

# Assessment of Nurses' Knowledge and Confidence Regarding Tracheostomy Care in a Pediatric Long Term Care Hospital in Saudi Arabia

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**Background:** The incidence of tracheostomy insertion in pediatric patients has increased over the last few decades. Tracheostomized pediatric patients need daily, meticulous care by qualified nurses to minimize severe, avoidable complications. Adequately trained nurses facilitate patients' stability, accelerate weaning from the ventilator, and reduce potential tracheostomy dislodgement.

**Methods:** A cross-sectional, retrospective cohort survey was conducted in September 2021, using an electronic version of a self-questionnaire, to assess nurses' knowledge and comfort level regarding tracheostomy care of pediatric patients at the International Extended Care Center in Jeddah, Saudi Arabia. Statistical analysis of the accrued data was performed using the SPSS 21.0 software package and a P-value <0.05 calculated by *t*-Test, was considered significant.

**Results:** Among 43 nurses included in the study, 14 (32.6%) were very comfortable taking care of tracheostomized patients, 13 (30.2%) were comfortable, and 16 (37.2%) were uncomfortable. Regarding knowledge, three main aspects of tracheostomy care were correctly answered (%) by all the nurses: knowledge of routine tracheal care (55%), tracheal care skills (11.6%), and tracheal emergency care (2.3%). The study showed a significant positive correlation between nurses' comfort level with tracheal care and academic degree, duration of pediatric experience, completion of more than one life support course, and attendance at the annual local tracheostomy care competency learning program (TCCLP; all  $P < 0.05$ ).

**Conclusion:** Deficits exist in nurses' knowledge of tracheostomy care. Improved knowledge garnered through repetitive participation in tracheostomy competency programs and life support courses correlate with greater comfort and more than 5 years of pediatric experience. Nurses' deficits in emergency care knowledge and skills should be addressed through a structured educational program and a simulation, hands-on based TCCLP course, irrespective of comfort level with tracheostomy care.

**Keywords:** pediatric nurses, tracheostomy, training skills, children, extended care, Jeddah

## Introduction

A tracheostomy is a well-established and frequently used procedure across all age groups to overcome upper airway obstruction, facilitate mechanical ventilatory support, and/or removal of tracheobronchial secretions.<sup>1</sup>

The incidence of tracheostomy has increased over the last few decades. The procedure is mostly performed on pediatric intensive care patients who are dependent on chronic ventilatory support, prior to transfer to extended care facilities with a long-term acute care service or admission to a non-critical area such as a step-down unit. The management of a tracheostomy is a complex activity with several potential complications if the nurse lacks the essential knowledge and skills to provide appropriate care.<sup>2,3</sup>

A systematic review conducted in 2020, reported that the most common complications of the surgical operation were cutaneous lesions and granulomas at the tracheostomy site.<sup>4</sup> Mortality related to the procedure was as high as 6% in

children and was mainly associated with cannula obstruction or accidental decannulation.<sup>4</sup> The largest prospective series of tracheostomy patients demonstrated a four-fold higher mortality in pediatric patients with hemorrhage versus those without hemorrhage ( $P < 0.001$ ).<sup>5</sup> Higher mortality rates were also evident in neonates, children aged 1–5 months, and those aged greater than 10 years compared to children 1–3 years of age.<sup>5</sup> Post-operative complications such as tube occlusion, infection of the stoma site, aspiration, hemorrhage, or excessive granulation of the trachea may occur. Compromised breathing following the removal of a tracheostomy is described as a late complication.<sup>6</sup>

At the International Extended Care Center (IECC), about 75% of the admitted pediatric patients are tracheostomized and ventilator dependent and require continuous monitoring and rigorous multidisciplinary care. Nurses are considered front-line health-care providers hence, proper knowledge of tracheostomy care and skills are critical to ensure patients' stability and safety. Expert, well-coordinated care reduces the incidence of unwanted complications such as laryngeal injuries and mechanical obstruction, accelerates weaning from the ventilator, and concurrently reduces the potential risk of malpractice litigation.<sup>7,8</sup>

The main objective of this study is to assess nurses' knowledge and comfort level with tracheostomy care of pediatric patients at the IECC in Jeddah, Saudi Arabia.

