Available online at www.sciencedirect.com

Resuscitation Plus

journal homepage: www.elsevier.com/locate/resuscitation-plus

Simulation and education

Knowledge and skills of pediatric residents in managing pediatric foreign body airway obstruction using novel airway clearance devices in Spain: A randomized simulation trial

Aida Carballo-Fazanes[a,b,c,d], *Verónica Izquierdo*[b,c], *Juan Mayordomo-Colunga*[b,e,f,g,h,*], *José Luis Unzueta-Roch*[i], *Antonio Rodríguez-Núñez*[a,b,c,d,j]

Abstract

Aim: Recent emergence of airway clearance devices (ACDs) as a treatment alternative for foreign body airway obstructions (FBAO) lacks substantial evidence on efficacy and safety. This study aimed to assess pediatric residents' knowledge and skills in managing a simulated pediatric choking scenario, adhering to recommended protocols, and using LifeVac© and DeCHOKER© ACDs.

Methods: Randomized controlled simulation trial, in which 60 pediatric residents from 3 different hospitals (median age 27 [25.0–29.9]; 76.7% female) were asked to solve an unannounced pediatric simulated choking scenario using three interventions to manage (randomized order): 1) following the recommended protocol of the European Resuscitation Council (encouraging to cough or combination of back blows and abdominal thrusts); 2) using LifeVac©; and 3) using DeCHOKER©. A Little Anne QCPR™ manikin (Laerdal Medical) was used. The variable compliance rate (%) was calculated according to the correct/incorrect execution of the steps constituting the proper actions for each test.

Results: Participants demonstrated a correct compliance rate only ranging between 50–75% in following the recommended protocol for managing partial FBAO progressing to severe. Despite unfamiliarity with the ACDs, pediatric residents achieved rates between 75% and 100%, with no significant difference noted between the two devices ($p = 0.173$). Both scenarios were successfully resolved in under a minute, with LifeVac© demonstrating a significantly shorter response time compared to DeCHOKER© (39.2 [30.4–49.1] vs. 45.1s [33.7–59.2], $p = 0.010$).

Conclusions: Only a minority of pediatric residents were able to adhere to the recommended FBAO protocol, whereas 70% of them were able to adequately use the ACDs. However, since a significant proportion could not, it seems that ACDs themselves do not address all issues.

Keywords: Choking emergency, FBAO, Basic Life Support, LifeVac, DeCHOKER, Training

Introduction

In the realm of emergency medical care, foreign body airway obstruction (FBAO; choking) remains a critical and potentially life-threatening challenge, representing the fourth leading cause of potentially preventable and treatable accidental death.[1,2] While FBAO can affect individuals of all ages, its prevalence is notably pronounced in young children and the elderly. The vulnerability peaks during mealtime, both out- and in-hospital setting.[3,4] In this sense, prompt recognition and quick and effective intervention is essential to ensure a positive patient outcome.[1]

In addressing FBAO, current recommendations from resuscitation councils are quite clear with step-by-step maneuvers to be performed according to the choking scenario and victim's age.[1,5,6] Despite these guidelines, the management of FBAO remains a complex undertaking, marked by weak level of evidence and controversy because of serious risk of bias and imprecision among studies.[7] This knowledge gap requires exploration into novel interventions to address this life-threatening event.

Airway clearance devices (ACDs) have emerged in recent years as non-powered suction-based devices: LifeVac© (LifeVac LLC, Nesconset, New York, NY, USA)[8] and DeCHOKER© (Dechoker

* Corresponding autor at: Paediatric Intensive Care Unit. Hospital, Universitario Central de Asturias, Avda. De Roma s/n, 33011, Oviedo, Spain.
E-mail address: mayordomojuan@uniovi.es (J. Mayordomo-Colunga).

https://doi.org/10.1016/j.resplu.2024.100695
Received 13 March 2024; Received in revised form 10 June 2024; Accepted 11 June 2024

2666-5204/© 2024 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).

