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Effectiveness of endotracheal intubation among system nurses under simulated conditions – pilot studies

Skuteczność intubacji dotchawiczej wśród pielęgniarek systemu w warunkach symulowanych

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STRESZCZENIE

SKUTECZNOŚĆ INTUBACJI DOTCHAWICZEJ WŚRÓD PIELĘGNIAREK SYSTEMU W WARUNKACH SYMULOWANYCH

Wstęp. Intubacja dotchawicza (ETI) może być procedurą niezbędną w sytuacji nagłego zatrzymania krążenia (NZK) wykonywaną przez personel pielęgniarski. Jej poprawne wykonanie usprawnia przebieg i organizację akcji ratunkowej oraz przyczynia się do wzrostu pewności siebie w sytuacjach stresowych.

Cel pracy. Ocena skuteczności intubacji dotchawiczej wśród pielęgniarek systemu w warunkach symulowanych.

Materiał i metody. Pilotażowe, prospektywne, obserwacyjne badanie symulacyjne z wykorzystaniu narzędzi zaawansowanego ewaluacyjnego fantoma do intubacji (BT-CSIE, model Q`ty) z tabletem (PC-1EA), laryngoskop z zaokrągloną rękojeścią Laryngoskop Intubrite. Wyniki poddano analizie Statistica PL 12.0 i Microsoft Office Excel 2016, posłużono się testem T-Studenta oraz chi-kwadrat.

Wyniki. Pielęgniarki posiadające specjalizację intubowały dwukrotnie szybciej (30,4 s.), od pielęgniarek w trakcie specjalizacji (68,8 s) bądź bez specjalizacji (67,5 s). Wykazano, że najkrótszy czas zakładania rurki dotchawiczej osiągnęli badani ze stażem pracy powyżej 10 lat (37,0 s). Nacisk na siekacze w trakcie badanej procedury średnio wynosił 10,9 N. Prowadzona wentylacja ze średnią objętością oddechową 543 cm^3 (p=0,024) mieściła się w zaleceniach Europejskiej Rady Resuscytacji (ERC).

Wnioski. Staż pracy i posiadana specjalizacja znacząco wpływa na skuteczność procedury intubacji w czasie, z zachowaniem zalecanych wartości częstotliwości i objętości oddechów zastępczych.

Słowa kluczowe: **pielęgniarka, jakość opieki, intubacja dotchawicza, symulacja**

ABSTRACT

EFFECTIVENESS OF ENDOTRACHEAL INTUBATION AMONG SYSTEM NURSES UNDER SIMULATED CONDITIONS – PILOT STUDIES

Introduction. Endotracheal intubation (ETI) may be a procedure necessary to perform by a nurse in the event of sudden cardiac arrest (SCA). Its correct execution improves the course and organization of a rescue operation and contributes to increased self-confidence in stressful situations.

Aim. Assessment of the effectiveness of endotracheal intubation among system nurses under simulated conditions.

Material and methods. A pilot study of prospective observational simulation study using advanced evaluation tools for intubation phantom (BT-CSIE, Q'ty model) with a tablet (PC-1EA), IntuBrite laryngoscope with curved handle. The results were analyzed with Statistica PL 12.0 and Microsoft Office Excel 2016, using the Student's t and chi-square tests.

Results. Nurses with specialization intubated twice faster (30.4 s) than nurses during specialization (68.8 s) or without specialization (67.5 s). The shortest time of inserting an endotracheal tube demonstrated subjects with over 10 years of work experience (37.0 s). The mean pressure on the incisors during the procedure was 10.9 N. Ventilation with an average tidal volume of 543 cm^3 (p=0.024) was in line with the recommendations of the European Rescue Council (ERC).

Conclusions. Work seniority and specialization significantly affected the effectiveness of the intubation procedure in time, while maintaining the recommended frequency and volume of mechanical ventilations.

Key words: **nurse, quality of care, endotracheal intubation, simulation**

INTRODUCTION

Endotracheal intubation (ETI) is the basic and effective way to open the airway in life and health threatening situations. The main indications for ETI are sudden cardiac arrest (SCA), respiratory failure in course of many diseases, and respiratory failure due to chest injuries [1]. The implementation of ETI requires appropriate qualifications, professional experience and manual skills. ETI is a standard procedure in the operating theatre or intensive care units.