## Materials and Methods

### Study Design

We conducted a cross-sectional, retrospective cohort survey in September 2021 at the IECC. The IECC is one of the largest centers in the entire western province of Saudi Arabia, with more than a 150-bed capacity, accommodating both adult and pediatric patients. The center provides an optimal level of long-term and acute care services and care for chronic ventilated patients. The study was designed to evaluate the knowledge, skills, and emergency response in tracheostomy care using a questionnaire with key items extrapolated from the published literature.<sup>9–11</sup> Participants provided informed consent to join the study, and data collection for analysis was accrued after full agreement by the participants. The project was approved by the IECC Institutional Review Board (IECC IRB) Jeddah, Saudi Arabia.

### Population

The questionnaire was distributed to all the 43-nursing staff at the IECC involved in the long-term care of tracheostomized pediatric patients. Medical records of the recruited subjects were reviewed, and pertinent demographic characteristics were assembled.

### Assessment Tool

A two-part questionnaire was utilized for the study. The first section included demographic data of both the patients and nurses. The second section comprised 3 main domains: First, a composite of 20 true and false questions assessing tracheal care knowledge;<sup>9</sup> second, ten multiple-choice questions to assess tracheal care skills;<sup>10,11</sup> last, two scenarios assessed background knowledge in emergency tracheostomy care. A written response to three additional open-ended questions following the two case scenarios, sought general knowledge about the contents of the tracheostomy kit, indications for suctioning the tracheostomy and the meaning of the mnemonic HME (heat, moisture, exchanger) and its function. Each of the correct responses to ten multiple choice questions on tracheal skills was awarded a score of 2 points with a total score of 20. Similarly, each affirmative and correct response to the questions in the case scenarios was allotted a score of 2 points for a total score of 20. The questionnaire was reviewed for content validity by four expert intensivists other than the authors of the study. Finally, we asked the nurses about their comfort level working with tracheostomized pediatric patients who required ventilator assistance.<sup>10</sup>

### Statistical Analysis

We conducted a descriptive analysis of the assembled data; Frequencies are reported for categorical data. Mean, and median indicate measures of central tendency. Responses were designed to measure confidence and comfort in the management of a tracheostomy during routine care and emergency situations. A four-point Likert scale (from 1- very

comfortable, 2 - comfortable, 3 - uncomfortable, 4 - completely uncomfortable) was used for the question that assessed the subjective comfort level of nurses with tracheostomy care.<sup>12</sup> Data analysis was performed using the SPSS 21.0 software package, and a P -value  $\leq 0.05$ , calculated by *t*-test, was considered significant.

## Results

### Demographic Data

Table 1 presents the general characteristics of the surveyed nurses. All 43 pediatric nurses who participated in this study completed the survey (100%); 40 (93%) were female, and 3 (7%) were male. The mean ( $\pm$  standard deviation) age of the respondents was 32.5 years (6.52). Regarding the level of education, the majority, 27 (62.8%), had a bachelor's degree. Forty-two nurses (97.7%) procured their nursing qualification outside the kingdom of Saudi Arabia, apart from one nurse (2.3%). Regarding experience, there was almost an equal distribution of nurses with less than one year ( $n=14$ ; 32.6%) and more than 5 years' experience ( $n=17$ ; 39.5%). All the nurses had attended a basic life support (BLS) course, more than half had participated in either a pediatric advanced life support (PALS) or combined BLS and PALS courses, while 6 (13.9%) were trained in BLS, PALS, and advanced cardiac life support (ACLS). Skills in all the life support courses were acquired internationally. Nurses

