Comparison of the efficacy of three methods of child intubation during resuscitation – pilot study

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PORÓWNANIE SKUTECZNOŚCI TRZECH METOD INTUBACJI DZIECI PODCZAS RESUSCYTACJI – BADANIE PILOTAŻOWE

Summary

Introduction. Securing the airway is one of the basic skills that paramedics should have. Obstruction of the airways is a major cause of cardiac arrest among children. Adequate airway management, oxygenation and ventilation are important goals of paediatric cardiopulmonary resuscitation.
Aim. The aim of this study is to compare the effectiveness of a paediatric patient intubation during simulated cardiopulmonary resuscitation performed by paramedic students.
Material and methods. Three intubation devices were compared in a simulated scenario of resuscitation: Miller Laryngoscope, GlideScope and ILMA. A group of 45 student paramedics intubated a pediatric manikin with uninterrupted chest compressions.
Results. The mean intubation time performed with these devices was 37.55 ± 12.84 s, 45.63 ± 21.63 s, 35.51 ± 5.87 s. The overall efficacy of intubation was 86.65% for Miller, 95.54% for GlideScope, and 91.12% for ILMA, respectively. Participants reported the ILMA to be easier to use in intubation method during chest compression scenario.
Conclusions. Video laryngoscopy and blind intubation using ILMA are a good alternative for the Miller laryngoscope for intubation during resuscitation without interruption of chest compressions.

Key words: child, resuscitation, intubation, paramedic students

INTRODUCTION

Adequate airway management is one of the main activities undertaken during emergency events. This procedure is all the more important in case of cardiac arrest in a child. Hypoxia arising from airway obstruction is a major cause of cardiac arrest in the paediatric population. It should be remembered that the patient's oxygen reserves in the normothermia with cardiac arrest are sufficient only for 3-5 minutes (1). The most recommended method for airway management in both children and adults according to the guidelines of the European Resuscitation Council, as well as the American Heart Association, is endotracheal intubation (ETI) (2, 3). Securing the airway using an endotracheal tube carries many benefits. First, the placement of an ETI can accomplish stable ventilation support without additional pauses in chest compressions during CPR. Secondly, it is possible to use a positive end-expiratory pressure (PEEP) and to measure the concentration of carbon dioxide in exhaled air. However, using the laryngoscope with Miller blade (MIL) for tracheal intubation is sometimes a difficult skill even for medical emergency professionals, and securing the airway becomes even more difficult in an emergent situation (4). Through the development of medicine and the introduction of new patency devices, intubation is now possible with the use of electronic visualization or intubation blindly.

AIM

The aim of the study was to compare time and success rates of different intubation devices for the emergency intubation during resuscitation with chest compression in a standardized paediatric manikin model performed by student paramedics.

MATERIAL AND METHODS

The study was approved by the Programme Council of the International Institute of Rescue Research and Education (Warsaw, Poland; Decision no. 2014/17). The study was conducted in May 2014. Forty-five paramedics (16 female and 29 male, age 31 ± 10) participated in this study. Participants were selected at random from among the students of medical universities in Masovian voivodeship. Participation in the study was voluntary. None of participants had previously used GlideScope or ILMA.

Prior to the trial, all participants were given a standard training session of two 45-min lectures on the anatomy of the airway and tracheal intubation with the laryngoscope with Miller blade no. 2 (Mercury Medical; Clearwater, FL, USA), GlideScope (Verathon, Bothell, WA, USA) and ILMA (Teleflex, Buckinghamshire, Great Britain). At the end of the training, instructors demonstrated the correct technique of intubation using a laryngoscope Miller, GlideScope and ILMA. After this part of the study, participants involved in the study practiced, under the supervision of instructors, endotracheal intubation using the above listed methods of intubation until they were comfortable with the devices. All intubations were performed using a Magill tracheal tube with 5.0 mm internal diameter (ID).

Intubation was performed on a training phantom MegaCode Kid (Laerdal, Norway). In order to standardize the difficulties associated with intubation during chest compression, a Lucas 2 device was used (Physio-Control, USA). During intubation attempts, only the person performing the intubation and instructors were present in the room – other people did not have the opportunity to observe the process of intubation.

A Research Randomizer program was used (www.randomizer.com) to divide the volunteers into 3 groups and to determine the order in which to apply the different ETI devices within each group. The first groups attempted ETI using the Miller, the second using the GlideScope and the third using the ILMA as a conduct for endotracheal tube. The detailed procedure of randomization is presented in figure 1. After completing the ETI procedure participants had a 15 minute break before performing another emergency procedure.

The primary endpoint of the study was the success rate of intubation. The secondary endpoint was defined as the time from insertion of the blade between the teeth to the first manual ventilation of the mannequin's lungs. If the examinee failed at all attempts, the case was excluded from the time calculations. Finally, students were asked to rate the ease of intubation using each device using a Likert scale from 1 (extremely easy) to 5 (extremely difficult). Quantitative data are presented as mean and standard deviation or percentage.