LLC, Wheat Ridge, CO, USA),[9] which have been introduced on the market and are now available in public areas[10] These devices were designed to remove obstructing materials from the airways through the application of suction.[8,9] However, its role and effectiveness in case of FBAO it not clear. Previous mannequin studies,[11,12] cadaver studies[13] and studies in real choking victims[14–17] reported significant success in dislodging a foreign body. Nevertheless, recent studies indicate that ACDs may not be effective in relieving the obstruction caused by diverse types of foods and even cause harm.[18] Given the scarcity of substantial evidence surrounding them (due to industry involvement and reporting biases, small sample size or preliminary results)[15,19,20] and the controversial findings, international treatment recommendations in 2023 advise against them until new evidence is obtained.[7,21]

While there is limited research on the assessment of the correct use of suction-based ACDs in the general population[22] and among health science students,[23] to the best of our knowledge, there is no study with these devices in pediatric healthcare professionals, treating a population at risk of suffocation: the pediatric age group. We studied pediatric trainees because pediatricians not only as professionals but also to inform and, when necessary or requested, train families on how to manage home and public places accidents. Additionally, given the misinformation about ACDs in the media, pediatricians play a crucial role in ensuring families receive the accurate and reliable information. Thus, as residents are the future pediatricians, it is essential that they have direct knowledge of the recommended protocol, the specific devices, and their proper utilization when required. In this regard, the current study has assessed the knowledge and proficiency of pediatric residents in managing a pediatric choking simulated model, using the currently endorsed protocol[6] as well as LifeVac© and DeCHOKER© devices.

Materials and methods

Participants

Sixty pediatric residents engaged in their training at three hospitals in Spain—specifically, the University Clinical Hospital of Santiago de Compostela, Hospital Infantil Universitario Niño Jesús in Madrid, and the Central University Hospital of Asturias —were voluntarily enrolled and none of them dropped out during the study. The recruitment process of this convenience sample transpired at their respective workplaces over the duration of June to October 2023.

The Research Ethics Committee of Santiago-Lugo did not consider it necessary to review the research protocol since it is a simulation study. All study participants provided written informed consent, adhering to the ethical standards outlined by the Declaration of Helsinki. They willingly agreed to contribute their data for research purposes, with an assurance of complete anonymity.

Study design and procedure

In the present randomized controlled simulation trial residents encountered a simulated victim with a FBAO and had to solve the situation through three interventions: 1) adhering to the presently recommended protocol (Supplementary material); 2) using the LifeVac© device; 3) employing the DeCHOKER© device. The start of the three simulated scenarios was randomized for the participants using a random number sequence. The topic and methodology of the study were unannounced to all participants.

To solve the scenario using the recommended protocol pediatric residents should follow the guidelines.[1,5,6] They were informed that they were in a shopping center and were alerted to a 14-year-old child choking on a grape. They were the first responders and found the child coughing. Participants were instructed to address the situation by following the recommended protocol for managing a partial obstruction (encouraging coughing), which would escalate to a severe obstruction (requiring the combination of back blows and abdominal thrusts).[1,5,6]

In the remaining two scenarios involving the LifeVac© and DeCHOKER© devices, the case presentation differed in that, upon arriving at the FBAO emergency, someone had previously attempted the recommended maneuvers, and they had failed. Subsequently, the participant was provided with the suction-based ACD to attempt to resolve the situation. Each device was supplied in its original packaging and with the manufacturer's leaflet. In each scenario, the participants had to choose the correct size mask (LifeVac©) and the correct size device (DeCHOKER©).

To simulate a choking child scenario with ACDs, we employed a mannequin representing a 14-year-old (Little Anne QCPR™; Laerdal). Conversely, for the simulation adhering to the recommended protocol, we utilized a trained young adult victim with anatomical features closely mirroring those of a 14-year-old. In this instance, the participants were informed that they were dealing with a real person and that they had to exercise caution when carrying out the recommended protocol. No training was performed before each test, nor was any information provided to participants during the tests; letting them act as if they were alone in the FBAO scenario.

Two trained investigators were responsible for the assessment. One of them completed a checklist regarding the correct or incorrect performance of each recommended step in each test, while the other was responsible for measuring the partial (for each step) and total times.

Materials

The LifeVac© device is a non-powered, non-invasive ACD designed to dislodge foreign bodies from the airway through unidirectional suction phenomenon.[8] This device, consisting of a facemask with a one-way valve connected to a plunger, is FDA registered as a Class II medical device. Three interchangeable mask sizes are included: small pediatric (for children weighing more than approximately 10 kg between 1 and 4 years of age), large pediatric mask (children over 4 years of age) and adult mask.