**Table 1** Demographic Data of the Nurses ( $n=43$ ) and the Relationship Between the Variables and Total Correct Answers

Variable	N (%)	Total Correct Answers (Mean)	p-value <sup>§</sup>
<b>Sex</b>			
Male	3 (7)	67.3	0.117
Female	40 (93)	68.4	
<b>Age in years</b>			
20–30	17 (39.5)	63.8	0.022
30–40	22 (51.2)	67.4	
40–50	4 (9.3)	75.2	
<b>Academic degree</b>			
Bachelor	27 (62.8)	71.5	0.015
Diploma	16 (37.2)	58.5	
<b>Duration of experience in the pediatric department</b>			
More than 5 years	17 (39.5)	80.7	0.007
2–5 years	5 (11.6)	78.6	
1–2 years	7 (16.3)	62.5	
Less than 1 year	14 (32.6)	47.4	
<b>Training courses</b>			
BLS	13 (30.2)	50.0	0.004
BLS and ACLS	18 (41.9)	61.5	
BLS and PALS	6 (14)	78.5	
BLS, PALS and ACLS	6 (14)	81.5	

(Continued)

**Table 1** (Continued).

Variable	N (%)	Total Correct Answers (Mean)	p-value <sup>§</sup>
<b>Frequency of attendance at the annual TCCLP course</b>			
Once	14 (32.6)	47.4	0.007
Twice	7 (16.3)	62.5	
3–4 times	5 (11.6)	78.6	
≥5 times	17 (39.5)	80.7	
<b>Comfort level with tracheostomy care</b>			
Very comfortable	14 (32.6)	85.9	Not applicable
Comfortable	13 (30.2)	69.9	
Uncomfortable	16 (37.2)	47.2	

**Notes:** <sup>§</sup>p-value calculated by t-Test (p-value < 0.05 considered significant).

**Abbreviations:** ACLS, advanced cardiac life support; BLS, basic life support; PALS, pediatric advanced cardiac life support; TCCLP, tracheostomy care competency learning program.

are mandated to attend the annual tracheostomy care competency learning program (TCCLP) at the local center. Program attendance ranged from one (n=14, 32.6%) to greater than five times (n=17; 39.5%; [Table 1](#)).

The demographic characteristics of the tracheostomized patients are outlined in [Table 2](#). Among the enrolled subjects, the sex distribution was similar. The primary diagnosis in most patients was neurologic (n=35; 76%) and all the patients in this category required prolonged mechanical ventilation. Overall, 89.1% (41/46) of the subjects who required a tracheostomy had acquired their primary illness at birth and the duration of the tracheostomy ranged from less than one year to greater than 5 years.

## Knowledge

A true and false section was designed to assess tracheal care knowledge. Eleven of the 20 questions (55%) were answered correctly by all the nurses. Overall, the true and false responses ranged from 27.9%–100% and 39.5%–100% respectively. The other responses of the respondents are summarized and compared in [Table 3](#).

**Table 2** Demographic Characteristics and Outcome Data for Pediatric Tracheostomized Patients (n=46)

Parameter	N (%)
<b>Age in years</b>	
<3	9 (19.6)
3–5	14 (30.4)
6–10	15 (32.6)
>10	8 (17.4)
<b>Sex</b>	
Female	22 (48)
Male	24 (52)

(Continued)

