Original Article

Evaluation of Enteral Nutrition in Newborn Intubated with Cuffed and Uncuffed Tube

Buse Duygu Yuksel, MSc, RN
Istanbul Medipol University, Ataturk Beykoz, Istanbul, Turkiye

Aysel Kokcu Dogan, RN, PhD
Associate Professor, Istanbul Medipol University Faculty of Health Sciences, Department of Nursing, Istanbul, Turkiye

Correspondence Aysel Kokcu Dogan Istanbul Medipol University Faculty of Health Sciences, Department of Nursing. Goztepe Mah. Ataturk Cad. No: 40/16, 34815 Beykoz, Istanbul E-mail: akdogan@medipol.edu.tr

Abstract
Purpose: This study was designed in the descriptive and relational screening model for the evaluation of enteral nutrition in the care of newborns treated with cuffed or uncuffed intubation tube and was conducted between March 2018 and June 2019.
Design and Methods: The sample of the research consisted of 129 newborn babies intubated with 47 cuffed and 82 uncuffed tubes in the Cardiovascular Surgery Intensive Care and Neonatal Intensive Care Units in a private University Hospital in Istanbul and whose parents volunteered to participate in the study. Data was collected using the "Information Form" and the "Evaluation of Enteral Nutrition Data Collection Form in the Care of Newborns treated with Cuffed and Uncuffed Intubation Tube." It has been determined that feeding is more effective in babies using cuffed intubation tubes in relation to the nutrition given to all babies in which both intubation tubes are applied.
Results: After full 24 hours of feeding; between the nutritional status and the feeding probe and the presence of gas in the stomach; between newborn weight and abdomen examination and skin color; between birth week and SpO2% values and sedation status of the baby; it was found that there was a significant difference (p<0.05) statistically, between the intubation tube applied to infants and the level of tube, cuff pressure, fixation band, defecation, gastric residue, oral secretion and intraoral secretion after feeding.
Conclusion: It was determined that enteral feeding was effective in the care of newborns treated with cuffed and uncuffed intubation, and the growth and development of babies with cuffed tubes were positively affected compared to those with uncuffed tubes. Therefore, based on these results, it is advised that the quality of care in the development of intubated newborn babies shall be improved by ensuring the continuity of in-service training programs for the nurses.

Keywords: Newborn, Intubation, Enteral Nutrition

Introduction

Endotracheal intubation is important for providing a secure airway in the treatment of resuscitation or respiratory support of intensive care patients. Prolonged or repeated intubation attempts may contribute to patient morbidity or lead to death (Ilginel, 2019). At least half of childhood diseases are caused by the problems with respiratory tract and lungs. For this reason, it is very important for nurses in intensive care units monitor babies who receive respiratory support, and to perform nutrition and care activities effectively for the benefit of child's health. In this study, it is planned to observe the enteral nutrition and the recovery and development status of the newborns in the intensive care unit where a cuffed and uncuffed intubation tube is applied.

Material and Methods

This study is designed in the descriptive and relational screening model for the evaluation of enteral nutrition in the care of newborns with cuffed and uncuffed intubation tube. The

research was carried out in a Cardiovascular Surgery Intensive Care Unit and Neonatal Intensive Care Unit in a private University Hospital in Istanbul.

Sample: The sample of the research consisted of 129 newborn babies intubated with 47 cuffed and 82 uncuffed tubes in the Cardiovascular Surgery Intensive Care and Neonatal Intensive Care Units in a private University Hospital in Istanbul between April 2018 and May 2019 and whose parents volunteered to participate in the study.

Data collection: The data of the study were collected using the survey method and laboratory findings (routine controlled blood gas, liver enzyme values and chest radiographs.) Data were formed using the "Information Form" and the "Evaluation of Enteral Nutrition Data Collection Form in the Care of Newborns treated with Cuffed and Uncuffed Intubation Tube." in cooperation with the literature and expert opinion. They were applied to newborn babies within the scope of the study, after making necessary explanations about the Data Collection Form to the nurses in the Neonatal Intensive Care Unit and Cardiovascular Surgery Intensive Care Unit of the private University Hospital in Istanbul. This study is limited to the data collected at the Neonatal Intensive Care Unit in the private University Hospital in Istanbul and newborn intubated babies in the KVC Intensive Care Unit. In addition, the research is limited to the follow-up of intubated babies covering only 24 hours. For patients included in the study, no application has been made that would violate patients' rights and affect the patient, which parents would consider inappropriate, and evaluation had been made on improving data.