The DeCHOKER© was developed as a device with a plunger system responsible for generating the negative pressure, also with unidirectional suction.[8] Unlike LifeVac©, it also features an oropharyngeal tube, acting as a tongue depressor, which makes it minimally invasive. DeCHOKER© is available in three different sizes: infants (1 to 3 years), children (3 to 12 years), and adults (12 years and older).

Little Anne QCPR™ (Laerdal; Stavanger, Norway) mannequin was used as a simulated FBAO victim when ACDs were employed to resolve the choking.

Measurements

Demographic information for participants, encompassing gender, age, year of residency, weight and height was recorded. Additional variables included their most recent training in FBAO, whether they had witnessed or addressed any choking incidents, and their familiarity with suction-based ACDs.

The primary study variables comprised the accurate execution of each step required for FBAO treatment using the recommended protocol, the LifeVac© device, and the DeCHOKER© device. Additionally, the time (in seconds) taken to resolve each scenario was measured. The variable correct compliance rate (%) was computed using the formula: (Σ steps correctly performed × 100)/number of steps assessed.

In this context, correct compliance rate for LifeVac© was calculated considering the following steps: 1) inserting the mask on the device's bellows, 2) correctly placing the mask to cover the victim's nose and mouth, 3) pushing in the handle/bellows, 4) pulling the handle upwards, and 5) ensuring the mask remains securely fixed to the victim's airway throughout the procedure.

DeCHOKER© correct compliance rate was determined by assessing the accurate or incorrect execution of the following sequence: 1) correctly placing the mask to cover the victim's nose and mouth, 2) pulling the plunger out, 3) forcefully pulling, and 4) ensuring the mask remains securely fixed to the victim's airway throughout the procedure.

The correct compliance rate for the current recommended protocol was computed by evaluating the precise or erroneous execution of the following sequence[1,5,6]: 1) encouraging coughing, 2) performing back blows, 3) accurately executing back blows, 4) performing abdominal thrusts, 5) accurately executing abdominal thrusts, 6) consistently applying 5 back blows × 5 abdominal thrusts, 7) accurately continuing 5 × 5, 8) indicating the initiation of CPR maneuvers in the event of unconsciousness.

Finally, following each test, participants were queried about a subjective variable—their choice between the two suction-based ACDs (LifeVac© and DeCHOKER©) and the reasons for their choice.

Data analysis

A descriptive analysis of the variables was performed. The researchers conducting the data analysis were blinded to which data belonged to each intervention. Categorical variables were reported as absolute and relative frequencies, while continuous variables were expressed as median (interquartile range) based on the non-parametric sample adjustment (Kolmogorov-Smirnov Test). The Chi-Square test was used to compare categorical variables. Furthermore, comparisons involving continuous variables between the LifeVac© and DeCHOKER© devices were conducted using the Wilcoxon signed-rank test. Analysis was performed using the SPSS statistical software (IBM corp., v. 25.0 for Mac), and for all analyses, a p-value of less than 0.05 was statistically significant.

Results

The characteristics of the 60 pediatric residents included in the study are detailed in Table 1. Over 70% of the participants had not undergone FBAO training for more than a year, and only one resident was acquainted with the related suction-based ACDs.

The outcomes concerning the scenario in which participants applied the steps of the currently recommended protocol for addressing FBAO are outlined in Table 2. It was noted that a majority of the steps were carried out by more than half of the sample, yet the percentage of correct execution varied significantly. In the case of back blows (performed by 60% of the sample), over 36% did them incorrectly due to a lack of knowledge regarding the correct number of blows. Similarly, while all participants performed abdominal thrusts, almost half did so incorrectly, as they were unaware of the exact number of thrusts. Regarding the execution of the abdominal thrusts, a substantial number of residents knew how to position themselves behind the victim and put both arms around de upper part of the abdomen (98.3%), place a closed fist between the umbilicus and the ribcage (86.7%), and grasp both hands and pull sharply inwards and upwards (95.0%).

Pediatric residents demonstrated the least recall for the step involving the continuation of 5 back blows and 5 abdominal thrusts while FBAO remained unresolved. Only half of the sample (30 participants) engaged in this step, and merely 16 (53.5%) executed it correctly. When considering the correct execution of all steps, only 13 (21.7%) of participants successfully achieved this. The median for the correct compliance rate stood at 62.5%, with the time taken until the initial clearance attempt being 47.6 s. No statistically significant differences were found between those who received training in the last year and those who received it over a year ago (Table 2).