**Table 2** (Continued).

Parameter	N (%)
<b>Primary diagnosis</b>	
Neurologic	21 (45.7)
Neuromuscular	14 (30.5)
Genetic and IEM with pulmonary failure	8 (17.3)
Trauma (post road traffic accident)	3 (6.5)
<b>Duration of primary illness</b>	
Since birth	41 (89.1)
From 1–5 years	5 (10.9)
<b>Tracheostomy indications</b>	
PMV for neurologic	21 (45.7)
PMV for neuromuscular	14 (30.5)
PMV for genetic and IEM with pulmonary failure	8 (17.3)
Trauma post road traffic accident	3 (6.5)
<b>Duration of tracheostomy</b>	
Less than 1 year	6 (13)
1–5 years	22 (47.8)
> 5 years	18 (39.2)
<b>Tracheostomy outcome/complications</b>	
Late obstruction	7 (15.2)
Accidental decannulation	8 (17.4)
Elective decannulation	4 (8.7)
<b>Discharge</b>	
Home care support	5 (10.9)
Normal-no support	0 (0)
<b>Mortality rate</b>	
Due to underlying cause	14 (30.4)
Due to tracheostomy	0 (0)

**Abbreviations:** IEM, inborn error of metabolism; PMV, prolonged mechanical ventilation.

## Skills

Nursing tracheal skills were assessed by multiple choice questions and the findings are depicted in [Table 4](#). Five (11.6%) nurses provided all the correct answers, and the total group scores for majority of the nurses ranged between 14–18 out of 20. Thirty (69.8%) erroneously stated that a tracheostomy is usually performed between the 3rd and 4th tracheal ring. Of note, only eleven nurses (25.6%) did not know all the information that should be included as part of the hand-off of a patient with a tracheostomy tube to another nurse.

**Table 3** Tracheal Care Knowledge Among the Study Participants (n=43)

Correct Answer	Questions	Correct Response n (%)
True	Secretions around a tracheostomy cannula may irritate the skin.	43 (100)
False	A patient with a tracheostomy tube cannot be fed orally	27 (62.8)
True	A spare tracheostomy tube should always be available due to the risk of accidental dislodgement	43 (100)
True	A patient with a tracheostomy tube should receive regular oral hygiene	43 (100)
True	Tracheostomy tubes are more efficient for the aspiration of respiratory tract secretions	23 (53.5)
True	Acute obstruction of a tracheostomy tube is most likely caused by a mucous plug	38 (88.4)
False	Regular tracheostomy tube changes are always done by the bedside nurse	17 (39.5)
False	It is unimportant to keep a tracheostomy kit available at the bedside for emergency.	37 (86)
True	A patient with a dislodged tracheostomy tube that cannot be inserted should be intubated with a endotracheal tube	12 (27.9)
False	The pressure needed for tracheostomy tube suctioning is 180 –200 mmHg	30 (69.8)
True	A tracheostomy opening should always be kept dry and clean to prevent infection	43 (100)
False	The tracheostomy cuff pressure should always be 40–50 mmHg.	24 (55.2)
True	The tracheostomy tie should be checked and secured regularly to avoid accidental dislodgement.	43 (100)
False	It is unimportant to measure the cuff pressure regularly for a cuffed tracheostomy tube	43 (100)
True	Suctioning a tracheostomy tube must not take more than 10 seconds.	40 (93)
False	For routine suctioning, the length of the suction catheter should exceed the length of the tracheostomy to be effective.	43 (100)
False	Bleeding from the tracheostomy cannula is the most common complication	43 (100)
True	The dressing used for stomal infection is Aquacel Ag	43 (100)
True	Patients require suctioning from the tracheostomy tube more frequently during the night rather than the day.	43 (100)
True	Tracheostomy tie changes should be done daily	43 (100)

**Table 4** Tracheal Care Skills of the Study Participants (n=43)

Correct Answer	Question (Q)	Correct Response n (%)
	<b>Q1</b> – A tracheostomy is usually performed between the:	
a	a. 2nd and 3rd tracheal ring.	13 (30.2)
	b. 3rd and 4th tracheal ring.	30 (69.8)
	<b>Q2</b> - The most common early tracheostomy complication is:	
b	a. Accidental decannulation.	42 (97.7)
	b. Pneumonia.	1 (2.3)

(Continued)

Table 4 (Continued).

