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ORIGINAL ARTICLE

The importance of the number of tracheal intubation attempts at the Emergency Department of King Abdullah Specialized Children's Hospital in Riyadh, Saudi Arabia

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ABSTRACT

Background: Tracheal intubation (TI) is an intervention in the Emergency Department (ED) to stabilise children and to protect the airway. The aim of the study was to investigate the prevalence of TI, the number of attempts to achieve successful intubation, the indications and the adverse outcomes related to TI in the paediatric population.

Methods: A quantitative cross-sectional study, using a chart review of the hospital's electronic database, was conducted with paediatric patients who required intubation, from May 2015 to the current date.

Results: A total of 159 paediatric patients' records were analysed. The proportion of a successful first intubation attempt was 87.4% (*n* = 139), two attempts 6.9% (*n* = 11), and three or more attempts 5.7% (*n* = 9). The most frequent indication for TI in the sample was trauma (35.3%, *n* = 55). In terms of TI-related complications, 22% (*n* = 35) experienced at least one complication. Of the successful first attempt group, cardiac arrest without return of spontaneous circulation (ROCS) was observed in 12.9% (*n* = 18). Other TI-related adverse events included hypotension requiring treatment (5.8%, *n* = 8), emesis (1.4%), bleeding through the tube (2.9%) and secretions via the tube (2.9%). For the two attempts group (*n* = 11), 18.2% (*n* = 2) had secretions from the tube and 18.2% experienced bleeding through the tube. For the three or more attempts group, cardiac arrest with ROCS (22.2%, *n* = 2), and secretions from the tube (22.2%, *n* = 2), were observed. The majority (96.2%) of the patients had a successful extubation, 8.7% (*n* = 13) experienced postextubation stridor, 2% (*n* = 3) became agitated, and 5.3% (*n* = 8) experienced respiratory distress.

Conclusion: The TI success rate was 87.4%, and adverse outcomes occurred in 22% of all attempts. There is a higher prevalence of TI-related adverse events with multiple attempts to intubate. It is urgent that ED healthcare providers maximise their efforts to achieve success with the first intubation.

Keywords: Intubation, tracheal, extubation, trauma.

Introduction

Tracheal intubation (TI) is a critical intervention in the stabilisation of critically ill children, performed by physicians in the Emergency Department (ED), Intensive Care Units and sometimes in the ambulance [1,2]. TI is indicated in various situations, including the inability to maintain a clear airway or unconsciousness. TI maintains an open and definite airway [3]. Successful intubation is the placement of an endotracheal tube in the trachea, which is confirmed by primary (e.g., chest rise and auscultation) and secondary (end-tidal carbon

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dioxide) methods of confirmation [4]. The risk of desaturation and adverse events during TI increases with the number of attempts, especially in patients who are young, experience upper airway obstruction, or have a difficult airway. The paediatric airway presents unique anatomic challenges due to the decreased physiological reserve at a younger age, related to the haemodynamic and respiratory decompensation in an urgent situation of acute respiratory failure or a severe head injury [5]. The most detrimental adverse TI associated events (TIAEs) are hypoxia and severe desaturation, which may be life-threatening if not restricted to the minimum required oxygen (4-6/minutes) [4]. Hypoxia aggravates the autonomic response, especially in patients with cardiac and vascular diseases, which increases the severity of the events [6]. Other severe events include cardiac arrest, emesis with aspiration, hypotension requiring treatment, laryngospasm and dental trauma [5]. A prospective study, including 3,382 TIs, investigated the association between the number of TI attempts and the adverse events, which were severe desaturation, cardiac arrest and hypotension [5]. The result indicates that the number of attempts increases with younger age, upper airway obstruction, and a difficult airway [5]. In addition, the study highlighted that the adverse events increase with multiple attempts [5]. A study was done in November 2014 to evaluate the incidence of TI associated risk factors in a paediatric intensive care unit with 1,516 patients [7]. The result indicates a 9% prevalence of difficult intubations and the risk factors were identified as younger age, difficult airway and upper airway obstruction [7]. The same study also found an association between a difficult TI and desaturation below 80% [7]. The aim of the current study was to determine the rate of successful TI, the indications and associated adverse outcomes of TI in paediatric patients, presenting at the Pediatric ED at King Abdullah Specialized Children's Hospital in Riyadh, Saudi Arabia. Due to a paucity of literature related to the review and assessment of TI and adverse outcomes in the region, the results will support improved care of intubated paediatric patients through improving the initial evaluation and providing the ideal settings to increase the probability of a successful first attempt and to avoid adverse outcomes.