According to the law in force in Poland, ETI may be performed by a nurse who meets the criteria of the emergency medical system and is competent to perform this activity, which results from the postgraduate education process. This activity is legally regulated by the ordinance of the Minister of Health of February 28, 2017. In the case of cardiac arrest, the system nurse is obliged to perform an ETI without a doctor's recommendation. A nurse can perform ETI without a doctor's order in the case of SCA. Improving this activity is the basis for postgraduate education during qualification and specialist courses [2,3,4]. As part of specialization training, nurses acquire knowledge and skills in the scope of taking specific activities in a life emergency, conducting pharmacotherapy, clearing the airways, including endotracheal intubation. In the case of SCA, the nurse should implement adequate protocols for advanced life support procedures in accordance with the applicable knowledge and guidelines of the European Resuscitation Council (ERC) [2-5].

The concept of using simulation in the education process and improving the acquired skills is aimed at increasing the confidence of the staff in terms of decision-making and implementation of individual procedures in emergency and unforeseen situations. Cyclic exercises in simulated conditions ensure a higher quality of medical services [6-8].

AIM

The aim of the study was to assess the effectiveness of ETI among nurses of the system under simulated conditions.

MATERIALS AND METHODS

A prospective, pilot observational simulation study was conducted in March 2018 at Center for Innovative Research in Natural and Medical Sciences at the University of Rzeszów and the Postgraduate Education Center for Nurses and Midwives in Rzeszów. The tests were performed using advanced evaluation phantom instruments for intubation (BT-CSIE, Q'ty model) with a tablet (PC-1EA), IntuBrite Laryngoscope with a rounded handle. The study was approved by the Bioethics Committee of the University of Rzeszów.

The number of 51 professionally active nurses of the system, working in a hospital (operating theatre 6%), intensive care unit (ICU) 22%, hospital emergency department (HED) and admission room (AR) 35%, and other surgical and conservative departments 37%, agreed to participate in the study. Nurses meeting the inclusion criteria participated in the study (voluntary consent to participate in the study, having the right to practice the profession of a nurse, health condition allowing for participation in study with the selected research technique and tools, fulfilling the criteria of a system nurse. Detailed data presenting the characteristics of the studied group are included in Table 1.

Tab. 1. Characteristics of the group

Work seniority [years]	1-5	6-10	11-15	16-20	21-25	26-32
	(n=21)	(n=13)	(n=4)	(n=4)	(n=4)	(n=5)
Employed in the department	**Department**		**%**		**n**	
	Operating theatre		6		3	
	ICU		22		11	
	HED/AR		35		18	
	Other departments		37		19	
Education	Higher		73		37	
	Secondary		27		14	
Specialization	With specialization		47		24	
	During Specialization		37		19	
	Lack		**19**		**8**	

The pilot study used the observational method and documentation analysis (scientific and research questionnaire developed by the authors) with the use of the following research tools: evaluation advanced phantom for intubation with a tablet (BT-CSIE production 2015, Q'ty model) – a head model for intubation, which enables intubation by tilting the head and protruding the jaw. It contains built-in sensors that are sensitive to incorrect use of the laryngoscope; dedicated tablet (PC-1EA) enabling monitoring of motion during ETI; laryngoscope with rounded handle (IntuBrite Laryngoscope, two light beams, dark UV light and white LED light); intubation kit including an endotracheal tube size 8.0, self-inflating bag (Laerdal Silicone Resuscitator for Adults >25 kg, volume 1.600 ml), a stethoscope, syringe for sealing the endotracheal tube with a volume of 10 ml, lubricant.

The following elements were taken into account to evaluate the effectiveness of the intubation performed: the average time of insertion of the endotracheal tube, the maximum pressure on the incisors during intubation, the assessment of the protrusion of the mandible in effective and all performed intubations, the degree of head tilt, the average tidal volume, the number of breaths during ventilation, the number of trials, correction of tube position and intubation efficiency. The effectiveness of the procedure was assessed taking into account the above-mentioned variables and the correctness of the activities performed. Individual variables were correlated with the work seniority of the respondents, education, and the individual components of the correct performance of ETI were compared with the qualifications of a nursing specialist, or with the participation of individual respondents in the final stages of specialization training.

