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Airway management during a respiratory arrest in a clinical simulation scenario. Experience at a pediatric residency program

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ABSTRACT

Introduction. Respiratory failure is the most common cause of cardiac arrest in pediatrics. Recognizing and managing it adequately is critical. Simulation is used to improve medical skills. The objective of this study was to establish the proportion of pediatric residents who recognized a respiratory arrest in a child at a simulation center.

Methods. This was an observational study in 77 residents. A simulation of a patient with respiratory distress that progressed to respiratory arrest was used.

Results. Among the 77 participants, 48 recognized respiratory arrest (62.3%). The mean time to recognize respiratory arrest was 34.43 seconds.

Conclusion. Respiratory arrest was recognized by 62.3% of participants. Among those who did so, the average time was 34.43 seconds. Severe failures were noted in some of the expected interventions.

Keywords: *respiratory arrest; high fidelity simulation-based education; internship and residency.*

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INTRODUCTION

Pediatric cardiac arrest occurs in 12.66 out of 1000 children, mainly due to respiratory problems. Initially, it presents as impaired respiratory and circulatory functions, with hypoxia and acidosis, and may lead to cardiorespiratory arrest.[1,2] Recognizing and managing it in an effective manner at such early stage is critical to prevent cardiorespiratory arrest in pediatric emergencies.[1]

In severe patients who are not having a cardiac arrest, an airway and ventilation assessment is essential. If respiratory distress is detected, the restoration of oxygen and ventilation should be the main focus. Provision of life support should continue if there is no improvement in spontaneous ventilation.[1] Respiratory arrest is defined as an ineffective spontaneous breathing and inadequate ventilation.[1] Although rare, compared to other conditions, the severity of respiratory arrest makes it a fundamental concern in the training of pediatricians and it is included in the study plan of the mandatory residency program.[3]

Simulation-based medical education is becoming increasingly common, as it improves manual skills and helps to retain information necessary for decision-making and conducting maneuvers.[4] In pediatrics, simulations are used to assess varying clinical scenarios, such as resuscitation, airway management, crisis resolution, and to teach medical procedures.[5] Logistical constraints and tight schedules make it difficult to regularly practice emergency and teamwork skills during the residency program. A simulation program within the hospital may significantly enhance training.[6]

Simulation is essential to the training of pediatricians working in emergency care by allowing them to practice in a realistic and controlled environment. Specific simulation-based study plans have been developed to enhance such skills.[7]

OBJECTIVES

The primary objective of this study was to establish how many second- and third-year clinical pediatric residents in a hospital in the City of Buenos Aires (CABA) were able to identify respiratory arrest in a simulated pediatric patient. The secondary objective was to describe how participants handled respiratory failure, in accordance with the guidelines proposed by the American Heart Association (AHA). It is worth noting that the 2016 guidelines were used as reference based on their accuracy in terms of steps to take; the subsequent editions did not introduce any change in relation to the management of respiratory arrest.

METHODS

Participants were pediatric residents from a hospital located in the City of Buenos Aires (CABA). Study participation was voluntary. The study was conducted as approved by the hospital's Teaching and Research Committee. A total of 86 second- and third-year residents were invited to participate because, during these years, the hospital's residency program offers emergency training sessions at a simulation center.

This was an observational study over 8 days at the Roemmers Center for Medical Simulation (Simulación Médica Roemmers, SIMMER) between March and April 2023. Previously, the participants were provided with the relevant bibliography and were given a test consisting of 20 multiple-choice questions, with feedback on their answers at the end. The purpose of this test was to assess basic theoretical concepts and served as a diagnostic tool to measure the participants' prior knowledge and standardize concepts.

Each day session lasted 8 hours, divided into 2 modules. The first module focused on training practical skills in cardiopulmonary resuscitation (CPR). During the second module, 4 simulated cases related to pediatric emergencies were presented. In the context of this study, a specific case was designed involving the care of a patient with progressive respiratory failure due to bronchiolitis, which eventually progressed to respiratory arrest (*Supplementary material*).

