domínguez P, et al; Spanish Study Group of Cardiopulmonary Arrest in Children. Outcome of out-of-hospital cardiopulmonary arrest in children. Pediatr Emerg Care. 2005;21:807–815.
9. Sánchez Erxaniz J, Santiago Burruchaga M, González Hermosa A, et al. Epidemiological characteristics and risk factors for apparent life-threatening events. An Pediatr (Barc). 2009;71:412–418.
10. Moran K, Stanley T. Toddler parents training, understanding, and perceptions of CPR. Resuscitation. 2011;82:572–576.
11. Ishye DL, Meyhoff CS, Lippert FK, et al. Skill retention in adults and in children 3 months after basic life support training using a simple personal resuscitation manikin. Resuscitation. 2007;74:296–302.
12. Al-Turkistani HK. Awareness and knowledge of pediatric cardiopulmonary resuscitation in the community of Al-Khobar city. J Family Community Med. 2014;21:125–129.
13. Nichols BG, Visotcky A, Aberger M, et al. Pediatric exposure to choking hazards is associated with parental knowledge of choking hazards. Int J Pediatr Otorhinolaryngol. 2012;76:169–173.
14. Bhanji F, Donoghue AJ, Wolff MS, et al. Part 14: Education: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18 suppl 2):S561–S573.