Table 3 presents data on the utilization of LifeVac© and DeCHOKER© in the simulated FBAO scenario. No significant differences were observed between the two devices in the comparison of the correct execution of each step indicated by the manufacturers. The step prone to the highest error rate involved keeping the mask close-fitting to the victim's airway as more than 20% of participants struggled to maintain a sealed airway during the procedure with both devices. Moreover, considering incorrect device's use, 12 participants (20%) using DeCHOKER© applied insufficient force while pulling the plunger, and 9 (15%) using LifeVac©, disconnected the mask from the plunging unit.

Regarding the time taken with the devices until the first attempt at clearance (the moment when the case was stopped), all participants completed the process in less than one minute. This time was shorter with LifeVac© in comparison with DeCHOKER© (39.2s [30.4–49.1] vs 45.1s [33.7–52.2]; $p = 0.010$). No differences were observed in the correct compliance rate, as the median was 100% for both suction-based ACD.

When comparing participants' correct execution of all steps among the three different methods, about 70% of the residents achieved it using ACDs including the manufacture's instruction leaflet, while only 21.7% did so with the FBAO protocol (Tables 2, 3).

Concerning the subjective feedback following the use of the ADCs, 35 participants (58.3%) expressed a preference for the LifeVac© device, citing its simplicity (27, 45.7%) and intuitiveness (15, 25%). Conversely, those who identified more advantages with DeCHOKER© highlighted its pre-assembled design (10, 16%) and a perception of greater negative pressure generated, noted by 22 participants (36%).

Discussion

This study provides the first findings from the assessment of the use of ACDs in a simulated child choking scenario addressed by pediatric residents. Pediatricians in training showed a lack of awareness regarding the existence and functionality of ACDs, which would be a challenge in offering guidance or dissuasion regarding inquiries by some professionals with the duty to assist (e.g., policemen, lifeguards) and lay people. Nevertheless, participants have demonstrated proficiency in executing the skills required for using the LifeVac© and DeCHOKER© devices (when provided with manufac-

Table 1 – Characteristics of the participants.

Variables	Participants n = 60
Age (years)	27.0 (25.0–29.0)
Weight (kg)	60.0 (52.0–68.0)
Height (m)	1.65 (1.60–1.73)
Gender	
Male	14 (23.3)
Female	46 (76.7)
Year of residency	
1	13 (21.7)
2	16 (26.7)
3	14 (23.3)
4	17 (28.3)
Prior training in FBAO	
Less than 1 year	15 (25.0)
More than 1 year	44 (73.3)
None	1 (1.7)
Type of training	
CPR course	33 (55.0)
Hospital simulation	9 (15.0)
Medical Degree	18 (30.0)
Have you ever witnessed a real-life FBAO event?	
Yes	10 (16.7)
No	50 (83.3)
Have you intervened when the FBAO?	
Yes	4 (6.7)
No	56 (93.3)
Are you familiar with the suction-based airway clearance devices?	
Yes	1 (1.7)
No	59 (98.3)

Continuous variables are expressed with median (interquartile range).

Categorical variables are expressed with absolute frequency (relative frequency).

turers' instructions). On the other hand, curiously they faced more problems to implement the currently recommended FBAO protocol.

The objective of FBAO intervention is to alleviate obstruction without causing harm or injury to the victim. In this regard, finding the most effective, quick and suitable treatment remains a challenge.[7] The currently recommended protocol involves a combination of back blows, abdominal thrusts and/or chest thrusts/compressions) but relies on a low certainty evidence. Furthermore, potential risks of these techniques, such as abdominal bruising and rib injuries, emphasize the ongoing search for alternatives.[1,5] In addition, our study confirms that even health professionals fail when performing the FBAO guidelines.[1,5,7]

In our study, the pediatric residents demonstrated a correct compliance rate only ranging between 50–75% in adhering to the steps of the recommended protocol for a victim experiencing partial FBAO that progresses to severe FBAO. In this instance, the residents did not have explicit instructions or algorithms for resolving FBAO, neither for general nor in pediatric patients. We postulate that this may have resulted in lower success rates than those achieved with the ACDs. However, in a real-world setting, the pediatric residents would not have been provided with instructions to apply the recommended protocol. In this regard, it is worth mentioning that only around 22% of participants successfully executed all the steps of the recommended protocol. Moreover, when considering those who received their latest FBAO training within the past year, this figure only increases to 33%. This underscores the necessity for additional or more targeted training in Spain, suggesting not only the scheduling of refresher practice during pediatric residency every 3–6 months, but also emphasizing the need for a strict policy regarding training and refresher programs. Similar findings have emerged in previous studies involving health science students, where despite receiving specific training, fewer than 23% of participants (n = 31) executed the steps accurately.[23] Limited studies have assessed the proficiency in executing these techniques compared to those required for applying ACDs, but the findings appear to align with our results, suggesting that performing the maneuvers of the recommended protocol is more challenging.[23]