Statistical Analysis of Data: The data obtained from the study were analyzed using the licensed SPSS (Statistical Package for Social Sciences) for Windows 22.0 program. As the descriptive statistical methods in the evaluation of the data, chi-square analysis was used to compare the number, percentage, and grouped variables.

Results

In the research group, 54.3% were male; 67.4% of them weigh between 2.5-4 kg; 60.5% of them were 34-38 weeks old; 36.4% were intubated with a cuffed tube and 63.6% were intubated with an uncuffed intubation tube; 2.3% were fed parenterally with TPN and 97.7% were fed enterally (see Table 1).

Following up 24 hours after feeding, it was determined that 62% of the newborn weight, 71.3% of the liver enzymes, 71.3% of the PH values and 71.3% of the pO2 values had increased; while 63.6% carbon dioxide, 60.5% bicarbonate, 58.9% sodium, 68.2% potassium, 72.1% calcium, 63.6% lactate, 50.4% glucose and 58.9% of bilirubin values had decreased.

Following up 24 hours after feeding in the study group, it was determined that 86% of them were fed with TPN; 61.2% of the feeding probe was in the stomach and 38.8% was in the intestine according to the chest x-ray; 71.3% of the patients had gas in their stomach according to the chest radiograph, 86.8% of the intubation tube was in the right place according to the chest radiograph while 13.2% of was not in the right place (see Table 2).

A statistically significant difference was found between the enteral feeding conditions of the newborns after 24 hours according to the birth week and the feeding probe according to the chest radiograph (X^2=8.41; p=0.045).

According to the chest X-ray of newborns with a gestational age of 28-33 weeks, the rate of having the feeding tube in the stomach was found to be higher compared to the newborn group with a gestational age of 33-38 weeks; according to the chest X-ray of newborns with a gestational age of 33-38 weeks, the rate of having a feeding tube in the intestine was higher than the group with a gestational age of 28-33 weeks (see Table 3).

A significant relationship was found between the intubation tube level (X2=6.893; p= .005<.05), and the cuff pressure control of the intubation tube (X2=82.434; p= .000<.05), and fixation band (X2=20.387; p= .000<.05), the defecation status (X2=4.889; p= .023<.05), and the residual status (X2=4.161; p= .032<.05), increase in the intra-oral secretion after feeding (X2=3.529; p= .049<.05), increase in the oral secretion (X2=7.142; p= .005<.05), according to the chest radiograph, the rate of gas presence in the stomach (X2=6.955; p= .008<.05). It was

determined that the rate of the intubation tube applied to the baby in the cuffed group, the rate of controlling the cuff pressure of the intubation tube, the cleanness and steadiness of the fixing band, was higher than that of the uncuffed group. In uncuffed group, the difference between the defecation quality of the patient, amount of residue, increase in the intra-oral secretion after feeding, general increase in the oral secretion, and according to the chest radiograph, the rate of gas presence in the stomach was determined higher than that of the cuffed group. (see Table 4).

Table 1. Descripition of the newborns

Groups		*Frequency (n)*	*Percentage (%)*
Gender	Girl	9	45.7
	Boy	70	**54.3**
Weight	1 - 2,4 Kg	19	14.7
	2.5 - 4 Kg	87	**67.4**
	Over 4 Kg	23	17.8
Birth Week	Less than 28 weeks	13	10.1
	Between 28-33 weeks	26	20.2
	Between 34-38 weeks	78	**60.5**
	More than 38 weeks	12	9.3
Intubation Tube Quality	Cuffed	47	36.4
	Uncuffed	82	**63.6**
Nutritional Status	Parenteral with TPN	3	2.3
	Enteral	126	**97.7**

Table 2. Enteral feeding status of newborn babies at 24 hours

Expressions	**Groups**	*Frequency (n)*	*Percentage (%)*
Weight	Increased	**80**	**62.0**
	Decreased	49	38.0