The mean, median and standard deviation were statistically determined. Due to the type of significant features

Tab. 2. Individual intubation parameters and group variables

Average tube insertion time depending on the seniority [s]	**1-5**	**6-10**	**11-15**	**16-20**	**21-25**	**26-32**
	4.8	77.5	37.0	76.0	41.0	37.0
Maximum pressure on the incisors [N]	12.2	15.6	0	11.7	7.7	11.8
The degree of head tilt [°]	58.4	62.4	57.5	65.7	54.5	48.0
Average breath volume [cm^3]	526. 0	507.0	575.2	618.0	482.5	574.0
Breaths per minute	15	16	16	12	12	14
Parameters and education of the respondents	**Secondary**			**Higher**		
Average tube insertion time [s]	63.1			50.7		
The degree of head tilt [°]	54.6			60.7		
Average breath volume [cm^3]	488.2			537.7		
Number of ventilations per minute	16			15		
Parameters and having specialization	**Lack**		**During specialization**		**With specialization**	
Average tube insertion time [s]	67.5		68.8		30.4	
The degree of head tilt [°]	63.0		57.81		63.66	
Average breath volume [cm^3]	490.1		525.9		546.2	
Number of ventilations per minute	16		16		13	
Parameters and department	**Operating theatre**	**ICU**		**AR/HED**		**other**
Average tube insertion time [s]	42.5	56.8		60.0		42.0
Maximum pressure on the incisors [N]	7.6	8.3		8.9		6.6
The degree of head tilt [°]	65.6	61.6		59.1		56.4
Average breath volume [cm^3]	545.5	544.3		529.0		512.0
Number of ventilations per minute	**15**	**16**		**15**		**14**

Tab. 3. The individual parameters and the ETI

		ALL INTUBATIONS	**EFFECTIVE INTUBATIONS**
TUBE INSERTION TIME (S)	Mean	61.4	54.5
	SD	0.8	0.7
	p	**0.003**	
PRESSURE ON THE INCISORS (N)	Mean	11.7	10.9
	SD	9.8	9.8
	p	**0.090**	
HEAD TILT [°]	Mean	59.1	62.7
	SD	12.0°	13.1°
	p	**<0.001**	
		Effective intubations	
AVERAGE VOLUME OF MECHANICAL VENTILATIONS (CM^3)	Mean	543.0	
	SD	108.1	
	p	**0.024**	
NUMBER OF VENTILATIONS PER MINUTE	Mean	16	
	SD	4.4	
	p	**0.040**	
		%	
NUMBER OF INTUBATION TRIALS	1	55	
	2	45	
CORRECTION OF TUBE POSITION	yes	29	
	no	71	
EFFECTIVENESS OF PERFORMED INTUBATION	yes	71	
	no	29	

assessed, the following were used in the statistical analysis: Student's t-test (to assess the relationship between two quantitative features), the chi-square test of independence was used in the statistical study, p value of <0.05 was considered statistically significant. The calculations were performed with the SPSS Statistica PL 12.0 software.

RESULTS

The shortest ETI time was achieved by nurses with specialization (30.4s), which is a result similar to the time recommended by the ERC. Taking into account all the variables and the correct performance of the procedure, successful intubation was performed by the majority of the respondents (71%) – Table 3. The shortest time of insertion of the endotracheal tube was achieved by those with 11-16 years of work seniority. Detailed analysis is presented in Table 2.

The highest efficiency in the first trial was achieved by nurses with the title of a specialist and nurses undergoing specialization, compared to those without specialization (p=0.004).

In the group with successful intubation, 46% applied mandible protrusion. This manoeuvre was most often performed by nurses during or already with specialization: nurses during specialization (N=11), with specialization, without specialization. Detailed results are presented in Tables 2 and 3.

Most of the subjects performed the correct head tilt during intubation (>60°). Successful intubations were performed with a mean head tilt of 62.7°. People with higher education significantly better cleared the airways by tilting the head (60.7%) than nurses with secondary education (54.6%) (p=0.001).

Emergency ventilation was performed according to the recommendations of the ERC (12-16 bpm). The results in the individual study groups remained at a similar high level (Table 2).

The tidal volume introduced by the subjects using a bag valve mask was within the recommended limits of 500-600 cm^3. The subjects ventilated with the average tidal volume of 543 cm^3. The most effective ventilation was performed by people with specialization (546.2 cm^3) and nurses employed in the ICU (544.3 cm^3) and the operating theatre (544.3 cm^3) (p=0.001). Detailed data is presented in Table 3.