Methods

This is a cross-sectional study of patients requiring TI and presenting to the Pediatric ED at King Abdullah Specialized Children's Hospital in Riyadh, Saudi Arabia. The participants were selected through a convenient sampling technique, and all patients who required TI and met the inclusion criteria were included. The inclusion criteria were both genders, aged 14 years and younger, and with an initial TI performed with direct laryngoscopy. The Institutional Review Board at King Abdullah International Medical Research Center approved the study. The research team collected the data for patients who presented from May 2015 to February 2018. Chart reviews of the electronic medical records were used to collect the data. Patient characteristics, including age and gender, TI indication, the position of the TI provider, number of attempts, post-intubation status and adverse events were extracted. Statistical analysis was performed using IBM-Statistical Package for the Social Sciences statistics software, version 22.0. Categorical data are presented as percentage, and for non-normally distributed continuous variables, the median and interquartile range. For the univariate analysis, the chi-square and logistics regression test for categorical variables, Fisher's exact test was used with cells containing five data points or less. The result was considered significant if the p-value <0.05.

Results

A total of 159 patients' records were reviewed and analysed. More than half (51.5%, n = 82) were males. The age at the time of the TI was 30% infants, 40% aged 1-7 years and 2% aged 8 years and above. The majority of the sample (n = 159) had a successful TI, the success rate of a single attempt was 87.4% (n = 139), two attempts (6.9%, n = 11), and three or more attempts (5.7%, n = 9). The most frequent indications for the TI were trauma (35.3%, n = 55), respiratory causes (25.6%, n = 40), neurological causes (12.8%, n = 20), sepsis (11.5%, n = 18); cardiac causes (6.4%, n = 10) and other causes (8.3%, n = 13) (Table 1). Overall, of 159 intubated patients, 27% (n = 43) experienced at least one TI associated complication. In the two attempts group, 14% (n = 6) had an adverse effect, and in the three or more attempts group, 11.6% (n = 5) experienced an adverse effect. In the successful first attempt group (n = 139), cardiac arrest without return of spontaneous circulation (ROSC) was experienced in 12.9% (n = 18 patients), followed by hypotension (5.8%, n = 8), bleeding through the tube (2.9%, n = 4), secretions from the tube (2.9%; n = 4) and emesis (1.4%, n = 2). For the two attempts group (n = 11), 18.2% (n = 2) had secretions from the tube, 18.2% (n = 2) had bleeding through the tube, cardiac arrest without return of spontaneous circulation (ROCS) 9.1% (n = 1), emesis 18.2% (n = 2), and 9.1% (n = 9) had hypertension requiring treatment. For the group with three or more attempts, cardiac arrest with ROCS was seen in 22.2% (n = 2), secretions from the tube 22.2% (n = 2), and hypotension 11.1% (n = 1) (Figure 1). In the current study, the proportion of patients with hypoxia with successful first attempt intubation was 15%, compared with 44% with multiple TI attempts. Increasing the number of TI attempts increases the risk of hypoxia five times (p-value = 0.031). Age was not associated with an increased risk of adverse events (Table 2). The number of TI attempts was strongly associated with TIAEs (p-value = 0.009). The number of TI attempts increases the proportions of any TIAEs from 23% for the first attempt, 54.5% for the second attempt and 55.6% for three or more attempts. In our study population, the majority (96.2%, n = 153) had successful extubation and only 3.8% (n = 6) had a failed extubation. A small proportion (12.4%, n = 19) of patients with successful extubation, experienced postextubation side effects. Of this group, 8.5% (n = 13) had stridor, 11 patients with one attempt of intubation, one patient with two attempts, and one patient with three or more attempts. A small proportion (2%, n = 3) became agitated, and 5.2% (n = 8) developed respiratory distress, and both had only one attempt of intubation. However, for 3.8% of the patients with a failed extubation, the reason was respiratory distress and stridor (Table 3).