ACDs designed to suction fluids and even small objects have been put in the marketplace and are now available in multiple public areas like shopping centers and airports[10] without clear evidence of their safety and effectiveness and the consequent controversy.[8,14,19,24,25] Our results indicate that pediatric residents were not aware of the ACDs and did not know how to use them. Nevertheless, despite this initial unfamiliarity, the residents demonstrated competence in employing the ACDs with the use of the manufacturer's instruction leaflet. Prior previous studies involving parents, educators,[22] and healthcare learners,[23] also have shown that such devices should be easy to use in a real case without specific training and only following the manufacturers' leaflet.

However, ease of use should not be conflated with the efficacy of airway clearance. In this sense, the most common error observed in both our study (20% of participants) and previous research (ranging from 14% to 43%)[22,23] pertains to the challenge of achieving a proper seal between the facemask and the mannequin's face during the procedure. This is a critical step, as the absence of a close-fitting makes it difficult to generate negative pressure, leading to suction failure. Consequently, we emphasize the necessity for specific training in ACD implementation, with a particular focus on mastering this critical aspect. Research has shown that a brief training session, lasting between 15–30 min, can be sufficient for the effective utilization of these devices.[16]

A concern about the use of ACDs might by the delay in initiating the currently recommended maneuvers or even lead to the omission of them. In fact, studies by Bhanderi[16] and Dunne[15] observed that, despite stating that the devices should be used only after fail of properly performed recommended maneuvers, many first responders skipped steps or the entire protocol, opting to apply the devices immediately. This complicates the assessment of whether these situations could genuinely be resolved without the use of devices through the correct application of the protocol. In this sense, our results indicate that, in the simulated scenario, both devices could be used without significant delay, as all participants were able to use them in less than one minute, with some advantage for the LifeVac©, in agreement with previous simulation studies.[12,22,23]

The users' preference in our sample was in favor of LifeVac© over DeCHOKER© and was based on the ease of use and also on the feeling of risk of the big oropharyngeal tube of the DeCHOKER© device that appeared potentially dangerous. The presence of such intraoral component was also noted as a source of concern, leading to heightened nervousness among those surveyed, as documented by Dunne.[15]

Considering the observed ease of use in our study and the potential effectiveness in real-life scenarios[14–17] we suggest these devices should be assessed in clinical trials, at least as rescue resources

Table 2 – Descriptive analysis of participants' execution of recommended steps for treating a child victim with FBAO.