Correct Answer	Question (Q)	Correct Response n (%)
	<b>Q3</b> - The most common late tracheostomy complication is:	
c	a. Hemorrhage.	1 (2.3)
	b. Occlusion by a mucous plug.	31 (72.1)
	c. Pneumonia.	11 (25.6)
	<b>Q4</b> – A tracheostomy affects which of the following functions?	
d	a. Ability to speak.	10 (23.3)
	b. Sense of smell.	0 (0)
	c. Ability to swallow.	6 (14)
	d. All the above.	27 (62.7)
	<b>Q5</b> - Information in a patient hand-off with a tracheostomy tube should include:	
d	a. Date of the tracheostomy tube placement, type, and size.	11 (25.6)
	b. Cuffed or uncuffed tube.	0 (0)
	c. Frequent suction is necessary.	0 (0)
	d. All the above.	32 (74.4)
	<b>Q6</b> - Which type of stomal dressing should be used for copious secretions?	
b	a. Aquacel Ag.	7 (16.3)
	b. Lyofoam.	33 (76.7)
	c. Both A and B.	3 (7)
	<b>Q7</b> - The main cause for an accidental decannulation is:	
d	a. Loose tracheostomy tie.	1 (2.3)
	b. Tube sometimes too short.	5 (11.6)
	c. Forceful cough.	11 (25.6)
	d. Both A and B.	26 (60.5)
	<b>Q8</b> - Suctioning a tracheostomy tube should not take more than:	
b	a. 20 seconds.	1 (2.3)
	b. 10 seconds.	42 (97.7)
	<b>Q9</b> – The recommended suction pressure for a tracheostomy tube in pediatrics is:	
a	a. 80 –120 mmHg.	36 (83.7)
	b. 150–180 mmHg.	2 (4.7)
	c. Based on the size of the tracheostomy tube.	5 (11.6)

(Continued)

**Table 4** (Continued).

Correct Answer	Question (Q)	Correct Response n (%)
	<b>Q10</b> – The appropriate suction catheter size for a tracheostomy tube size 4 is:	
b	a. 6	1 (2.3)
	b. 8	40 (93.1)
	c. 10	1 (2.3)
	d. All the above.	1 (2.3)

**Note:** Each correct response was awarded a score of 2 points for a total score of 20.

## Background Knowledge in Emergency Tracheostomy Care

Two case scenarios (Table 5) evaluated nurses' responses in emergency cases. Only one nurse got all the answers correct (2.3%), and the overall scores ranged between 9–20 (median:14). Sixty-five percent of the nurses (n=28) did not know what to do with an introducer or obturator. Although 81% - 94% of the nurses had experienced the respective acute

**Table 5** Scenarios to Assess Knowledge of the Emergency Care of a Tracheostomy (n=43)

Scenario	Correct Response n (%)
<b>Case 1: A 3-year-old male child, mechanical ventilator dependent via a size 4 tracheostomy tube, develops a forceful cough and abnormal movement leads to dislodgement of the tracheostomy tube.</b>	
Have you dealt with this emergency before? (Yes/No)	35 (81.4)
What is the first thing you will do? *Call for help, take immediate action to protect the patient's airway by re-inserting the tracheostomy tube or use a bag-valve-mask ventilation.	30 (70)
Do you have a spare tracheostomy at the bedside? (Yes/No)	43 (100)
What tracheostomy tube size will you use to insert? *Same size 4 or a smaller size if the insertion is difficult to achieve.	43 (100)
Do you know what to do with the introducer or obturator? (Yes/No)	15 (34.9)
<b>Case 2: A 4-year-old female child, mechanical ventilator dependent via a tracheostomy tube size 4.5, develops desaturation with absent chest rise.</b>	
Have you dealt with this emergency before? (Yes/No)	39 (90.7)
What is the first thing you will do? *Check for DOPE	5 (11.6)
Do you know what the mnemonic DOPE stands for?	12 (27.9)
What size of suction catheter and suction pressure will you use if the tube was obstructed with a mucous plug? * Suction catheter size Fr 6–8, and *Suction pressure between 80–120mmHg.	36 (83.7)
<b>Overall comfort level with tracheostomy emergency care</b>	
Comfortable	13 (30.2)
Uncomfortable	30 (69.8)

**Note:** \*Each affirmative and correct response was awarded a score of 2 points; Total score: 20.

**Abbreviations:** DOPE, displacement, obstruction, pneumothorax, equipment failure.



scenarios in their clinical practice, disappointingly only 13 (30%) were comfortable dealing with such emergencies if they arose.