Liver Enzymes	Increased	**92**	**71.3**
	Decreased	37	28.7
pH values	Increased	**92**	**71.3**
	Decreased	37	28.7
pO2 values	Increased	**92**	**71.3**
	Decreased	37	28.7
Carbon dioxide	Increased	47	36.4
	Decreased	**82**	**63.6**
Bicarbonate	Increased	51	39.5
	Decreased	**78**	**60.5**
Sodium	Increased	53	41.1
	Decreased	**76**	**58.9**
Potassium	Increased	41	31.8
	Decreased	**88**	**68.2**
Calsium	Increased	36	27.9
	Decreased	**93**	**72.1**
Lactate	Increased	47	36.4
	Decreased	**82**	**63.6**
Glucose	Increased	64	49.6
	Decreased	**65**	**50.4**
Bilibrin	Increased	53	41.1
	Decreased	**76**	**58.9**
TPN Attendance	Yes	**111**	**86.0**
	No	18	14.0
	Stomach	**79**	**61.2**

Nutritional Probe according to Chest X-Ray	Instestine	50	38.8
Gastric Gas according to Chest Radiograph	Yes	**92**	**71.3**
	No	37	28.7
Accuracy of Intubation Tube location according to Chest Radiograph	Yes	**112**	**86.8**
	No	17	13.2

Table 3 Comparison of the newborn birth week and enteral nutrition status after 24 hours

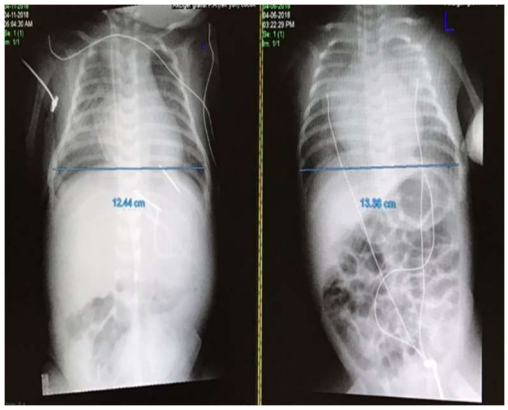
Expressions	Groups	Less than 28 Weeks		Between 28-33 Weeks		Between 34-38 Weeks		More than 38 Weeks		X^2 p
		n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	
Weight	Increased	6	46.2	17	65.4	52	66.7	5	41.7	4.339 .227
	Decreased	7	53.8	9	34.6	26	33.3	7	58.3	
Liver Enzyme valıues	Increased	9	69.2	17	65.4	59	75.6	7	58.3	2.177 .537
	Decreased	4	30.8	9	34.6	19	24.4	5	41.7	
PH values	Increased	10	76.9	19	73.1	55	70.5	8	66.7	.391 .942
	Decreased	3	23.1	7	26.9	23	29.5	4	33.3	
pO2 values	Increased	8	61.5	21	80.8	56	71.8	7	58.3	2.741 .433
	Decreased	5	38.5	5	19.2	22	28.2	5	41.7	
Carbon dioxide	Increased	3	23.1	9	34.6	29	37.2	6	50.0	2.011 .570
	Decreased	10	76.9	17	65.4	49	62.8	6	50.0	
Bicarbonate	Increased	7	53.8	11	42.3	29	37.2	4	33.3	

	Decreased	6	46.2	15	57.7	49	62.8	8	66.7	1.572 .666
Sodium	Increased	8	61.5	10	38.5	31	39.7	4	33.3	2.677 .444
	Decreased	5	38.5	16	61.5	47	60.3	8	66.7	
Potassium	Increased	5	38.5	7	26.9	25	32.1	4	33.3	.567 .904
	Decreased	8	61.5	19	73.1	53	67.9	8	66.7	
Calsium	Increased	6	46.2	5	19.2	21	26.9	4	33.3	3.337 .342
	Decreased	7	53.8	21	80.8	57	73.1	8	66.7	
Lactate	Increased	6	46.2	8	30.8	26	33.3	7	58.3	3.699 .296
	Decreased	7	53.8	18	69.2	52	66.7	5	41.7	
Glucose	Increased	6	46.2	14	53.8	42	53.8	2	16.7	6.018 .111
	Decreased	7	53.8	12	46.2	36	46.2	10	83.3	
Bilibrin	Increased	7	53.8	11	42.3	31	39.7	4	33.3	1.247 .742
	Decreased	6	46.2	15	57.7	47	60.3	8	66.7	
TPN Attendance	Yes	11	84.6	21	80.8	71	91.0	8	66.7	5.990 .112
	No	2	15.4	5	19.2	7	9.0	4	33.3	
Nutritional Probe according to Chest X-Ray	Stomach	10	76.9	21	80.8	41	52.6	7	58.3	**8.041** **.045**
	Intestine	3	23.1	5	19.2	37	47.4	5	41.7	
Gastric Gas according to Chest Radiograph	Yes	11	84.6	22	84.6	50	64.1	9	75.0	5.436 .143
	No	2	15.4	4	15.4	28	35.9	3	25.0	
Accuracy of Intubation Tube location according to Chest Radiograph	Yes	13	100.0	20	76.9	68	87.2	11	91.7	4.455 .216
	No	0	.0	6	23.1	10	12.8	1	8.3	