Variables	Overall (n = 60)	Training < 1 year (n = 15)	Training > 1 year (n = 44)	*v2* *p*-value
Encourage to cough				
Yes	55 (91.7)	15 (100)	39 (88.6)	1.198
No	5 (8.3)	–	5 (11.4)	$p = 0.371$
Give 5 back blows				
Yes	36 (60.0)	7 (46.7)	28 (63.6)	2.020
No	24 (40.0)	8 (53.3)	16 (37.4)	$p = 0.364$
Give black blows correctly	n = 36	n = 8	n = 28	
Yes	23 (63.9)	6 (75.0)	17 (60.7)	6.223
No	13 (36.1)	1 (12.0)	11 (39.3)	$p = 0.183$
Give 5 abdominal thrusts				
Yes	60 (100)	15 (100)	44 (100)	–
No	–	–	–	
Give abdominal thrusts correctly				
Yes	31 (51.7)	9 (60.0)	21 (47.7)	1.626
No	29 (48.3)	6 (40.0)	23 (52.3)	$p = 0.444$
Continue to 5 back blows and 5 abdominal thrusts				
Yes	30 (50.0)	7 (46.7)	23 (52.3)	1.158
No	30 (50.0)	8 (53.3)	21 (47.7)	$p = 0.561$
Continue to 5 back blows and 5 abdominal thrusts correctly	n = 30	n = 7	n = 23	
Yes	16 (53.3)	5 (71.4)	11 (47.8)	2.310
No	14 (46.7)	2 (28.6)	12 (52.2)	$p = 0.679$
Start BLS for unconscious victim				
Yes	55 (91.7)	14 (93.3)	41 (93.2)	11.187
No	5 (8.3)	1 (6.7)	3 (6.8)	$p = 0.004$
Start BLS for unconscious victim correctly	n = 55	n = 14	n = 41	
Yes	53 (96.4)	13 (92.8)	40 (97.6)	11.857
No	2 (3.6)	1 (7.2)	1 (2.4)	$p = 0.018$
Perform all the steps correctly				
Yes	13 (21.7)	5 (33.3)	8 (18.2)	1.794
No	47 (78.3)	10 (66.7)	36 (81.8)	$p = 0.408$
Correct compliance rate	62.5 (50.0–75.0)	50.0 (37.5–100.0)	62.5 (50.0–75.0)	0.836[b]
Time to back blows (sec)	14.5 (12.4–19.5)	13.0 (12.5–20.2)	14.5 (12.2–19.5)	0.712[b]
Time to abdominal thrust (sec)	21.5 (15.7–28.2)	19.5 (15.5–20.6)	24.3 (15.7–29.2)	**0.019**[b]
Total time (sec)	47.6 (43.2–57.6)	48.3 (43.9–53.2)	47.5 (42.5–59.4)	0.207[b]

Abbreviations: FBAO = Foreign Body Airway Obstruction; BLS = Basic Life Support; sec = seconds.

Continuous variables are expressed with median (interquartile range).

Categorical variables are expressed with absolute frequency (relative frequency).

p-values calculated by Chi-square test.

[b] Kruskal-Wallis test.

when FBAO recommended techniques (back blows and abdominal thrusts) fail or become unfeasible. In this context, earlier studies have highlighted the challenge of performing abdominal thrusts on individuals in wheelchairs or bedbound patients.[16] In such circumstances, ACDs could emerge as a viable alternative, given their adaptability in seated or reclined positions. Nevertheless, drawing substantial conclusions is constrained by the fact that most of these studies provided preliminary, limited data or industrial involved bias.[15,25] Furthermore, there are even studies conducted on cadavers that reveal difficulties and, in certain instances, ineffectiveness in clearing specific food items such as saltine crackers, whole grapes, and cashews using LifeVac© and DeCHOKER©.[18]

In addition, subsequent studies ought to investigate the negative pressures produced by both devices under varying forces and speed of traction, along with definition of the optimal pressure for effective and safe clearance of airway obstruction.[18]

Limitations

Our study has certain limitations. Firstly, the application of ACDs on a plastic mannequin may not precisely replicate the conditions in conscious humans experiencing severe FBAO, potentially leading to different results in a real-life scenario. Secondly, the efficacy of the devices in foreign body clearance was not assessed due to the non-specific nature of the mannequins used for FBAO, and the airway was not sealed. On the other hand, in the two scenarios involving ACDs, a mannequin was used for FBAO simulation whereas in the recommended protocol scenario a real trained victim was employed. This was necessitated by the inherent difficulty in effectively performing "encourage to cough", "back blows", and "abdominal thrust" on a dummy. Besides, the three scenarios were conducted consecutively without a wash-out period, under the assumption that they were distinct enough not to be influenced by this factor. Additionally, the order was randomized to minimize any potential learning bias. Participants

Table 3 – Descriptive analysis of the participants' performance with LifeVac© and DeCHOKER© devices during an adult victim FBAO.

Variables	LifeVac©	DeCHOKER©	*p*-value
Place the mask correctly covering the victim's nose and mouth			
Yes	56 (93.3)	54 (90.0)	0.301
No	4 (6.7)	6 (10.0)	
Push in handle			
Yes	59 (98.3)	–	–
No	1 (1.7)	–	
Pull handle (LifeVac©) // Pull the plunger out with force (DeCHOKER©)			
Yes	60 (100)	58 (96.7)	–
No	–	2 (3.3)	
Keep the mask fixed to the victim's airway throughout the procedure			
Yes	47 (78.3)	48 (80.0)	0.754
No	13 (21.7)	12 (20.0)	
Perform all the steps correctly			
Yes	42 (70.0)	44 (73.3)	0.445
No	18 (30.0)	16 (26.7)	
Correct compliance rate	100 (80.0–100)	100 (75.0–100)	0.173[a]
Time to device fitting on the victim	30.9 (25.8–39.2)	35.9 (27.8–47.2)	0.010[a]
Total time	39.2 (30.4–49.1)	45.1 (33.7–59.2)	0.010[a]

Continuous variables are expressed with median (interquartile range).
Categorical variables are expressed with absolute frequency (relative frequency).
p-values calculated by Chi-square test.
[a] *p*-values calculated by Wilcoxon test.

were asked not to share information with others to avoid risk of bias. Finally, our study lacks a formal sample size calculation.