## Responses to the Open-Ended Questions

Of the three open-ended questions, none of the nurses were able to identify the entire contents of the tracheostomy kit. Among the indications for tracheostomy suction, 9 nurses (20.9%) would execute the procedure for excessive secretions, 11 (25.6%) for respiratory distress or desaturation and 23 (53.5%) for any combination thereof. Thirty-four nurses (79%) did not understand what HME implied or its function. Moreover only 12 (28%) appreciated the meaning and implications of displacement or obstruction of the endotracheal tube, pneumothorax, and ventilator or equipment failure (DOPE).

## Subjective Comfort Level

At the end of the questionnaire, we asked the nurses if they were well updated and felt comfortable working with tracheostomized pediatric patients requiring ventilator assistance or not. To assess the level of confidence, we compared their answers to this question (subjective confidence) with their objective total score. Among 33 (76.7%) nurses who confirmed that they were well updated and confident, 54% scored above average, 35% were average, and 11% were below average ( $P=0.005$ ). Among the ten (23.3%) nurses who responded negatively to the question and were uncomfortable with tracheostomy care; 33 (76.7%) scored below average, and 10 (23.3%) had pass scores ( $P=0.002$ ). Finally, among the 43 nurses, 14 (32.6%) were very comfortable working with tracheostomy patients, 13 (30.2%) were comfortable, and 16 (37.2%) were uncomfortable. Of interest, we found no clear relationship between nurses' age and confidence level with tracheostomy care, which ranged from 64.7%, 54.4% and 100% in those aged 20–30 years, 30–40 years, and 40–50 years respectively.

## Discussion

Among intensive care patients, 10–24% will need a tracheostomy.<sup>13</sup> The most common indications for tracheostomy in children with chronic disorders are neurologic and neuromuscular illnesses.<sup>14</sup> Although tracheostomy is a simple, safe procedure when proactively planned, it may involve serious complications postoperatively if a proper care plan is not instituted by qualified nurses.<sup>15,16</sup> Nurses are the front-line staff in tracheostomy care which mainly involves dressing, tube changing, suctioning, and managing potential emergencies. A nurse-to-patient ratio of 1:1 is recommended to ensure optimal care in an intensive care unit and a ratio of 1:2 in high dependency patients.<sup>17</sup> While the tracheostomy care of children is the responsibility of nurses in their primary unit of practice, multidisciplinary, collaborative interprofessional teamwork should be strongly encouraged to achieve optimal patient outcomes.<sup>15</sup>

Among the subjects enrolled in our study, the primary diagnosis in most patients who required a tracheostomy was neurologic 21 (45.7%) and neuromuscular 14 (30.5%) disease. Overall, most patients had the procedure performed between one and five years of age ( $n=22$ ; 47.8%) and 18 (39.1%) had a tracheostomy instituted at greater than 5 years. Veder et al reported that the primary reasons for a tracheostomy were airway obstruction comprising laryngotracheal obstruction and craniofacial anomalies and those requiring respiratory support for cardio-pulmonary and neurological diseases.<sup>18</sup> The group of children with airway obstruction were younger when tracheostomized (3.0 months vs 31.0 months,  $P < 0.05$ ) and were dependent for a longer duration (median 21.5 months vs 2.0 months,  $P < 0.05$ ) than the pulmonary support group.