Table 4. Comparison of intubation tube quality and activities performed before stating nutrition

Activities Performed Before Feeding	Groups	Cuffed		Uncuffed		X^2
		n	*%*	*n*	*%*	*p*
Has 30-45 degrees of extension been achieved?	Yes	47	100.0	79	96.3	1.760
	No	0	.0	3	3.7	.253
Has the appropritae intubation tube level applied to the baby?	Yes	47	100.0	71	86.6	**6.893**
	No	0	.0	11	13.4	**.005**
Has the cuff pressure of the intubation tube been checked?	Yes	45	95.7	11	13.4	**82.434**
	No	2	4.3	71	86.6	**.000**
Has the OGS/NGS level been checked?	Yes	47	100.0	81	98.8	.578
	No	0	.0	1	1.2	.636
Do both lungs breath equally?	Yes	37	78.7	56	68.3	1.616
	No	10	21.3	26	31.7	.143
Is the patient's chest movement compatible with the ventilator?	Yes	45	95.7	78	95.1	.026
	No	2	4.3	4	4.9	.619
Does the patient's lungs sound normal?	Yes	37	78.7	54	65.9	2.381
	No	10	21.3	28	34.1	.088
Does the auscultated sound in both lungs the same?	Yes	31	66.0	49	59.8	.488
	No	16	34.0	33	40.2	.306
Is the fixing tape clean and steady?	Yes	46	97.9	51	62.2	**20.387**
	No	1	2.1	31	37.8	**.000**
Does the patient have sedation?	Yes	14	29.8	23	28.0	.044
	No	33	70.2	59	72.0	.494
	Yes	2	4.3	7	8.5	

Is there a difference in mobility if the patient is not sedated?	No	45	95.7	75	91.5	.844 .297
Is pain evaluated?	Yes	45	95.7	78	95.1	.026 .619
	No	2	4.3	4	4.9	
Stiffness in the abdomen?	Yes	12	25.5	16	19.5	.637 .280
	No	35	74.5	66	80.5	
Does the patient have defecation?	Yes	40	85.1	70	85.4	.002 .580
	No	7	14.9	12	14.6	
If there is defecation, is the situation different ?	Yes	0	.0	8	9.8	**4.889** **.023**
	No	47	100.0	74	90.2	
Is the residual less than half of the patient?	Yes	40	85.1	59	72.0	2.897 .066
	No	7	14.9	23	28.0	
Is the residual more than half of what is sent?	Yes	5	10.6	21	25.6	**4.161** **.032**
	No	42	89.4	61	74.4	
Is there any increase in oral secretion after feeding?	Yes	3	6.4	15	18.3	**3.529** **.049**
	No	44	93.6	67	81.7	
Is there an increase in-tube secretion?	Yes	7	14.9	12	14.6	.002 .580
	No	40	85.1	70	85.4	
Is there an increase in intra-oral secretion?	Yes	2	4.3	18	22.0	**7.142** **.005**
	No	45	95.7	64	78.0	
Does feeding affect the patient's aspiration time?	Yes	2	4.3	3	3.7	.029 .602
	No	45	95.7	79	96.3	
Is there Gastric Gas according to Chest Radiograph?	Yes	27	57.4	65	79.3	**6.955** **.008**
	No	20	42.6	17	20.7	



Picture 1. Chest X-ray of a baby in the KVC intensive care unit before and after the cuffed intubation tube was applied.

Discussion

Endotracheal tubes are widely used with pediatric patients. Traditional airway management for infants and small children is performed with uncuffed endotracheal tubes (Nobuaki, 2019). Regardless of endotracheal tube diversity during intensive care, 36.4% of all newborns are cuffed, 63.6% are intubated with uncuffed intubation tube, 2.3% are parenterally with TPN, and 97.7% are enterally fed.