Conclusions

In the case of simulated FBAO, pediatric residents faced challenges in applying the recommended protocol, as only a minority of them were able to complete all the steps correctly. In contrast, even though the ACDs were unfamiliar to almost all residents, about 70% were able to use these devices. However, a significant proportion could not, indicating that ACDs alone do not address all issues.

Funding

This study was supported by the Primary Care Interventions to Prevent Maternal and Child Chronic Diseases of Perinatal and Developmental Origin Network (RICORS, RD21/0012/0020), Instituto de Salud Carlos III, Madrid, Spain, funded by the Recovery, Transformation and Resilience Plan 2017–2020, ISCIII and the European Union—Next Generation EU.

CRediT authorship contribution statement

Aida Carballo-Fazanes: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Verónica Izquierdo:** Writing – review & editing, Methodology, Investigation, Data curation. **Juan Mayordomo-Colunga:** Writing – review & editing, Project administration, Methodology, Investigation, Data curation. **José Luis Unzueta-Roch:** Writing – review & editing, Project administration, Methodology, Data curation. **Antonio Rodríguez-Núñez:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2024.100695.

Author details

[a]*CLINURSID Research Group, University of Santiago de Compostela, Santiago de Compostela, Spain* [b]*Primary Care Interventions to Prevent Maternal and Child Chronic Diseases of Perinatal and Developmental Origin (RICORS), Instituto de Salud Carlos III, RD21/0012/0025, Madrid, Spain* [c]*Simulation, Life Support, and Intensive Care Research Unit (SICRUS), Health Research Institute of Santiago de Compostela (IDIS), Santiago de Compostela, Spain* [d]*Faculty of Nursing. University of Santiago de Compostela, Santiago de Compostela, Spain* [e]*Pediatric Intensive Care Unit. Hospital Universitario Central de Asturias, Oviedo, Spain* [f]*University of Oviedo, Oviedo, Spain* [g]*Instituto de Investigación Sanitaria del Principado de Asturias (ISPA), Oviedo, Spain* [h]*Centro de Investigación Biomédica en Red (CIBER) – Enfermedades Respiratorias. Instituto de Salud Carlos III, Madrid, Spain* [i]*Pediatric Intensive Care Unit. Hospital Infantil Universitario Niño Jesús, Madrid,*

Spain [j]*Pediatric Critical, Intermediate and Palliative Care Unit, University Clinic Hospital of Santiago de Compostela (CHUS), Galician Public Health System (SERGAS), Santiago de Compostela, Spain*