The R statistical package for Windows (version 3.0.0) was used for statistical analysis. Results were reported as mean and standard deviation (± SD) or absolute numbers and percentages. As data were found not to be normally distributed, non-parametric tests were applied. We used the a median test for continuous variables and an uncertainty coefficient test for categorical data. The cumulative success rate associated with time to complete tracheal intubation was analyzed using Kaplan-Meier analysis. P value < 0.05 was considered to be statistically significant.

RESULTS

The effectiveness of intubation including the three intubation attempts is presented in table 1. Overall effectiveness in the Miller laryngoscope was 86.65%, for the GlideScope – 95.54% while in the case of ILMA intubation – 91.12%. The effectiveness of the first intubation attempt for the above methods was respectively: 51.11, 80 and 82.22%. There was a statistically significant difference in efficacy between the GlideScope and Miller laryngoscope ($p = 0.0312$) and between ILMA and Miller laryngoscope ($p = 0.0389$).

The average time for intubation with the use of the Miller laryngoscope was 37.55 ± 12.84 s. For the GlideScope and ILMA, times were respectively 45.63 ± 21.63 s and 35.51 ± 5.87 s. The analysis showed statistically significant differences in the intubation time between Miller and GlideScope devices ($p = 0.0482$) as well as between ILMA and GlideScope devices ($p = 0.0395$).

Participants reported the ILMA to be easier to use in intubation during chest compression scenario (table 2).

Data is given in absolute numbers and percentage. Ease of intubation was rated on a Likert scale.

DISCUSSION

According to Gerritse et al., child intubation effectiveness when performed by paramedics in pre-hospital settings was insufficient and ranges from 63.4 to 77% (1, 4, 5). This means that one in four children requiring airway protection and proper ventilation is not intubated, or the endotracheal tube is inserted incorrectly.

Researchers demonstrate that incompetent intubation can cause severe soft-tissue injury, as well as cause hypoxic damage to the central nervous system (6). Then using alternative methods of intubation may be helpful, such as blind intubation devices or video laryngoscopes. These devices can be used in the case of a particularly difficult airway management, which frequently occurs in children. Intubating a child in a pre-hospital condition additionally subjects it to a higher intensity of stress – as sudden cardiac arrest in children is relatively less common than in adults.

In this study, the average time of intubation laryngoscope Miller and blind intubation via the laryngeal mask ILMA was comparable and amounted to 37.55 and 35.51 seconds (respectively), however, the efficacy of the