Prior to conducting the study, a pilot test was conducted with a group of 8 trained pediatricians, including 4 trainers and 4 chief residents. The purpose of this pilot test was to assess the understanding of the simulated scenario. The performance of the participants in the pilot test was not considered in the analysis of results.

Prior to the start of the study days, all participants signed a confidentiality agreement and an informed consent to participate in the study.

For all participants, the simulation was carried out using the Gaumard® SIM One-Year-Old model. The time from the beginning of the clinical scenario, which started when the resident physician entered the emergency room, was recorded. In all cases, the respiratory arrest occurred 60 seconds after participant arrival, and the case was considered terminated 120 seconds after initiation (*Supplementary material*).

During the simulation, the investigators observed the participants' performance using a Gesell chamber and recorded the results in a checklist.

The primary outcome variable was the proportion of resident physicians who recognized respiratory arrest and the time at which they did so. When the respiratory arrest was recognized, we also assessed whether participants performed assisted bag-mask ventilation and the quality of such ventilations, which was obtained from the monitor's automatic recording through the interface connected to a computer.

Within the framework of this study, several variables were recorded. Recognition of the respiratory arrest was highlighted, considered "yes" if communicated verbally or if appropriate measures were taken. The use of personal protective equipment, chest revealing, airway position, secretion aspiration, pulmonary auscultation, and other procedures were assessed. The quality of ventilations was assessed as "adequate" or "inadequate" based on frequency and volume. In addition, continuous quantitative variables were recorded, including time in seconds to first intervention, time to adequate adjustment of the O_2 delivery device, and time to recognition of the respiratory arrest.

Expected actions are then mentioned: airway and ventilation interventions in patients with signs of respiratory failure should be initiated prior to a complete assessment.[8] The initial assessment should be completed in less than 1 minute. During such assessment, the child should be placed in the position that best favors their respiratory efforts. The initial treatment should focus on administering 100% oxygen and clearing the airway by aspiration. If the patient is awake, drowsy, or unconscious, a nasopharyngeal airway may be used; however, the oropharyngeal airway should only be inserted if the patient is comatose and has no gag reflex.[9] If the patient is unresponsive to basic airway maneuvers or has inadequate or ineffective respiratory effort, ventilation should be assisted manually.[10] In case of respiratory failure, ventilation should be initiated by means of a bag-valve-mask or a flow inflating bag to improve oxygenation and ventilation. If this is unsuccessful, an artificial airway should be used, preferably through endotracheal intubation or, if not possible, with a laryngeal mask or other alternative device.[11]

Data management

All parameters related to the outcome variables were collected and entered into an *ad-hoc* database using Microsoft® Excel® 365. A descriptive analysis of the variables was performed, estimating the mean and standard deviation for continuous variables. In the case of dichotomous variables, proportions were estimated and expressed as a percentage (%).

RESULTS

A total of 77 residents participated in the study: 40 second-year residents and 37 third-year residents; their average age was 28.3 years (*Table 1*). Among the 77 participants, 48 (62.3%) identified respiratory arrest. *Tables 2* and *3* provide details of the participants' additional performance. Results were observed to be inconsistent: although 62.3% of participants recognized respiratory arrest, only 54.5% initiated bag-mask ventilation. This is because some participants recognized respiratory arrest towards the end of the simulation, which prevented them from having sufficient time to perform ventilation.

DISCUSSION

This study emphasizes the importance of education and training in the management of respiratory emergencies in pediatrics. To support

Table 1. Characteristics of residents who participated in the study

Previously witnessed a respiratory emergency (IARF)	39 (50.6%)
Witnessed a CRA-related situation	21 (27.3%)
Previously attended simulation sessions	52 (67.5%)
Ever witnessed the placement of a laryngeal mask	6 (7.8%)
Completed other resuscitation course	10 (13%)
Had a rotation at the PICU/NICU	24 (31.2%)

IARF: impending acute respiratory failure; CRA: cardiorespiratory arrest; PICU: pediatric intensive care unit; NICU: neonatal intensive care unit.

this premise, we carried out the observation of a clinical simulation scenario specially developed for this study. Although 62.3% of the participants were able to recognize the respiratory arrest —in an average time of 34.43 seconds—, significant deficiencies were identified in relation to some of the expected interventions.