Table 1. *Demographic character of the study population.*

		One Attempt | *n* = 139 *n* (%)	Two Attempts | *n* = 11 *n* (%)	Three or more attempts *n* = 9 *n* (%)
Age	Infant, < 1 year	42 (30.4)	4 (36.4)	2 (22.2)
	1-7 years	63 (45.7)	3 (27.3)	4 (44.4)
	8 years or older	33 (23.9)	4 (36.4)	3 (33.3)
Gender	Male	71 (51.1)	10 (90.9)	1 (11.1)
	Female	68 (48.9)	1 (9.1)	8 (88.9)
Etiology	Respiratory	33 (24.3)	5 (45.5)	2 (22.2)
	Cardiac	10 (7.4)	0	0
	Neurological	17 (12.5)	1 (9.1)	2 (22.2)
	Sepsis ‖ Shock	13 (9.6)	2 (18.2)	3 (33.3)
	Trauma	51 (37.5)	2 (18.2)	2 (22.2)
	Others	12 (8.8)	1 (9.1)	0
Medication used	Fentanyl	106 (76.3)	9 (82)	9 (100)
	Midazolam	110 (79)	9 (82)	8 (88.9)
	Succinylcholine	44 (31.7)	4 (36.4)	4 (44.4)
	Ketamine	19 (13.7)	1 (9)	1 (11)
Any TIAEs		32 (23)	6 (54.5)	5 (55.5)

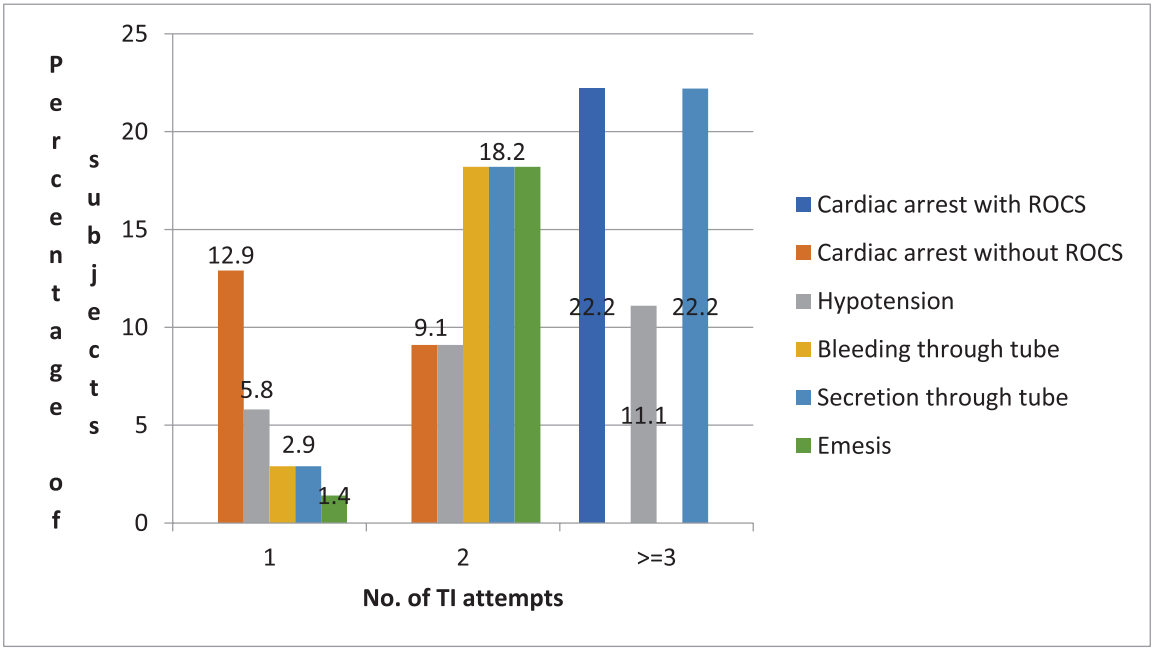

Figure 1. *TI Associated Adverse effects.*

Table 2. *TI and factors associated with TIAEs.*

95% CI	*P*-value	OR		Variables
1.15-19.16	0.031	4.69		Oxygen saturation
0.40- 7.6	0.465	0.54		Age
			1	Use of muscle relaxant
0.233- 3.01	0.786	0.838	2	
0.153-2.30	0.460	0.598	3	

Discussion

TI is an important intervention in the stabilisation of critically ill children in the ED setting. The concept of a successful first attempt is frequently promoted as the goal for providers in the ED [4]. The rate of a successful first attempt TI was reported in the literature range from 60% to 70% [4,5]. In a retrospective analysis, Nishisaki et al. [4] reported, in a prospective analysis with 1,821 pediatric intubated patients, the first attempt success rate was 62.2%, which is supported by the Sanders at al. [8] study, reporting a 60% first attempt success rate with 1,265 patients. In the current study, the first attempt success rate was 87.4%, which is higher than reported in literature. The higher rate could be due to the institutional system where most of the physicians attending acute patients are senior staff, with close supervision of trainees in the department.