Regarding overall tracheostomy complications, the rate in our study was low (Table 2), and in the main were of late onset manifesting as obstruction with a mucous plug or stoma infection and because of timely intervention, were uneventful. Accidental decannulation occurred in 17.3% of patients. Elective decannulation was performed in 8.7% of the patients, which correlated with children who were tracheotomized post road traffic accidents, and who were discharged to home care. Mortality occurred in 30.4% of the patients due to underlying illnesses such as acute respiratory distress syndrome and septic shock and was unrelated to tracheostomy complications. Our findings align with a low tracheostomy-related mortality of 1.43% in a recent pediatric, population-based study.<sup>19</sup>

The IECC provides orientation and an annual comprehensive and competency-based learning program for all nurses involved in the care of tracheostomized pediatric patients who are chronically ventilator dependent. The TCCLP is

a mandatory course for all nurses. We found that nurses who attended more than five courses were highly comfortable with tracheostomy care.

Hands-on care for tracheostomized pediatric patients is commonly taught by the transmission of knowledge and experience from one nurse to another.<sup>10</sup> In our study, we found that there was a significant relationship between years of experience and level of knowledge and comfort with the management of a tracheostomy. Nurses with more than five years of experience had higher scores in knowledge and comfort compared to nurses with experience of less than one year. The findings differ from Mungan et al who reported an insignificant relationship either between duration of experience or academic qualifications.<sup>9</sup> Paul et al found that graduate nurses who acquired knowledge in their undergraduate studies were more confident than those who received it during their practice.<sup>20</sup>

Our analysis showed no clear relationship between nurses' age and percent confidence level with tracheostomy care, which was lowest among nurses aged 30–40 years (54.4%) and highest in those who were 40–50 years of age (100%). This is consistent with the findings by Mungan and Sreeja et al where there were insignificant differences in knowledge across the age groups.<sup>9,21</sup>

Regarding academic degree qualifications and the comfort level of nurses with tracheostomized patients, 74.1% (n=20/27) had a bachelor's degree, and most of the uncomfortable nurses (56.3%; n=9/16) had a general nurse diploma. There was a significant association between academic degree and comfort level (P=0.015). This could be either due to the difference in the curriculum or self-confidence backed by a higher academic degree. The results contrast with the report by Sreeja et al who found no significant difference in knowledge relative to educational qualifications.<sup>21</sup> Additionally, Al Nemare et al,<sup>22</sup> found no difference in the confidence level between nurses who graduated from outside or inside Saudi Arabia, while in our study, we had only one nurse who graduated from Saudi Arabia and was uncomfortable with tracheostomy care.

BLS, ACLS, and PALS are required courses for resuscitation and are now mandatory for all health care providers. Interestingly, in our study, we found a significant relationship between nurses who were certified in more than one course and their comfort level with tracheostomy care. The nurses who were only BLS certified felt uncomfortable, while the nurses who were additionally certified in PALS or ACLS were comfortable as were those certified in both PALS and ACLS.

In our study, nurses were more knowledgeable and skilled with routine daily tracheostomy care compared to dealing with emergencies, which is consistent with the documentation by Mungan et al.<sup>9</sup> This deficit is a major concern that may lead to compromised outcomes and merits consideration when designing the next TCCLP course. A study conducted in 2016 to assess nurses' confidence level with tracheostomy care in two tertiary care centers in Jeddah, showed that 88.6% were not very confident in the care of patients with a tracheostomy, and providing ventilatory assistance.<sup>23</sup> Similarly, in Turkey, Mungan et al found in three tertiary state hospitals that the level of nurses' knowledge with tracheostomy care was below expectations.<sup>9</sup> In contrast, Al Nemare reported that 60% of the nurses were confident and that 47% of the nurses did not feel or were unsure if they were up to date with recent information regarding tracheostomy care. More than half of the participants seemed to have inadequate training and support, and most of the practice was experience-based, rather than evidence-based, as confidence level correlated with years of experience.<sup>22</sup> We compared the subjective and objective comfort levels with tracheostomy care, and of the 76.7% of nurses who felt they were comfortable, 89% were truly comfortable, according to their scores. Eleven percent thought they were comfortable and well updated but had a below-average score which shows an apparent deficit in nurses' perspective of their knowledge and skills. Pritchett et al reported that intensive care nurses were significantly more comfortable in the management of both a fresh and established tracheostomy compared to non-intensive care nurses.<sup>24</sup> Additionally, non-intensive care nurses with more than five years of pediatric experience were statistically more comfortable handling accidental tracheal decannulations.<sup>24</sup>