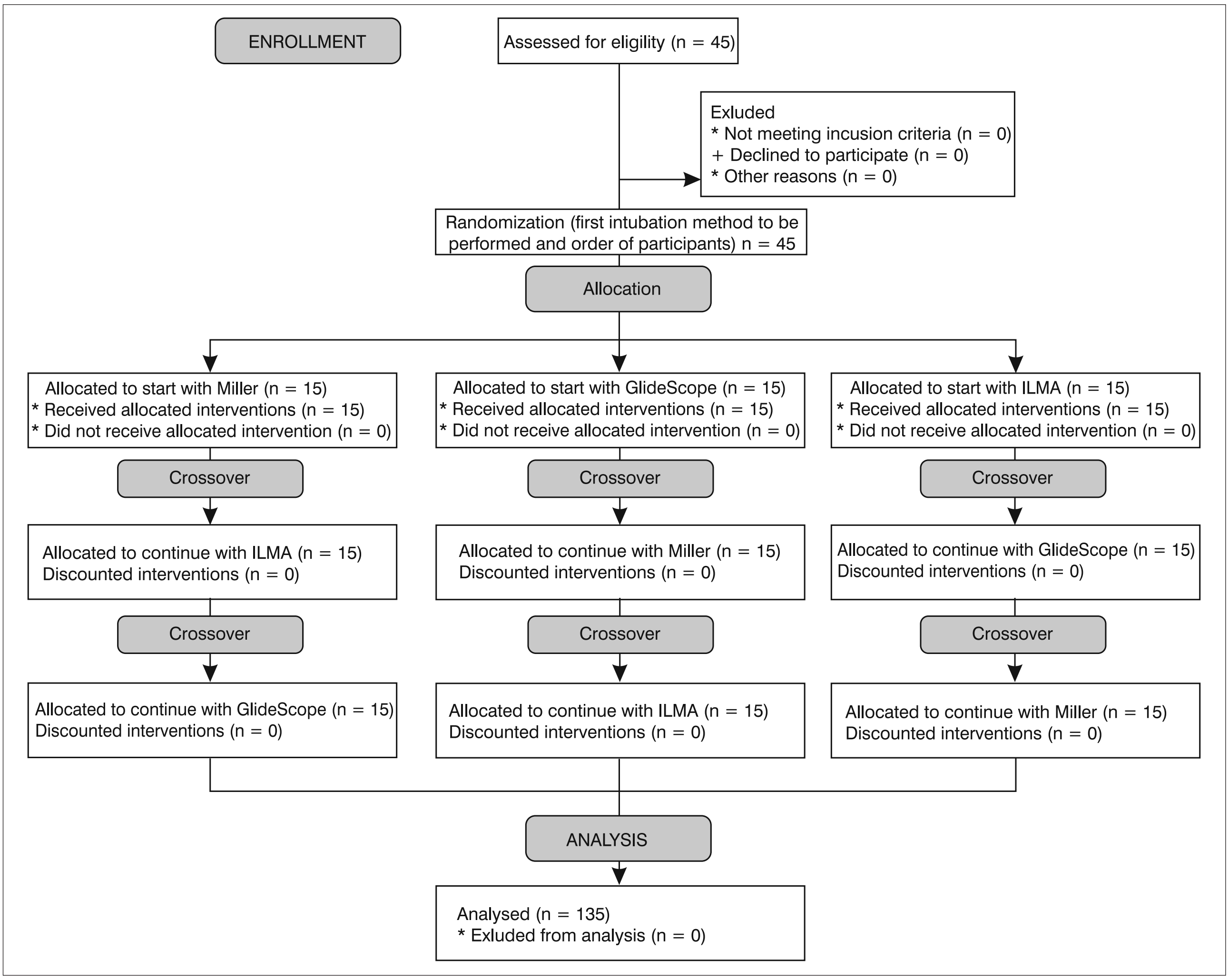

Fig. 1. Flow chart of design and recruitment of participants according to CONSORT statement.

Table 1. Effectiveness of intubation attempts.

The method of intubation	**The effectiveness of intubation approaches**			
	First (%)	**Second (%)**	**Third (%)**	**Unsuccesfull (%)**
Miller	51.11%	17.77%	17.77%	13.35%
GlideScope	80.0%	8.88%	6.66%	4.46%
ILMA	82.22%	6.66%	2.24%	8.88%

Table 2. Ease of intubation reported by intubator.

Intubation device	**Ease of intubation**					
	1 (extremely easy)	**2**	**3**	**4**	**5 (extremely difficult)**	**Average**
Miller	6 (14.44%)	12 (26.66%)	17 (37.77%)	5 (11.11%)	5 (11.11%)	2.8
GlideScope	25 (55.55%)	9 (20.0%)	2 (4.44%)	8 (17.77%)	1 (2.22%)	1.91
ILMA	28 (62.22%)	5 (11.11%)	6 (14.4%)	4 (8.88%)	2 (4.44%)	1.82

first attempts of intubation is in favour of using the ILMA, because it was higher by 31.11% compared to the Miller laryngoscope for intubation.

The total efficacy of direct intubation in studies by Sakles et al. was 57% (7), while in studies by Mosier et al. it was 96.65% (8). In our study, the effectiveness of the first attempts of intubation was 51.11% and was lower than in studies by Mosier – 68% (8), Tung – 88% (9). Also, direct intubation time in studies of other authors was shorter: Tung – 17.4 s (9), Rodríguez-Núñez – 28.2 s (10).

In the case of video-laryngoscopy with the GlideScope the effectiveness of the first attempt in our study was 80%. Other studies show different effectiveness of this method of intubation: Sakles – 75% (7), Mosier – 78% (11), Tung – 100% (9). In the case of the execution time of intubation, Tung and Rodríguez-Núñez obtained a shorter period of time (17.7 s [9] and 38.0 s [10]) than the authors of this study (45.63 s). Intubation with the video laryngoscope GlideScope in this study was on average about 8 seconds longer than for intubation with the Miller laryngoscope. However, the effectiveness was significantly higher – in the first sample amounting to 80%. Moreira, in a study comparing simple intubation to video-laryngoscopy in a neonate, obtained 53 and 26% effectiveness, respectively, for standard laryngoscope and video-laryngoscope, and a mean intubation time was 25.5 s and 39.4 s (11).

The last method tested in this study was a 'blind' intubation using the ILMA laryngeal mask as a conduct for endotracheal intubation. The mean intubation time using this method was 35.51 s and the overall effectiveness was 91.12%. Melissopoulou et al. showed that when intubation was carried out using the ILMA, obtained the time of 20.06 s (12). In contrast, studies conducted by Shah et al. indicate that the overall effectiveness in the case of intubation using ILMA was 96.63% (13).

A key issue affecting the selection of equipment in their daily work is the ease of using them in the particular procedure. For the be easier to use in intubation method participants recognized the ILMA and GlideScope devices. Rabiner et al. showed that internists preferred the video laryngoscopy to direct laryngoscopy (14).

CONCLUSIONS

The results of this study demonstrated that video-laryngoscopes or ILMA used as a conduct for endotracheal tube may be a good alternative to the standard Miller laryngoscope for pediatric intubation during cardiopulmonary resuscitation. Participants reported the ILMA to be easier to use in intubation method during chest compression scenario.

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