DISCUSSION

In the realities of Polish health care, ETI by a nurse is a special procedure in the case of SCA in hospital conditions. Early protection of airway patency, proper ventilation, and medical emergency procedures in accordance with current ERC recommendations increase the chances of successful resuscitation. The use of simulation to practice individual procedures allows for the efficient performance of a given activity, positively influences making important decisions, improves the rescue operation and provides the optimal sense of security in stressful situations.

The study assesses the quality of ETI performed by system nurses employed in individual hospital departments. This is the first study in Poland in which the individual components of the ETI procedure performed by system nurses are verified. The individual stages were divided according to the time of performance, the pressure on the incisors during manoeuvres with the laryngoscope, and alternative ventilation: the tidal volume and the number of breaths per minute and the quality of conducted substitute ventilation.

The literature presents many reports that show the quality of intubation and the duration of the procedure, comparing different types of laryngoscopes [9-11]. The most interesting data is presented by Akihisa et al. in randomized, cross-over studies with 31 nurses working in the wards and operating theatre of Mizonokuchi University Hospital, Teikyo University School of Medicine. The effectiveness of different laryngoscopes is presented. The participants achieved a mean time of endotracheal tube insertion in 19.15 seconds [9]. In the currently available studies assessing the duration of the endotracheal intubation procedure, this value was within the range of 20.8-32.5 s [9-13]. It should be emphasized that these tests were carried out with the use of various types of laryngoscopes, which could have had a significant impact on the results of the measured parameter. Comparing with the above results, the time of inserting the endotracheal tube in our study was significantly longer and amounted to an average of 54.5 s.

The results of our study conducted among nurses of the system showed the effectiveness at the level of 71%. Very similar result of the study – 70.3%, was also obtained by Akihisa in the study of King Vision and Macintosh laryngoscopes [9]. Based on the analysis of the studies, it can be concluded that the effectiveness of ETI in all studies was high. Based on the analysis of the available literature, no studies were found looking for the relationship between the quality of ETI and such variables as mandible protrusion, head tilt, quality of ventilation and their impact on the effectiveness of intubation.

In our study among 51 nurses working in various departments the efficiency of 70.0% was achieved using the IntuBrite laryngoscope. Aleksandrowicz and Szarpak, examining the differences in intubation with the GlideScope and Macintosh laryngoscopes, achieved the efficiency of 94.3% [15]. Hung et al. obtained 100% of ETI effectiveness comparing Trachway and Macinthosh [10]. Choi et al., in the work on the Pentax Airway Scope, C-MAC Video Laryngoscope, Glidescope Video Laryngoscope and Macintosh Laryngoscope, obtained the success rate of the procedure at the level of 86.0% [11]. In the study with a group of paramedics and nurses on methods of opening the airways, Saeedi et al. obtained 73.0% efficiency of ETI [12]. Miki et al. in studies conducted in a group of 31 nurses showed an effectiveness of 91.4% using Airway Scope [14].

Our study showed that the nurses under study correctly ventilate an intubated patient. The mean tidal volume was within the recommended 500-600 cm^3 (mean 543 cm^3) and the number of breaths was 12-16 ventilations per minute. Choi et al., in a study conducted on a group of 90 nurses and emergency technicians in South Korea, studied the effectiveness of various laryngoscopes. The authors assessed the time of the first ventilation from the moment of grasping the laryngoscope and inserting the endotracheal tube into the trachea, thus determining the total intubation time. Due to the lack of reports on the emergency ventilations rate and tidal volume, it is impossible to compare them with the results of our study, however, reports on the duration of the entire procedure allow for comparison with our analyzes [15].

The presented results of our study enable a better understanding of the influence of variables on the components of the effectiveness of endotracheal intubation. Undoubtedly, the variety of factors prompts the continuation of the research subject, in particular in terms of the implementation of educational activities aimed at the correctness and speed of endotracheal intubation. The use of medical simulation in practice with ETI allows to verify the quality of services and improves them.

CONCLUSIONS

Work seniority and specialization significantly affected the effectiveness of the intubation procedure in time, while maintaining the recommended frequency and volume of mechanical ventilations.

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