Infants with extremely low birth weight have been reported to have higher protein and energy in the first week of life and were allowed start parenteral amino acids early (Poindexter et al., 2006), to give higher lipids to babies with sufficient protein intake for the first two weeks, positively affect growth and neurodevelopmental outcomes in the future (Schneider et al., 2018). According to the follow-up 24 hours after feeding, the increase in the weight, blood gas values and liver enzymes of newborn babies show that enteral nutrition is effective. Since the glycogen levels of newborns are low, blood sugar monitoring is important in this period. A 3-6 hour feeding delay can lower the blood glucose level below 30 mg/dL in a healthy newborn. Since glucose is the basic fuel for brain metabolism, it causes serious tissue damage and neuron loss in the brain (Trolli et al., 2012). Newborn babies in the study group were fed with regular periods with a tolerance follow-up and it was observed that 50.4% decrease in blood glucose values indicates the importance of following blood sugar level.

It is thought that the significant difference between the birth week of the babies and the enteral feeding conditions after 24 hours depend on the physical development of the babies older than 33 weeks.

It was determined that the majority of the babies in the study group were fed with TPN, and according to the chest radiograph, the feeding probe was in the stomach, and there was gas in the stomach, and the intubation tube was in the right place.

In the picture, the same patient was compared by two clinics. The development of a baby intubated with an uncuffed intubation tube in the neonatal intensive care unit before the operation was ensured by the necessary follow-up treatment due to congenital heart disease and was followed up with a cuffed endotracheal tube in the KVC intensive care unit. While the amount of gas covering the stomach in chest x-ray is quite high before the operation, there is almost no gas in the stomach after the application of the cuffed intubation tube (Picture 1) and Meyer et al. (year) revealed that there is a strong relationship between long-term laryngotracheal complications and shock

during emergency intubation, and the use of cuffed tubes is not related to this issue (Tonnesen et al., 1981). Allowing some air leakage in the use of cuffed tubes has been advocated as a preferred method to prevent mucosal ischemia. Some anaesthesiologists support the idea of getting rid of ischemic injury by inflating the cuff only to 20 cm H2O (equivalent 16 mmHg). At the same time, finding a major air leak may cause difficulties. What complicates this issue is that the amount of leakage varies greatly depending on the patient's position, sedation level, and muscle relaxation (Fine & Borland, 2004). Our study result shows that, in parallel with this study, the possibility of gas leakage while using uncuffed tubes may increase the amount of gas in the stomach of infants.

Studies show that the incidence of tube change in paediatric anaesthesia practice is higher than that of the adult and this incidence increases especially when using uncuffed tube (Weiss & Gerber, 2005). The reintubation rate in uncuffed tube group was 23% in the study of Khine and his colleagues (Khine et al., 1997), 30% in the study of Weiss and his colleagues (Weiss et al., 2009) and 46% in the recent study by Schraam and his colleagues (Schramm et al., 2012). In line with these rates, as a result of intubation of infants with uncuffed ETT, a significant relationship was found between the suitability of the intubation tube level applied to the baby and the quality of the intubation tube ($p < .05$). The compatibility rate of intubation tube applied to the baby in the cuffed group is higher than the uncuffed group.

Cuffed endotracheal tube use is also very useful to reduce the risk of aspiration of gastric content in children whose stomach is full (Khan et al., 2016). Failure of tube placement at proper level can cause aspiration risk, self-extubation and subsequent respiratory arrest; this is more likely a case in uncuffed tubes. It is thought that the cuffed tube is safer in terms of self-extubation, and the tubes incorrectly located at the level is not suitable may pose a danger during nursing care practices.

There is a significant difference between the quality of the intubation tube of newborns and the state of the fixation band being clean and stable. The rate of clean and stable fixation band in the cuffed group is higher than that of the uncuffed group. It is important that the tube is stable and the band is clean in intubated newborn babies, since the tube ligament can affect the level of the tube and cause excessive venting in the stomach, resulting in complete dislocation of the tube. As a result, it may cause respiratory arrest for the baby. It is thought that smaller tubes and low cuff pressure, which are specially designed for newborns in cuffed intubation applications, may be more effective during feeding and care.

It was found that babies over 4 kg had higher intraoral secretion rates after feeding compared to the babies between 2.5 to 4 kg.