Based on the literature, the majority of the indications for intubation in the paediatric population are due to respiratory compromise. In Nishisaki et al. [4] and

Table 3. *Post extubation outcome and number of TI attempts.*

Extubation outcome	Total[a]	TI attempts		
Successful extubation	153	One Attempt (*n* = 139)	Two attempts(*n* = 11)	Three or more attempts (*n* = 9)
Stridor	13	11	1	1
Agitation	3	3	-	-
Respiratory distress	8	8	-	-
		One attempt (*n* = 139)	Two attempts (*n* = 11)	Three or more attempts(*n* = 9)
Failed extubation	6	6	0	0
Stridor	3	3	-	-
Respiratory distress	3	3	-	-

[a]Combination of post extubation complication.

Sanders et al. [8], one of the main indications to intubate patients was lower respiratory causes 33.1% and 33%, respectively. Respiratory compromise is frequently reported as the most frequent cause of intubation in paediatric patients. A study reported that 80% of the study population was intubated due to respiratory compromise, in contrast to trauma and underlying neurological problems [9]. Some variations in the indication of intubation are reported in the literature, for example, a report indicating that the majority of patients was intubated due to an altered level of consciousness [10]. The variations could be explained by the institutional system. In the current study, trauma was the main reason (34.5%) for TI, followed by respiratory causes (27.6%). The study was conducted in a level I trauma centre which may have played a role in the distribution of TI indications in the sample. TIAEs are always a possibility with intubation, and depend on many factors such as the patient, practice, number of attempts, and the provider [4]. The literature indicates that multiple attempts to intubate are associated with an increased risk of TIAEs [4]. Lee et al. [5] described the incidence of TIAEs in their study as 10% in patients with one attempt, 29% in patients with two attempts, and 38% in patients with three intubation attempts or more. The most frequent TIAEs in the successful first attempt group were oxygen desaturation (9.2%), and main stem intubation (3.2%). In the multiple attempts group, oxygen desaturation was also the most frequent TIAE (37.8%), followed by oesophageal intubation (15.8%). However, the TIAEs in the current study were different from the study by Lee et al. [5]. In the current study, we reported an increased risk of TIAEs with the number of attempts as hypoxia, secretions via endo TI tube and cardiac arrest. In addition, the risk of hypoxia increased with the number of attempts.

In the current study, a small proportion (3.9%) had a failed extubation, similar to what is reported in the literature and not associated with the number of attempts. The main causes for extubation failure were stridor and respiratory distress. All of the patients with extubation failure had successful first attempt intubations, and the literature also reported that multiple intubation attempts were not associated with failure to extubate. [11-13].

This is the first study describing the current TI practice in the paediatric ED setting in Saudi Arabia. The study has some limitations. We had a relatively small sample size compared with the literature. It was not possible for the research team to determine whether the TIAEs in the paediatric patient were due to the patient's condition prior to intubation or after intubation. This study did not report detailed information about the level of expertise of the TI provider, as other studies hypothesised that there is an association between TI outcomes and the provider's level of training [8,14]. Further research is required to clarify the association between the role of the provider and the prevalence of TIAEs.

Conclusion

In summary, the ED was a feasible context to document TI processes and the associated outcomes. The TI success rate is 87.4%, and adverse associated outcomes occurred in 22% of all attempts. The TIAE rate increases with multiple intubation attempts. The findings of the study emphasize the importance of all ED healthcare providers to maximise their efforts to achieve a successful first attempt during intubation.

List of Abbreviations

ED	Emergency department
ICU	Intensive care unit
KAIMRC	King Abdullah International Medical Research Center
PICU	Pediatric intensive care unit
ROSC	Return of spontaneous circulation
TI	Tracheal intubation
TIAEs	Tracheal intubation associated events

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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None.

Consent to participate

The study design adhered to the principles of Helsinki and was approved by research board at King Abdullah Medical Research Center protocol number RC 17/078/R. No consent is required for this type of data.

Ethical approval

The study design adhered to the principles of Helsinki and was approved by research board at King Abdullah Medical Research Center protocol number RC 17/078/R.

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