REFERENCES

1. Olasveengen TM, Semeraro F, Ristagno G, et al. European Resuscitation Council Guidelines 2021: basic Life Support. Resuscitation 2021;161:98–114.
2. Norii T, Igarashi Y, Sung-Ho K, et al. Protocol for a nationwide prospective, observational cohort study of foreign-body airway obstruction in Japan: the MOCHI registry. BMJ Open 2020;10: e039689.
3. Foltran F, Ballali S, Passali FM, et al. Foreign bodies in the airways: a meta-analysis of published papers. Int J Pediatr Otorhinolaryngol 2012;14:S12–9.
4. Norii T, Igarashi Y, Akaiwa M, et al. Food choking incidents in the hospital: incidents, characteristics, effectiveness of interventions, and mortality and morbidity outcomes. Resuscitation 2023;188:109806.
5. Couper K, Abu Hassan A, Ohri V, et al. Consensus on science with treatment recommendations: removal of foreign body airway obstruction; International Liaison Committee on Resuscitation (ILCOR): Niel, Belgium. https://costr.ilcor.org/document/removal-of-foreign-body-airway-obstruction307tfsr-costr; 2020 [accessed 7 December 2023].
6. Van de Voorde P, Turner NM, Djakow J, et al. European Resuscitation Council Guidelines 2021: paediatric Life Support. Resuscitation 2021;161:327–87. https://doi.org/10.1016/j.resuscitation.2021.02.015.
7. Olasveengen TM, Mancini ME, Perkins GD, et al. Adult Basic Life Support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2020;142:S41–91.
8. LifeVac LLC. [homepage on the Internet] Lifevac; LifeVac LLC: New York, NY, USA. https://www.lifevac.net; 2021[accessed 7 December 2023].
9. DeChoker LLC. [homepage on the Internet] Dechoker; DeChoker LLC: Wheat Ridge, CO, USA. https://www.dechoker.com; 2021 [accessed 7 December 2023].
10. Rodriguez-Ruiz E, Abelairas-Gómez C, Barcala-Furelos R, Rodríguez-Núñez A. Foreign body airway obstruction and anti-choking suction devices. Time to step forward. Resuscitation 2020;157:133–4.
11. Lih-Brody L, Singer M, Brody E. 382 Lifevac: a novel device for the resuscitation of the adolescent choking victim. Ann Emerg Med 2017;70:S149–50.
12. Patterson E, Tang HT, Ji C, Perkins GD, Couper K. The efficacy and usability of suction-based airway clearance devices for foreign body airway obstruction: a manikin randomised crossover trial. Resusc plus 2021;5:100067.
13. Juliano M, Domingo R, Mooney MS, Trupiano A. Assessment of the LifeVac, an anti-choking device, on a human cadaver with complete airway obstruction. Am J Emerg Med 2016;34:1673–4.
14. Saperstein DM, Pugliesi PR, Ulteig C, Schreiber N. Successful use of a novel device called the LifeVac to resuscitate choking victims – worldwide results. Int J Clin Skills 2018;12:216–9.
15. Dunne CL, Viguers K, Osman S, Queiroga AC, Szpilman D, Peden AE. A 2-year prospective evaluation of airway clearance devices in foreign body airway obstructions. Resusc plus 2023;16:100496.
16. Bhanderi BG, Palmer HS. Evaluation of DeChoker, an Airway Clearance Device (ACD) used in adult choking emergencies within the adult care home sector: a mixed methods case study. Front Public Health 2020;8:541885.
17. Gal LL, Pugleisi P, Peterman D. Resuscitation of choking victims in a pediatric population using a novel portable non-powered suction device: real world data. Pediatr Ther 2020;10:e371.
18. Ramaswamy A, Done A, Solis R, Srikanth M, Olinde L, Belafsky P. The efficacy of two commercially available devices for airway foreign body relief: a cadaver study. Laryngoscope Investig Otolaryngol 2023;8:708–11.
19. Dunne CL, Peden AE, Queiroga AC, Gomez Gonzalez C, Valesco B, Szpilman D. A systematic review on the effectiveness of anti-choking suction devices and identification of research gaps. Resuscitation 2020;153:219–26.
20. Couper K, Abu Hassan A, Ohri V, et al. Removal of foreign body airway obstruction: a systematic review of interventions. Resuscitation 2020;156:174–81.
21. Berg KM, Bray JE, Ng KC, et al. International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations: Summary From the Basic Life Support; Advanced Life Support; Pediatric Life Support; Neonatal Life Support; Education, Implementation, and Teams; and First Aid Task Forces. Resuscitation 2023;2023:109992.
22. Carballo-Fazanes A, Abelairas-Gómez C, Rodríguez-Ruiz E, Barcala-Furelos R, Rodríguez-Núñez A. Anti-choking suction devices use. A pilot simulated study with parents and kindergarten teachers. Resuscitation 2022;177:5–6.
23. Cardalda-Serantes B, Carballo-Fazanes A, Rodríguez-Ruiz E, Abelairas-Gómez C, Rodríguez-Núñez A. Would anti-choking devices be correctly and quickly managed by health science students? A manikin crossover trial. BMC Med Educ 2023;23:365.
24. Van de Voorde P, de Lucas N. A 'foreign body' in the 'foreign body airway obstruction' algorithm. Resuscitation 2020;153:258–9.
25. Dunne CL, Osman S, Viguers K, Queiroga AC, Szpilman D, Peden AE. Phase one of a global evaluation of suction-based airway clearance devices in foreign body airway obstructions: a retrospective descriptive analysis. Int J Environ Res Public Health 2022;19:3846.