The results show that incompatibility at the tube level, excess secretion, and mouth band pose cause risk for the baby and the caring nurse. Although intubation is performed by anaesthesiologists, treatment, nutrition and care process are among nurse' responsibilities. The amount of nutrition will increase the weight of the babies, but the gas accumulated in the stomach affects this situation negatively. Increased mouth secretions will cause the tube ligaments to become wet and babies will be at risk of self extubation and aspiration. Therefore, it is important to check the infants with low birth weight frequently against aspiration risk.

In enteral feeding, defecation tracking, bowel sounds and abdominal movements are important criteria that must be followed during the baby's development process. In this study, a significant relationship was found between the defecation quality and intubation tube quality of newborns ($p < .05$). It is thought that the difference is due to the fact that there is no defecation difference in babies intubated with cuffed and uncuffed.

Conclusion: it was determined that enteral feeding was effective in the care of newborns who had cuffed intubation, and the values of babies who had cuffed tubing after feeding were higher than that of uncuffed intubation after 24 hours. In line with these results; nurses should raise awareness in the care practices for newborns in accordance with cause and effect relationships, show the determination to plan and apply the cuffed intubation method that will shorten the

healing process of infants, and continuously conduct research on different groups.

References

Fine FG, & Borland LM. (2004). The future of the cuffed endotracheal tube. Pediatric Anaesthesia;14(1), 38-42. https://doi.org/10.1046/j.1460-9592.2003.01203.x

Ilginel MT. (2019). Anesthesia in Pediatric Airway Management, Archives Medical Review Journal; 28(3). 211-219. doi:10.17827/aktd.418038

Khan MU, Khokar R, Qureshi S, Al Zahrani T, Aqil M, Shiraz M. (2016). Measurement of endotracheal tube cuff pressure: Instrumental versus conventional method. Saudi Journal of Anaesthesia;10(4). 428-431. doi: 10.4103/1658-354X.179113

Khine H, Corddry D, Kettrick R. (1997). Comparison of Cuffed and Uncuffed Endotracheal Tubes in Young Children During General Anesthesia. Anesthesiology;3(86).627-631. https://doi.org/10.1097/00000542-199703000-00015

Nobuaki S. (2019). Determination of the Appropriate Depth of Cuffed Endotracheal Tubes in Pediatric Intensive Care. Pediatric Critical Care Medicine;20(11).1101-1102. doi: 10.1097/PCC.0000000000002138

Poindexter BB, Langer JC, Dusick AM, Ehrenkranz RA. (2006). National institute of Child Health and Human Development Neonatal Research Network. Early provision of parenteral aminoacids in extremely low birth weight infants: Relation to growth and neurodevelopmental outcome. The Journal of Pediatrics;148,300-305. https://doi.org/10.1016/j.jpeds.2005.10.038

Schneider J, Fischer Fumeaux CJ, Duerden EG, Guo T, Foong J, Bickle Graz M, Hagmann P, Mallar Chakravarty M, Hüppi PS, Beauport L, Truttmann AC, Miller SP. (2018). Nutrient Intake in the First Two Weeks of Life and Brain Growth in Preterm. Neonates Pediatrics. 141(3). https://doi.org/10.1542/peds.2017-2169

Schramm C, Knop J, Jensen K, Plaschke K. (2012). Role of ultrasound compared to age-related formulas for uncuffed endotracheal intubation in a pediatric population. Pediatric Anaesthesia;22(8).781-6. https://doi.org/10.1111/j.1460-9592.2012.03889.x

Trolli SE, Kermorvant-Duchemin E, Huon C, Bremond-Gignac D, Lappilonne A. (2012). Early lipid supply and neurologial development at one year in very low birth weight. Early Human Development;88. 25-29. https://doi.org/10.1016/j.earlhumdev.2011.12.024

Tonnesen A, Lowell Vereen, JA. (1981). Endotracheal Tube Cuff Residual Volume and Lateral wall pressure in a model trachea. Anesthesiology;55(6). 680-3.

Weiss M, Dullenkopf A, Fischer JE, Keller C, & Gerber AC. (2009). Prospective randomized controlled multi-centre trial of cuffed or uncuffed endotracheal tubes in small children. British Journal of Anaesthesia; 103(6). 867–73. https://doi.org/10.1093/bja/aep290

Weiss M, Gerber AC.; Dullenkopf A. (2005). Appropriate placement of intubation depth marks in a new cuffed paediatric tracheal tube. British Journal of Anaesthesia;94(1),80-7. https://doi.org/10.1093/bja/aeh294