Insufficient knowledge regarding tracheostomy care is a widely reported issue that impacts outcomes and may result in increased mortality in such patients. Our study showed that multiple factors play a significant role in nurses' comfort level with tracheostomy care such as academic degree, experience duration, and training courses. To improve nurses' comfort level, we suggest that all centers with tracheostomized patients encourage nurses to procure a bachelor or higher degree, undergo mandatory training for a prescribed number of hours, motivate nurse's with more than five years of experience to nurture and mentor nurses with less experience and to be certified in PALS and ACLS courses. Parker et al

also recommended the addition of tracheostomy care skills into BLS.<sup>1</sup> We noted that 32 (74.4%) of 43 nurses knew all the information to be included in the medical record when handling tracheostomized patients and fully appreciated the significant impact of bedside hand-off using the Situation, Background, Assessment, Recommendation (SBAR) technique that Abbaszade et al reported in their study.<sup>25</sup> Nurses should familiarize themselves with this framework to optimize communication between members of the health care team about a patient's condition and enhance the quality of nursing care across all dimensions.

Finally, we strongly recommend a continuous quality improvement project with an auditing process. This should perhaps become the traditional theoretical teaching module of tracheostomy care with a well-structured, pediatric disease focused program, using high fidelity simulation methods to increase nurses' knowledge, skills, and ultimately comfort level.<sup>26–29</sup>

There are several limitations of this study that merit consideration. First, we included only one center with a small, specific sample size of pediatric patients. However, there was no selection bias since all the nurses in the center participated in the survey, which is a major strength and our questionnaire covered more than one practical aspect of tracheostomy care. Second, the questionnaire was adopted from the available literature but was not internally or externally validated for robustness before implementation, although the components were uniformly agreed upon by the local intensivists. Third, although the findings in part were replicated in other studies, our findings are applicable and generalizable to similar long term care facilities. Last, we did not address safety recommendations for children who received a tracheostomy during the COVID-19 pandemic. In a state-of-the-art review, Meister et al outlined modified protocols for tracheostomy care, albeit predominantly in adults, stressing the importance of safety across multidisciplinary teams and healthcare providers with the use of personal protective equipment and being more vigilant for potential complications.<sup>30</sup>

## Conclusion

Nurses' performance in this study showed a significant positive correlation between nurses' comfort level with tracheal care and academic degree, duration of pediatric experience, completion of more than one life support course, and attending the annual local tracheostomy care competency learning program. Our study confirms that nurses with more pediatric experience, repetitive participation in tracheostomy care programs and advanced life support courses, achieve greater competency with tracheostomy care. The disappointing revelation is that nurses often score the competency and confidence of dealing with a tracheostomy higher than their knowledge-based answers support. The gap in nurses' knowledge and skills regarding emergency care of a tracheostomy needs to be fully addressed in the next annual educational program using a proper structured and valid simulation model with a continuous quality auditing tool.

## Data Sharing Statement

Data supporting the findings of this study are available upon request from the corresponding author.

## Ethical Approval

Data collection for analysis was accrued with participants' agreement and was approved by the IECC Institutional Review Board (IECC IRB) Jeddah, Saudi Arabia, dated 13/09/2021.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors report no conflicts of interest in relation to this work.

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