A failure in the quality of ventilations administered was observed: hyperventilation was used in most cases; similar results were observed in the study by Julia M. Niebauer et al.[12]

The results highlight the limitations of previous training in the acquisition of the skills required to face such scenario. This is consistent with findings from other studies, indicating the systematic presence of significant delays and deviations in key components of pediatric resuscitation.[13]

Although our study showed that the average time for certain interventions was shorter than that reported in the bibliography (Hunt et al. reported an average time of 1.5 minutes for the recognition of cardiorespiratory arrest),[13] it is not possible for us to conclude that this difference is due to a better performance of the participants in our study, since the conditions of both studies were completely different, making an effective comparison difficult.

Table 2. Participants' performance (dichotomous variables)

Wore personal protective equipment	58 (75.3%)
Revealed the chest	22 (28.6%)
Positioned the airway	44 (57.1%)
Aspirated secretions	28 (36.4%)
Performed pulmonary auscultation	76 (98.7%)
Considered the option of placing an oropharyngeal airway	0 (0%)
Regularly reassessed vital signs and O_2 saturation with pulse oximetry	73 (94.8%)
Provided assisted bag-mask ventilation	42 (54.5%)
Connected the oxygen to the source	32 (42.6%)
Practiced an adequate ventilation frequency	23 (31.2%)
Maintained an adequate minute volume	15 (19.5%)
Noted and prepared the insertion of an advanced airway	17 (22.1%)
Selected a laryngeal mask	0 (0%)

Table 3. Participants' performance (continuous variables)

	n*	Mean	Median	SD	Minimum	Maximum
Time in seconds until first intervention	77	21	21	10.2	4	52
Time in seconds to adjustment of the O_2 administration device using high-level O_2 equipment	64	41.98	40	21.78	9	100
Time in seconds until recognizing the respiratory arrest, since it occurred	48	34.43	33.5	16.21	10	60

n: number of participants on which the statistical calculation was made (those who had the performance described during the time the simulation lasted).*
SD: standard deviation.

A greater knowledge of resuscitation guidelines improves performance in resuscitation skills, but the retention of such skills decreases over time. Therefore, there is no guarantee that the skills to provide high-quality resuscitation will be maintained over time.[13]

Furthermore, our findings are consistent with the concept that errors are common in pediatric emergency care, including problems related to compliance with the AHA guidelines.[13]

The participants in this study were second- and third-year residents with little experience in emergencies (72.7% had never witnessed a cardiorespiratory arrest). We believe that part of the deficiencies in the acquisition and maintenance of skills may be influenced by the significant impact of the COVID-19 pandemic on the decline in respiratory emergency care by pediatricians.[14,16]

Hunt et al. demonstrated that the implementation of rapid-cycle deliberate practices is associated with an improved performance on key quality of life measures and the progressive acquisition of resuscitation skills during pediatric residency.[16]

With frequent and repeated practice, this methodology improves manual ability and facilitates the retention of information necessary to act in emergency situations.[5,6] This teaching approach must continue to be implemented and enhanced to ensure that residents acquire the skills required to recognize and properly manage a respiratory arrest.

Among the limitations of this study, we identify the lack of an analysis that establishes a relationship between the poor performance of residents and the identification of respiratory arrest. Such relationship could be influenced by variables that function as possible confounding factors, such as the resident's level of education (second or third year), previous experience in simulation or experience in administering ventilatory support to actual patients. Although some of these data were collected when describing the population, they are not the main focus of this study.

CONCLUSION

Respiratory arrest was recognized by 62.3% of participants in a mean of 34.43 seconds. Deficiencies in key interventions were observed, and it is worth noting the need for more rigorous training. ■

Supplementary material available at: https://www.sap.org.ar/docs/publicaciones/archivosarg/2024/10172_EM_Lomez_Anexo.pdf

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